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Economic Factors of the Development of Agricultural Markets and Rural Areas

Edited by
Michał Roman and Monica Roman

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Article

Sustainable Economy and Development of the Rural Territory: Proposal of Wine Tourism Itineraries in La Axarquía of Malaga (Spain)

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Abstract: The certification of Malaga and Ronda wine route, within the model of certified wine routes in Spain, has given a new boost to wine tourism in Malaga. The study focuses on La Axarquía, located on the Eastern Costa del Sol in Southern Spain, which has been a reference point in the wine business since ancient times and has its own identity. This research aims at elaborating a diagnosis of the territory related to the possibilities offered by the area, from the perspective of the heritage resources and services provided by the winemakers outlining two efficient enotourism itineraries that enhance the value of the territory's resources. The methodology used starts with the study of the territory in order to profile the existing resources, a task that was complemented by the analysis of the documentary sources required in order to understand the peculiarities of the territory. From there, a process of interviews was carried out between April and November 2019 with 100% of the winemakers and around 70% of the territory's agents. The results of the research are specified in a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis, which has allowed evaluating the possibilities of the enotourist development in La Axarquía, which is complemented with a proposal of two possible itineraries that will promote such development of the rural territory. The conclusions convey the possibilities of the territory of a tourist segment which puts its resources to good use and moves forward the deseasonalization and destructuring of tourism in Malaga, especially on the Eastern Costa del Sol, according to criteria of efficiency and profitability with wine as a reference, although it could be applied to other gastronomic and cultural resources linked to the tourist sector in other geographical areas.

Keywords: economy; sustainable development; wine routes; Axarquía; rural tourism

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1. Introduction

Wine tourism has a special impact on rural economies (López-Guzmán et al. 2009) as it involves activities in wineries, events, as well as different hospitality activities (Carlsen and Charters 2006). Wine has gone from being a consumer product to favoring the establishment of a development model for the rural territory, which requires policies and actions that seek a change in the productive structure, with the objective of environmental sustainability, as well as the enhancement of the heritage and culture of villages and nations (Bruwer and Rueger-Muck 2019; Lourenço-Gomes et al. 2015).

The economic data on wine show the interest of this resource. In terms of production, in 2019 it reached 26,000 million liters, of which 24,400 were consumed. Italy (47.5 mhl), France (42.1 mhl) and Spain (33.5 mhl) represent 48% of the total production (OIV 2020). And if we consider the value of wine tourism, Italy was estimated at 2.5 billion euros with 14 million tourists (MTV 2020); France accumulated more than 10 million wine tourists who accounted for 5.2 billion euros for the sector (Saybus 2020).

In Spain, the institution that channels this tourism in a regulated manner is ACEVIN (Spanish Association of Wine Cities). It is a body that has numerous objectives, among which stand out the promotion and collaboration with other European cities that traditionally produce wine and a proposal for responsible wine tourism that could be achieved through sustainability and competitiveness plans to apply the concept of Social Responsibility to the territorial, socioeconomic and cultural sphere of the Wine Routes (ACEVIN 2020).

In 2021 it integrates 30 routes, with more than 2000 associated companies that make up the wine tourism offer of the destinations that are members of the Wine Routes of Spain Club. A significant figure is the number of visits to wineries and museums of the Wine Routes in 2019, which amounted to 3,076,334, experiencing a growth over the previous year of 3.9% with an expenditure of just over 85 million euros per year, representing a growth of around 5.68%. Turnover reached 256 million euros, adding the part corresponding to the catering, hotel, business and leisure sectors (ACEVIN 2020).

These data are a true reflection of the interest of a sector that, linked to tourism, exerts a great power of attraction in certain destinations, as they have placed value on tourism formulas that have rural areas as protagonists (Khartishvili et al. 2019). It should be noted that wine routes in destinations with tourist saturation can diversify the offer by revitalizing the inland (Díaz Armas 2008), as well as promote job creation and rural development by favoring the deseasonalization of demand, as stated by numerous authors (Álpizar and Maldonado 2009; Álvarez García et al. 2014; López-Guzmán et al. 2009; Ramis Hernández 2010).

Enotourism is defined as the movement of certain travelers for a holiday focused on getting to know certain areas and landscapes where wine is produced and carrying out activities that increase knowledge about this product (Elias Pastor 2006). It is a consolidated activity that is increasingly popular in countries with a long tradition in the Old World such as Spain, Italy, France, Portugal, Greece, Romania, Germany or Serbia (Coros et al. 2019; Dougherty 2012; Festa et al. 2020; Khartishvili et al. 2019; Koch et al. 2013; Lourenço-Gomes et al. 2015; Trišić et al. 2020; Vieira-Rodríguez et al. 2013; Wolikow 2014), implementing tourism strategies significantly in other places such as Australia, New Zealand, South Africa, Canada or the USA (Bruwer 2003; Hall et al. 2019a; Kirkman et al. 2013).

Wine routes are an opportunity for the promotion of cultural values, gastronomy and local products, with a special consideration for wine (Bessière et al. 2013; Etcheverria 2015). Thus, the aim of this work is to investigate the possibilities of La Axarquía to develop a wine route through itineraries that discover the tourist potential of the area. From an academic point of view, it is essential to analyze these routes with criteria of efficiency and profitability, since for the wine route to be an attractive destination, it is necessary to know the resources available in the territory and this is a particularly important factor, as it may be what initially motivates the tourist to visit the area (Gatti and Incerti 1997).

This study is located in a line of research that revolves around wine tourism and Málaga wine route (Ruiz-Romero de la Cruz et al. 2017), circumscribed in La Axarquía of Malaga as it is a place where the climate, landscape and culture add an important value to the traditional activity of making wines protected under the Certificates of Origin "Malaga", "Sierras de Malaga" and "Pasas de Malaga" (DDOMSPM). The conclusion of this research phase culminated in a publication that modelled the fundamental elements (Figure 1) that should be present in a wine route in general and specifically in La Axarquía (Cruz-Ruiz et al. 2020). The structure of this research is based on the knowledge of the potential of La Axarquía in Malaga (Spain), located in the southern Mediterranean. After a review of the literature, the methodology of the study is presented, consisting of a field study, an analysis of documentary sources and in-depth interviews with winemakers and agents involved in the sector. The results obtained made it possible to carry out a specific diagnosis of the territory by means of a SWOT analysis. On this basis, several proposals for wine tourism itineraries have been drawn up, outlined with economic criteria of profitability for the

geographical area analyzed and its surroundings. The study ends with a discussion section and the conclusions.

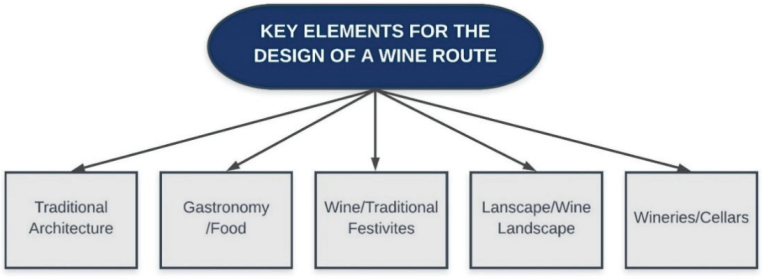

Figure 1. Key elements for the design of a wine route. Source: Cruz-Ruiz et al. (2020).

The research has raised the following questions:

Q_1: Does the territory of La Axarquía have sufficient resources to structure an enotourist offer that benefits its development?
Q_2: What is the diagnosis of the territory according to the stakeholders and winemakers?
Q_3: Do the existing wineries offer adequate services to contribute to the development of the rural territory?
Q_4: Is it possible to design wine tourism itineraries in La Axarquía with the elements available?

2. Theoretical Background

The development of wine tourism has grown and in many countries it has been due to wine routes, which can be defined as a set of duly marked itineraries that pass through a specific geographical area with a wine tradition, an essential issue if we take into account that they can be the reason for choosing a destination (Michael Hall 2013).

The study of the wine tourism phenomenon can be studied from three perspectives, Getz and Brown (2006) highlight its interest for regional development and its strategies. The opinions of consumers is another point of view that should be taken into account (Alant and Bruwer 2004; Garibaldi et al. 2017; Ruiz-Romero de la Cruz et al. 2017) and, on the other hand, the perspective provided by the wineries and the opportunity they have to promote and sell their product directly to visitors is of great analytical value (Carlsen 2011; Hall et al. 2019b; Peters 2018; Festa et al. 2020).

The enhancement of the territory's heritage is an important incentive for tourists to make the decision to visit a destination. This includes aspects such as the natural landscape and environment, heritage, cities, architecture, artefacts, vineyards, wineries and wines (Getz 2000; Getz and Brown 2006; Sparks 2007). The sensory enjoyment and pleasure produced by the consumption of wine, as well as by the territories where wine routes are located as the main motivation for wine tourists (Pulpón and Ruiz 2019; De Uña-Álvarez and Villarino-Pérez 2019; Wolikow 2014), make them a more demanding traveller in terms of quality, personalization and differentiation (Alonso and Liu 2012; Carlsen and Boksberger 2015; Fountain 2018; Vasco Santos et al. 2019).

Characterizing wine tourists allows us to build an appropriate offer, and numerous studies have produced profiles that bring us closer to their reality (Famularo et al. 2010; Garibaldi et al. 2017; Marzo-Navarro and Pedraja-Iglesias 2009; Quintal et al. 2017; Wade et al. 2006). Comparative studies between different types of tourists are not very abundant, although they are a very useful tool for making strategic decisions that make it possible to redirect the flow of visitors in order to deseasonalize tourism activity (Díaz Armas 2008; Ruiz-Romero de la Cruz et al. 2019).

The economic development potential of certain regions is linked to their ability to develop interesting tourism segments that offer economically viable alternatives and

generate income for the local population (Roman et al. 2020). In this regard, wine tourism has an interesting attraction, generating visitor flows that bring significant economic benefit (Carlsen 2004; Gammack 2009; Hall and Mitchell 2000), providing greater brand awareness and involvement (Charters and Ali-Knight 2002), increasing the number of subsequent visits and encouraging purchasing behavior (Johnson and Bruwer 2007; Mitchell and Hall 2006; O'Neill et al. 2002). In this way, wineries are able to progressively add value to the destination, invigorating the traditional agricultural sector and innovating wine products with an impact on local economies. Hashimoto and Telfer (2013) highlight the contribution of wine routes to the improvement of wine product marketing strategies, economic performance and the efficiency of wine producers, while Carmichael and Sense analyze the competitiveness and sustainability of wine destinations (Carmichael and Senese 2012).

Wine routes are therefore an integrated strategy for a rural development (Ferreira and Hunter 2017; Northwood 2000; Williams and Kelly 2001). They are intimately linked to institutional decisions, as well as to the commitment and responsibilities acquired between the public and private spheres, a point at which noticeable divergences can arise (Ferreira and Hunter 2017; Northwood 2000; Williams and Kelly 2001). The design of an enotourism route must address different angles (Blum et al. 2014; Cruz-Ruiz et al. 2020; Getz et al. 2007; Getz and Brown 2006): gastronomic (Crespi-Vallbona and Mascarilla-Miró 2020; Millán Vázquez de la Torre and Pérez 2014), cultural (Arnáiz et al. 2019; Carrasco et al. 2019; Mitchell et al. 2012), natural heritage or terroir (Harvey et al. 2014; Holland et al. 2014) and formative (Buhalis and O'Connor 2005; Famularo et al. 2010; Wargenau and Che 2006).

Wine routes are defined by the vineyards, festivals, shows and especially the wineries of a given wine-producing region (Sigala 2014). All this in a geographical space where the exploitation of the vine and the wine-making takes place, where the wineries are located, where the interaction of the tourist with all the elements that make up the wine tourism route occurs (Cruz-Ruiz et al. 2020; Pulpón and Ruiz 2019), becoming, together with the terroir, basic elements in the conceptualization, design and management of wine routes (Brás et al. 2010; Pérez-Calderón et al. 2015) and being one of the primary resources in the wine business (Riera Palmero 2014; Yagüe Guillén and Jiménez 2002).

It is in this framework where wineries have a greater chance of creating an offer focused on the attraction of wine linked to the hedonistic experience (Bruwer and Alant 2009; Crespi-Vallbona and Mascarilla-Miró 2020). Collaboration between all the actors involved is decisive for generating value on the routes (López-Guzmán et al. 2009; Medina and Tresserras Juan 2008; Miranda Escolar and Fernández Morueco 2011; Vieira-Rodríguez et al. 2013; McGregor and Robinson 2019) and for the entire wine sector (Gomis et al. 2010). A collaboration that will be more productive if the possibilities of generating enotourism circuits in geographical areas that meet certain conditions are analyzed.

The study of the wine tourism offers and the needs of wine tourists has received contributions from the perspective of case studies (Chiodo et al. 2020; Holmes 2017; Ilieş et al. 2020; Trišić et al. 2020; Triantafyllou et al. 2020); which have led academics and specialists to understand the dynamics of this sector being assumed by the wineries as well as the public and private agents involved (Cruz-Ruiz et al. 2020).

All of these arguments highlight the importance of wine tourism and the interest in designing sufficiently attractive itineraries for the development of a sustainable tourism model. This is a challenge that institutions will have to take on from a multidisciplinary perspective, in which geographers, sociologists and economists, among others, will have to intervene (Fernández Portela and Vidal Domínguez 2020). In this way, the process of shaping a wine route as a tourism product is considered a way of conserving and enhancing the cultural heritage that belongs to the identity of the local population (Carrasco et al. 2019; Pulpón and Ruiz 2019), as well as an opportunity for economic diversification (Northwood 2000; da Silva et al. 2018; Wolikow 2014).

3. Territory of La Axarquía

La Axarquía belongs to the easternmost part of the province of Malaga and has a total surface area of 1026.7 km^2 (Figure 2). It is bordered by the Mediterranean Sea to the south, while to the north and east is the province of Granada and to the west it is bordered by the capital of Malaga and the regions of Antequera and Nororma (Lucena 2007). It has peculiar features, orography, farming systems and diversity of landscape and resources. The average altitude of the region is 391 m, reaching a maximum altitude of 2069 m, making it a territory with steep slopes alternating with open areas.

It has a Mediterranean-type climate, semi-tropical with mild winters and warm summers. In fact, Tejeda, Almijara and Alhama mountain ranges protect this territory from the cold north winds. Its subtropical latitude allows it to enjoy 3000 h of sunshine a year. Average temperatures in the coastal area range from an average of 10 °C in winter to 25 °C in summer, being somewhat more extreme in the inland villages, especially in those located above the 900 meter mark (Carrión-García 2015).

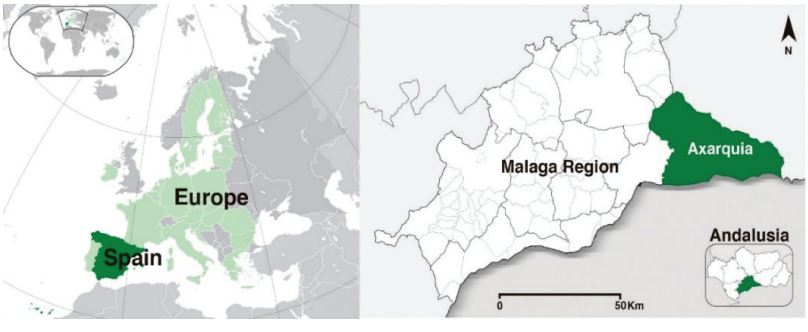

Figure 2. Location map of La Axarquía (Malaga, Spain). ETRS89 UTM 30S. Own elaboration.

The cultivation of vines in La Axarquía has certain peculiarities that make it attractive for wine tourism, including the grape harvest, which is one of the earliest in Europe that used traditional techniques for harvesting. The difficulty imposed by the physical environment on the tasks of maintaining the vines and harvesting the grapes, which have to be done by hand, means that this viticulture can be described as heroic (CERVIM 2020).

La Axarquía is currently made up of 31 municipalities and up to 67 districts. The total population in the last municipal census amounts to 214,323 inhabitants and, as shown in Table 1, Vélez-Málaga is the most populated urban center, with 81,643 inhabitants (IECA 2020), therefore it is part of the province of Malaga, but has a sufficient entity to be analyzed separately. It has its own bodies that identify it and work in a coordinated manner throughout the territory, such as the Association of Municipalities of La Axarquía (Mancomunidad de Municipios de la Axarquía) and the Centre for Rural Development of La Axarquía (Centro de Desarrollo Rural de la Axarquía, CEDER).

At present, the coast municipalities of La Axarquía have a much higher population density than those of the inland, which means a strong urban pressure on the coast strip (Almeida García and López Cano 2003). Table 1 shows the towns and their surface areas, with Vélez-Málaga, Rincón de la Victoria, Nerja, Torrox and Algarrobo standing out as the most densely populated. On the other hand, the least populated municipalities are those located inland, marked by a rugged terrain and more complicated accesses, which may influence their tourist potential, the latter being Salares, Árchez, Alfarnatejo, Macharaviaya, Sedella, Cútar, Totalán and Canillas de Albaida.

Table 1. Population of La Axarquía.

Municipality	Surface (has.)	Population
Vélez Málaga	157.9	81,643
Rincón de la Victoria	27.51	47,179
Nerja	85	21,091
Torrox	51	17,234
Algarrobo	9.73	6444
Cómpeta	54	3922
Colmenar	66	3376
Frigiliana	41	3009
Periana	58.76	3048
Benamocarra	6	3011
Riogordo	41	2724
Alcaucín	45.1	2230
La Viñuela	27.22	2034
Almáchar	15	1811
Sayalonga	18.3	1681
Canillas de Aceituno	42	1677
Benamargosa	12.12	1511
Comares	25.5	1315
Moclinejo	15	1271
Arenas	26.3	1156
Alfarnate	34	1069
El Borje	24	930
Iznate	8	868
Canillas de Albaida	33	716
Totalán	9.21	607
Cútar	20	614
Sedella	32	606
Macharaviaya	7.24	480
Alfarnatejo	20	377
Árchez	4.8	385
Salares	10	169

Source: IECA (2020).

4. Materials and Methods

The research was carried out in three stages. The first consisted of a study of the wine production area of La Axarquía. The visits to this geographical area were made between April and November 2019, a method used by other researchers to learn about the reality of wine tourism in specific areas (Bruwer 2003; López-Guzmán et al. 2014). In this phase a vital issue for the structuring of the itineraries of the wine tourism route was analyzed, namely the resources and services offered.

The information obtained was completed by means of a documentary analysis using multiple sources (General Catalogue of Andalusian Historical Heritage, Catalogue of Protected Assets and Spaces of the Provincial Council of Malaga and tourist information available both in brochures and online).

The second stage consisted of an in-depth interview with winemakers and agents involved in the production of wine (Table 2), an appropriate tool for exploring the subject, as it allows for the evaluation of non-neutral knowledge (Gillis and Jackson 2002; Mason 2006; Pepper and Wildy 2009). The questionnaire was designed by a work team belonging to the SEJ 121 "Mediterráneo Económico" research group at the University of Malaga and was structured in a single section of XII questions. In order to eliminate problems of comprehension and subsequent interpretation of the data, a pilot experience was carried out by selecting four participants. The interview (Appendix A) invited participants to comment on what they believed to be the key strengths and weaknesses of the wine activity in terms of wine tourism. The authors of the responses have remained anonymous. The interview was implemented by all 100% of the winemakers, whose wineries are located in eight

municipalities in the region. Vélez Málaga and Cómpeta hosted two wineries and the rest were distributed in the nearby towns of Árchez, Colmenar, Moclinejo, Sayalonga, Sedeya, and Torrox. Ten responses were collected from institutional representatives, managers of public and private companies, and other entities, which represented 70% of the institutional sector present in the territory of La Axarquía.

Table 2. Fact sheet of the interview.

Data Collection Method	**Semi-Structured In-Depth Interviews**
Sample	Winery owners and managers, business sector agents, representatives of institutions and social agents.
Number of interviewees	20
Sampling period	April–November 2019
Interviewees	100% of wineries: Bodegas Hermanos López Martín, Bodega José Molina, Bodegas Almijara, Bodegas Luis Picante, Bodega A. Muñoz Cabrera, Bodegas Bentomiz, Sedella Vinos, Bodegas Medina y Toro, Bodegas Jorge Ordoñez & Co., Cooperativa Unión Pasera de la Axarquía (Ucopaxa)
	70% of agents: Mancomunidad Costa del Sol Axarquía (Turismo), Centro de Desarrollo Rural de la Axarquía (CEDER-Axarquía), Asociación para la Promoción Turística de la Axarquía (APTA), Delegación Agricultura Junta Andalucía, Turismo Andaluz, Asociación de Empresarios de Vélez Málaga, Asocación de Empresarios de Nerja, Asociación Agraria de Jóvenes Agricultores (ASAJA) Vélez Málaga, Unión de Pequeños Agricultores Axarquía (UPA-Axarquía). Fundación Cueva de Nerja.

Source: own elaboration.

Once the interviews had been analyzed, a SWOT was structured to determine the real situation and define the implementation of possible wine tourism itineraries in the region of La Axarquía, a methodology already used in other studies on the development of strategies related to wine tourism (Carrà et al. 2016; de la Torre and Navarro 2008; Wilkins and Hall 2001). SWOT analysis is a multi-application tool that can be used to analyze different aspects of a strategic nature, given that it provides excellent information for decision-making. The benefit obtained with its application is the knowledge of the real conditions in which an organization finds itself, in order to assume risk and take advantage of the opportunities offered by the environment. It is important that the wine industry and the tourism industry identify and understand their key strengths, weaknesses, opportunities and threats, as well as how these factors interact, so that effective decisions can be made in terms of sustainable wine tourism development (Álvarez García et al. 2014; Millán 2012).

Thirdly, with the information available, we proceeded to make a proposal for wine tourism itineraries that take into account the needs indicated by the interviewees, as well as the heritage elements of the territory and the most necessary services for the development of the enotourism route, having in mind the findings made by the research group (Cruz-Ruiz et al. 2020), shown in Figure 1.

5. Results

The study of heritage resources, both tangible and intangible, tourism services and wineries present in a geographical space is valued to the extent that they provide options for progress in the form of wine tourism itineraries, taking into account the peculiarities of the territory. In this case study and in researches applied to other wine-growing areas, where wine and tourism come together (Harvey et al. 2014), where the rural is perceived as

a space in which the land prevails as an element of production, the values, resources and culture itself promote products to discover and enjoy (Privitera 2010).

5.1. Heritage and Services in La Axarquía

Following the Table 3, we can observe that the material heritage has a great diversity in the region in the form of unique historical buildings, traditional architecture and monuments, representing elements that add value to the territory. Obviously, the richness of this matter is highly variable and does not necessarily correspond to the size of the municipality, hence the importance of the fieldwork carried out.

Table 3. Types of tourist resources and services offered in the municipalities of La Axarquía.

	Tangible Heritage				Intangible Heritage					Services Offered				
Heritage and Services / Municipalities	**Wineries**	**Traditional Architecture/ Historic Buildings**	**Museums**	**Archaeological Heritage**	**Gastronomy**	**Traditional Festivities**	**Craftwork/Local Products**	**Nature/Wine Landscape**	**Leisure/Sports Services**	**Wine Shops/Wine Cellars**	**Restaurants**	**Tourist Services Companies**	**Tourist Offices**	**Accommodation**
Vélez Málaga	2	x	x	x	x	x	x	x	x	x	x	x	x	x
Rincón de la Victoria		x	x	x	x	x	x	x	x	x	x	x	x	x
Nerja		x	x	x	x	x	x	x	x	x	x	x	x	x
Torrox	1	x		x	x	x	x	x	x	x	x	x	x	x
Algarrobo		x		x	x	x		x		x	x		x	x
Cómpeta	2	x	x		x	x	x	x		x	x		x	x
Colmenar	1	x	x		x	x	x	x		x	x			x
Frigiliana		x	x		x	x	x	x	x	x	x	x	x	x
Periana		x	x		x	x	x	x	x	x	x	x		x
Benamocarra		x			x	x		x			x		x	x
Riogordo		x			x	x		x			x			x
Alcaucín		x		x	x	x	x	x		x	x		x	x
La Viñuela		x			x	x		x		x	x		x	x
Almáchar		x	x		x	x	x	x			x			x
Sayalonga	1	x	x		x	x		x		x	x			x
Canillas de Aceituno		x			x	x	x	x			x			x
Benamargosa		x			x	x	x	x			x			x
Comares		x		x	x	x	x	x			x	x	x	x
Moclinejo	1	x			x	x	x	x		x	x			x
Arenas		x			x	x	x	x	x		x			x
Alfarnate		x	x		x	x	x	x		x	x		x	x
El Borje		x			x	x	x	x			x			x
Iznate		x			x	x	x	x			x			x
Canillas de Albaida		x			x	x	x	x			x			x
Totalán		x		x	x	x	x	x			x			x
Cútar		x			x	x	x	x						x
Sedella	1	x			x	x	x	x		x	x		x	x
Macharaviaya		x			x	x	x	x			x			x
Alfarnatejo		x			x	x	x	x			x			x
Árchez	1	x			x	x	x	x		x	x			x
Salares		x			x	x	x	x			x			x

Source: Own elaboration according to IECA (IECA 2020), as well as on elements and resources of La Axarquía in the General Catalogue of Andalusian Historical Heritage and the Catalogue of Protected Assets and Spaces of the Provincial Council of Malaga. The symbol "x" means that the element is present in the corresponding municipality.

With regard to the tasks related to viticulture, heritage elements have been preserved, in particular the grape drying sheds for the production of raisins must be mentioned due to their exceptional nature. As reported by the respondents, there is a worrying and progressive process of disappearance of agricultural heritage elements, wine presses, drying sheds and warehouses, due to the updating of wine-making work and the lack of valorization of these places until recently. Some of them are part of the history of certain wine-producing localities in the territory under study.

Therefore, this vast heritage is present, to a greater or lesser extent, in all the municipalities of La Axarquía in the form of historic buildings (churches, houses, old industries, archaeological remains). As far as museums are concerned, although there are several of these infrastructures, only one of them is entirely devoted to traditional wine making. It is located in the municipality of Cómpeta. In the rest we can find and recognize some elements related to wine production, as well as archaeological, artistic or anthropological ones that illustrate the historical and patrimonial richness of the region.

In this way, the itineraries to be designed will be determined by the local wine industry and the value of its culture, contributing to sustainable development and preserving the existing rich heritage, a casuistry observed in other territories (Carrasco et al. 2019) under the model of wine tourism product club in Spain (Gomis et al. 2010).

La Axarquía has a strong sense of identity reflected in the potential of its intangible heritage. Even today, in most of its municipalities you can still find examples of traditional trades, mainly those related to agriculture and in particular those related to wine-making.

Festivals are another attraction and a perfect complement to wine tourism visits (Getz 2019; López-Guzmán et al. 2019). The cultural and ethnographic variability endows La Axarquía with a complex festive framework developed throughout the year, be it the typical patron saint feasts or other festivities and events related to the traditional tasks of wine and gastronomy, which is an added motivation for the visitor. In fact, the prominence of wine and raisins is a central theme of certain festivals usually held in the summer months, when the grapes are harvested. The municipalities with the greatest wine-growing traditions, such as Cómpeta, Moclinejo and Colmenar, are the main protagonists, although raisins and grapes are also part of the popular culture in El Borge, Iznate and La Viñuela.

The wine landscape is the most outstanding natural and genetic heritage. The tourist resource of the landscape and the vineyard offer one of the most interesting options in a wine tourism route (González Morales et al. 2015). In this sense, the vineyards of La Axarquía make up a very characteristic landscape due to the unevenness of the terrain, which makes it necessary to use mules to harvest the grapes. In addition, it is considered an economic and heritage resource, due to its determining influence on productive activities of great relevance, among which is tourism and also residential development (Almeida García and Cortés Macías 2011).

As for services, these are concentrated in the municipalities with the largest number of inhabitants and in the centers characterized by their offer of sun and beach tourism activities, such as Rincón de la Victoria, Vélez Málaga, Torrox and Nerja. Leisure services and tourist service companies are present in the aforementioned municipalities, to which are annexed Periana and Arenas, where there are companies related to active tourism.

More than a third of the municipalities in the inland of the region, apart from those on the coast, have tourist information offices, which makes them interesting stop points on the route: Cómpeta, Frigiliana, Benamocarra, Alcaucín, La Viñuela, Comares, Alfarnate and Sedella. Restaurant and accommodation services are omnipresent in all the towns. The type of accommodation is varied, ranging from the large hotels located in the coastal towns of Vélez Málaga and Nerja to the small rural hotels in municipalities such as Arenas, as well as the tourist apartments that flourish in towns such as Frigiliana and Alcaucín. In the case of restaurants, all the towns except Cútar have them and, even though the types are varied, local gastronomy is present in all of them.

5.2. Diagnosis of the Territory: SWOT

The information compiled through the interviews has allowed the elaboration of a diagnosis of La Axarquía by means of a SWOT, in which the strengths and weaknesses, threats and opportunities of wine tourism in the area are specified (Table 4).

The present offer of services is based mainly on tangible elements such as wine and wineries, but there are intangible elements that add attractiveness and interest such as the surrounding elements or the associated services. The geographical context has a major influence on the analysis. In the case of La Axarquía, it has recently been transformed into an area where agriculture has given way to tourism as a source of income, becoming just another zone of the metropolitan area of Malaga, which can generate conflicts of interests that can be overcome with proper planning (Almeida García 2011).

Furthermore, it is necessary to take into account the important role played by the different local, provincial and regional public administrations in the development of the initiatives related to the construction of a certified wine route, as they require active incentive policies, as well as elements to boost the necessary infrastructures and the promotion of the territory. SWOT shows the most relevant issues for outlining the actions that can be derived from public policies to support the development of the rural territory.

Table 4. SWOT matrix on the wine sector in La Axarquía.

WEAKNESSES	STRENGTHS
• Need to adapt the wineries to the demand for wine tastings and local gastronomy. • Problems of promotion and communication (marketing) of the wine tourism attractions of La Axarquía. • Lack of interest in the world of wine among the sun and beach tourists who visit the area, as wine culture is not a priority for them. • Lack of professional experts specialized in the richness of heritage and/or oenology. • Inadequate indication of wine tourism points of interest. • Lack of collaboration between the different establishments involved. • Dispersed population centers and poor land communications.	• Visually attractive agricultural landscape. • Wide variety of tangible and intangible heritage. • Wide variety of local events and festivities. • Recovery of ethnographic spaces that enhance the wine itinerary. • Wide and varied range of rural accommodation and restaurants. • Deep-rooted ancestral winemaking tradition • High quality of the vineyards in the area with native and endemic grape varieties.
THREATS	**OPPORTUNITIES**
• Limited number of wineries with adequate infrastructures to guarantee the reception of visitors. • Possibility of other tourist itineraries overshadowing La Axarquía itineraries. • Progressive disappearance of the traditional wine landscape due to the introduction of non-native agricultural species. • Small wineries with limited production volumes. • Little dialogue between institutional authorities and winemakers.	• Willingness of public institutions to promote wine tourism as a sustainable tourism offer. • Emergence of operators specializing in wine tourism • Concern for the sustainability and survival of viticulture as an activity that provides high added value. • Integration of La Axarquía into the Malaga and Ronda Wine Route. • Compatibility of wine tourism with other rural and inland tourism activities. • Differentiation through the development of a sustainable tourism product. • Large number of visitors and tourists from the coast.

Source: own elaboration.

5.3. Characteristics of the Wineries and the Services Offered

Wine tourism as an economic driver has its ultimate expression in the organization of routes and itineraries. A construction that requires institutional collaboration and the involvement of private initiatives that are channeled through the winemaking businesses in La Axarquía.

The research carried out in person in each of the wineries (Table 5) has allowed a rigorous study of their possibilities and a mapping of the characteristics of each one of them, which is essential for the elaboration of wine tourism itineraries. Table 5 shows the characteristics of the wineries in the area of La Axarquía, as well as the services they provide.

Table 5. Characteristics and services of the wineries of La Axarquía.

	Characteristics						Services				
Wineries	**Town**	**Founding Year**	**Type of Business ***	**Own Vineyards**	**Products**	**Business Marketing Language ****	**Tasting/ Gastronomic Menu**	**Direct Sale of Wine**	**Visits to Vineyards**	**Events**	**Website**
Hermanos López Martín	Archez	1988	Family-run	x	Wine	Spanish		x			
José Molina	Colmenar	2011	Family-run	x	Wine	Spanish/English	x				x
Almijara	Cómpeta	1993	Family-run	x	Wine	Spanish/English	x	x			x
Luis Picante	Cómpeta	2001	Family-run		Wine	Spanish		x			
A. Muñoz Cabrera (Dimobe)	Moclinejo	1927	Family-run	x	Wine	Spanish/English	x	x	x	x	x
Bentomiz	Sayalonga	2003	Family-run	x	Wine	Spanish/English	x	x	x	x	x
Sedella Vinos	Sedella	2006	Family-run	x	Wine	Spanish/English	x	x	x		x
Medina y Toro	Torrox	2006	Family-run	x	Wine	Spanish	x	x			x
Jorge Ordoñez & Co	Vélez-Málaga	2004	Family-run	x	Organic wine	Spanish/English	x	x		x	x
Cooperativa Unión Pasera de la Axarquía	Vélez-Málaga	1980	Cooperative	x	Wine/Raisins	Spanish		x			x

* The typology indicates the ownership of the business and its structure, irrespective of the corporate form under which they are registered in the business and company registers. ** Languages in which the public is served for the marketing of the wineries' wines. The symbol "x" means that the element is present in the corresponding winerie. Source: Own elaboration.

The predominant business structure is the family-run type, with the exception of UCOPAXA, a cooperative that brings together more than 700 farmers and which produces and markets 70% of Malaga's raisin production, making various types of wine. Most of the wineries have their own vineyards; only Bodegas Luis Picante purchases must from local producers to make its wines. With regard to wine production, the traditional production of sweet wines in the area has given way to red, rosé and white wines, which in the case of Bodegas Jorge Ordoñez are organically produced.

In the case of the wineries, the dates on which they were founded are striking, with those that began their activity at the end of the 21st century dominating the scene in the heat of the growing interest in viticulture. However, we recognize the singularity of Bodegas A. Muñoz Cabrera, known as Dimobe, founded in 1927, whose business has continued uninterruptedly since then.

Despite the fact that all the wineries are committed to wine tourism, the degree of development of services is uneven. Customer service is provided in Spanish and English, at least in most of them. Most of the wineries offer the possibility of wine tastings which can be accompanied by gastronomic menus, while visitors can buy the wines they produce directly. Wine-related events are only offered at three wineries, while vineyard tours are only available at three of the wineries.

6. Organization of Wine Tourism Itineraries

Tourist routes and itineraries are nowadays a matter of great interest for the competent tourist bodies in Spain. In the case of Malaga, their existence is promoted by the Public Company of Andalusian Tourism, the Provincial Council of Malaga, and in La Axarquía by La Axarquía Rural Development Group (Grupo de Desarrollo Rural de La Axarquía, CEDER).

The wine tourism itineraries proposed for La Axarquía highlight the importance of the existing heritage resources and services. The opinions gathered among the agents involved point to the existence of numerous routes of tourist interest which can be based on the attractions of the area. The interviewees acknowledged the existence of some institutional initiatives, although they have not had a significant impact on the localities along the routes.

With regard to an enotourism route or itinerary, it must have a layout that brings together specific resources and that meets the criteria of efficiency and economic profitability. Assuming these criteria in a geographical, cultural and historical context linked to wine, two different wine tourism route/itinerary options are proposed, taking into account environmental sustainability criteria, placing value on the tangible and intangible elements it possesses and combining the efforts of social and institutional agents, private companies, producers and consumers.

After having catalogued the elements present in the region of La Axarquía useful for the definition of a wine tourism route, having validated them through a field study and the interviews in the SWOT matrix, we believe that it is possible to propose two wine itineraries in La Axarquía. Logically, the role played by the wineries is fundamental, especially those that are more closely linked to the wine tradition or those that show a greater interest in being linked to the wine tourism route.

These itineraries try to create a coherent visit, in which the greatest number of heritage elements and services are present, taking into account the mandatory inclusion of the wineries, which work as a critical element and must necessarily be included in the itinerary. The density of heritage elements complicates the route, as almost any corner of the territory is worth a visit. Services are another of the keys to success. The restaurant offer covers almost all the municipalities, with interesting proposals that recover the local culinary heritage and modernize it, while the local wines have an important presence in bars, restaurants and in the few wine cellars in the area. There is a wide range of possibilities for overnight stays in the area, thanks to the large network of rural accommodation available in most of the municipalities.

• 1st Proposed Itinerary

The first itinerary aims to showcase the largest number of wineries in La Axarquía, as well as its heritage elements (Figure 3). It is a circular route that starts and ends in Vélez Málaga, which is the municipality where the visitor can find the largest offer of accommodation and which is easily accessible from the A-7 motorway, which connects with the city of Malaga in 30 min. Vélez Málaga is the head of the region of La Axarquía and is home to two wineries, Jorge Ordóñez & Co. and Ucopaxa, the latter also dedicated to the marketing of raisins.

There is a wide range of heritage and services on offer, and it is worth highlighting the heritage that is concentrated in the historic center. The direction of the route does not affect the visit, so the first point of interest is Bodegas Medina y Toro, located in Torrox, a municipality that is divided between the coastal strip and Almijara mountain range and that is organized along the axis marked by the river Torrox. This town has a historical and archaeological heritage that dates back to the time of the Roman colonization and includes important remains of industrial activities such as the San Rafael sugar factory. The next milestone on the route is the town of Cómpeta, which stretches along the southern slopes of Sierra Almijara to the Montes de Málaga, with a landscape of hills covered with vineyards, olive groves, almond trees and scrubland. The town is especially known for

its wine-growing tradition and culture and is home to Bodegas Luis Picante and Bodegas Almijara. Numerous heritage elements can be found (the cemetery of San Sebastián and its historic quarter stand out), as well as popular festivals.

Traditional work has also been preserved, apart from the work of the vineyard, which is still practiced today, such as the lime industry and tinplate craftwork. The next point on the route is Árchez, a small town at the foot of Sierra Tejeda, surrounded by vines and olive trees and which preserves a minaret of Muslim origin. In this town you can visit the Hermanos López Martín winery, whose main interest lies in the surrounding landscape and ethnographic values.

The route can be extended to Sedella, a municipality of singular interest that treasures an interesting popular architecture and where traditional crafts such as imagery and esparto grass work are still preserved. Sedella Vinos winery is responsible for keeping alive the town's winemaking tradition, where the mountain landscape and the vineyards, olive and almond groves coexist. The return is from Cómpeta in the direction of Sayalonga on the A-7206. This small municipality of steep slopes is home to Bodegas Bentomiz, ending the route back in Vélez Málaga.

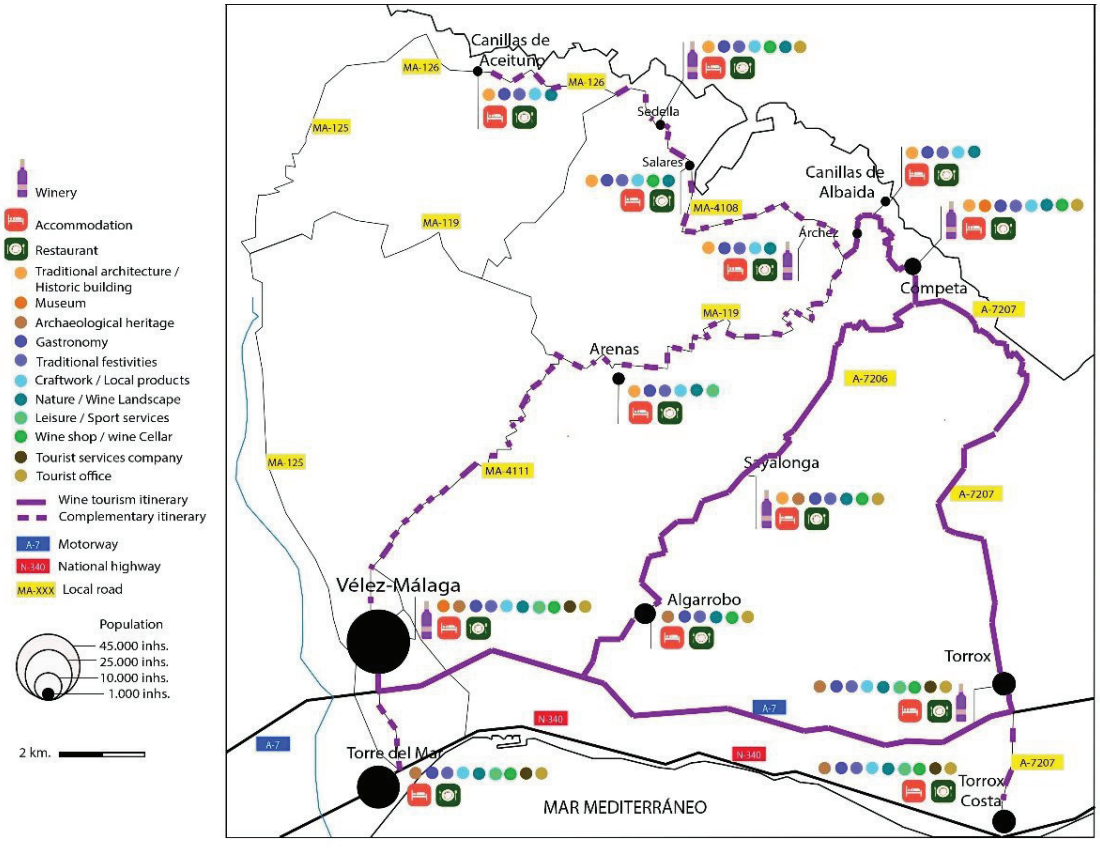

Figure 3. Own elaboration based on the Digital Cartography of Andalusia (IECA). Location map of Itinerary #1. La Axarquía (Malaga, Spain). ETRS89 UTM 30S.

- 2nd Proposed Itinerary

The second itinerary takes in what is known as the Raisin Route, which has an interesting heritage value, both tangible and intangible (Figure 4). It highlights the vineyard landscape in a steeply sloping terroir that extends over the hills of the Montes de Málaga and where the traditional grape drying sheds are also located. The route can be followed in either direction, and if you take the possible extension to El Rincón de la Victoria, it is a circular route. The possibilities for overnight stays in the area are varied, especially in terms of rural accommodation.

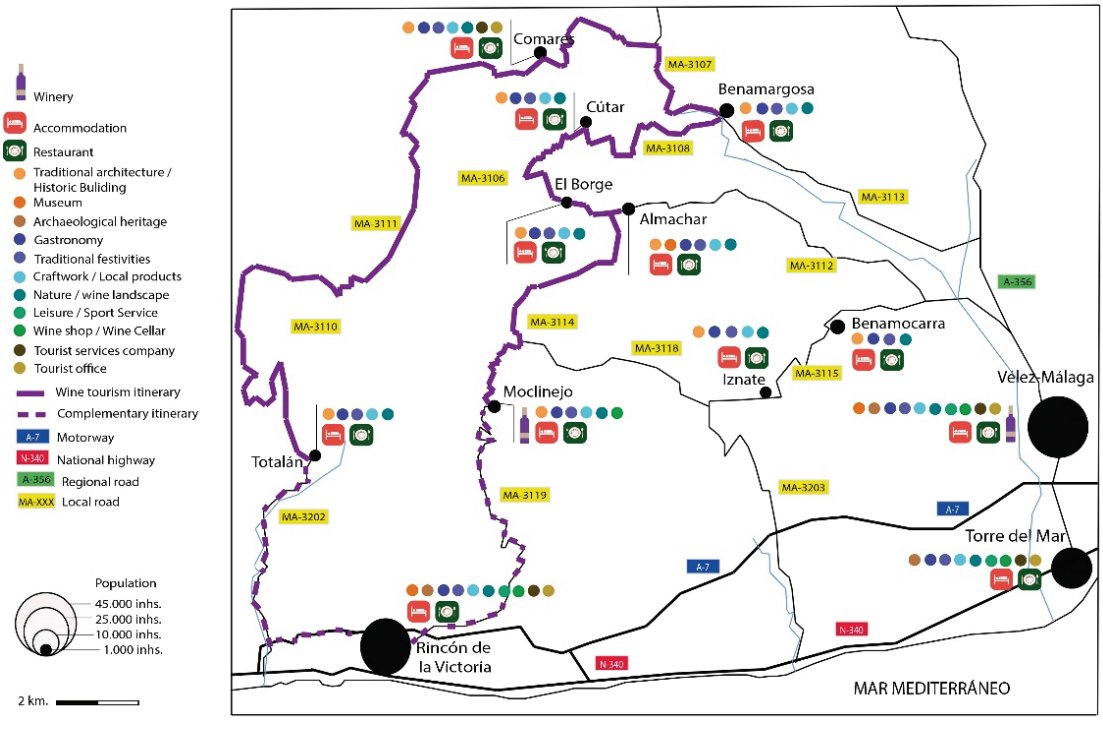

Figure 4. Own elaboration based on the Digital Cartography of Andalusia (IECA). Location map of Itinerary #2. La Axarquía (Malaga, Spain). ETRS89 UTM 30S.

Starting from Moclinejo, it is there where you can visit Bodegas Muñoz Molina, the only establishment dedicated to the production of wine along the route. The next point of interest is Almáchar, situated on a hill located between the rivers El Borge and Almáchar and here, from the end of August, you can observe the process of drying the grapes to produce raisins. Other activities of interest are the festivals and popular celebrations around the livestock activity and the typical products of the area such as "ajoblanco". A short distance away is El Borge, a municipality that is clustered around the Ejido hill, on the banks of the river from which the town takes its name. The urban center is integrated into the landscape with a structure of winding streets adapted to the relief of the area. Of interest are several heritage elements such as the cemetery, the parish church and two old mills. The traditional activities of grape harvesting and processing are still common among the inhabitants. The route now heads towards the small town of Cútar, which spreads out on a hill of the same name, dominating the surrounding valley. It is worth mentioning some heritage elements linked to economic activities, such as mills and fountains. Apart from the wine-growing activity, traditional trades such as esparto and basket weaving are still preserved. The route continues to Benamargosa, which takes its name from the river that runs through it and which allows the development of orchards where citrus and avocado

trees are grown, blending in with the vineyard landscape. Comares is the next point on the route, located on the hill from which it takes its name. Its geographical conditions made it an excellent defence post, especially during the period of Moorish rule. It is around the fortifications of this period that the historic quarter is clustered, with its typical Moorish urban layout, which is completely pedestrianized due to the narrowness and steepness of the streets. There are numerous heritage elements, some of which are linked to the defensive function of the town or to religious worship, as well as those of a civil nature. Of particular note is the folkloric expression of the Verdiales, a style of fandango typical of the province of Malaga, which takes its name from this locality in one of its styles and which is danced in its popular festivals. The route ends in Totalán, a small municipality adjoining the town of Málaga, which adapts to the terrain and takes advantage of the waters of the stream of the same name that runs through the town. The urban layout denotes its Moorish origins, although the area has been inhabited since prehistoric times.

7. Discussion

In recent decades, the rural world has been undergoing profound social and economic changes in many territories, joining a global and intensely interconnected world and demanding a better exploitation of its resources, among which wines are particularly important (Baird et al. 2018; Brunori and Rossi 2000). In this context, wine tourism and, more specifically, wine routes and itineraries, are a way that reflects the consumption patterns of tourists seeking leisure experiences that are close to and adapted to their lifestyles.

Sensitivity to environmental values, sustainability and the search for authenticity through cultural and landscape elements are an important asset for the economic development of rural wine-growing areas, as tourists are willing to pay to discover new experiences far from the overcrowding of traditional holiday destinations (Cristófol et al. 2020; Pulpón and Ruiz 2019). In fact, public and private actors in La Axarquia have undertaken sustainability policies both in coastal areas and in the rural territory.

In the case of Spain, ACEVIN plays a transcendental role in improving the wine tourism offer in places with a great wine tradition, promoting quality tourism. In recent times, numerous routes have been set up, such as the Ronda and Malaga route (including the territory of La Axarquia), which is just beginning its journey and represents a great business opportunity for each of its tours (Vázquez Palmero et al. 2017; Ruiz-Romero de la Cruz et al. 2017).

Wine and wineries are the central axis that articulates the exploitation of this tourist segment. Therefore, these businesses should organize tastings and guided tours in which the singularities of Malaga's wines and their production methods are made known. However, a wine tour contains more elements, so special attention must be paid to accommodation, restaurants, complementary tourist activities, infrastructures (Alberdi Collantes 2018; Asero and Patti 2009; Festa et al. 2020), as well as to an adequate availability of information about the destination (websites, maps, brochures and tourist documentation) (Cassar et al. 2018).

8. Conclusions and Implications

The research has examined the resources and services available in the region of La Axarquía to create itineraries that represent an undoubted opportunity for economic diversification that can have a direct impact on the economy, fulfilling the objectives promoted by UNESCO to enhance the value of local heritage. Some of these wineries with a long tradition in the family business will play a fundamental role in the development of the wine tourism itineraries, satisfying a demand from wine tourists who are looking for a unique experience during their visit, as well as the opportunity to discover vineyards, wine landscapes, traditions and local festivities. Some of the wineries in La Axarquía have made an important updating effort, organizing visits to their vineyards, as well as wine and local gastronomy tastings, favoring the dissemination of Spanish wine culture.

The planning and organization of wine tourism and the collaboration between institutions and companies are necessary in order to correct the imbalances that are being generated by the massive offer of sun and beach in the coastal area, concentrated in certain coastal municipalities such as Rincón de la Victoria, Torre del Mar, Torrox Costa and Nerja. The diversion of the flow of visitors towards a quality and sustainable tourist activity must take into account the inherent limitations of the region in terms of environmental pressure, capacity and preservation of the natural environment, as well as a landscape that gives it a unique identity. At present, the flow of visitors makes short trips to the production areas, responding to a need to "discover" the values of the interior of the region and showing its capacity to concentrate its visits on weekends and short holiday periods.

The research findings highlight the importance of promoting quality wine production and its landscape as distinctive tourism resources, favoring the creation of a brand image and a transversal territorial discourse that local agents perceive as one of the most important factors of the necessary rural development in this environment.

Wine routes are perceived as an opportunity for sustainable economic development and as an opportunity for synergy between wine, natural landscape and cultural heritage. The strategy to be followed involves the appropriate management of resources with the aim of rebalancing the tourist area of the region, a measure aimed at the specialization of tourist resources by means of their enhancement through the creation of facilities for their enjoyment, recognition and sustainable management.

One of the most critical aspects of this work is the need to involve the local community, so that they feel represented and participate in the whole process of setting up an enotourism route, something that worries most of the interviewees.

The region of La Axarquía meets all the conditions to become a successful wine destination, which is why the role of the institutions must be very active, allocating resources for training and support for emerging service companies, as well as promotion through the mechanisms available to the different bodies, providing both technical and economic resources to the companies involved.

The results of the study are specific to a particular region and therefore cannot be generalized, but the conclusions can be useful for the actors responsible for the development of an economic sector as important as tourism, as well as opening a path for research into the development of future wine routes.

The field study and, in particular, the interviews with the agents and winemakers have highlighted the interest in starting or continuing a new line of business, which goes beyond the interest in marketing a wine product. They are aware of the need to promote wine tourism in the area as a way of developing the rural territory and making their businesses profitable. Adaptations to the needs of regulated wine tourism are not homogeneous and are at different stages, depending on the interest and impulse of the owners. An awareness-raising effort on the part of the institutions that we believe would result in greater tourism benefits for the area and for their own businesses.

The case study has led to a proposal for the layout of two possible wine itineraries conceived with criteria of efficiency and sustainability, which can favor the progress of La Axarquía, achieving one of the main objectives of the development of the rural territory, as well as economic and socio-cultural effects. The wine route in La Axarquía is based on a unique and specific tourist product, for which we establish a series of suggestions:

- Visit and participation in the harvesting and winemaking process.
- Training of wine tasting experts.
- Training of experts in local heritage and culture.
- Increased complementary offer (events, active tourism, cultural tourism, gastronomic tourism).
- Improvement of road infrastructures.
- Active promotion of the destination and improvement of the information available.
- Creation of a specific and distinctive markers of the route and of all the elements likely to be attractive to visitors.

- Improving the online presence of the wineries and the possibilities offered by social networks.
- Improving of private and institutional collaboration.
- Commitment to the production of organic wines

In general, we believe that the link between wine businesses and those whose existence is based on raisins, as is the case in Malaga, should collaborate closely and could even participate jointly in the future design of tourist routes with both elements as essential resources to promote the tourist development of the rural territory in this area. It would be a unique specialization that would reinforce their identity in the marketing of new tourist products. In fact, the very structure of the Ronda and Malaga wine route is covered by the Regulatory Council of the Designation of Origin, which includes both wines and raisins. Future studies and actions on the territory should take into account the heritage elements and relate them to the sustainability of the territory as a way to generate wealth in the terroir.

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Appendix A

Model interview with winemakers and stakeholders
Name:
Position:
Institution/company:
Date:
Ref:

1. Do you think it would be interesting for La Axarquía to have its own itinerary in the Malaga Wine Route?
2. What needs do you detect in La Axarquía in order to promote it as a tourist destination?
3. Do you think that the current offer of La Axarquía is interesting for tourists?
4. Are the resources and services of La Axarquía sufficient to attract wine tourists?
5. What problems do you detect in La Axarquía related to the wine tourism activity?
6. How would you qualify the offer of tourist accommodation in La Axarquía?
7. What should be the involvement of the wineries in the wine route?
8. Is the involvement of the private agents and institutions of La Axarquía in the implementation of the certified wine route adequate?
9. Do you think that a sustainable wine tourism offer can be designed in La Axarquía?
10. Do you think that the wine tourism itineraries are compatible with other existing activities?
11. Do you think that the service providers of La Axarquía are sufficiently involved with the new wine tourism route?
12. Do you think that the new wine tourism itineraries will have an economic impact on the development of La Axarquía?

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Mapping Online Geographical Indication: Agrifood Products on E-Commerce Shelves of Mercosur and the European Union

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Abstract: The agrifood products market has never before contained as many niches than it does at this moment in history. The use of geographical indication (GIs) is one of the oldest ways of granting protection for and promoting these goods. Although they date back thousands of years, only since the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement has there been a common understanding in regard to their use. Although the GI system has the same structure globally, each region shows different performance. Therefore, the influence of institutions in this market is still an enigma to be explored. In this work, we sought to compare the performance of Mercosur and the European Union in relation to GI products and categories in this exchange arena by analyzing e-retail supermarkets. To do so, we collected data from 44 online supermarkets from both economic blocs and analyzed the relevant attributes of the products offered. Then, we compared both blocs through the use of graphics and economic sociology tools. We present novel results relating to differences in GI performance, discuss the reasons for such differences and examine the construction of the market. Our results show that the EU had significantly more products than Mercosur and had a wider variety of GI products on e-retail shelves. Moreover, in the EU, the advertised products originated mainly from within the economic bloc, whereas the majority of GI products advertised in Mercosur originated primarily from abroad. This difference indicates to dominance of the EU' systems, demonstrating that its institutions are effective in terms of trade and commerce development mechanisms. However, in both blocs, a restricted number of categories and registers were found.

Keywords: economic sociology; geographical indication; European Union; Mercosur; market arena; e-retail; comparative approach

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1. Introduction

The agrifood products market has never before contained as many niches as it does at this moment in history. One of those niches, in particular, has been around for thousands of years. However, it only gained official label status in the 18th century in the form of geographical indications (GIs). Official designations of this nature have their origins in Portugal, with Port wine, which had its production rules and characteristics established by the Marquis of Pombal who created a specific public company to deal with its case. In France, the pioneering Portuguese spirit was echoed years later by standardizing a protection system for agrifood products and wines based on characteristics arising from their places of origin. According to Barham (2003), GIs establish their differentiation of products on natural, human and historical factors. The sum of these three factors comprises what Allaire (2018, p. 63), based on the work of Goodman (2002), refers to as "the immaterialization of food and the institutionalization of quality", a concept that goes far beyond the specific soil and climate of a region capable of providing specific characteristics to certain products.

Although they date back thousands of years, this type of product has only recently gained official character under French, Portuguese and Italian legislation, among those with greater prominence. However, this market is too complex to be formed solely by the institutional factors. Ilbery and Kneafsey (1999) demonstrate that the niche market for local specialty food products (SFPs) is located in the intersection between producers and institutional and consumer networks. The point of intersection of all these networks of actors is in the arena of exchange. A significant number of works focus on the products or consumers. However, little attention has been given to the arena itself. For this reason, this work's importance is to shed light on the materialization of commerce in the arena of economic action and the differences between Mercosur and the European Union on this matter.

Works such as that by Kenney et al. (1989) and Bonanno and Constance (2001) show the neo-Fordist process by diffusion of a model based on mass consumption and production. This process resulted in an increasing homogenization of agriculture and food production worldwide. This fact is highly relevant in such a specific nature since GI labels intend to promote a more authentic and unique food (Broude 2005). This paradox could result from the structural impacts of a global consuming/production process in different countries due to its socio-economic position (Wallerstein 2011). How institutional policies affect these products' impacts on the final customers is crucial for understanding this market's functioning (Fracarolli 2021). Recent work suggests that this differentiation reflects on retail prices (Deselnicu et al. 2013). Additionally, GI can function as a relevant marketing tool (Agostino and Trivieri 2014; Dogan and Gokovali 2012; Lamarque and Lambin 2015; Mancini 2013; Teuber 2010). The market theory proposed by Allaire (2010), Fligstein (1996, 2008a, 2008b) and Fligstein and Dauter (2007) might answer some of these issues.

Over the last few years, many efforts were taken to encourage the market to provide alternatives with intrinsic food values. One known origin-related path is localized agrifood systems (Fernández-Zarza et al. 2021; Barham and Sylvander 2011). Many scholars have studied the strategy of trust-building through GI. However, Dias and Mendes (2018) show that, despite the growing number of published articles, most of them focus on southern European countries, are concentrated on four topics and are predominately empirical. Thus, there is a lack of literature comparing Mercosur and the EU, electronic commerce regarding such products, as well as multiple product market analysis, since most works focus on a single or a few products (Dias and Mendes 2018; Roselli et al. 2018; Teuber 2010; Renard 1999; Agostino and Trivieri 2014; Addor and Grazioli 2002). As such, the present work seeks to help fill the gap in the literature about this issue. Although this market has the same conformation structure globally, apparently, each region of the globe has a different proportion of each element. For example, the GI market in the European Union (EU) has reached incomparable numbers of registers compared to all other regions. In South America, on the other hand, the Southern Common Market (Mercosur) has an even greater area of production and a greater diversity of agrifood products. However, this diversity apparently has not developed in this specific market. To better understand this market's functioning, this work seeks to compare the difference between the performance of GI products and categories on this market exchange arena in Mercosur and the European Union by analyzing the e-retail supermarkets. To answer this question, this work understands that only a thorough investigation of this link in the market can provide the pieces of this complex puzzle. What are the characteristics of this market inin both blocs? What sort of goods do both markets address and sell? What are the commercialized products' origins in both blocs? Due to little comparative attention having been paid to the matter in terms of economic blocs, this work focuses on the market arena for GI products and its differences between Mercosur and the EU.

To answer that question, this initial research paper proposes to deepen the existing research by looking at the diversity of product offerings on the websites of significant retail supermarkets from selected countries of both the EU and Mercosur in a quantitative manner. The investigation considers e-retail supermarkets in Portugal, Spain, France,

Italy, Germany, Greece and Poland on the European side. In addition, the research looks into e-retail supermarkets from Argentina, Brazil, Paraguay and Uruguay on the South American side. In the sections that follow, the work uses economic sociology to illuminate the market issue. Finally, both economic blocs' markets are analyzed to point out the differences between them on the practical effects of institutional support of Intellectual Property (IP) based on the data collected in the field.

By doing so, this work hopes to identify the practical functioning of the GI market in Mercosur and the EU's electronic supermarkets. Additionally, economic sociology theory is used with the intention to reveal corporate control issues, the embeddedness of the state and productive groups relation to this economic niche, and the market-driven strategy of promoting specific product categories.

The paper starts by presenting the formation of agrifood niches through the changing of food production–consumption logic due to globalization, followed by how economic sociology tries to explain market functioning through the theory of markets and institutional influence. Additionally, it develops the state of the art by bringing present considerations of the GI market into the findings on labeling efforts to decommodify it.

After this, it explains the methodology used for collecting data from available online supermarkets to characterize the products, the categories found and the origins of those products. Additionally, it graphically explains the phases of analysis followed in the present work.

Subsequently, the results found for the analyzed data are displayed, the graphic results are presented, and the major figures discovered relating to the collected material are described. This section is followed by a discussion of these results, including analyzing them, matching them to the existing economic sociology literature, and their implications on the market. Finally, the work ends with a summary of the developed work, its findings and suggestions for future works and policies towards market evolution.

2. Agrifood Niche Pathway

2.1. Production Models

Globalization is a comprehensive, widespread phenomenon with conceptual divergences. However, regardless of the possible interpretations, this phenomenon affects the relations between people and communities (Held and McGrew 2007) and implies the massification and standardization of consumer goods inherited from Fordism (Bonanno and Constance 2001). Thus, it has an effect on the process of inserting and marketing commodities in the global agenda. Simultaneously, producers of other types of agricultural goods need other productive arrangements to achieve success and remain in the market. This adaptation is vital for those on the periphery and semi-periphery of the world (Wallerstein 2011).

With this productive logic in force on the planet, agricultural producers seek to differentiate their products to meet demand by adding value resulting from territorial appreciation (Artêncio et al. 2019). However, as producers struggle as a result of globalization's impacts, consumers start to demand less standard or industrialized products due to food's mass production. This sort of demand is what Allaire and Sylvander (1997) call the "logic of quality" in opposition to a "productivist logic". This paradox impacts the change of the productive logic from scale to scope as it becomes impossible for certain rural actors to produce commodities and obtain gains by production volume.

Due to the intriguing effects produced in this adaptation of productive logic, most of the works investigating the GI market focused on how the producers address the economic aspects (Allaire 2010; Dervillé and Allaire 2014; Giovannucci et al. 2009; Menapace and Moschini 2012, 2014; Moschini et al. 2008; Swinnen 2010; Tregear et al. 2007). However, there is a scarcity of studies seeking to unveil the general effects of how institutional policies, mainly arising from IP, reflect product offerings and prices on retail markets. Nevertheless, this broad approach is necessary and capable of providing clues beyond the local individual cases addressed by much of the literature. Additionally, it presents

itself as necessary due to the recent increasing valorization of food quality, especially those relating to the origin and culture (Fernández-Zarza et al. 2021; Gocci and Luetge 2020). On this matter, culture plays a significant role through identity values imbued with the characterization of food, which are stated as a clash of tradition and global value chains (O'Brien and Creţan 2019; Olofsson et al. 2021; Truninger and Sobral 2011).

Globalization is a process of production and consumption of goods that impacts each country in different ways. When it comes to agriculture, there is no difference. This process impacts the agri-food sector by severely industrializing goods by concentrating those products on food corporations and over logistics of massive production (Bonanno and Constance 2001; Renard 1999). As an effect of such a process, authors such as McMichael (1996) point out that communities must reposition themselves through niches to resist globalization's pressure. Furthermore, such a process demands local, regional and national identities to sustain culture-related food (Beriss 2019). Through this it becomes clear that globalization impacts nation states differently in terms of their global position and pushes the market towards niche formation to preserve culture-related agrifood products such as GI.

2.2. Institutional Mechanism

In the middle of this formatting process, the global system based on transnational trade, and the circulation of people and goods' circulation is continually increasing. However, price formation rarely results from an optimum trade between atomized buyers and sellers regulated by an invisible hand. Agrifood goods are no different. As pointed out by McMichael (1997, p. 630), "capitalist organization of agriculture is a political process, and is central to the dynamics of an evolving state system (including supra-statal institutions)."

The New Economic Sociology (NES) proposes the rejection of causal monism as an explanatory source of social causes. Granovetter (1985, 1990, 2018) proposes an embeddedness approach to economic action, an economically situated form of social action, and economic institutions as social constructions. The author resumes the association of economics and sociology approached by Weber, Polanyi and Durkheim. Thus, from the NES, a strand addresses institutions as abstract structures that act as social constructions, socially related to other social constructions, that operate economic actions (Abramovay 2000, 2004; Fligstein 2001; Smelser and Swedberg 2010; Steiner 2017).

In the sociological field, the Theory of Markets points out possible paths to forming and stabilizing this niche. Fligstein and McAdam (2012) suggest that most social action occurs in "meso-level social orders" or fields. These fields are those in which the actors involved cooperate to create and stabilize a market. In the agrifood case, the detachment of market niches such as GI can obey similar cause and effect. By collaborating to cooperate and define the unique characteristics of their products, which, therefore, they need a different degree of protection, groups of producers or their representatives can create formal institutions. Such institutions then have a dialogue with the state. In turn, the latter can act by granting such differentiated treatment to a greater or lesser degree.

The construction of these institutions allows, through IP rights, the creation of a new, highly specialized, premium market, which has a reduced number of actors and is legally protected. Consequently, this newly created market is stabilized by legal devices designed and regulated by the state or suprastate entities. Thus, the theory developed by Fligstein (2002) does not restrict specific segments but offers a general conception of the varieties of capitalism resulting from globalization. This argument is analogous to that observed by Belletti et al. (2017) when attending to the relationships between goods with GI and private, collective and public interventions.

It is precisely in this new market for protected agrifood products that the intention is to examine the retail market's practical effects. Thus, the existence of institutions with a greater or lesser degree of strength may have an impact on their final commercial stage.

2.3. Market Scenario

Several works point out that premium agrifood products such as GI benefit from labeling, and the consequent price mark-up of them is the issue that collective producers look for when protecting this IP (Bureau and Valceschini 2003; Crespi and Marette 2003; Deselnicu et al. 2013; Chilla et al. 2020). Although the premium varies between products (Deselnicu et al. 2013), the effects of product offerings and the differences between both markets are objects of this work.

It is well-known that SFPs are more expensive than ordinary ones. However, recent findings show that consumers' willingness to pay for and preferences for SFPs show better results when based on trust and when studies are related to consumers rather than retail shops (Cacciolatti et al. 2015; Calvo-Porral and Jean-Pierre 2017; Giraud et al. 2005; Lamarque and Lambin 2015). Besides, there is little work in the comparative scope between Mercosur and the EU which may show the characteristics and mechanisms that make this market more functional. Such analysis of articles on the product categories or product origin is well developed on Dias and Mendes's (2018) work.

While in Europe, this market is consolidated and has a long regulatory history, it is still seen as a potential market in Latin America. However, with the signing of the broadest IP agreement in the 1990s, the Trade-Related Aspects of Intellectual Property Rights (TRIPS), it became clear that the development of protected brands and GIs is not limited to the normative aspect. Previous works point out GI as a strategy for rural development (Agarwal and Barone 2005; Agostino and Trivieri 2014; Barjolle et al. 2009; de Mattos Fagundes et al. 2012; Ilbery et al. 2001; Roselli et al. 2018). However, these works suggest that other factors, such as commercial strategies, public policies and product qualification, play an influential role. In short, in commercial terms, agrifood products have the potential for commercial success for participants since they are linked to other strategies besides IP protection.

While some authors differentiate the GI market from other forms of certification and labeling (Galtier et al. 2008; Grote 2009; Laurent and Mallard 2020), others treat it analogously to other labels, such as organic labels (Aprile et al. 2012; Menapace et al. 2011; Roselli et al. 2018). The work of Galtier et al. (2008), for example, addresses GI as a label qualitatively different from other certifications in the case of coffee. The authors understand that other certifications are only the standardization of qualitative attributes. At the same time, GI would be a genuine manner capable of "decommodifying" the market due to the unique characteristics (Galtier et al. 2008) and also a way to strengthen the rural networks towards the development of smallholders (Oriana et al. 2021). The present work argues that IP's protective arrangements constitute institutions that create a new market and, therefore, allow different rules, which result in asymmetries concerning ordinary products.

In regional terms, just like the number of GI registrations, there is a predominance of works that address the European context in comparison to studies that consider Latin American countries. This scenario highlights the importance of addressing the theme, which is used worldwide, in comparative terms, to measure their differences. Likewise, the deepening of the retail market's effects in both the countries that make up Mercosur and the EU may show strategies used by producers and traders of products with GI to a greater or lesser degree of success. The economic blocs in question have built different agrarian models, which may or may not be part of the causal explanation of the proportionality of using this agrifood products market tool.

3. Methodology

As a comparative proposal of analysis, this work recognizes the necessity of adequate different realities. Social sciences often require the use of common concepts in both compared realities and acknowledge the sociocultural differences between them, and do not assume a universality (Smelser 1967; Mahoney 2007). Thus, this work compares the market in the same arena of the same modality of the IP protection of products and considers all

the differences considered by Fracarolli (2021). Additionally, Sartori (1991) points out the need for a finalistic means of comparison, for which reason this work seeks to find out how the market in both regions differs and the reasons for that, including whether it could be improved.

An alternate comparative approach proposed by Ragin (2014) describes a modern construction of the comparison, based on the calibration, of the qualitative outcomes and the set-theoretic relations regarding the different realities. This way, the present work understands that a more in-depth explanation is required. Thus, it uses economic sociological tools as an interdisciplinary approach (Smelser 2003) to address the problematic and leading causes and reasons, as the ones proposed by Swinnen (2007, 2010, 2016) on niche agrifood market formation and by Fligstein (1996, 2002, 2008a, 2008b) on how markets stabilize and are constructed. The quantitative data will be used to support the qualitative analysis. Hence, considering the contributions of both authors, the hypothesis assumed is that the EU's market will have a significantly more endogenous influence on its products. Additionally, the countries from southern Europe will have a substantial dominance in the markets of both economic blocs.

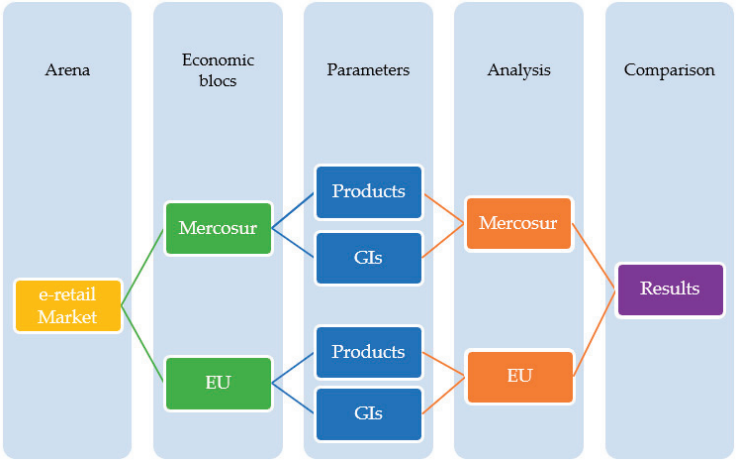
This work uses mixed methods of quantitative and qualitative research design. It compares the categories of product offerings, their origin, the penetration of GI products, and the difference between both economic blocs. In addition, the work maps the sources of GI agrifood products, excluding wine, aromatized wines and spirits. Finally, the work also evaluates the cultural aspects involved in constructing the niche market regarding IP.

This research consists of the comparison of three essential aspects of GI in retail markets. The first one is to analyze the offerings of GI agrifood products advertised by web retail supermarkets. The second is to map the origins of these goods, comparing Mercosur and the EU. The third one is to analyze the GI systems according to their inside and outside influence on web retail super- and hypermarkets. The sum of these three aspects can indicate how institutions build GI agrifood markets in each bloc.

The analysis consists of five parts. Firstly, the arena of exchange where the transaction of goods happens is selected—in this case, the chosen arena is the super- and hypermarkets available online, i.e., the e-retail market. Secondly, the regions where these trades happen are chosen—since this work aims to compare two economic blocs, Mercosur and the EU, these are the regions of the randomly selected e-retailers. Thirdly, data relating to the number of products and the variety of GIs present in online retail supermarkets of these blocs is collected. Fourthly, the analysis of these indexes is undertaken in both categories, considering GI categories and their origin. Finally, the comparison between Mercosur and the EU is conducted. After that, a discussion of the findings takes place and possible outcomes are debated. Over the following subsections, we detail each step of this analytical work according to Scheme 1.

Since "markets are socially constructed arenas where repeated exchanges occur between buyers and sellers under a set of formal and informal rules governing relations among competitors, suppliers, and customers" (Fligstein and Calder 2015, p. 1), they also need to be also investigated while considering these biases. Thus, the intention is to collect data indicating the GI products markets' differences from the perspective of both economic blocs.

Considering specific issues, it is necessary to clarify some details. This work involved a search for products and respective GIs on retail supermarkets and hypermarkets that allow web shopping. If the website requires an address to shop, the center of the country's most populated city is used. All GI agrifood products registered on the EU or Mercosur database were considered. Only agrifood products were collected and considered for this work; wines, spirits, and aromatized wines were not considered.



Scheme 1. Methodology of analysis of the GI market arena.

However, before searching the products sold across all countries, it was necessary to find the existing GIs. To do that, it is crucial to understand that there is a single register source for the EU, but there are independent ones for each of Mercosur's countries, according to Fracarolli (Fracarolli 2021). Therefore, this work contemplated all EU registers and all registers in each Mercosur country. On the European side, this work examined the EU database at eAmbrosia (European Commission 2020). Overseas, the considered data were from the available dataset from each authority from Argentina, Brazil, Paraguay and Uruguay (INPI 2020; Prosur Proyecta 2020; Ministerio de Agricultura, Ganadería y Pesca 2020); however, Paraguay is still in the process of registering products and Uruguay only has registers of wine products. Since this work does not contemplate wines, spirits, or aromatized wines, there were no products from Uruguay or Paraguay.

For the data collection, we went through the websites of four major grocery retail supermarkets for all of the active members of Mercosur (Argentina, Brazil, Paraguay and Uruguay) and the most representative EU members (Italy, France, Spain, Portugal, Greece, Germany, and Poland). The criterion for choose these countries was the need to pick the most relevant GI markets of each. In the Mercosur case, all active members were selected due to most of the available countries allowing for comparison. Additionally, these countries chosen from the EU represent over 80% of the EU's GI registers, which ensures a significant number of registrations for a relevant comparison. For each supermarket, all products with a GI label registered in the respective country were considered.

This work uses the EU criteria to separate the products into comparable categories available at the European Commission on eAmbrosia (European Commission 2020). The categories for agrifood products are: 1.1 Fresh meat; 1.2 Meat products; 1.3 Cheeses; 1.4 Other products of animal origin; 1.5 Oils and fats; 1.6 Fruits, vegetables and cereals fresh or processed (FVC); 1.7 Fresh fish, mollusks and crustaceans and derived; 1.8 Others such as spices; 2.1 Beers; 2.2 Chocolate and derived; 2.3 Bread, pastry, cakes and alike; 2.4 Beverages from plant extracts; 2.5 Pasta; 2.6 Salt; 2.7 Natural gums and resins; 2.8 Mustard paste; 2.9 Hay; 2.10 Essential oils; 2.11 Cork; 2.12 Cochineal; 2.13 Flowers and ornamental plants; 2.14 Cotton; 2.15 Wool; 2.16 Wicker; 2.17 Scutched flax; 2.18 Leather; 2.19 Fur and; 2.20 Feathers.

3.1. Analysis

The proper analysis of the captured data in a single presentation of the numbers does not represent the market's complexity. The use of graphical tools is significatively more representative and able to demonstrate in-depth aspects. Considering the broad-spectrum analysis, two approaches are necessary to bring light to this market. The first considers

the number of GI products in the online markets of both Mercosur and the EU and the respective origins in each category. The second considers the diversity of GI registers in both economic blocs and their respective countries by category. To do so, using this data, a set of graphics will demonstrate the above mentioned.

The first analysis considers the number of products found over the 44 e-retail markets. Data will be analyzed from both Mercosur and the EU in terms of the origin of the found products and in terms of category representations on the product offerings. These data will show the most relevant type of products commercialized in Europe and Mercosur and which are the most appropriate sources of these products.

The second analysis relates to the diversity of the GI products commercialized in e-retail markets in both blocs. Data will be presented regarding the origin of the GIs found and the categories in which GI is sold in these markets. These results will show how these registers' diversity is presented and how this is reflected in the e-retail market.

After all data and graphics are presented, the paper analyses the numbers, perspectives and meanings of all of the data. The data and graphics will show how the market behaves in terms of the number of products and the sector's relevance. Each part of the graphics will appropriately represent the category's share and its influence on this market. Afterward, in order to be comparable, both Mercosur and the EU will be put side by side on the treemap so they can be more intuitively represented. By doing so, the work focuses on the embedded aspects of local/global issues, such as the importance of niche markets. This methodology aims to clarify some aspects, such as the role of origin-related production pointed out by McMichael (1996) and the market's consumer arena objective as questioned by Hinrichs (Hinrichs 2000). Additionally, as demonstrated before by Belletti et al. (2017), this work's results can improve the policy towards proper regulation and valorization through development by enhancing knowledge of this market.

3.2. Comparisons

After all data are collected and analyzed separately, quantitatively and qualitatively, it is possible to compare this research paper's two main aspects. Firstly, what is the difference between Mercosur and the EU for the reality of GI product commerce in online retail supermarkets? By comparing the number of products, we expect to see the difference between both in terms of product offerings and in terms of diversity of products. By comparing GI registers, we hope to see the reflection of how effective the system is in reflecting the registers into the actual market.

Secondly, by examining the treemap graphics, the comparison between both blocs will show the actual niche formation: i.e., from whom, to whom, and the categories of goods that are more relevant to this market. The results are expected to show how significant the GI agrifood market is in the e-retail sphere in both economic blocs via a qualitative and quantitative approach.

4. Results

This collected data resulted from the scraping of 2184 products from 44 online supermarkets from 11 countries. This search presented the selling of 314 different GI registered products. GI products' search was conducted on four of the most popular grocery retail supermarkets in each country. Although some other relevant supermarkets could have been part of this research, many did not have an online shop. The results shown above are separated initially into economic blocs and posteriorly by the number of products and GI diversity.

4.1. European Union

The empirical results of the data collection contained information from 28 online supermarkets across the eight countries. The survey found 1784 products labeled as GI products. From those products, 462, or 25.90%, were found in French supermarkets, with France being the country with the most products. Spain, on the other hand, with 128, or

7.17%, meaning that it was the country with the least number of products. Besides, of the 1706 GI products from the countries surveyed, the research found 59 other products from Austria, Denmark, Netherlands, and Ireland within the economic bloc, a total of 98,93% of the GI products from the bloc. Besides, seven other GI products from the United Kingdom (UK) and 12 from Cambodia were from outside the bloc, a total of 19 or 1.07%. No products from the Mercosur were found. Nonetheless, 1005 or 56.33% of the products belonged from the 1.3 category, the most relevant one. The categories 1.9, 2.0, 2.2, 2.4, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.19 and 2.20 presented zero products.

All these 1784 products constituted 289 different GIs. Besides the GIs from the surveyed countries, there were 276 different GIs from the surveyed EU countries, ten other GIs from other EU countries and three from outside the bloc. Italian markets showed 81, or 28.03%, different GIs from the researched countries, as the one with the greatest numbers. On the other hand, Poland has six, or 2.08%, different GIs, being the country with the lowest numbers. From the 10 GIs found from other EU countries, one belonged to the 1.2 category, and the other nine were found in the 1.3 category. With regards to the products from outside the bloc, the survey found two different GIs from the UK and one from Cambodia. Additionally, category 1.3 not only had the greatest number of products but was also the most numerous relevant category in the number of different GIs. Category 1.3 had 105 different GIs, or 36.33%. Since the categories 1.9, 2.0, 2.2, 2.4, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.19 and 2.20 presented zero products, no GIs could be summed up.

As presented, the variety of GIs from inside and outside the EU is significantly alike the number of products from inside and outside as well, as presented in Figure 1.

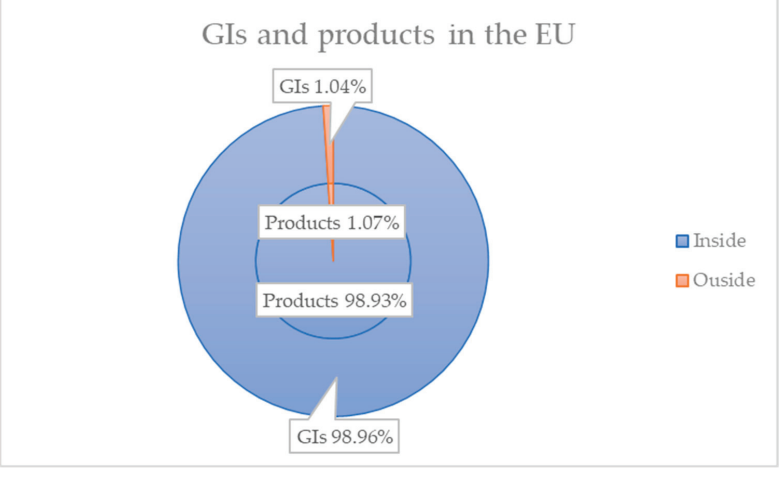


Figure 1. Origin of offered products and GI registers in e-retail markets of the EU.

Figure 1 shows that almost all of the products found in the survey come from countries that belong to the EU. Only about 1% of the products are from outside the bloc. The same happens when it comes to the varieties of GIs found in the EU e-retail markets survey. The GIs from outside the bloc found on the survey are barely representative, as it is only about 1%. This survey demonstrates how protective the bloc is of its own goods and how open it is to goods from outside. It demonstrates a severe protective system and the effectiveness of the EU policy towards valorization of inner goods.

On the other hand, there is a minor difference between GI registers and the number of products in the EU's e-retail markets regarding the categories of products. Such difference is clearly demonstrated in Figure 2.

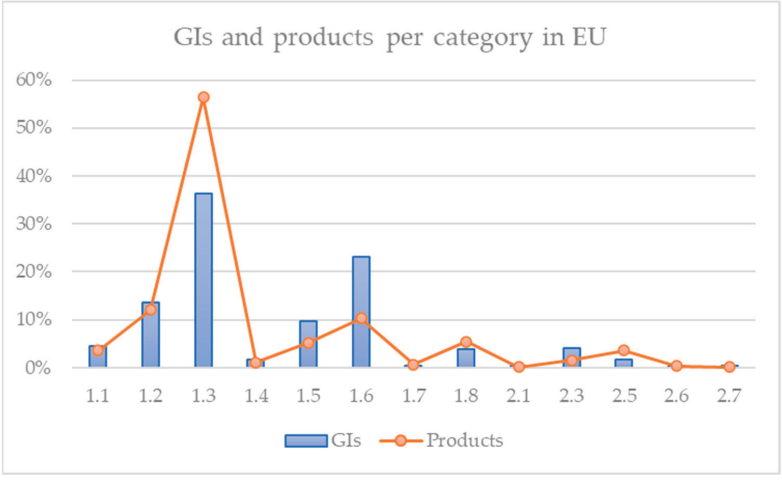


Figure 2. Products and GI registers in e-retail markets of the EU regarding categories.

This second graph shows a different perspective. Concerning the products found over the course of the survey, it shows similar proportions of both products and varieties of GIs in each category. However, in terms of products, category 1.3 (cheese) has an evident distinctiveness from the others, consisting of almost 60% of products found. Furthermore, in terms of GI varieties categories 1.3 (cheese), 1.6 (FVC) and 1.2 (meat products) all consist of over 10% of products. However, these data also show the system's concentration on promoting a few select categories, predominantly the cheese category.

4.2. Mercosur

The results of the Mercosur bloc presented significantly different findings from those of the EU. The empirical results of the data collected information from among the 16 online supermarkets of the four countries. The survey found 388 products labeled as GI products. From those products, 180, or 46.39%, were found in Argentine supermarkets, with Argentina being the country with most products. Paraguay, on the other hand, with 43, or 11.08%, was the country with the least number of products. Additionally, the GI products found from within the bloc were 185, or 47.68%. Besides, all other GI products found were from the EU, a total of 203 or 52.32%. The categories 1.1, 1.4, 1.7, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.19 and 2.20 presented zero products.

All these 388 products constituted 25 different GIs. The GIs from Mercosur constituted a total of six, and the remaining 19 were all from the EU. From within the economic bloc, Brazilian markets showed three, or 50%, being the country with the highest numbers. Neither Paraguay nor Uruguay had its products available. All other 19 different GIs were: five in category 1.2; ten in category 1.3; two in category 1.5; one in category 1.6; and one in category 1.8. The EU countries with GI products available across Mercosur's supermarkets were Italy, Spain, Greece, France, Denmark, and Portugal. Additionally, category 1.3 not only had the greatest number of products but was also the most numerous relevant category in terms of the number of different GIs. Nonetheless, 216 or 55.67% of the products belonged to category 1.8, the most relevant one, of which 169, or 78.24% of the 216 products were either coffee or Yerba Mate. All other products from this category were the Aceto Balsamico di Modena from Italy. Category 1.3 had 11 different GIs or 44% of all GIs found in Mercosur. Since the categories 1.1, 1.4, 1.7, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, 2.19 and 2.20 presented zero products, no GIs could be summed up.

Conversely to the results presented in the above subsection, there is a significant difference between the number of products and the diversity of GI registers in Mercosur. Moreover, contrary to the EU, most products and GIs are from outside the economic bloc, as shown in Figure 3.

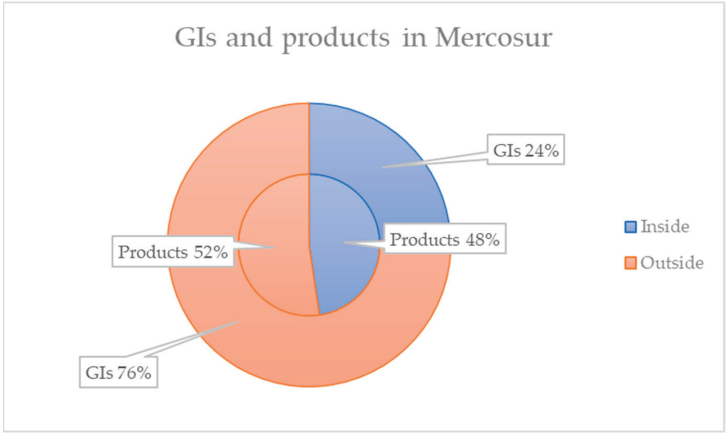


Figure 3. Origin of offered products and GI registers in e-retail markets of Mercosur.

On the Mercosur side, the data evidences a different situation from the EU. In terms of products, more than half of them were from outside the bloc. Likewise, the variety of GI that appeared in the results brings about a scenario where three-quarters of the GIs on the market come from outside the bloc. All of the products and GIs from outside the bloc come from the EU. This demonstrates the influence of the EU system over others, such as Mercosur. Additionally, the proportions demonstrated in this research show each system's capacity to overcome one another.

Regarding the categories that appeared on the South American side, fewer categories were present. Additionally, there is an unmatched proportion of GIs and products found between the categories 1.3 and 1.8, as demonstrated in Figure 4.

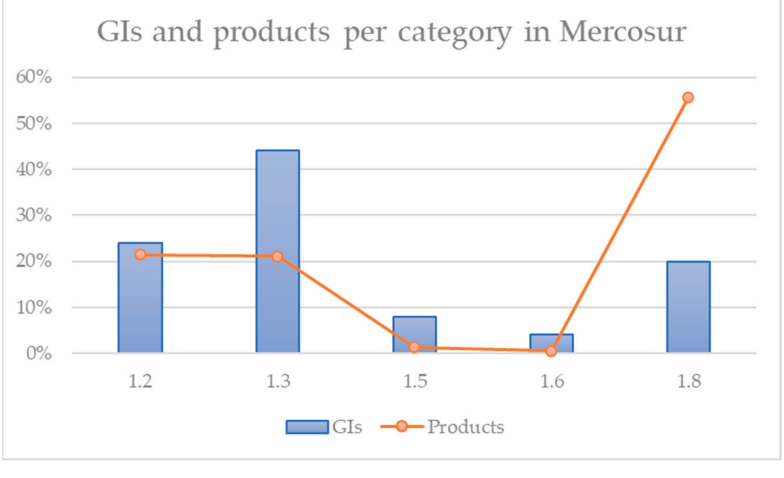


Figure 4. Products and GI registers in e-retail markets of Mercosur regarding categories.

In Figure 4, the results present a disordered situation. Mercosur's findings contained only five categories of products. Unlike the EU, Mercosur does not have registered products in all categories (INPI 2020), and Paraguay and Uruguay have no registered agrifood products other than wine. Therefore, the results are more a sum of efforts than an aligned strategy. Even the category with the most products (1.8) is substantial due to only one product from inside the bloc (Yerba Mate, from Argentina) and a significant participation of a product from outside the bloc (Aceto Balsamico di Modena, from Italy). Moreover, over 40% of GIs found are European cheeses.

4.3. Overview

The overall results show a vast difference in GI products' online market performance between Mercosur and EU. Meanwhile, the number of GI products found is 388 at Mercosur supermarkets and 1784 in the EU, representing 97 products per country for the former and 254.9 for the latter, as shown in Figure 5. It shows the proportions of GI products by their origin found in each group of e-retail markets. The first observation allows the inference that most GI products found in the EU markets are from within its countries, mainly from the Mediterranean ones. On the other hand, in Mercosur's markets, about half of GI products are from outside. The GI products from within are mainly from Argentina.

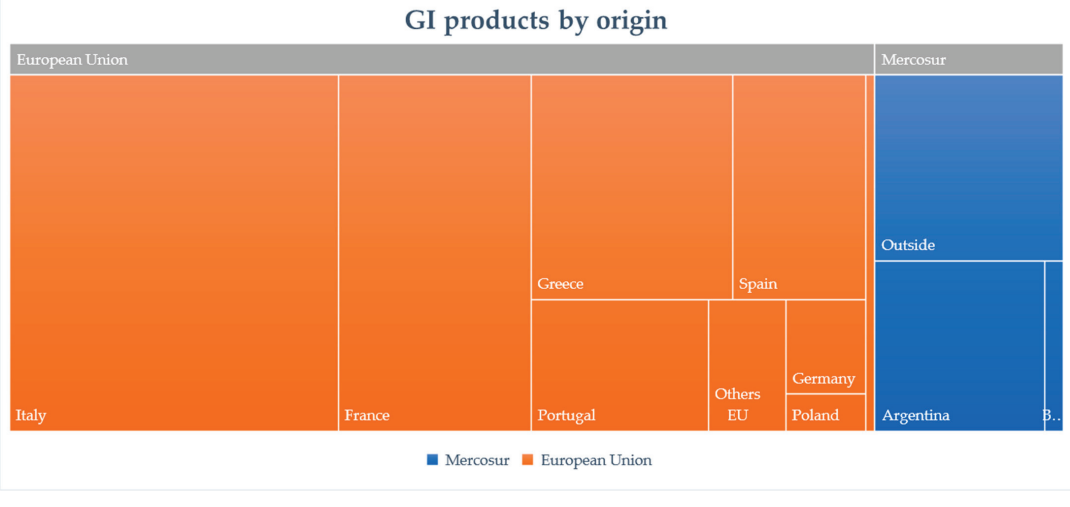


Figure 5. GI products in e-retail markets of Mercosur and the EU according to the origins.

Besides the products, the issue of the origin and proportions of the wide variety of GIs present on the markets of each economic bloc is another important issue to consider. In Figure 6, there is a clear demonstration of the data collected. This graphic shows that the products' origins have a similarity between the number of products and the number of registered GIs present in each bloc. However, there are a few differences, such as the proportion of the variety of GI in Mercosur, which is now more abundant from countries outside the bloc.

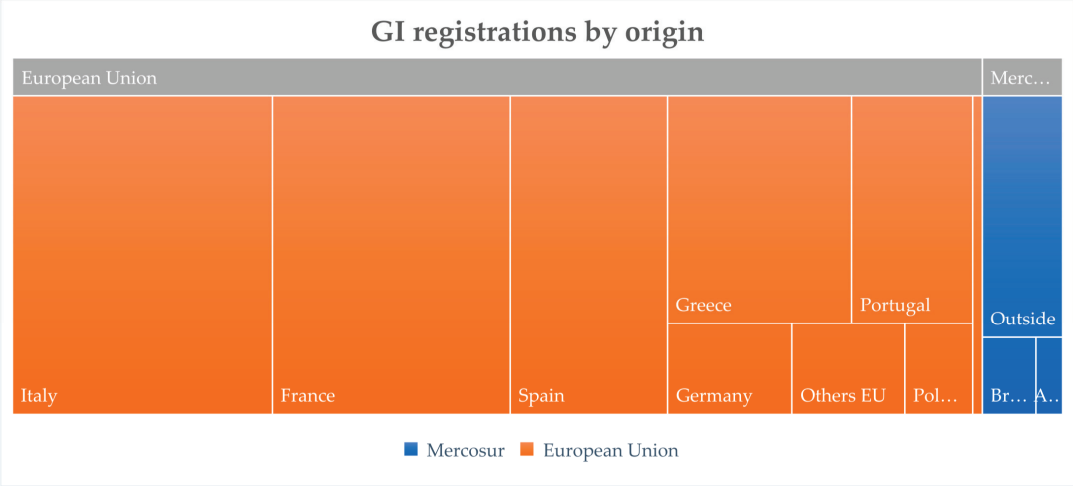


Figure 6. Presence of GIs registrations on Mercosur and in the EU in the e-retail market by country.

One other important aspect of the analysis is the issue regarding the number of registrations in each bloc and the number of GIs actually present on the e-retail market. As shown in Figure 7, only a small portion of registered products appeared in the survey for both blocs.

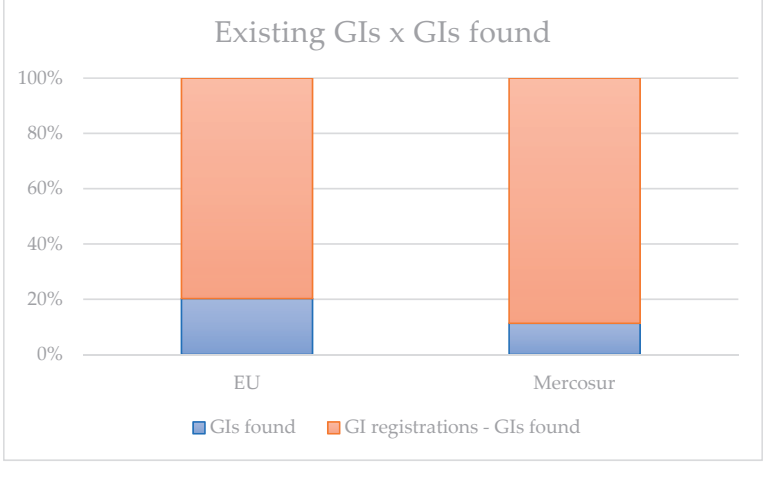


Figure 7. Difference of existing GIs versus GIs found in e-retail market in Mercosur and the EU.

Figure 7 shows that only 286, or 20.23%, GIs were found on the EU e-retail market from 1414 existing intrabloc registrations, while in Mercosur, only 6, or 11.32%, were found from 53 existing GIs. These results allow an inference that in the e-retail market, there is an absence of representation in both blocks, although, in Mercosur, the representation is even more fragile. This graph demonstrates that even a substantial number of registrations do not guarantee a product's presence in the market—or at least in the e-retail market. Besides, this denotes that whichever economic bloc is in question has an underrepresentation of its protected products. However, considering the abundance of products in the absolute and relative terms that appeared on the survey, the results point to different reasons. The

EU has demonstrated a significant number of products and GIs despite the poor results on representation. Therefore, the characteristics suggest that such a scenario is more related to a focused commercial strategy based on a robust institutional system, as is discussed later on. On the other side, considering the absence of products and barely representing GI varieties on major e-retail, the results suggest a discussion of the lack of systematic and coordinated policy towards developing the GI market. Nonetheless, all the possible causes and implications of such a path are discussed in the next section.

5. Discussion

The difference between the Mercosur and the EU is evident. Three aspects are crucial for understanding the differences between them: the number and diversity of GI products, the categories of these products and their GI diversity, and the products commercialized in this kind of arena.

The first one relates to the number of products. Figures 1 and 3 show an enormous difference between the blocs on the number of products surveyed in e-retail markets. The EU presented 4.6 times more GI products than in the Mercosur region; however, this is not due to the number of countries, since the EU has 254.9 products per country and Mercosur has only 97. Additionally, the origin of those products is another important fact for this comparison. As presented in Figure 5, only 19 products were from countries outside the bloc, while in Mercosur, the number of products from outside the bloc was 203, more than half of the total. All of the 203 products found in Mercosur's markets were from the EU, and none of the foreign products in the EU were from Mercosur.

This asymmetry indicates that products' presence is not from bilateral agreements but due to a nontariff protectionist strategy of the agrifood market developed by the EU, as endorsed by some works and more relevant in the Mediterranean region (Josling 2006; Huysmans and Swinnen 2019; Huysmans 2020). Additionally, in the EU, the proportion of foreign products is similar to the variety of GI in the market. On the other hand, in Mercosur's e-retail markets, the proportion of inside products in the market is twice the proportion of the variety of GIs. This is due to the abundance of one specific product from within, Argentine Yerba Mate, as demonstrated in category 1.8 of Figure 4.

Consequently, such a scenario presents the assertiveness of Granovetter's (1985) approach on the association of economics and social action. The clear difference between inner products in each bloc demonstrates that the market is not only a matter of supply and demand but construction of the field. The detachment of this niche category through IP rights configure a field as theorized by Fligstein (2001) and Fligstein and McAdam (2012). Thus, the stabilization of this market involves strengthening the social relationship between the productive class and the state, as supported by Fracarolli (2021) and the argument pointed by Belletti et al. (2017) on the influence on private and public interventions.

However, the creation of the GI label does not guarantee this new field. The institutional support of the state, as pointed by Fracarolli (2021), pushes the market stabilization and promotion not only within territories but towards a conception of control as conceptualized by Fligstein (2002) and tends to protectionist measures, as previously observed by Swinnen (2007, 2016) and Huysmans and Swinnen (2019).

The second aspect regards the products' categories. There are significant differences between the economic blocs regarding the categories of products available via e-retail in both regions. In comparison, the EU has products in a broader diversity of categories. There were 13 categories of 30 on the electronic shelves of the EU. Among the products found, cheese products stand out, representing almost 60% of all products. On GI variety criteria, the cheese, FVC, meat products and oils represent more than 80% of GIs found, as shown in Figure 2. Despite all categories, the products and GIs commercialized in e-retail supermarkets focus only on a few types of products. On the other side of the Atlantic Ocean, the scenario is even more restricted. Only five of all these categories had products on display in e-retail markets in Mercosur. Among these products found, such as the EU, the cheese category presented the most GIs on the market, as shown in Figure 4. Products

and GI registers in e-retail markets of Mercosur regarding categories. However, it did not reflect on the number of products on the market. Regarding the products' criteria, category 1.8 had more than 50% of all found products. This is mainly due to the 153 "Yerba Mate" products and the 47 "Aceto Balsamico di Modena" products found in the supermarkets surveyed.

The difference in the variety of products found in both blocs brings the discussion onto the purposes of GI as a form of IP. Since fewer than half of the categories in both blocs had products available in e-retail markets, this raises a question on the reasons for such low performance and underrepresentation. Additionally, it needs to be asked where are these other products are sold and if they are sold. For such questions, further research is necessary. By number of registrations, wines, spirits and aromatized wines are the main focus of the EU GIs. However, this work looks only into agrifood products that exclude those beverages. There are few relevant protected categories for agrifood products presented by Figures 2 and 4. The reasons for seeking such a modality of IP could be either counterfeit protection or economic enhancement and value-adding.

The results found in this research are in accordance with Dias and Mendes's (2018) work regarding the variety of GI products. As discussed by Meloni and Swinnen (2018), Huysmans and Swinnen (2019) and Josling (2006), the southern countries of Europe stand out in this market. Therefore, it is a natural assumption that their product categories are brought into the spotlight. Such an event raises questions about the reasons for these categories to stand out, being important factors to consider in addition to the valuation premium due to the label, an ordinary object of studies (Bureau and Valceschini 2003; Crespi and Marette 2003; Deselnicu et al. 2013; Chilla et al. 2020). The distribution of product categories demonstrates the strength of the EU's IP protection quality scheme and the strength of the federalism of the EU's institutions (Fligstein 2008a). However, the research showed that most GI registers in Mercosur and the EU are not reflected by the actual market, specifically in electronic supermarkets. Moreover, such performance shows that IP rights protection does not guarantee market share, and there are possible dominant groups within the influential groups. However, such an assumption requires further studies.

The last aspect regards the number of existing registrations and the number found on the e-retail survey. Despite the significant difference between the proportions of both blocs, both severely lack absolute representation. The EU has only 20% GIs found, and Mercosur has only 11% from the existing ones. The vast majority of products not found over this survey need to be deeply investigated. If not e-retail, what kind of market is their arena of commerce? Much study has been done on wines (Agostino and Trivieri 2014; Addor and Grazioli 2002; Teuber 2011; Meloni and Swinnen 2018) and other more consolidated agrifood markets (Lamarque and Lambin 2015; Roselli et al. 2018; Dentoni et al. 2012; Hughes 2006). Nevertheless, research on less famous products can bring light to the functioning of this market.

Further investigation is required on the current economic activity of GI registrations that did not appear in the survey. The variety of unrepresented products needs further investigation. The reasons for this could rely either on the failure of the value chain of economic activity, on strictly regional commerce or on the lack of socio-political performance to guarantee similar representation for other products in the same categories. Again, the stratification of these categories and the concentration of categories sustain Swinnen's (2007, 2016) argument that the embeddedness of social organizations and state institutions develop arrangements that favor particular groups. The underrepresentation of such GI products enlightens the market on the matter of the results of embeddedness between groups of producers, commerce arenas and state institutions. Markets are social actions, as stated previously by Granovetter (1985), Abramovay (2004), and Allaire (2010), which require interventions by all involved parties in order to build and stabilize. The GI market is no different and this is reflected on e-commerce as demonstrated. Consequently, the EU

has a more stabilized and solid market, despite a significant lack of registered GIs in the arena.

Therefore, considering the EU and Mercosur results, the market's configuration approached points for strategic analysis. The EU, despite having a broader range of categories with significantly more registered GIs as well as translation of these GIs into products, there is a clear focus on goods such as cheese, meat products, oils and FVCs. On the other hand, Mercosur has only a few categories represented, not only in products available via e-retail but also on registrations (Fracarolli 2021). The divergent focus on strategy between countries is reflected in a market that cannot develop its full potential. It indicates that the focus on some products may incentivize others to seek GI protection. The focus on categories of products can improve commerce and benefit others. This slow snowball effect can boost commerce relations and serve as a bargaining chip subject to include other matters, also requiring further investigation.

Nevertheless, the intensifying of trade can benefit "decommodified" networks of producers by cooperation. Such detachment of products allows the institutionalization of commerce to operate in an embedded way through the state, which can now bargain for differentiated economic treatment. In this case, the Mercosur–EU agreement in the final stage involving GI products could benefit the market, although, some interest groups with higher tier state relations may operate to set asymmetric standards for privileged actors (Swinnen 2010, 2016).

6. Conclusions

This work aimed to compare Mercosur and the European Union in terms of the performance of GI products and categories in this market exchange arena by analyzing e-retail supermarkets. To do such work, the investigation surveyed 44 e-retail supermarkets in 11 countries, seven of which were from the EU and four from Mercosur, in order to compare the GI market of both economic blocs in terms of product offerings, variety of products and effectiveness of registration. It consisted of a five-part analysis, according to Scheme 1. First, the research consisted of agrifood products labeled as GI, excluding wines, aromatized wines and spirits, resulting in 2184 products from 44 online supermarkets from 11 countries. This search presented the selling of 314 different GIs. Second, after the survey, the work classified the products according to the eAmbrosia database. Finally, it analyzed the collected data according to three essential aspects of GI in retail markets: GI offerings, the origin of the goods and the geographical influences from each bloc.

The survey of these websites revealed an expected difference between the two blocs. The differences are revelatory. The EU has a much more active GI market, well represented from within in terms of both products and GIs, and focused on specific goods categories, while Mercosur has a significantly less developed market shown on e-retail due to having fewer products and GIs in absolute and relative terms, a disadvantageous proportion of outside/inside products, and GI variety expressively for inner economy and production, along with a disordered strategy towards agrifood GI segments.

The global system leans toward expansionist capitalism, strengthening the mass production of agrifood goods by massification and standardization (Bonanno and Constance 2001). However, it also results in a countermovement in search of different, more culturally relevant products. This phenomenon creates niche markets regulated by state or suprastate institutions in the case of GI products. These regulations are embedded between the state and interest groups of niche producers. Nevertheless, they can be beneficial for intensifying the trade in value-added products and supporting the primary sector on a broad spectrum, particularly smallholder agrifood farmers.

The evidence presented in this paper supports the premise initially stated that the EU and Mercosur have a significant market difference regarding the e-retail of GI products. The differences concern quantity, variety and representativity. Such differences find pathways by strengthening strategic sorts of goods that lead institutional mechanisms towards economic benefits. Despite the risk of agendas and equity treatments being hijacked by

interest groups, state actions on economic and development policies can be beneficial to smallholder farmers and culture-related agrifood producers by institutionalizing the differentiation of these products. The difference in the category of products capable of pushing forward others still requires further investigation. However, a consistent strategy for the improvement of the economic bloc points to developing the whole protected system and products. The strengthening of the system can also serve as a positive commercial-driven strategy for the primary sector of the economy. Moreover, it can promote steps towards a culturally embedded with broader democratic spectrum in the agrifood sector. Likewise, by fostering such a niche economy, there can be a positive impact on other sectors such as tourism.

Additionally, the present work revealed three major issues regarding the present market. The first one relates to the number of products. The number of GI products that appeared on the survey on e-commerce in EU markets is significantly greater than in Mercosur. This is mainly due to the strength of the institutional arrangements of each bloc. Thus, the presence of GI products shows an apparent asymmetry of inner-bloc GI performance. The second aspect regards the products' categories; here too the EU has a broader representation than Mercosur. However, even in this scenario, only a few categories were represented in e-retail in both economic blocs. This also denotes the cruciality of political institutions and their relations with the producers of such categories. The last aspect concerns the absence and underrepresentation of most GI products in e-retail major supermarkets of both blocs. This discovery, despite being relevant to scientific enlightenment, needs further investigations to clarify its causes. Furthermore, the reasons rely either on the failure of the value chain of economic activity, on strictly regional commerce, or lack of socio-political performance. Overall, the creation of the GI label does not guarantee that a new field, as in Fligstein and McAdam's (2012) concept, prevails and finds favorable conditions in a niche market.

Finally, the present work brings novelty into the e-retail market of GI products in the EU and Mercosur. The mentioned findings present the importance of the socio-political construction of this market. It also points to the importance of market-oriented normativity for the development of GI products and their culturally embedded aspects. Such properly planned construction can promote the development of agrifood products.

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Import Risks of Agricultural Products in Foreign Trade

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Abstract: This paper aims to identify the main risk groups according to their significance on imports of agricultural products. After analysis of the scientific literature, eight groups of risks associated with agricultural products import were determined: supply risks, demand risks, production risks, management plus operational risks, logistical plus infrastructural risks, political risks, policy plus regulatory risks and financial risks. In order to assess the importance of all import risk groups, three Multicriteria decision support methods (MCDM)—SAW, TOPSIS and Geometric means—for expert evaluation are used. The article introduces a new import risks assessment framework CIRA (Country's Imports Risk Assessment) contributing to the systematic approach of a country's international trade risks management. The results order risk groups according to their importance in the following order: production (the most crucial risk group), logistical plus infrastructural, financial, management plus operational, political, supply, policy plus regulatory and demand risks.

Keywords: import risks; agricultural products; agro-trade; food import; SAW; TOPSIS; geometric means

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1. Introduction

In 1919, J. M. Keynes already expressed the wish that, "the inhabitant of London could order by telephone, sipping his morning tea in bed, the various products of the whole earth... and reasonably expect their early delivery upon his doorstep" (Keynes and Volcker 1920, p. 50). What was once a courageous wish has now become reality. During Industry 4.0, especially due to the COVID-19 pandemic, many ordinary customers are accustomed to modern trade tools such as various e-commerce channels for ordering goods from different parts of the world, with delivery to their destinations (Mehrolia et al. 2020). Global supply chains and their potential are no longer surprising. The main point of interests become customer wishes, prices and terms of delivery. Shrinking trade restrictions between countries, which mainly consists of free trade agreements, technological opportunities and countries aiming to boost trade, have led to transactions with an increasing number of international trade partners and results in increasing chances and increasing business risk.

On the other hand, trade growth has affected the risk increase in the food sector. For example, after the horsemeat scandal in 2013, the importance of food safety has increased in Europe (Rieger et al. 2016). Cases of food scandals encouraged more research, which revealed more facts that are significant. The NAO (2013) reported, "Recent analysis of the components of a pizza, carried out for the Food Safety Authority of Ireland, found that pizza was made from 35 different ingredients that passed through 60 countries, on five different continents". Since 2013, globalisation is still growing. Countries are increasingly interlinked and processes are becoming more and more challenging to maintain. International trade regimes (e.g., import bans) and technical possibilities (e.g., border controls) cannot fully guarantee import security, thereby increasing the risk of unsafe food imports (Skuland 2020).

However, the risk of unsafe food imports is not the only one related to imports. Studies of the World Economic World Economic Forum (2019) revealed the world's most

considerable potential risks (e.g., climate change risk) and identified the most significant risks affecting the whole world. The majority will affect the agro sector. The OECD (2020) notes that agricultural policymakers mainly focus on primary agrarian production problems. A food systems approach emphasises the possible effects of agricultural policies on nutritional and environmental outcomes. The results achieved by the world food system from the 1960s to the present show impressive achievements: the world's population has more than doubled and world food production has tripled. Thus, more food per person is provided at a lower price and achieved through increased productivity. It would be impossible to balance the population's nutritional needs with environmental well-being. Among other things, food systems provide a livelihood for those working in farms worldwide and the agro sector's food supply. Food systems depend on natural resources and must simultaneously contribute to environmental sustainability and people's livelihoods. The "triple challenge" is marked as a strike balance between food security and nutrition, ensuring people's livelihoods and ecological sustainability in pursuit of Sustainable Development Goals. There is no doubt that food systems face a daunting triple task that needs to be addressed urgently by seeking synergies between trade-offs and policy coherence challenges (OECD 2020).

Nevertheless, international trade is essential for all countries, especially for small ones since their economic development is based on international trade. It is noticeable that most policy measures promote exports (EC 2015), while imports are not encouraged (Moreno and García-Álvarez 2018; Van den Berg et al. 2017; Wymenga et al. 2013; Kulikov and Minakov 2018). Van den Berg et al. (2017) studies look at the link between imports and a firms' productivity. Although scientists note that the relations between the company's import and export performance are not fully explored, productivity is an intermediate factor in import–export relations. Wagner (2013) studies show that importing firms are more productive than non-importing firms are. The link between importing and productivity is manifold (Van den Berg et al. 2017).

While international trade is widely studied around the world, it does not address the risks related to it (Gervais 2018). The response to threats remains quite essential and responsible, ensuring stability and trade of each country. It is evident that import risks were previously analysed separately (Huang et al. 2017; Caccavale and Giuffrida 2020; Hyuha et al. 2017; Shmatko et al. 2020; Caccavale and Giuffrida 2020) or incorporated into global supply chains (Zhao et al. 2020; Behzadi et al. 2018; Laborde et al. 2020). The gap is noticeable in analysing import risks for a single country. Import risks can harm a country's trade and their management can improve a country's trade performance.

The purpose of this article is to identify the main risk groups for imports that need to be examined in the context of trade in agricultural products in the country and to adapt them according to their importance for the management of international trade. Research focuses on the macro-level risks without going into micro risks incurred vis-à-vis enterprises. Analyses of the scientific literature and Multicriteria decision methods are used. The risk groups set out in this article could help to manage a country's argo trade. Current work introduces a new imports risk assessment framework, CIRA, contributing to the systematic approach to a country's international trade risks management. The case of Lithuania is used.

2. Literature Analysis

Import risks are analysed by researchers from a variety of perspectives and for different purposes. Some articles identify risks and seek solutions to mitigate them (e.g., Zobov et al. 2017, etc.). Other articles identify, assess and provide recommendations to reduce risks (e.g., Welburn et al. 2016, etc.). Since the agricultural sector provides everyday products that affect the quality of life, it is the cornerstone of each country. Despite this, the farm sector is analysed as a risky and sensitive sector (Novickytė 2019). The risk of production is identified as one of the highest (Hardaker et al. 2015). It is noticeable that low cost and price competition is decreasing worldwide and it remains dominant in those sectors where the

main factors involved in production are natural resources and low-skilled labour, which is relevant to the agricultural and food sector (Drozdz 2018).

The literature analysis reveals five types of import-related risks: (1) food security, (2) food quality (food safety risks), (3) risks for natural resources (risk of uneven distribution of natural resources due to the trade), (4) risks for the labour market and (5) risk of stable supply.

Many scientists devoted their research to import security risks (Huang et al. 2017; Caccavale and Giuffrida 2020; Hyuha et al. 2017, etc.). Import security risks are risks related to importing a sufficient quantity of food at affordable prices and in the required period. Despite all the risks, imports are organised for three purposes: import to produce, to re-export and import to consume. It is important to manage all these flows of goods to achieve their trade objectives. Feng et al. (2016) confirmed complementarity between imports and exports. They noticed that product improvement through technology and quality development depends on imported raw materials. It has been observed that all companies that have expanded their imports of intermediate raw materials have grown their export volumes, but the distribution of benefits remains uneven. The distribution depends on the source of import, industry intensity and the conditions of the company's ownership.

The most significant impact was observed when imports were made by private sector producers rather than by non-traders. Comparing import sources showed that intermediate costs from higher-income countries were more beneficial and facilitated exports to more demanding and profitable G7 markets. Van den Berg et al. (2018) examined the link between imports and firms' productivity, where productivity is an intermediate factor in import-export relations. Scientists note that the connection between the company's import and export performance has not yet been fully explored (Van den Berg et al. 2018). Wagner (2012) research shows that importing firms are more productive than non-importing because importers themselves enter international and global supply markets and buy higher quality intermediate products at lower costs, which contributes to the competitiveness of their products. Moreover, participation in the international network provides opportunities to purchase more innovative technological products and to obtain foreign suppliers' tactics (Van den Berg and Van Marrewijk 2017).

Some authors analyse factors of one risk type, e.g., demand risks (Hyuha et al. 2017) or logistics (Shmatko et al. 2020). Others analyse risk factors along the entire supply chain (Zhao et al. 2020; Behzadi et al. 2018) or key risks to global food security (Laborde et al. 2020). Some studies cover all or several food groups and some studies examine the risks of only one food product (e.g., rice, cereals, etc.). The country's food security is a critical factor for governments that do not produce enough available food in their own countries. The reasons may range from insufficient natural resources for agricultural production: mountain areas, soil, water pollution and growing population (such as China, Korea, Japan, etc.). Analyses by Hyuha et al. (2017) showed that the determinants of import demand in the context of food security and concluded that one can control import demand by managing the following main factors: population growth, domestic production, prices in the country and countries domestic consumption. The research shows that the government could be self-sufficient and save foreign exchange costs if it controls high population growth and increases domestic production through high-yielding technologies by supporting farmers to increase domestic food production and by stabilising prices.

As international trade unites all countries and all countries are largely bound by the ideas of free trade and the work of international institutions such as the WTO, the prosperity of some countries depends on the possibilities provided by others. In many cases, the well-being of one country can be a threat to the well-being of other countries and this is particularly noticeable in the context of food security. Some countries lack food resources and others export those resources for financial gain. Many scientists analyse the dependence risk of food import (Huang et al. 2017; Caccavale and Giuffrida 2020; Hyuha et al. 2017; etc.). Often, the most significant threats are due to the capabilities and actions of

large countries. According to Huang et al. (2017), China will manage its import security risks and will not be at risk of the growing demand for food in the world in the foreseeable future. Among other things, imports of feed and certain specific foods (say soybean, bread, dairy products and sugar) could provide an opportunity for many exporting countries to expand their production and export to the Chinese market. Caccavale and Giuffrida (2020) analysed food security indexes (e.g., the Global Hunger Index (GHI), the Global Food Security Index and the Ending Rural Hunger Index) and proposed a new composite food security index, rendering it possible to measure the country's food security. Yu et al. (2019) dealt with the "triple high phenomenon" in China's cereals sector, where a high level of domestic production at that time did not result in a decrease in imports even when the stocks were high. A group of scientists analysed import security risks by analysing import substitution possibilities (Zobov et al. 2017). They stated that one can achieve the goals of import substitution only through the modernisation of production and the introduction of innovative technologies in the food industry. Khanal et al. (2018), by analysing trends in import and domestic production demand, found that product selection priorities differ between countries. The local population in some countries prefer local products (e.g., milk and tomatoes) to imported products.

Food quality risks (food safety risks) due to the health effects of imported food are examined by many scientists (Welburn et al. 2016; Herrera-Herrera et al. 2019; Attrey 2017; Ruhm 2016; Smith et al. 2017; Pietrzyck et al. 2021, etc.). The researchers analyse the safety of imported food for health by taking into account many aspects: countries of origin, products groups, qualitative parameters and trend of irregularities. Each country seeks to protect the health of its population by controlling the quality of imported food. Importing and exporting countries often have different systems and procedures for food inspection and certification. Compliance with quality requirements is a significant goal for many countries wishing to export. Welburn et al. (2016) analysed US food import risk infringements detected under the Operational and Administrative System for Import Support (OASIS) of the Food and Drug Administration (US FDA). Risks differ by product type (e.g., among fish products, vegetables or dairy products groups), type of infringement, economic factors (GDP) of the country and by the country of origin. Herrera-Herrera et al. (2019) investigated the content of heavy metals in fish from Colombia. Smith et al. (2017) analysed infectious risks related to importing to the US. The Attrey (2017) study showed that food quality control measures during inspections are effective and create confidence in the safety and quality of food supply. However, according to the authors, quality requirements can sometimes be an obstacle to international trade in food products. Increasing focus on the introduction and implementation of trade-distorting rules and regulations is making trade more difficult. Focusing on tightening the rules opens the opportunity to bypass the purpose of trade. As recommended by the WTO, cooperation in exporting and importing countries is becoming a cornerstone to ensure smooth and secure trade. Existing control systems should be set up following the approved guidelines.

Further studies analysed food safety from another perspective. Otero et al. (2018), looking at obesity problems and stated that food choices are structurally conditioned by income inequality and food supply offer. According to this study, people eat what huge oligopolistic food producers offer together with distributors. Moreover, the neoliberal position of a state creates the conditions for the market situation. Researchers have proposed a neoliberal diet risk index to assess people's risk of wholesome food. The index expands the limitations of existing measures, which usually hides the inequalities within countries.

Resource use risk is understood as the risk of unequal distribution of natural resources due to international trade in agricultural products. This risk focuses on the sustainable use of limited natural resources (e.g., water and soil) to produce food products and the distribution of emissions due to trade between countries. It is recognised that agriculture is linked to the use of natural resources. Different countries have an uneven approach to natural resources. Moreover, the production of both basic foods and all other food products requires various resources. For example, some countries lack suitable soil, others

lack water or lack fertiliser. In the course of trade, there is a risk that available economic resources will be over-exploited. The Zhu et al. (2019) study assesses the potential of China's water resources for agricultural production by the water stress index. They note that the processing industry can participate in the development of innovative technologies to address declining resources. Gemechu et al. (2016) analysed the risks of the supply and the sustainable supply of raw materials differentiated by countries according to import patterns. Bach et al. (2016, 2017) addressed pollution issues due to the global changes in industry and technical logic. A demand for abiotic resources has led to the increased pollution of natural resources, such as water and soil.

Only a few studies analysed the labour market import risk. Adda and Fawaz (2020) evaluated the impact of import competition on the labour market and the health of US workers and found that import shocks harm human employment, income and human health. They determined that imports had harmful effects on human physical and mental health, especially in areas where there is intense survivability competition. As a result, it has been observed that access to health care in those areas has declined, rendering the disease more severe. Then, more patients were hospitalised for their treatment. The impact of imported products on the market has led to an increase in the mortality of manufacturing workers. Lang et al. (2019), by examining the growth of imports from China, also found a negative impact in those areas on employment, income and health of the population.

Colantone and Stanig (2018) revealed the impact of globalisation on the results of the EU elections. The author examined the impact of Chinese imports on different regions and the results of their votes. According to the study, support for nationalist and isolationist parties for radical-right parties increased due to a stronger import shock. This reflects the results of the regional elections as revealed by the analysis of individual voting choices. Therefore, import risk can have a direct impact on the country's governance.

The increase in regional trade agreements (RTAs) reflects the growing need for such contracts in the last decades. The WTO's attempt to secure free trade agreements is limited (Hoekman 2019) and not all countries are well willed and equally treatable (e.g., usage of non-tariff barriers). Governments tend to benefit and gain specific advantages of trade using a variety of instruments. There are also different commercial reasons. It was found that, according to factors contributing to the increase in RTAs analysis, the usage of common languages and the influence of distances play an essential role. On the other side, geographical indication does not play a significant role in regional trade agreements (Jámbor et al. 2020). Moreover, it has been proven that countries trade with each other based on the size of their GDP, population, cultural affinity, institutional support and physical proximity (Jindřichovská 2020). The main reasons for trade often lie outside trade in agro products. Countries are promoting trade and seeking to maximise benefits, which does not always have a positive impact on the agro sector of the country.

Therefore, in order to improve risk management performance, there is a need to manage many supply chain risks effectively and efficiently. Many scientists (Zhao et al. 2020; Behzadi et al. 2018; Hyuha et al. 2017; Nyamah et al. 2017, etc.) analysed supply chain risks. Risks and uncertainty in supply chains are becoming increasingly relevant as food supply chains become more complex, especially in times of shocks such as pandemics. The interest in assessing vulnerabilities of supply chains, disruptions and disturbances increased. Some scientists analyse threats, crises and robustness effects. The analysis of supply chains includes many risks, such as output risk, market risks (covering both supply and demand risks), uninterrupted supply risk and substitutability of output as a factor in reducing output risk. For food security purpose, researchers analyse different risk factors and group them into different risk types. For example, Ho et al. (2015), by summarising literature of various supply chain risks, divide risk factors into macro-risks, micro-risks (demand, manufacturing and supply risks) and different types of flow (information, transportation and financial risks). Nyamah et al. (2017) and later Zhao et al. (2020), by analysing the entire supply chain risk factors, divide all factors into nine risk groups: demand-side risks, supply-side risks, biology and environmental risk, weather-related risks, management and

operational risks, logistical and infrastructural risk, policy and regulatory risks, political risks and financial risks. The authors also assess the critical risk factors found throughout the supply chain, which include the primary material source to the end consumer regardless of how many countries are involved in the supply chain. The COVID-19 pandemic has led to the stronger management of supply chain risks and more risk studies on food supply chains (Laborde et al. 2020; Sharma et al. 2020; Aday and Aday 2020; Jablonski et al. 2021). The revealed period of the pandemic showed that not only food supply companies but also different industries are closely connected. Any disruption in one part of the supply chain breach affects disruptions throughout the global supply chain (Aday and Aday 2020). Technological development enabled the use of advanced strategies and technologies for supply chain risk management, such as machine learning and big data (Ivanov et al. 2019; Baryannis et al. 2019).

To summarize, all risk factors posed by imports were divided into eight risk groups according to their nature. The framework including CIRA's main risk groups and their primary factors are presented in Table 1.

Table 1. Groups of food import risk and their factors (created by authors, 2021).

Group of Risk	Factors	Authors
Supply risks	Foreign supplier bankruptcy; capacity fluctuations/shortages on the foreign supply market; yield uncertainty (related, e.g., with weather conditions) of foreign suppliers; substitution availability; market price volatility/fluctuations of foreign suppliers; lack of information sharing between supply partners.	(Zhao et al. 2020; Behzadi et al. 2018; Nyamah et al. 2017; Welburn et al. 2016)
Demand risks	Volatility of customer demand; market price volatility/fluctuations; local suppliers yield uncertainty (e.g., related with weather conditions); insufficient information from customers; supply and demand imbalance; substitution availability; changes in food safety requirements; changes in labour disputes (threat to local labour market); change in customer attitudes.	(Nyamah et al. 2017; Otero et al. 2018; Zhao et al. 2020; Welburn et al. 2016; Behzadi et al. 2018; Adda and Fawaz 2020;)
Production risks	Risks from pests, diseases and additives; contamination related to poor sanitation and illnesses; perishability of the product; contamination affecting food safety; substitution availability; resource dependency; rapid technological development; contamination and degradation of production and processing processes.	(Zhao et al. 2020; Nyamah et al. 2017; Welburn et al. 2016)
Management and operational risks	poor management (skill shortage); lack of investment in promoting agro-food products; risks associated with contract fulfilment; poor asset allocation management decisions; usage of expired products; poor quality control; poor decision making in the use of inputs; equipment breakdowns; inability to adapt to changes in cash and labour flows; forecast and planning errors; tax evasion.	(Zhao et al. 2020; Nyamah et al. 2017)
Logistical and infrastructural risks	Poor supply infrastructure; lack of information sharing among partners; high energy costs; volatility in fuel price; distribution system; poor agricultural infrastructure; rapid technological development; poor infrastructure and services; unreliable transport; undependable transport; conflicts and labor disputes affecting transport; changes in transportation; lack of infrastructure and service units; poor performance of logistics service providers; lack of effective system integration.	(Nyamah et al. 2017; Shmatko et al. 2020; Otero et al. 2018; Zhao et al. 2020)
Political risks	Political instability, war, civil unrest or other socio-political crises; interruption of trade due to disputes with other countries; nationalisation/confiscation of assets, especially belonging to foreign investors; changes in the political environment due to introduction of new laws or stipulations.	(Nyamah et al. 2017; Spink et al. 2019; Zhao et al. 2020)
Policy and regulatory risks	Distribution system stricter food quality and safety standards; animal welfare legislation negatively affecting the competitiveness; trade competitiveness legislation; potential restrictions on waste disposal; weak institutional capacity to implement regulatory mandates.	(Nyamah et al. 2017; Otero et al. 2018; Welburn et al. 2016; Zhao et al. 2020; Attrey 2017)
Financial risks	Delay in payment; possible non-payment; uncertain trade, market, land and tax policies; inadequate financial support; change in exchange rate; insufficient credit.	(Zhao et al. 2020; Bachev 2017; Nyamah et al. 2017)

3. Methodology

The framework CIRA with eight risk groups was developed and includes the following: supply risks, demand risks, production risks, management and operational risks, logistical and infrastructural risks, political risks, policy and regulatory risks and financial risks. An expert evaluation method was employed to assess chosen groups of risks according to their importance. It covers the following four steps: (1) development of a questionnaire; (2) selection of experts; (3) fulfilment of the survey; (4) interpretations of the survey results. Figure 1 presents the process of the research.

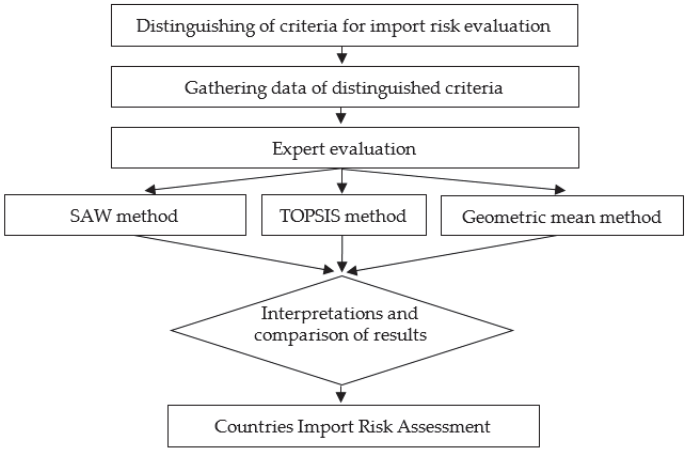

Figure 1. The process of the research.

The case of Lithuania is used for the research because of its geographical location and size. Furthermore, Lithuania is a small EU country for which trade occurs under all existing inter-lateral agreements with EU countries and other countries. Therefore, it faces all the risks inherent in a small open economy.

According to Libby and Blashfield (1978), seven experts (optimal number) participated in the survey. Table 2 represents qualitative information about the experts. The case of one country (Lithuania) is analysed. Most of the experts were from Lithuania. However, the international experts permitted us to observe the situation from a broader perspective and to have an impartial opinion. Experts filled in the questionnaire for each risk group. A three-level Likert scale was used (low risk, middle risk and high risk).

Table 2. Qualitative information about experts.

Expert No.	Country	Experience in International Trade	Workplace (Leader Position)
E_1	Japan	More than 10 years	Government sector
E_2	Netherlands	More than 10 years	Government sector
E_3	China	More than 7 years	Government sector
E_4	Lithuania	More than 10 years	International Trade Association
E_5	Lithuania	More than 20 years	Scientific Institution
E_6	Lithuania	More than 20 years	Government sector
E_7	Lithuania	More than 15 years	Scientific Institution

Three Multicriteria decision support methods were used to assess the analysed risk groups and to obtain the most reliable research results: Simple Additive Weighting (SAW),

Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) and Geometric mean.

SAW method is the most well known and most widely used. It was investigated by MacCrimmon (1968) and is treated as one of the most used multi-criteria decision-making methods. This method integrates the values of variables and weights into a single magnitude (Kraujalienė 2019). The application of the SAW method involves three steps: (1) ratios calculation to perform the normalization; (2) calculation of weighted sums of the normalised values; (3) prioritization of risk groups according to the calculated values. All Multicriteria decision methods have their advantages and disadvantages. The SAW method's disadvantage is that all criteria ought to be maximising. In addition, the SAW method requires all the criteria values r_{ij} to be positive. In our case, all the criteria have positive values and so we did not need to convert them. After receiving the data of expert assessments, the calculation of maximising ratios to perform the normalization was conducted according to the following equation (Ginevičius and Podvezko 2008).

$$\bar{r}_{ij} = \frac{r_{ij}}{\max\limits_{j} r_{ij}} \tag{1}$$

The normalization for risk indicators was calculated according to the following equation (Ginevičius and Podvezko 2008).

$$\bar{r}_{ij} = \frac{r_{ij}}{\sum_{j=1}^{n} r_{ij}} \tag{2}$$

After the normalization procedure, weighted sums of normalised risk values were calculated according to Equation (3) (Ginevičius and Podvezko 2008):

$$S_j = \sum_{i=1}^{m} w_i \bar{r}_{ij} \tag{3}$$

where:

w_i—the weight of the ith criterion;
$\bar{r}_{ij}$—normalised value from formula (1) and; m—number of criteria used for risk evaluation.

Risk groups are ranked according to S_j's calculations. The higher the value of S_j, the more important is the risks group.

Hwang and Yoon (1981) introduced the TOPSIS method. The method gain popularity for due to its ease of use and understandable application. Compared to other methods available, TOPSIS may be more stable in the data variation case (Kraujalienė 2019). This method's main principle is that the optimal dote should have the farthest point in the distance from the negative ideal solution point and the shortest line from the positive ideal solution (Dandage et al. 2018). The application of the TOPSIS method involves four steps: (1) normalization procedure; (2) calculation of the best and the worst alternatives; (3) calculation of the distance to the ideal solution and the worst solution; (4) prioritization of risk groups according to the calculated values. TOPSIS can be applied to minimising indicators and maximising ones, i.e., there is no need to convert indicators. The method, TOPSIS, utilizes vector normalization (Podviezko and Podvezko 2014), as described in the following equation.

$$\tilde{r}_{ij} = \frac{r_{ij}}{\sqrt{\sum_{j=1}^{n} r_{ij}^2}} \tag{4}$$

After the normalization procedure, the best alternative V^+ and the worst alternative V^- needs to be chosen.

Then the distance D_j^+ of every considered alternative to the ideal solution and its distance D_j^- to the worst solution needs to be calculated using the following equation (Podviezko and Podvezko 2014).

$$D_j^+ = \sqrt{\sum_{i=1}^{m} \left(\omega_i \widetilde{r}_{ij} - V_i^+\right)^2} \quad (5)$$

$$D_j^- = \sqrt{\sum_{i=1}^{m} \left(\omega_i \widetilde{r}_{ij} - V_i^-\right)^2} \quad (6)$$

The main cumulative criterion C_j's is calculated (Podviezko and Podvezko 2014) by the following equation.

$$C_j^* = \frac{D_j^-}{D_j^* + D_j^-};\ (j = 1,\ 2,\ \ldots,\ n),\ \left(0 \le C_j^* \le 1\right) \quad (7)$$

Risk groups are arranged according to C_j's calculations. The closer the value of C_j is to 1, the more important the risk group is.

If the two multicriteria methods results differ in assessing risk groups or possesses the same value, a third method can be used for a more accurate risk group ranking. In the scientific literature, the use of geometric mean weights of (normalised) indicators were considered superior to simpler and more common "weighted arithmetic mean" (Tom and Rogge 2016). The geometric mean is calculated according to Chakraborty and Zavadskas in the following equation (Chakraborty and Zavadskas 2014).

$$\Pi_j = \sqrt[m]{\prod_{i=1}^{m} \widetilde{r}_{ij}} \quad (8)$$

See $\widetilde{r}_{ij}$ calculation in Formulas (1) and (2). Coincidence of group values shall be verified before determining the significance of import risks groups by using different multicriteria methods. In the case of discrepancies, the results of different methods are summarised and the final assessment of the significance of risk groups is carried out (Palevičius et al. 2016). The framework of import risk assessment CIRA is based on the results of risk group assessments according to their importance.

4. Research Results

As mentioned in the literature review, the framework of eight risk groups was developed: supply risks, demand risks, production risks, management and operational risks, logistical and infrastructural risks, political risks, policy and regulatory risks and financial risks. The results using the SAW method are presented in Table 3.

Table 3. Assessment of import risk groups using the SAW method.

Risk Group	Weights	E_1 *	E_2 *	E_3 *	E_4 *	E_5 *	E_6 *	E_7 *	S_j
Supply risks	0.111	3.50	2.00	1.62	2.33	1.50	3.94	1.40	0.26
Demand risks	0.101	1.75	2.00	3.23	2.33	1.50	2.63	1.40	0.21
Production risks	0.160	5.25	3.00	3.23	2.33	3.00	3.94	2.80	0.54
Management and operational risks	0.118	1.75	3.00	3.23	2.33	3.00	2.63	1.40	0.29
Logistical and infrastructural risks	0.146	3.50	3.00	3.23	4.67	3.00	1.31	2.80	0.45
Political risks	0.117	1.75	3.00	1.62	2.33	3.00	1.31	4.20	0.29
Policy and regulatory risks	0.110	1.75	2.00	1.62	2.33	3.00	2.63	2.80	0.25
Financial risks	0.137	1.75	3.00	3.23	2.33	3.00	2.63	4.20	0.39

* Normalised values.

According to the SAW method, the significance of the risk groups is as follows: production risks (the most crucial risk), logistical and infrastructural risks, financial risks,

management and operational risks, political risks, supply risks, policy and regulatory risks and demand risks.

The results using the TOPSIS method are presented in Table 4.

Table 4. Assessment of import risk groups using the TOPSIS method.

Risk Group	E_1 *	E_2 *	E_3 *	E_4 *	E_5 *	E_6 *	E_7 *	D^+	D^-	C_j
Supply risks	0.43	0.26	0.21	0.30	0.20	0.50	0.17	0.60	0.40	0.40
Demand risks	0.21	0.26	0.42	0.30	0.20	0.33	0.17	0.69	0.27	0.28
Production risks	0.64	0.40	0.42	0.30	0.39	0.50	0.35	0.35	0.65	0.65
Management and operational r.	0.21	0.40	0.42	0.30	0.39	0.33	0.17	0.65	0.36	0.35
Logistical and infrastructural r.	0.43	0.40	0.42	0.60	0.39	0.17	0.35	0.43	0.52	0.54
Political risks	0.21	0.40	0.21	0.30	0.39	0.17	0.52	0.65	0.42	0.39
Policy and regulatory risks	0.21	0.26	0.21	0.30	0.39	0.33	0.35	0.63	0.31	0.33
Financial risks	0.21	0.40	0.42	0.30	0.39	0.33	0.52	0.55	0.50	0.48

* Normalised values.

The best alternative V^+ and the worst alternative V^- according to the TOPSIS method are presented in Table 5.

Table 5. The best alternative V^+ and the worst alternative V^- results according the TOPSIS.

Alternatives	E_1	E_2	E_3	E_4	E_5	E_6	E_7
Best alternative V^+	0.640	0.397	0.417	0.603	0.392	0.500	0.522
Worst alternative V^-	0.213	0.265	0.209	0.302	0.196	0.167	0.174

According to TOPSIS expert evaluation method, the significance of the risk according to their importance was as follows: production risks (the most crucial risk), logistical and infrastructural risks, financial risks, supply risks, political risks, management and operational risks, policy and regulatory risks, demand risks.

The results of risk group evaluation according to their importance using the SAW and TOPSIS methods differs. In order to determine the straightforward approach of the significance of the risk groups another technique—the Geometric mean (GM) method—is used. The results are presented in Table 6.

Table 6. Assessment of import risk groups using the Geometric mean.

Risk Group	E_1 *	E_2 *	E_3 *	E_4 *	E_5 *	E_6 *	E_7 *	GM
Supply risks	0.667	0.667	0.500	0.500	0.500	1.000	0.333	0.607
Demand risks	0.333	0.667	1.000	0.500	0.500	0.667	0.333	0.577
Production risks	1.000	1.000	1.000	0.500	1.000	1.000	0.667	0.872
Management and operational risks	0.333	1.000	1.000	0.500	1.000	0.667	0.333	0.662
Logistical and infrastructural risks	0.667	1.000	1.000	1.000	1.000	0.333	0.667	0.788
Political risks	0.333	1.000	0.500	0.500	1.000	0.333	1.000	0.639
Policy and regulatory risks	0.333	0.667	0.500	0.500	1.000	0.667	0.667	0.630
Financial risks	0.333	1.000	1.000	0.500	1.000	0.667	1.000	0.760

* Normalised values.

The import risks assessment according to their importance by the Geometric mean are ordered in the following manner: production risks (most crucial risk group), logistical and infrastructural risks, financial risks, management and operational risks, political risks, policy and regulatory risks, supply risks and demand risks. The place order of risk groups also differs from previous estimates. The summarised results of risk group assessment are presented in Table 7.

Table 7. Summarised results of import risk groups.

Groups of Risk	SAW Range	TOPSIS Range	GM Range	Total Range
Supply risks	6	4	7	5.7
Demand risks	8	8	8	8.0
Production risks	1	1	1	1.0
Management and operational risks	4	6	4	4.7
Logistical and infrastructural risks	2	2	2	2.0
Political risks	5	5	5	5.0
Policy and regulatory risks	7	7	6	6.7
Financial risks	3	3	3	3.0

The importance of import risks summarized by all used methods is as follows: production risks (most crucial risk group), logistical and infrastructural risks, financial risks, management and operational risks, political risks, supply risks, policy and regulatory risks and demand risks. According to this assessment, the final framework—CIRA—is developed. This new import risk assessment framework contributes to the systematic approach of a country's international trade risk management.

5. Discussion and Conclusions

Literature analyses shows that the relevance of the risk is increasing and it covers several aspects. Import risk management is important not only for companies but also for each country. Assessing the risks posed by imports is vital for the well-being of the country's population (improving the quality of life) and for its security (in the context of food security, economic and political welfare). It is significant for the country to not only monitor export risks but also to manage import risks. Normally, authors analyse the key risk factors. Our research has shown that the risk factors examined by most authors (Huang et al. 2017; Hyuha et al. 2017) belong to the group of production risks (e.g., country security, unequal distribution of resources and labor market factors), which the country needs to manage the most.

In addition, without managing import risks and especially risks included in production risk group, the country's security is threatened. Leaving it to self-process (under self-interested businesses) may result in insecurity relative to population interests. In order to manage this group of risks, there is a need for political interventions that contribute to OECD (2020) analysis. After analysing the import risk groups presented by various authors, the new framework for CIRA was developed. Our research is primarily based on supply chain risk management, which is also the focus of other researchers (e.g., Nyamah et al. 2017; Spink et al. 2019; Zhao et al. 2020). However, considering the specificities of agricultural products, the role of food quality risk and other import risks observed by other scientists (Welburn et al. 2016; Herrera-Herrera et al. 2019; Attrey 2017; Ruhm 2016; Smith et al. 2017) and that are incorporated into risk groups has been expanded to form a common framework for CIRA. It allows the analysis of all import risk groups of a country by using one framework.

Using multicriteria decision support methods, risk groups were assessed according to the importance of countrywide governance. As all risk groups are significant in the supply chain, it is vital to determine which groups of risks are relevant for governmental management. Since all multicriteria decision support methods have their disadvantages, the use of the three methods ensures an optimal result. In addition, the rating of risk groups allows politicians to focus more clearly, for which risk groups more attention should be given and which should be managed first. It allows using CIRA widely in practice, including the increase in export or reduce of imports and the balance of a country's trade to incorporate import risk management.

The results of our research showed that managing the production risks group is most crucial. This can be explained by the fact that most of the factors involved in this group are related to the primary production of agricultural products and are mainly directed to

primary production where the role of the country's government could be most significant. Our results show that the import of primary agro products is seen as the most significant risk. However, the situation may differ from one product group to another. For example, the distribution of risk groups in the supply chains of processed food products may vary according to importance.

Further studies are needed to assess the import risks of the different product categories. Nevertheless, managing imports of primary production is the most important for the country. According to our research, the distributions of other risk groups are as follows: logistical and infrastructural risks, financial risks, management and operational risks, political risks, supply risks, policy and regulatory risks and demand risks. It demonstrates the importance of supporting sectors management in the interest of ensuring the effective functioning of whole supply chains. According to importance, groups of risks can differ in importance due to the countries from which imports are produced. The need for further research is required. It could bring a broader perspective of the importance of the import risks factors and not only risk groups and their effect on business when planning, managing or mitigating an import from different counties or various product groups. Researchers could also analyse import risks in other supply networks (e.g., different retail chains).

Groups of risks can differ according to the countries from which imports are made. The need for further research is required. It could bring a broader perspective of the risk factors and their effect that businesses should consider when planning, managing or mitigating an import from different counties or various product groups.

The research has some limitations. CIRA framework covers risks related at the country level. Future research might cover factors that assesses, with particular attention, and identifies import risk factors for different food product groups. Those factors could also be ranked and compared between different food products groups (e.g., dairy products, grains, beverages, processed food, ready to eat food, etc.). Further research could also bring a wider perspective of the risk factors for separated country groups or different countries. Furthermore, combined (quantitative and qualitative) risk evaluation methods could be used.

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Assessment of the Financial Autonomy of Rural Municipalities

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Abstract: The present study demonstrates the possibilities for assessment of the financial autonomy of rural municipalities using the TOPSIS method. The study aimed to design and empirically verify the model for assessment of the financial autonomy of rural municipalities. As a result of the empirical study, an integrated system for assessment of the financial autonomy of rural municipalities was designed. The applicability of the TOPSIS method is demonstrated by the assessment of the financial autonomy of rural municipalities performed for two regions of Lithuania in the period 2009–2019. The empirical study showed that medium-low level of financial autonomy was characteristic of all the rural municipalities in the selected regions. On one hand, the findings suggested the presence of "convenient dependence" of the rural municipalities on the centralised allocation. On the other hand, they signalled the lack of the incentives for the rural municipalities to make use of the capacities and create sustainable, stable economic and social prospects.

Keywords: financial autonomy; TOPSIS method; rural municipalities

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1. Introduction

In the European Union member countries, regional and local objectives are implemented by the local government units (LGU), i.e., municipalities. Pursuant to the European Charter of Local Self-Government (1985), the municipalities have the right and ability to independently handle and manage a substantial share of public affairs by fully assuming their own responsibility and following the interests of the local residents. Financial autonomy of LGUs influences multifunctional development of the rural areas, which is one of the goals of the EU's Common Agricultural Policy (CAP) (Głowicka-Wołoszyn and Satoła 2018).

The importance of autonomy assessment of LGUs is generally is indisputable if viewed from the financial perspective. Financial autonomy is the prerequisite of existence of a local government and the key factor of stable local development. Sustainable financial resources are the foundation of social and economic development in rural areas in particular (Satoła et al. 2019; Łuczak et al. 2018b). Hence, assessment of the level of financial autonomy of rural municipalities has recently become an increasingly important research topic from the economic and socioeconomic perspective. Financial autonomy (FA) is also the basic category assessed in the analysis of financial stability of LGUs (Satoła et al. 2019).

FA of LGUs is closely related to the economic, fiscal policy, fiscal decentralization, and regional development theories. This suggests the multidimensional character of the phenomenon described by a number of indicators. Assessment of revenue indicators of FA is important in FA assessment of rural municipalities, as the revenue indicators demonstrate different aspects of the FA level. The set of indicators used for the analysis of the same phenomenon of FA of rural municipalities differs from researcher to researcher (such as index of subnational autonomy (Shah 1994), composite indicator of fiscal autonomy (Beer-Tóth 2009); indicator of financial self-sufficiency (Kozera et al. 2017); self-financing index, fiscal autonomy index (Głowicka-Wołoszyn and Satoła 2018); fiscal wealth indicator

(Satoła et al. 2019). As a result, different research studies often generate contradictory or, in certain cases, even incomparable findings. There is the lack of a single summarizing integrated indicator which would objectively show FA of the rural municipalities analyzed. Moreover, many discussions have emerged in relation to satisfaction of the needs of the rural areas, promotion of their local economic and social development, the amount of financial resources that should be allocated to the municipalities, and the methods of improvement of their FA level.

Viability of the multi-attribute assessment methods, which fall under the group of multi-criteria decision-making methods, has been particularly emphasized in the scientific literature as these methods enable integrated assessment of complex values. Due their versatility, the multi-attribute assessment methods may be employed when dealing with different areas, and are relevant in FA assessment of rural municipalities. The most appropriate method was chosen for analysis of the problematics of FA assessment of rural municipalities in view of the specifics and solution of the problem (*namely, the theoretical principles of FA assessment and the assessment method for FA level of rural municipalities*). The selection of the method was performed by describing the possible multi-criteria, multi-attribute decision making methods. TOPSIS (*Technique for Order Preference by Similarity to Ideal Solution*) is one of the multi-attribute methods appropriate for FA assessment as a multidimensional phenomenon. The scientific literature analysis has shown that this method is mostly used in the studies (Vavrek and Pukala 2019; Satoła et al. 2019; Głowicka-Wołoszyn and Satoła 2018; Kozera et al. 2017; Kozera and Głowicka-Wołoszyn 2016) involving FA assessment of rural municipalities. It should be noted that new indicators describing financial autonomy were added to the empirical study conducted by the authors of the present article. Unlike other empirical studies, linear normalization of rural municipalities revenue indicators was performed. The rural municipalities of two regions of Lithuania were first classified according to the constructed synthetic index of financial autonomy. In general, the TOPSIS method has enabled comprehensive and integrated FA assessment of the rural municipalities by using a single integrated, summarizing indicator.

This paper is structured as follows: Section 2 provides a literature review revealing the complexity of assessment of the financial autonomy phenomenon. It explores the relations between the phenomenon of financial autonomy of LGUs and the economic theories and evaluates the applicability of the multi-criteria assessment methods to assessment of the financial autonomy of rural municipalities. Section 3 describes the designed model for assessment of the financial autonomy of rural municipalities. Section 4 presents the research findings by demonstrating its applicability to assessment of the financial autonomy of rural municipalities in two regions of Lithuania. Section 5 provides the conclusions.

2. Literature Review

2.1. Relation between the Phenomenon of Financial Autonomy of LGUs and Economic Theories, and Complexity of the Assessment

Financial autonomy (FA) is the term operated when referring to the complex, multidimensional economic phenomenon based on the economic, fiscal policy, fiscal decentralisation, and regional development theories, and is related to financial resource allocation, redistribution, and stabilisation. Several categories of economic theories could be recognized in the research studies on FA, such as theories on economic growth, sustainable development, inequality, incentive, limiting, centralisation, decentralisation, and regional development theories (see Figure 1). Hence, the theories and the categories thereof demonstrate the multidimensional character of FA of LGUs and the complexity of its assessment.

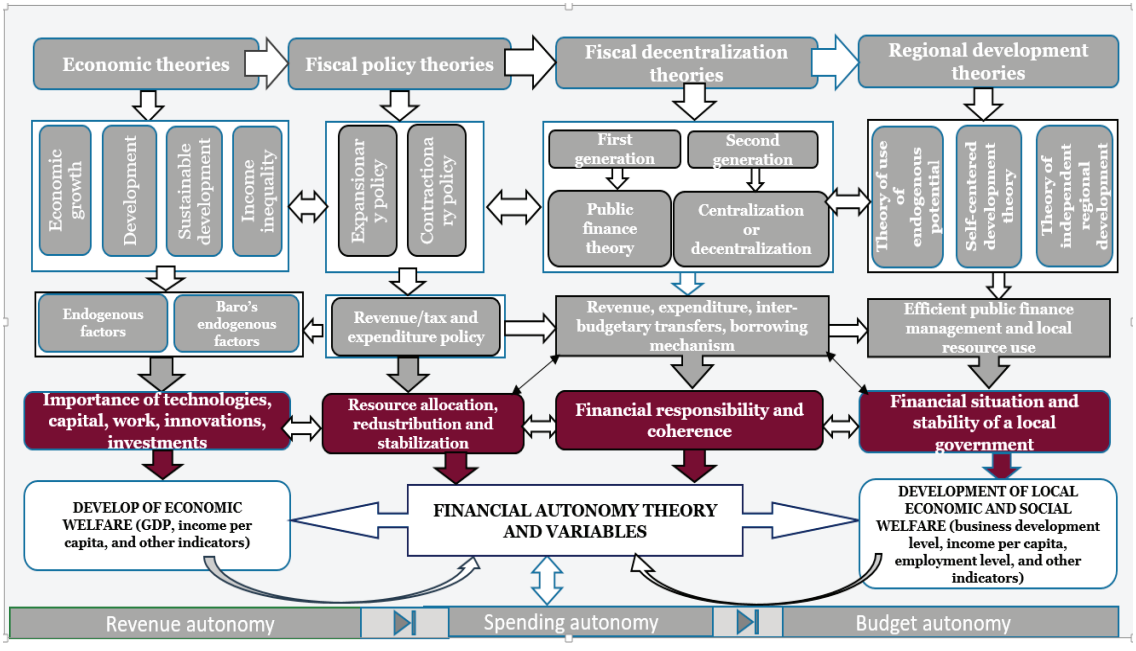

Figure 1. Relation between the phenomenon of financial autonomy and economic theories. Source: made by the authors.

The economic theories related to growth and development enable the researchers studying the FA phenomenon to identify the endogenous factors that are important for improvement of the FA of LGUs. The researchers (Satoła et al. 2019; Standar and Kozera 2019; Głowicka-Wołoszyn and Satoła 2018; Łuczak et al. 2018b; Rudytė et al. 2018; Kozera et al. 2017; Scutariu and Scutariu 2015; Jemna et al. 2013) have not only listed a large number of the factors determining the FA of LGUs, but have also presented different classifications of these factors. Hence, an analysis of the FA factors with particular emphasis on the FA levels of the LGUs is also an important research topic from the economic and social perspective (Standar and Kozera 2019).

The scientific literature analysis has demonstrated that the FA of LGUs depends on the revenues received/earned and rational expenditure management. This is the essence of the (incentive and limiting) fiscal policy theories related to the key measures. The latter include tax revenue received by the state in the form of taxes from natural persons and companies, and the state expenditure that, if properly allocated, enhances the domestic economy. According to Salm (2014), the features of a rational local tax system are based on the decentralization theory. While every tax is required to follow rational criteria, such as economic efficiency and ease and cost of administration, local taxes shall also meet a few additional criteria, such as fiscal autonomy and balance of interest, which specifically apply to the local level.

In FA asssment of LGUs, the majority of researchers usually focus on the revenue autonomy, giving less attention to the expenditure autonomy. The researchers (Satoła et al. 2019) have emphasised that identification of the sources of revenue, which could be deemed as the FA drivers, presents a considerable challenge. Financial autonomy and the issue of revenue generation are one of the key issues related to local governments worldwide. According to Hajilou et al. (2018), municipalities become unsustainable due to the absence of a comprehensive approach towards implementation of the autonomy policy, sources of revenue of the financial sector, municipalities, and macroeconomic system in the area of changes and interventions. Hence, along with FA, financial sustainability is

becoming one of the most widely used terms and is associated with John Hicks' notion of maximum income. This means that assessment of revenue autonomy, where the researchers (Satoła et al. 2019; Standar and Kozera 2019; Głowicka-Wołoszyn and Satoła 2018) place the strongest emphasis on the level of own revenues, plays a significant role where the FA of LGUs is addressed. Nonetheless, the FA of LGUs does not necessarily imply that implementation of local public tasks would only be limited to the duty of autonomous funding. Following the fiscal policy principles, with the own (tax and non-tax) revenue being inadequate, the central government allocates funds on the basis of grants in order to assure implementation of public tasks. Nevertheless, where public funds account for a substantial share of budget revenue of the municipality, there are considerable limitations of the freedom of use of the financial resources (Oulasvirta and Turala 2009). Hence, the local government becomes highly dependent on the funding from the state budget, considerably affecting the FA of LGUs.

As evidence suggest, transfers induce municipalities to underutilize their own tax bases (Shah 1994). This raises the issue of "convenient dependence" of municipalities on the centralized allocation in the long run. The researchers (Satoła et al. 2019; Hajilou et al. 2018; Jakovljevic et al. 2019; Jakovljevic 2013) have therefore made attempts to validate the need for a sustainable LGUs funding system. The rationale behind this kind of system is that the financial resources received by LGUs correspond to the expenditure incurred by them in implementation of their tasks. This depends on the optimum degree and scope of fiscal decentralisation reflecting rational management of public funds. Shah (1994) argues that the decentralization of responsibilities and the rationalization of intergovernmental transfers should be supported by strengthening local institutional capabilities.

In the scientific literature, financial autonomy is often mentioned in the context of research of financial decentralisation (Beer-Tóth 2009). The theories of fiscal decentralisation identify the interacting elements which link the components of fiscal autonomy, namely, revenue, expenditure, and budget autonomy of LGUs, to each other. Hence, the FA research have been contributing significantly to the theory and practice of fiscal decentralisation in the recent decades and are becoming the focus of the researchers, supranational organisations, policy makers, and economists. This is supported by the results of the studies conducted by the majority of the researchers analyzed (Satoła et al. 2019; Vavrek and Pukala 2019; Głowicka-Wołoszyn and Satoła 2018; Ladner and Keuffer 2018; Kozera et al. 2017; Kozera and Głowicka-Wołoszyn 2016; Psycharis et al. 2016; Cigu 2014; Jemna et al. 2013; Beer-Tóth 2009), demonstrating the importance of FA of LGUs as an individual, remarkable, and complex phenomenon.

The phenomenon of FA of LGUs and the determining factors are closely related to the theories of regional growth and development. From the perspective of the local governance processes, the theories of use of the regional endogenous (internal) potential are highly important, as they define the internal factors that determine the FA level of LGUs (Standar and Kozera 2019). If viewed from the perspective of the economic theories of self-oriented and independent regional development, LGUs would be expected to be more autonomous and make use of their internal potential. It has been found in the series of studies that the character of the Lithuanian fiscal policy is determined by political limitations. This situation suggests that the fiscal policy measures employed in Lithuania are not yet sufficiently directed at formation and assurance of sustainability of public finance. This obviously has an impact on the autonomy of a local government as well as development of its inner financial potential (Skauronė et al. 2020). Hence, empirical studies are needed in order to explore the financial situation and capacities of LGUs.

A lack of an integrated approach towards the analysis or assessment of the differences between the Lithuanian municipalities and, in particular, rural municipalities in terms of financial autonomy has been observed. In the international research domain, researchers (Satoła et al. 2019; Standar and Kozera 2019; Głowicka-Wołoszyn and Satoła 2018) generally agree that there is the lack of assessment of the differences between LGUs of a specific

country in terms of FA. They have stressed the need for such research as well as for innovation in development of public finance theories.

Hence, the background analysis has shown a diversity of the contexts of FA studies suggesting the multidimensional nature of the phenomenon (revenue, spending, budget autonomy) by assessing the allocation, redistribution and stabilization functions, and emphasizing the value of FA and sustainability. Analysis of the previous empirical studies has revealed that the researchers employ different number of indicators for FA assessment (see Table 1). This reveals the complexity of assessment of this economic phenomenon.

Table 1. Number of indicators used for FA level assessment of rural municipalities in the studies.

Authors, Year	Satoła, Standar, Kozera, 2019	Standar, Kozera, 2019	Glowicka-Woloszyn, Satola, 2018	Luczak, Kozera, Bacci, 2018	Kozera, Łuczak, Wysocki, 2017	A.L. Scutariu, P. Scutariu, 2015	Jemna, Onofre, Cigu, 2013
Number of indicators, units	7	7	11	8	9	2	5

It has been generally suggested in the scientific literature that the complexity and multidimensional character of the phenomenon analyzed determine the choice in favor of multi-criteria methods for FA assessment of rural municipalities.

2.2. Analysis of the Multi-Criteria Methods and Selection of the Most Appropriate Method for FA Assessment of Rural Municipalities

The scientific literature analysis has shown that the FA level of LGUs is usually assessed using the Multiple Objective Decision Making (MODM) methods classified as the multi-criteria decision making methods. The scientific literature analysis has revealed that the multi-criteria methods are applicable to both exact and social sciences universally. These methods have been observed to be widely used for assessment of the economic phenomena in Lithuania.

The FA phenomenon is multidimensional; therefore, multiple objective methods are used, as they help analyse the alternatives that belong to the infinite set of solutions. In view of the specifics of the implications pertaining to the empirical study, first, comparison of the multi-criteria decision analysis methods was performed and enabled the authors of the paper to identify the most appropriate FA assessment method (see Table 2).

Based on the comparison analysis of the multi-criteria methods, TOPSIS (*Technique for Order Preference by Similarity to Ideal Solution*) method, which showed the most favorable assessment result, was selected for the design of the methodology for empirical study of FA assessment of rural municipalities. According to Łuczak et al. (2018a), this method is referred to as the benchmark method in the international practice.

The TOPSIS method is based on Hellwig's idea of construction of a synthetic property. It enables synthetic assessment of a phenomenon with multiple properties (Hwang and Yoon 1981).

The rationale behind the choice of TOPSIS methods is generally based on the fact that this method:

- is the most widely and frequently (30%) applied for assessment of the majority of phenomena, activities, compared to other methods (AHP—20%; VIKOR—6.67%, ELECTRE—16.67%; other methods—10%) (Aruldoss et al. 2013);
- is applicable to dealing with economic, financial issues in international practice;
- has been employed in the most recent empirical studies assessing FA of LGUs and, in particular, rural municipalities (Vavrek and Pukala 2019; Satoła et al. 2019; Standar and Kozera 2019; Łuczak et al. 2018a; Łuczak et al. 2018b; Głowicka-Wołoszyn and Satoła 2018; Kozera et al. 2017; Kozera and Głowicka-Wołoszyn 2016).

Table 2. Comparison of the multi-criteria, multi-attribute quantitative methods.

Attributes	Multi-Criteria, Multi-Attribute Quantitative Methods							
	AHP	**Fuzzy**	**ELECTRE**	**TOPSIS**	**PROMETHE**	**SAW**	**VIKOR**	**COPRAS**
International practice for addressing economic objectives	Not applicable	Applicable	Applicable	Applicable	Not applicable	Applicable	Applicable	Applicable
Measurement dimensions for different criteria	Available	Available	Not available	Available	Available	Available	Not available	Not available
Complexity of the method	Average	Average	Very complex	Complex	Complex	Simple	Complex	Simple
Objective structure	Hierarchic	Linear	Linear	Linear Non-linea Vector	Linear Non-linear	Linear	Linear	Linear
Assessment of qualitative criteria	Available	Available	Available	Available	-	Available	Available	Available
Assessment of quantitative criteria	Not available	Not available	Available	Available	Available	Available	Available	Available
Method for identification of the best alternative	T. Saaty method	Alternatives priority	Dominant relationship	Closeness to the ideal solution	Alternatives priority	Weighted	Closeness to the ideal solution	Proportionate
Labour costs	Average	Average	High	High	High	Low	High	Low

Source: made by the authors according to (Slavinskaitė 2017; Aruldoss et al. 2013; Ginevičius and Podvezko 2008; Hwang and Yoon 1981; Simanavičienė 2011; Zavadskas et al. 2014).

3. Methodology

The process of design of the FA assessment model for rural municipalities started with problem definition, substantiation of the research period, definition of the data, limitations, and sampling.

Problem and research period. The problem under the investigation was defined in the form of the following question: *How could the FA level of rural municipalities be assessed?* FA assessment of rural municipalities is important as it leads to solutions of development of economy and social welfare of rural municipalities, sustainable allocation, redistribution and growth of financial resources. It also pinpoints the need for new scientific insights into this economic phenomenon in the areas of the economic, fiscal policy, decentralisation, and regional growth theories.

The studies dedicated to FA assessment of rural municipalities tend to apply the longest assessment period possible. The reason behind this is that the econometric research methods used for assessment of data for a longer period tend to generate more accurate research results.

Data and limitations. Any research starts with data collection, gathering and systematisation. FA assessment of rural municipalities required using statistical data for calculation of the revenue and expenditure autonomy indicators. The limitations affecting appropriateness, validity, and correctness of the indicator calculation and determining database selection and data normalisation decisions were identified in the study.

Sample selection. The analysis of scientific and regulatory sources suggested clear absence of a definition of "rural municipalities". Scientists and researchers (Kriaučiūnas 2018; Horlings and Marsden 2014; Normann and Vasström 2012; Žukovskis et al. 2013; Ward and Brown 2009; Atkočiūnienė 2008; Vidickienė and Melnikienė 2008) mostly analyse the definitions of "rural areas", "rural regions", "countryside", and "rural communities". Lithuania does not have any officially recognized classification of regions into rural and urban. The criteria for identification of rural regions remains under the theoretical scrutiny not only in Lithuania, but also worldwide (Copus and Macleod 2006; Mueller et al. 2004;

Kostov and Lingard 2004). The scientific literature analysis has shown that the issue of delineation of urban and rural areas is generally a fairly complex scientific issue.

Hence, the design process for the model of FA assessment of rural municipalities followed the methodology proposed by the Organisation For Economic Co-operation and Development. The methodology employs three-fold classification of municipalities as rural, semi-rural, or urban. Quantitative boundaries were proposed for definition of rural municipalities under the methodology, where:

- the municipalities with more than 50% of the population living in the rural type residential areas were considered to be rural municipalities;
- the municipalities with 15 to 50% of the population living in the rural residential areas were attributed to semi-rural municipalities.

Based on the above criteria of the quantitative boundaries, the group of rural municipalities could be formed in order to reflect the set of alternatives $A = (A_1, A_2, A_3, \ldots A_i \ldots A_m)$.

Model design stages. The assessment model based on the multi-criteria TOPSIS method was designed for FA assessment of rural municipalities. The following model design stages could be identified:

Stage 1. Selection and calculation of the partial indicators describing FA of rural municipalities.

Stage 2. Assessment of FA level of rural municipalities and formation of the synthetic indicator/index.

Process of stage 1.

Step 1. The model design process primarily involved identification of the revenue autonomy indicators defining the FA of rural municipalities, the revenue autonomy being one of the distinctive properties of FA of a rural municipality. Hence, the set of revenue autonomy indicators was formed: $R = (r_1, r_2, r_3, \ldots, r_n)$. The revenue indicators assessing FA of rural municipalities were selected according to the following criteria:

- The indicators had been used by more than one author in their studies (Vavrek and Pukala 2019; Satoła et al. 2019; Standar and Kozera 2019; Łuczak et al. 2018a; Łuczak et al. 2018b; Głowicka-Wołoszyn and Satoła 2018; Kozera et al. 2017; Kozera and Głowicka-Wołoszyn 2016).
- Statistical data collected and published periodically were available for calculation of the indicators.

Step 2. Direction, i.e., minimization or maximization, was determined for each indicator.

Step 3. The sets of n indicator values of rural municipalities, each containing m elements, were created in Excel database (all the calculations were performed using this tool) in accordance with the registration year of the revenue indicator values for the FA of the rural municipalities (2009–2019). Decision matrices were formed using the data sets (Simanavičienė 2011):

$$P = \begin{bmatrix} r_{11} & r_{12} \cdots & r_{1n} \\ r_{21} & r_{12} \cdots & r_{2n} \\ r_{m1} & r_{m2} \cdots & r_{mn} \end{bmatrix} \quad (1)$$

Step 4. The objective significance of the indicators was then determined using the entropy method. The entropy method is applicable in the cases where maximization is required for all the indicators of the decision matrix. In case the decision matrix contained the indicators that required minimization, they were rearranged using the following formula (Simanavičienė 2011):

$$\overline{r_{ij}} = \frac{1}{r_{ij}} \quad (2)$$

Values of the indicators that required maximization remained unchanged:

$$\overline{r_{ij}} = r_{ij}, \text{ where } i = \overline{1, m;}\ j = \overline{1, n.} \quad (3)$$

The rearranged decision matrix was formed in the following way:

$$\overline{R} = \left[\overline{r_{ij}}\right], \ \left(i = \overline{1,m;} \ \ j = \overline{1,n}\right). \tag{4}$$

Step 5. It should be noted that assessment of multi-criteria phenomena using the TOPSIS method employ the indicators that have different units. Hence, prior to any calculations (alternative ranking procedure), the data must be transformed to align the dimensions of the variables. Linear, non-linear, and vector transformations may be used for normalization of the indicators. The possibilities for normalization are very diverse, and the rules of six formulas can be applied (Simanavičienė 2016).

The set of revenue indicators defining the FA of rural municipalities included highly asymmetric or outlying properties caused by differences in the units used. Consequently, the decision matrix was normalized (to make sure that all of its elements were dimensionless values) by applying two methods. For the revenue indicators determined under the objective significance principles, normalization was performed using the linear normalization formula (Simanavičienė 2011; Ginevičius and Podvezko 2008):

$$p_{ij} = \frac{\overline{r_{ij}}}{\sum_{i=1}^{m} \overline{r}_{ij}}, \ \left(i = \overline{1,m;} \ j = \overline{1,n}\right). \tag{5}$$

The researchers (Simanavičienė 2011, 2016; Ginevičius and Podvezko 2008; Podvezko 2008) often propose applying vector normalization using the following formula:

$$\widetilde{p_{ij}} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{m} r_{ij}^2}}, \tag{6}$$

The normalization method generally depends on the circumstances of the research and possibilities for minimization or maximization of the indicators. Hence, linear normalization was performed primarily in order to empirically verify the applicability of the FA assessment model to rural municipalities. The task was then solved by vector normalization after the research results had been obtained and assessed. Afterwards, comparison of the empirical study results was performed.

Following the normalization, the matrix of normalized values of the revenue indicators was develope $\overline{P} = \left[p_{ij}\right]$ (Simanavičienė 2011):

$$\overline{P} = \begin{bmatrix} p_{11} & p_{12} \cdots & p_{1n} \\ p_{21} & p_{12} \cdots & p_{2n} \\ p_{m1} & p_{m2} \cdots & p_{mn} \end{bmatrix} \tag{7}$$

Step 6. Entropy level E_j of each revenue indicator was determined using the following formula (Simanavičienė 2011):

$$E_j = -k \cdot \sum_{i=1}^{m} p_{ij} ln p_{ij}, \ \ \left(i = \overline{1,m;} \ \ j = \overline{1,n}\right), \text{ where } k = \frac{1}{lnm}, \tag{8}$$

The value of entropy varied within the interval $[0, 1]$; hence, $0 \leq E_j \leq 1$, the variation level of j-the indicator was determined by calculating the revenue indicators:

$$d_j = 1 - E_j, \ \left(j = \overline{1,n}\right). \tag{9}$$

The study did not employ any subjective (expert's) assessment of the indicators, and the decision was made to consider all the FA indicators of rural municipalities as equally important. Hence, objective significance of the revenue indicators was determined using the following formula (Simanavičienė 2011):

$$q_j = \frac{d_j}{\sum_{j=1}^{n} d_j}, \ \left(j = \overline{1,n}\right), \tag{10}$$

where: q_j—the values of objective significance of indicators.

The calculated values of objective significance of the revenue enabled the authors to determine the significance and importance of the indicator in the empirical study. Researchers usually suggest eliminating the indicators that are insignificant for the research upon consideration of significance of the respective indicator.

It should be noted that, where individual FA indicators are analyzed, only single-dimension profile research for the type analyzed may be performed and may cause difficulties in formulation of general conclusions (Głowicka-Wołoszyn and Satoła 2018). Hence, during the second stage of the model design, a synthetic indicator/index for FA assessment of rural municipalities was developed using the partial indicators by applying the TOPSIS method (Hwang and Yoon 1981).

Process of stage 2.

Step 1. Distance of each rural municipality to the positive and negative ideal decision was calculated. Under the TOPSIS method, the coordinates of the positive, i.e., ideally best (A^+), and negative (A^-) ideal points helped determine closeness of each rural municipality to the development model (A^+) and opposite negative model (A^-).

Positive, ideally best, and negative ideal points were calculated (see Formulas (12) and (13)).

Positive, ideally best point was calculated using the formula (Hwang and Yoon 1981; Simanavičienė 2011):

$$A^+ = \left\{ \left(\max_i v_{ij} \middle| j \in J \right), \left(\min_i v_{ij} \middle| j \in J' \right) \middle| i = \overline{1,m} \right\} = \left\{ a_1^+, a_2^+, \ldots, a_n^+ \right\}, \quad (11)$$

where: j—set of indices of the indicators with higher values as a more preferable option; j'—set of indices of the indicators with lower values as a more preferable option. Negative ideal variant was determined using the following formula (Simanavičienė 2011):

$$A^- = \left\{ \left(\min_i v_{ij} \middle| j \in J \right), \left(\max_i v_{ij} \middle| j \in J' \right) \middle| i = \overline{1,m} \right\} = \left\{ a_1^-, a_2^-, \ldots, a_n^- \right\}, \quad (12)$$

Step 2. Following the calculation of the positive, ideally best, and negative ideal variant, it became possible to determine the closeness of each rural municipality to the positive ideal solution of development (A^+) and negative ideal solution (A^-) in the n-dimensional Euclidean space under the formula (Hwang and Yoon 1981; Simanavičienė 2011):

$$L_i^+ = \sqrt{\sum_{j=1}^n \left(v_{ij} - a_j^+ \right)^2}, \ \left(i = \overline{1,m} \right), \quad (13)$$

$$L_i^- = \sqrt{\sum_{j=1}^n \left(v_{ij} - a_j^- \right)^2}, \left(i = \overline{1,m} \right). \quad (14)$$

Step 3. The final step of the TOPSIS method (Hwang and Yoon 1981) involved determination of the value of synthetic indicator/index of FA of each rural municipality. The index was mathematically expressed by the formula (Hwang and Yoon 1981; Ginevičius and Podvezko 2008; Simanavičienė 2011):

$$K_i = \frac{L_i^-}{L_i^+ + L_i^-}, \ \left(i = \overline{1,m;} \right), \text{ where } K_i \in [0, 1]. \quad (15)$$

where: K_i—value of the i-ths alternative generated by assessment under the TOPSIS method, with the highest K_i value corresponding to the best alternative.

L_j^+—total closeness of the i-ths alternative to the ideally best variant;

L_j^-—total closeness of the i-ths alternative to the ideally worst variant.

Step 4. The determined synthetic indicator/index values were rearranged in a linear manner and became the basis for grouping of the municipalities into typological classes by

the FA level (Satoła et al. 2019; Łuczak et al. 2018b). The typological classes/clusters of rural municipalities were determined in view of the mean indicator value (M) and standard deviation (S) (see Table 3).

Table 3. Classification of rural municipalities into classes/clusters by financial autonomy level.

Class/Cluster	Financial Autonomy Level	Mathematical Value
Class I/cluster	High	$K_i \geq M + S$ (16)
Class II/cluster	Medium high	$M \leq K_i < M + S$ (17)
Class III/cluster	Medium low	$M - S \leq K_i < M$ (18)
Class IV/cluster	Low level	$K_i < M - S$ (19)

Source: made by the authors according to (Satoła et al. 2019).

In general, the following components could be identified in the methodology for design of the FA assessment model for rural municipalities:

- problem formulation (definition of the problem, gathering of database and information);
- problem solving consisting of the steps comprising the first stage (decision making, formulation of the task) and second stage (task solution using the TOPSIS method) of the model design process;
- decision making in relation to the problem (interpretation of the results generated and formulation of the general conclusions).

Depending on the specifics of the research problem and possibilities for application of the multi-criteria TOPSIS method, the model for FA assessment of rural municipalities could be summarized schematically (see Figure 2).

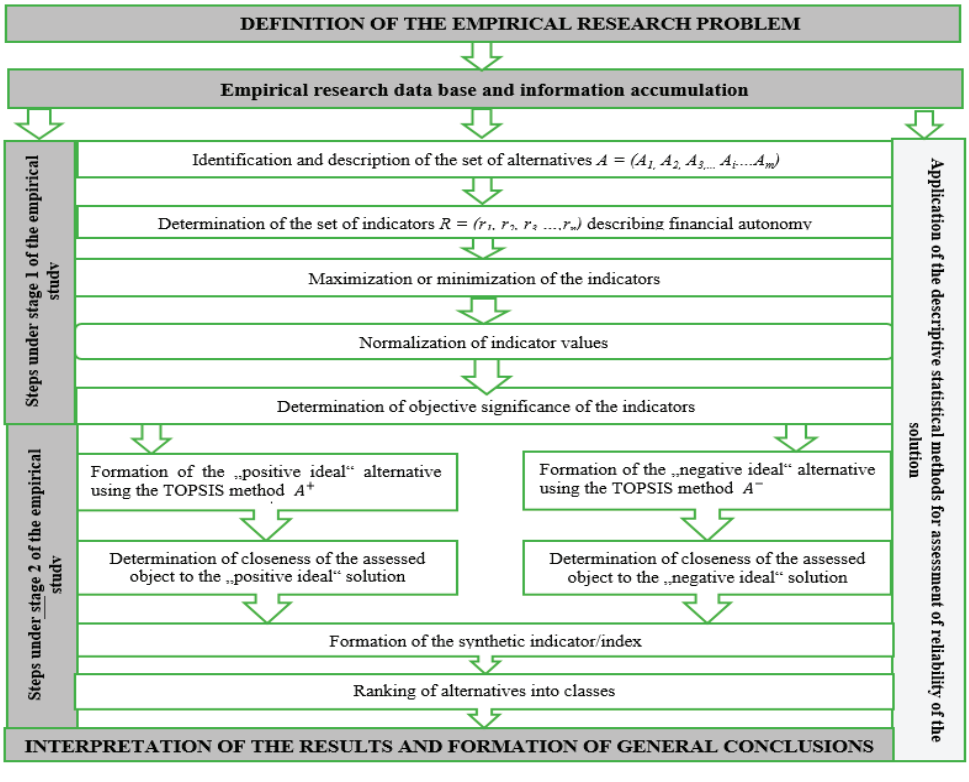

Figure 2. Model for FA assessment of rural municipalities. Source: made by the authors.

The decomposition of the model into main components does not necessarily imply that the problem indicators will not be revised or the problem solution part will not be revisited after definition of the problem and the related variables (indicators) or before the decision making part. Analysis of the problem could actually be repeated multiple times using an expanded the set of alternatives, including new variables, revising the research stages and limitations, verifying the reliability of application of the methods of descriptive statistics, until the most appropriate solution is reached.

Application of the designed model was demonstrated further in the present research by performing the FA assessment of rural municipalities in the regions of Lithuania.

4. Results and Discussion

Upon Lithuania's accession to the EU, particular focus was placed on rural areas and rural municipalities, representatation of their interests, and their financial autonomy. The issues of rural areas have been emphasized in the EU's and national documents, the ideas expressed and assessments made by policy makers and economists. This particularly relates to the issue of low financial autonomy thereof. This topic is noticeably becoming increasingly relevant on the national level, as rural municipalities account for the two thirds of Lithuania's territory and 60% of all the municipalities.

During the empirical study, a group of 36 rural municipalities was formed from Lithuania's 60 municipalities. However, in the present pilot study, the rural municipalities of Panevėžys and Kaunas were chosen to assess their FA levels. The set of possible alternatives consisted of 5 rural municipalities of Panevėžys region (Biržai—A_1, Kupiškis—A_2, Panevėžys—A_3, Pasvalys—A_4, Rokiškis—A_5 district municipalities) and 4 Kaunas region municipalities (Kaišiadorys—A_6, Kaunas—A_7, Prienai—A_8, Raseiniai—A_9 district municipalities). The resulting set of alternatives: $A = (A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9)$.

The choice of rural municipalities of the specific regions was prompted by certain economic and social changes that were challenging for the majority of Lithuania's regions. Nonetheless, distinctive changes were observed in the chosen regions in relation to their demographic and socioeconomic potential, and even greater differences between individual municipalities were noticed.

Over the preceding eleven years, the population of Panevėžys region had decreased by almost 25%, while the birth rate had decreased by 22% (Department of Statistics of the Republic of Lithuania 2020). This was one of the greatest drops among Lithuania's counties. The demographic changes affected the supply of labour force in the region, posed risks to the economic development of the region, impaired region's attractiveness to foreign investments and, at the same time, financial development of the rural municipalities. In Panevėžys region, rural municipalities comprised the major part of the territory (5 of 6).

The modern character of Kaunas region was provided by the advanced economic development that assured high quality of life and rapid modernisation of the countryside with particular focus on the harmony between the human and the environment. This guaranteed sustainable development of the region (The Regional Development Department under the Ministry of the Interior of the Republic of Lithuania 2020). For example, over the preceding 11 years, population increase by 11.7% and an increase in business concentration, which was considerably lower in other rural municipalities, were observed in the rural municipality of Kaunas district [the Department of Statistics of the Republic of Lithuania].

The present research involved the data analysis and assessment covering the 11-year period, i.e., 2009 to 2019. The period specified is associated with the recently growing interest in not only local economic growth and regional development, but also improvement of the FA of municipalities. Extension of the period would be considered following the assessment of the results of the pilot study.

The FA of the alternatives chosen in the empirical study was defined from the perspective of revenue autonomy; hence, nine revenue indicators were primarily selected on the basis of specific criteria (see Table 4). In relation to maximization and minimization of the revenue indicators, it was assumed that, in the case considered, indicator R_8—state

financial intervention indicator, indicator R_9—transfers per capita, EUR had a minimizing character (a dampening effect on the FA), and all other indicators had a maximizing character (a driving effect on the FA). The lowest value of the minimizing indicator was its best value. The set of indicators was formed: $R = (r_1, r_2, r_3, r_4, r_5, r_6, r_7, r_8, r_9)$.

Table 4. Revenue indicators for financial autonomy measurement of rural municipalities and description of the indicators.

Indicator, Unit of Measure	Indicator Designation	Indicator Calculation Methodology	Direction of the Indicator Value
PIT per capita, EUR	r_1	PIT transferred into the municipal budget/population of the municipality	Maximizing
Fiscal wealth index or tax revenues per capita, EUR	r_2	Tax revenue/population of the municipality	Maximizing
PIT (%) in the total municipality revenues	r_3	PIT transferred into the municipal budget/total municipal revenues × 100%	Maximizing
Own revenues per capita, EUR	r_4	Own municipal revenues/population of the municipality	Maximizing
Share of own revenues in total revenues (%)	r_5	Own municipal revenues/population of the municipality × 100%	Maximizing
Index of financial autonomy, 1st degree/share of own revenues in total revenues, (%)	r_6	Own municipal revenues/total municipal revenues × 100%	Maximizing
Non-tax revenues per capita, EUR	r_7	Municipal non-tax revenues/population of the municipality	Maximizing
Share of grants in the total municipal revenues or State intervention ratio (%).	r_8	Transfers from the state budget (grants)/total municipal revenues × 100%	Minimizing
Transfers per capita, EUR	r_9	Transfers from the state budget (grants)/population of the municipality	Minimizing

Source: made by the authors.

The study involved identification of the limitations affecting appropriateness, validity, and correctness of the indicator calculation, and determining the decisions on database selection.

1. Pre-2014 data are presented in the former national currency litas, while post-2014 data—in euros. The data reflect the municipal tax and non-tax revenues and grants. The data are published in the statistical databases of the Ministry of Finance of the Republic of Lithuania (2020) and State Tax Inspectorate under the Ministry of Finance of the Republic of Lithuania (2020) (hereinafter—the STI). Due to the difference in the currency, the data were recalculated to be presented using a single currency. This enabled further comparative analysis of the indicators. Nevertheless, certain calculation inaccuracies could have appeared as a result of the recalculation.

2. The databases (reports) by the Ministry of Finance of the Republic of Lithuania (2020) contained predicted rather than actual municipal tax and revenue data, which also could have led to certain calculation inaccuracies. This could have also influenced objective assessment of the FA of the municipalities;

3. The predicted and actual municipal revenue data are provided in the reports available in the archive databases of the STI. Nevertheless, the greatest challenge is presented by the presentation of the data on the personal income tax (hereinafter—the PIT). The latter is determined by the procedure of PIT allocation to municipalities governed by the Law on the Approval of Financial Indicators of the State Budget and Municipal Budgets. Pursuant to the procedure:

3.1. before 2017, the municipal budget revenues from PIT consisted of the transfers of tax instalments from the STI and grants from the state budget;

3.2. from 2017, the municipal budget revenues from PIT consisted of the transfers of tax instalments from the STI in accordance with the tax allocation share (%) established by the law, including the grants from the state budget and excluding the amounts transferred into the state budget.

Considering the above limitation determining the level of accessibility, validity and objectivity of the empirical research data, it was decided to use the statistical data available in the databases of the Department of Statistics of the Republic of Lithuania (2020). Actual data of the municipal revenues (taxes) were presented in the databases of the Department of Statistics of the Republic of Lithuania and corresponded to the data presented in the reports on implementation of the municipal budget. Moreover, the data for all the years of the research period were accurately recalculated/expressed in euros, and the PIT included all the final transfers from the STI.

Descriptive characteristics of statistics revealed the tendencies of financial autonomy in rural municipalities of two regions of Lithuania during the analyzed 11-year period from 2009 to 2019 (see Tables 5 and 6).

Table 5. Descriptive statistics of indicators describing the level of financial autonomy in rural municipalities of Panevėžys region, 2009–2019.

Indicator	Mean	Median	Standard Deviation	Min	Max
PIT per capita, Eur	344.99	294.71	121.02	221.04	591.69
Fiscal wealth index or tax revenue per capita, Eur	378.10	327.18	129.43	236.38	651.05
PIT (%) in the municipality revenues	40.64	40.85	6.28	30.33	54.65
Own revenues per capita, Eur	419.55	359.64	149.04	257.35	754.66
Share of own revenues in total revenues (%)	41.95	35.96	14.90	25.73	75.47
Index of financial autonomy, 1st degree/share of own revenues in total revenues, (%)	49.30	49.40	6.96	38.30	63.76
Non-tax revenues per capita, Eur	41.44	33.17	22.14	13.06	108.73
Share of grants in the total municipal revenues or State intervention ratio, (%)	50.71	50.60	6.96	36.14	61.70
Transfer per capita, Eur	412.74	403.15	64.69	273.24	625.05

Source: own calculations based on Department of Statistics of the Republic of Lithuania (2020).

Table 6. Descriptive statistics of indicators describing the level of financial autonomy in rural municipalities of the Kaunas region, 2009–2019.

Indicator	Mean	Median	Standard Deviation	Min	Max
PIT per capita, Eur	325.11	290.94	107.71	207.52	535.13
Fiscal wealth index or tax revenue per capita, Eur	367.01	331.27	110.42	227.26	595.80
PIT (%) in the municipality revenues	41.84	41.82	6.68	31.47	55.99
Own revenues per capita, Eur	403.50	365.43	128.99	244.80	685.65
Share of own revenues in total revenues (%)	40.35	36.54	12.90	24.48	68.57
Index of financial autonomy, 1st degree/share of own revenues in total revenues, (%)	51.87	51.92	6.47	40.19	63.95
Non-tax revenues per capita, Eur	35.91	27.20	22.07	14.90	121.07
Share of grants in the total municipal revenues or State intervention ratio, (%)	48.13	48.02	6.47	36.05	59.81
Transfer per capita, Eur	366.83	377.97	88.02	214.93	615.95

Source: own calculations based on Department of Statistics of the Republic of Lithuania (2020).

The change of PIT per capita differed by 2.67 times (Panevėžys region) and 2.57 (Kaunas region) between the municipalities. This suggests that allocation of the PIT could have been different for each rural municipality and did not encourage the less affluent municipalities to undertake the measures to increase it. This may have been due to the fact that competition for the tax is a slow acting instrument.

The share of own revenue per capita showed that the difference between the less affluent and affluent municipalities was 2.9-fold (Panevėžys region) and 2.8-fold (Kaunas region). On the other hand, high value of the indicator (EUR 754.66) was registered in only one rural municipality of Panevėžys region, while the median of own revenue per capita was EUR 360 (in rural municipalities of Panevėžys region) and EUR 365 (in rural municipalities of Kaunas region).

The share of own revenue in the total revenue (1st degree financial autonomy indicator, %) had an upward trend, increasing by 46 percentage points on average in the rural municipalities of Panevezys region and by 52 percentage points in the rural municipalities of Kaunas region.

The results support the importance of the transfers into the revenue structure of rural municipalities and, at the same time, high dependence of the local governments on the state budget, signalling unfavorable conditions for the development initiatives, multifunctional growth, or progress in local self-regulation.

Hence, the research results have revealed that the redistribution function of the fiscal policy in Lithuania was defective and did not promote financial autonomy and economic well-being of municipalities in the analysis period. This was due to the fact that support was granted to the weaker municipalities, and they received larger amounts of the redistributed PIT. If not for the redistributed PIT, the municipalities making active efforts to attract investors and help create jobs would have retained more funds.

To group the rural municipalities of the selected regions into classes by FA level, the multi-criteria decision-making task was solved using the TOPSIS method.

The sets of values of each indicator, each containing 11 elements, were formed in the Excel database according to the years of the respective values of the revenue indicators (2009–2019). Eleven solution matrices were formed on the basis of the data for each selected alternative, i.e., the respective rural municipality. The revenue indicators were expressed in different units, i.e., either euros or %, and were primarily subjected to normalization. As a result, the indicator values became dimensionless. Given that the revenue indicators had been determined under the objective significance principles, normalization of the indicators was performed on the basis of the linear method. Values of the normalized indicators were further used in the subsequent FA assessment of the rural municipalities.

Objective significance of the revenue indicators was determined using the entropy approach involving assessment of the level of variation and weight of each indicator (see Table 7).

Assessment of the revenue indicators for the FA of rural municipalities of Panevėžys and Kaunas regions revealed the fluctuation in their variation level. Fluctuating and changing variation level of the FA indicators of individual rural municipalities was observed in Panevėžys and Kaunas regions in the assessment period.

Upon calculation of the objective significance values of the revenue indicators of rural municipalities in the regions analyzed, the indicators with the greatest weights were identified: non-tax revenues per capita, EUR. (r_7), PIT per capita, EUR (r_1), own revenues per capita, EUR (r_4), indicator of the level of own revenues, % (r_5), and fiscal wealth index or tax revenues per capita, EUR (r_2). The result showed that the indicators of the rural municipalities became more significant in terms of their variation in the assessment period. However, insignificant variation was also observed for certain indicators. The indicators of the first-degree FA or the share of own revenues in the total revenues, % (r_6) became particularly distinctive for all the rural municipalities analyzed. Hence, it could be concluded that the share of own revenues in the overall revenue structure of the municipalities varied insignificantly, which also supported the minor changes in the

FA levels of the municipalities. It could therefore be claimed that the FA of the rural municipalities analyzed remained medium low.

Table 7. Level of variation and weight of the revenue indicators of the financial autonomy of rural municipalities, 2009–2019.

Indicator Alternative	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9
Indicator variation level (d_{ij})									
Rural municipalities of Panevėžys region									
A_1	0.0246	0.0241	0.0037	0.0243	0.0243	0.0034	0.0292	0.0038	0.0022
A_2	0.0248	0.0210	0.0041	0.0227	0.0227	0.0033	0.0457	0.0024	0.0042
A_3	0.0209	0.0198	0.0043	0.0216	0.0216	0.0043	0.0626	0.0055	0.0014
A_4	0.0244	0.0238	0.0042	0.0252	0.0252	0.0041	0.0389	0.0038	0.0017
A_5	0.0243	0.0241	0.0033	0.0258	0.0258	0.0037	0.0430	0.0038	0.0022
Rural municipalities of Kaunas region									
A_6	0.0209	0.0129	0.0040	0.0135	0.0135	0.0012	0.0270	0.0016	0.0039
A_7	0.0220	0.0211	0.0023	0.0207	0.0207	0.0021	0.0165	0.0035	0.0064
A_8	0.0217	0.0180	0.0026	0.0230	0.0230	0.0029	0.0809	0.0026	0.0022
A_9	0.0213	0.0182	0.0027	0.0210	0.0210	0.0024	0.0612	0.0019	0.0022
Weight of objective significance of the indicator (q_j)									
Rural municipalities of Panevėžys region									
A_1	0.1761	0.1729	0.0268	0.1740	0.1740	0.0241	0.2095	0.0270	0.0155
A_2	0.1643	0.1393	0.0271	0.1506	0.1506	0.0217	0.3026	0.0160	0.0278
A_3	0.1290	0.1224	0.0266	0.1334	0.1334	0.0263	0.3865	0.0338	0.0084
A_4	0.1615	0.1570	0.0279	0.1663	0.1663	0.0273	0.2572	0.0253	0.0112
A_5	0.1555	0.1545	0.0214	0.1654	0.1654	0.0238	0.2754	0.0241	0.0143
Rural municipalities of Kaunas region									
A_6	0.2123	0.1314	0.0409	0.1369	0.1369	0.0118	0.2744	0.0158	0.0396

The weights of significance of the FA indicators of the rural municipalities in Panevėžys and Kaunas regions (see Table 8) were used further for the calculations of stage II of the empirical study using the TOPSIS method. The values of synthetic indicator/index of the FA of rural municipalities in the assessment period are presented in Table 8.

Table 8. Synthetic indicators of the FA level of rural municipalities, 2009–2019.

Alternatives	Panevėžys Region					Kaunas Region			
Year	A1	A2	A3	A4	A5	A6	A7	A8	A9
2009	0.4507	0.4062	0.3785	0.4842	0.4442	0.3951	0.5026	0.3641	0.407
2010	0.4610	0.4125	0.3279	0.4586	0.4371	0.3723	0.5181	0.3260	0.333
2011	0.4655	0.4016	0.3133	0.4223	0.3975	0.3776	0.5270	0.3358	0.324
2012	0.5068	0.4277	0.3642	0.4360	0.4285	0.4820	0.5297	0.3623	0.351
2013	0.4594	0.3588	0.3277	0.3765	0.4055	0.4669	0.5212	0.3566	0.359
2014	0.5095	0.3818	0.3331	0.4130	0.4250	0.4309	0.5130	0.3045	0.339
2015	0.5282	0.4199	0.3367	0.4347	0.4367	0.4176	0.5183	0.3098	0.349
2016	0.5240	0.3965	0.3404	0.4343	0.3913	0.4312	0.5071	0.3101	0.345
2017	0.5254	0.4023	0.3486	0.4477	0.4179	0.4420	0.5113	0.3104	0.338
2018	0.4649	0.3466	0.3016	0.4052	0.3933	0.3956	0.5064	0.2920	0.304
2019	0.4596	0.3547	0.2959	0.3891	0.3705	0.3821	0.5051	0.2884	0.302

Source: own calculations.

The results of assessment of the FA level of rural municipalities using the TOPSIS method suggested relative closeness of the "best" rural municipalities in Panevėžys and Kaunas regions to the "ideally worst" variant, which remained constant over the years. For example, the first alternative—Biržai district rural municipality of Panevėžys region—maintained the first position in terms of the closeness to the "negatively ideal" variant in the assessment period 2009–2019. The same result was observed for Kaunas district

rural municipality of Kaunas region, which also maintained the first position in the period 2009–2019. However, the relative closeness of all other rural municipalities to the "ideally worst" variant fluctuated over the years (see Figure 3).

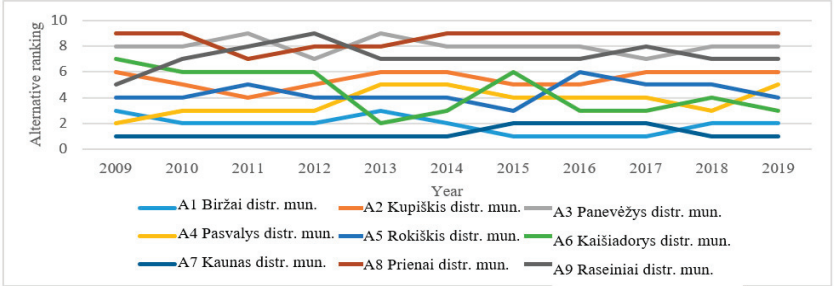

Figure 3. Variation of the priority of rural municipalities by the indicator of the level of financial autonomy, 2009–2019. Source: made by the authors.

The figure shows the change of the priority of the rural municipalities over the years. However, Table 8 and Figure 3 do not suggest which of the alternatives, i.e., rural municipalities, was the top alternative in terms of the FA level. To obtain a measurable result, the mean, median, minimum and maximum rationality values of the FA level of rural municipalities were calculated (see Figure 4).

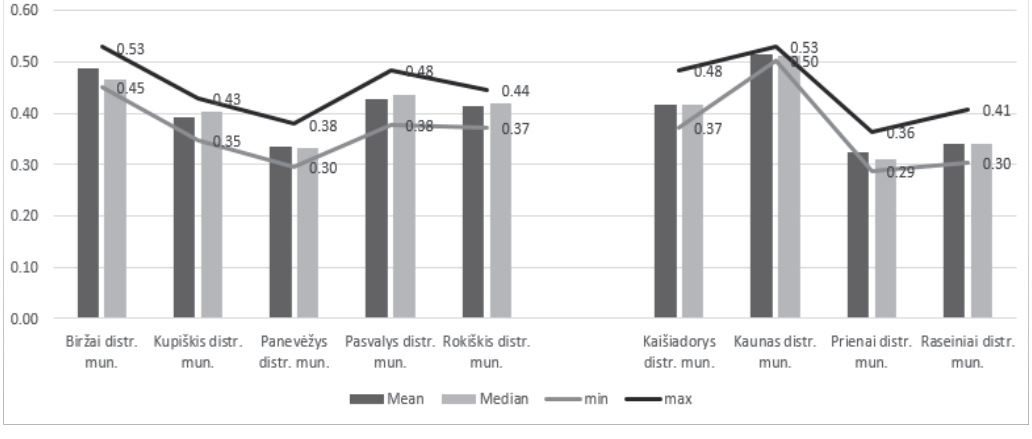

Figure 4. Assessment of the FA level of rural municipalities. Source: made by the authors.

The priority order of the alternatives, i.e., rural municipalities, by mean values of the FA level was formed: $A_7 > A_1 > A_4 > A_6 > A_5 > A_2 > A_9 > A_3 > A_8$.

The last step in the empirical study involved grouping of the rural municipalities of the selected regions into typological classes by the mean values of the synthetic indicators/indices of their FA levels. The results calculated using the TOPSIS method and the descriptive statistics methods of the mean and standard deviation were used as the basis for identification of the 4 types of the FA levels of rural municipalities in the selected regions. 4 typological classes of rural municipalities were identified in accordance with the FA levels (high, medium high, medium low, and low) based on Table 3. The rural municipalities of the selected Panevėžys and Kaunas regions fell into the typological class of medium low level by their FA level (see Table 9).

Table 9. Classification of the rural municipalities by the financial autonomy level *.

Financial Autonomy Level	Boundaries of the Synthetic Indicator	Distribution of the Municipalities of Panevėžys Region	Distribution of the Municipalities of Kaunas Region
I (high)	[0.719; 1.00)		
II (medium high)	[0.508; 0.719)		
III (medium low)	[0.297; 0.508)	Biržai distr. mun., Pasvalys distr. mun., Rokiškis distr. mun.; Kupiškis distr. mun.; Panevėžys distr. mun.	Kaišiadorys distr. mun.; Kaunas distr. mun.; Prienai distr. mun.; Raseiniai distr. mun.
IV (low)	[0.00; 0.297)		

* Values of the FA level of rural municipalities are presented as the respective mean values of the last 3 years (2017–2019). Source: made by the authors.

Following the multi-criteria assessment of the FA of rural municipalities using the TOPSIS method, the mean values of financial indicators were then calculated and compared within the identified classes by regions. The article presents the indicators of the rural municipalities of the analyze regions which varied the most significantly in the assessment period (see Figure 5). Comparison of the indicators describing the financial autonomy of rural municipalities of the two selected regions and their mean values showed that the situation of the financial condition of rural municipalities in Panevėžys region was better than that of the rural municipalities in Kaunas region.

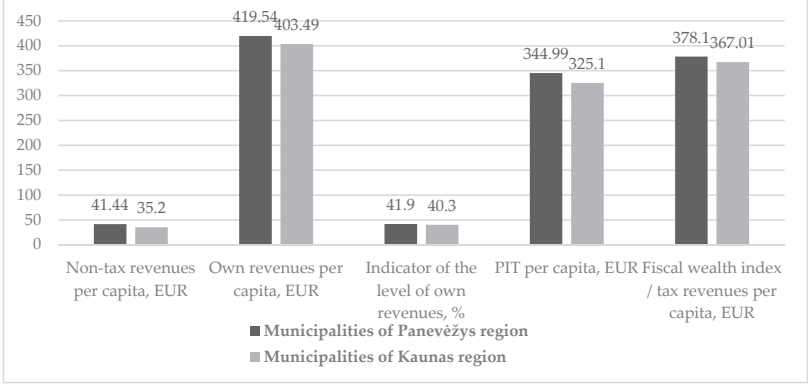

Figure 5. Indicators of FA of the rural municipalities which varied the most significantly, 2009–2019. Mean values of the FA indicators of the rural municipalities which varied the most significantly.

The research results have demonstrated the homogeneity of the rural municipalities in relation to the FA level. On one hand, the empirical research results have pinpointed the issue of "convenient dependence" of the rural municipalities in the analyzed regions on the centralised allocation. On the other hand, the lack of the incentives for them to make use of the capacities and create sustainable, stable economic and social prospects has become evident. In individual rural municipalities, the State intervention ratio (%) of public intervention varied greatly. In the rural municipalities of Panevėžys region, transfers from the state budget (grants) accounted from 36% to 62%, and in Kaunas region—from 36% to 60% in the total income of the respective municipalities. The PIT as the main revenue of municipalities was also redistributed. The PIT accounted for 40.6% of the total income in the rural municipalities of Panevėžys region, and for 41.8% in the rural municipalities of Kaunas region (see Tables 7 and 8). The data show high dependence of

the municipalities on centralized financial management, which is regulated by legal acts enabling municipalities to refrain from being financially active and autonomy.

The changing legal base causes an increase only in the number of the state and allocated functions that continue to be under the influence of the state-level authorities, and the autonomous competence of the municipalities is not expanded. It should be noted that Lithuanian legal acts do not establish a definition of the concept of "own revenues". Therefore, the questions arise as to which tax and non-tax revenues are the ownership of the municipality, and how the indicators of own revenues should be assessed. Even one of the key sources of municipal revenues, the PIT, collected within the municipalities, is subject to centralized redistribution. The municipalities have limited capacity to collect local taxes: the revenues from the local taxes make just up to 10% of the total municipal revenues. On one hand, this obviously shows the reluctance of the Lithuanian state authorities to abandon their influence in certain activity areas and increase the financial autonomy of the municipalities. On the other hand, the municipalities supported by the central government eventually become passive and make little use of own resources and potential in terms of improvement of own financial autonomy. This, therefore, raises the issue of municipalities' "convenient dependence" on centralized allocation. The conducted empirical study of financial autonomy assessment of the rural municipalities also showed the medium low level of financial autonomy. Hence, there is currently the need in the country to analyze the financial autonomy of the municipalities, assess the situation, and explore the possibilities for improvement.

It could be claimed that the model used in the present empirical study is reliable in various aspects. FA assessment of rural municipality using the multi-criteria TOPSIS method enabled the authors to design a single summarizing indicator of financial autonomy of rural municipalities, assess the FA level of rural municipalities of the selected regions, and form the typological classes. It should be noted that limitations of the empirical research data, methods of verification and assessment of the FA indicators, sensitivity of the TOPSIS method towards the normalization rules applied may considerably affect the objectivity of the assessment.

5. Conclusions

Financial autonomy of local government units is the term employed when referring to the complex, multidimensional economic phenomenon based on the economic, fiscal policy, fiscal decentralisation, and regional development theories. It is related to responsible and sustainable financial resource allocation, redistribution, and stabilisation. Hence, assessment of the phenomenon involves complex aspects that cannot be measured directly. In view of the above, the multi-criteria TOPSIS method was selected and enabled the authors to assess the financial autonomy of rural municipalities by presenting a single summarizing indicator and to determine the respective levels of financial autonomy. The complex, integrated assessment model applied to assessment of financial autonomy of rural municipalities of the two regions was designed during the empirical study.

The conducted empirical study and data analysis have not provided compregensive exploration of financial autonomy of rural municipalities from the perspective of socioeconomic development. Nevertheless, they established the basis for further analysis of the scope, factors, and conditions of the phenomenon. For deeper and more comprehensive assessment and comparison, it is necessary to not only assess the level of financial autonomy of all the remaining rural municipalities of Lithuania, but also to analyse their socioeconomic factors and effect on the regional development. Hence, the empirical study should be resumed by extending the methodology with the view towards determination of the socioeconomic factors and effect thereof on development of the municipalities and financial sustainability (stage 3 of the empirical study).

The novelty of the research findings is demonstrated by the designed multi-criteria assessment model for assessment of financial autonomy of the rural municipalities using a single indicator. The study is also significant in that the assessment of the financial

autonomy was performed for the rural municipalities as the local government units, as it was not subject to an integrated analysis on the national level. The model is relevant in addressing of the scientific and practical goals. It also enables the practitioners and theorists to assess and rationalize the financial autonomy of LGUs by gaining a better understanding of the whole, providing reasonable suggestions on increasing of the financial autonomy of LGUs. The presented model is also relevant for modeling of the scenario of the links between financial autonomy and the impact of socioeconomic factors on the development of municipalities and financial sustainability development indicators.

The results of the empirical study have revealed that the analyzed municipalities of the selected regions were characterised by the medium low level of financial autonomy. The finding has shown that the municipalities were very homogeneous, and their financial state and possibilities to implement own tasks still depended on the national budget allocations.

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Economic Evaluation of the Management of Municipal Firms at the Level of Rural Local Self-Governments (Case Study)

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Abstract: The municipality generally uses its property to perform self-governing functions, and public or business activities. In the conditions of the Slovak Republic, the municipality operates either as a legal entity in its own name or carries out business activities with the help of a contributory and budgetary organization or business firm established by the municipality. Revenues from business activities form an important part of the revenue of local self-government budgets. The aim of this paper was an economic evaluation of the management of municipal firms at the level of rural local self-governments in the conditions of the Slovak Republic on the basis of selected economic indicators. At the same time, we analyzed the relationship between selected economic indicators in relation to the size, lifespan and number of employees of the firm. The analysis was performed in the time period 2015–2019 on a sample of municipal firms at the level of rural local self-governments. For the analysis, we used selected mathematical–statistical methods (Shapiro–Wilk test, Kruskal–Wallis test, and regression analysis). The analysis showed that the differences in the profitability of municipal firms from the point of view of the region in which they operate as well as from the point of view of the number of employees is not statistically significant. Statistical significance was not demonstrated even within the volume of revenue of municipal firms from the point of view of the region in which the municipal firm operates. The volume of revenues of municipal enterprises with the population of the municipality as well as the length of time of operation on the market is growing, but these are not the only factors on which these results depend.

Keywords: municipal firms; business; economic evaluation; local self-government; rural municipalities

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1. Introduction

In several countries, especially in western and central Europe, local self-government is independent, and direct state interference in its competences is prohibited (Aleksee 2013). However, Zhang et al. (2020) note that when local self-governments have sufficient fiscal autonomy, decentralizing fiscal power to sub-provincial governments is found to have a greater impact on increasing marketization and market efficiency. Moreover, in the environment of modern liberal democracies, there is an ever-increasing trend towards the application of the subsidiarity system (Levický et al. 2019; Pauličková 2010). On the other hand, there is a theory that the provision of financial needs of local self-government should be set in proportion to the performance of its competencies and tasks (Oplotnik et al. 2012; Klimovský 2008). Revenues of self-governing budgets generated through

the use of the self-governing property for business purposes contribute to increasing the financial independence of local self-governments. In recent years, the business of local self-governments has proved to be one of the central interests of public administration worldwide. Local self-governments are expected to play a broad and proactive role in supporting local economic development, in addition to performing traditional public service functions. To achieve this, they must constantly innovate to attract talent and investment in the process of meeting the needs of the people in their jurisdictions through the provision of public services (Mei et al. 2016). According to Mbecke (2015), to define and generalize the phrase municipal business is not easy at all. According to him, conducting business in municipalities is not easy for two reasons. First, business is limited and still a subject of research. Second, the management of public services is also an area where much remains to be explored, including in the area of public sector business. Municipal business is a scientific discipline that seeks to understand the extent to which local self-governments and their representatives shape the discovery, creation, exploration, exploitation, and diffusion of new opportunities and the economic, social, and environmental consequences. Although public sector business capacities have not been comprehensively examined, it is worthwhile to start with some features that can contribute to the success of business at the local level. We can understand the business activity of the municipality in a narrower or broader sense. In a narrower sense, we can understand the combination of "municipal business" only as the municipality's own business activity. In a broader sense (from the point of view of using public property), we can also understand the business activity of legal entities established or funded by the municipality and legal entities in which municipalities participate with property as business deposit (Hudec 2011). By conducting business, municipalities secure part of their revenue, and at the same time, they create a competitive environment for other entrepreneurs. Municipal firms also participate in creating activities that are necessary for the municipality in terms of complexity. Gorzelak (2019) states that, in addition to revenue, municipal firms also directly create job opportunities for the inhabitants of the municipality in which the municipal firms have their registered office, which improves the overall image of the municipality. This is also confirmed by Babun (2020), who states that local self-government with adequate administrative and financial autonomy has the ability to find and attract labor power for municipal firms, which also ensures the growth of human capital in the area. Entrepreneurial activity enables municipalities to cooperate with other municipalities to solve development programs that they cannot implement from their own resources (e.g., construction and operation of a municipal solid waste landfill). This form of using municipal property can be decided by the municipal council or the mayor. The municipality is obliged to set aside the property used for business, keep it in special records and to depreciate it in accordance with the accounting for the municipality's business activities. Decision making in the management of municipal property in the Slovak Republic is the competence of the municipal council and the mayor of the municipality, who can decide on the market method or non-market method of management. In the market method of management, local self-government prioritizes revenue generation with the main goal of strengthening the local budget. In non-market management, the local self-government uses the municipal property to fulfil its competencies arising from the law, while the social characteristics of the provided goods are preferred, and the generation of revenue has only a secondary role. According to Bumbalová et al. (2021), the main purpose of municipal firms should be to carry out economic activities in the public interest. On one hand, this does not automatically exclude activities unrelated to the competences of self-government; on the other hand, self-government favors the achievement of social well-being over profitability.

2. Theoretical Background

The theory of business emerging in the public sector is an unmistakable sign that it is difficult to draw the line between the private and public sectors. Additionally, the municipal firm is one of the elements that, by nature, are located at the intersection between

these two sectors (Bumbalová 2011). This is also confirmed by Vinnari and Näsi (2008), who state that municipal firms in Finland are, therefore, explicitly at the intersection of private and public organizations, as they fulfill primary commercial objectives, are an integrated organizational unit of local self-government and are covered by local legislation. However, Pirošík (2014) notes that in such a firm there may be a possible conflict of public and private interest. He states this in the example of Slovak municipal firms. Slovak legislation does not prohibit the combination of the performance of functions in the legislative and executive bodies of the municipality with activities in municipal firms. Although such a situation is often desirable, especially in the case of the mayor, as he is the statutory body of the municipality and bears direct responsibility for it, it is not possible to overlook the related problems that arise. These elements are contained in the concept of the so-called municipal firm, which Stoilova (2010) and Fil'a et al. (2020) define as an entity engaged in economic activities that are beneficial for society but unprofitable for the private sector; beneficial to the private sector, but cannot be implemented by that sector; natural monopolies. This is also confirmed by the research of Bumbalová and Balážová (2014), who note that approximately half of municipal firms are engaged in activities directly related to self-government competencies, and the other half of firms have differently oriented main subjects of activity. However, the direct provision of public services for the inhabitants, which were identified in the questionnaire as municipal services, was mentioned by only 9% of firms, another 13% stated a combination of municipal services and another focus. It follows that municipalities do not set up their municipal firms primarily for the purpose of providing services to the inhabitants, but search for ways to manage property (33% of firms), or try to generate their own funds through profits of firms operating in the market, outside the sphere of public services. This is also confirmed by Klimovský (2008), who notes that under certain conditions, municipal firms are governed by the motive of profit and competitiveness. This is also confirmed by Stoilova (2010), according to whom municipal firms are able to profitably produce goods and provide services and also compete in the conditions of the private sector. Another confirmation of this is by Clifton et al. (2010), who state that some municipal firms in Italy have managed to achieve such a degree of competitiveness that they have also penetrated global markets (e.g., energy companies from Milan and Brescia), and their stocks have appeared on the stock exchange. However, Bumbalová (2011) notes that in the case of municipal firms, the profitability aspect may not play a key role. Municipalities often seek to provide local public services for inhabitants through a municipal firm. It is precisely this role that is the base of these firms, as opposed to firms operating in a competitive private sector. The framework of the private sector, therefore, does not seem to be a completely satisfactory context for the placement of the term "municipal firm". It is in this context of several different views of the authors on the municipal firm that we decided to focus in our research on the profitability of municipal companies in terms of individual identification factors (region, number of employees, municipality size, and longevity).

Hypothesis 1 (H1). *We assume statistically significant differences in the profitability of municipal firms in terms of individual identification factors (a—region and b—number of employees).*

Hypothesis 2 (H2). *We assume a statistically significant linear dependence of the profitability of municipal firms on individual identification factors (a—size of the municipality and b—longevity).*

Fölster et al. (2016) adds that some municipalities have a large number of municipal firms, which on the one hand, provides private consumption and, on the other hand, competes with private firms or tries to push private firms out of the market. Nevertheless, it is possible to perceive a municipal firm from the point of view of building local self-government for several key reasons: they create stable and quality jobs for community members; they increase local economic stability by reducing local self-government dependence on private firms; they often provide goods and services to areas lacking access that are overlooked for profit-only service providers; they often provide goods and services

to local people at a lower cost than providers providing profit-only services; they generate new local revenues that can be used for other self-government expenses; they often provide greater reliability, transparency and democratic control than providers providing profit-only services (Community-Wealth ORG 2018). Achieving and adhering to all of the abovementioned principles is not an easy task in the environment of municipalities. From a theoretical point of view, these problems are dealt with in business theory, which is understood as a critique of the bureaucratic approach to public administration. The basis of this theory is to find a way to systematically avoid a collision between allocation economy and efficiency, on one hand, and inefficiency of use, on the other. The starting point is in the environment of business management (Osborne and Gaebler 1993). Kraftová (2002) devotes much of her own theory to a municipal firm, stating that it is an economic entity that provides products without a profit motive and without the driving force of market competition. On the other hand, she argues that since these firms operate through the use of public resources, which are very limited, they need to be managed efficiently. Through the effectively implemented business activities of the municipality, it is possible to obtain additional resources to ensure the needs for the performance of self-government and the production of local public goods or services. Financial resources obtained from businesses can be reused in the expansion of the implemented business activities or in the expansion, reconstruction and modernization of municipal property (Takáč 2006). Municipal firms are, therefore, a fundamental part of the business activities of municipalities. The business activity of the municipality represents a tool for creating suitable economic conditions for the development of business activities in the private sector (Országhová and Gregáňová 2018; Smutka and Steininger 2016). Arapis (2013) states that these firms have helped the government in various ways at all levels, including building infrastructure, stimulating economic growth, providing public services and diversifying government revenue sources. Grossi and Reichard (2008) state that the trend in several European countries is relatively high employment in municipal firms, e.g., in Germany, almost 50% of the municipality´s labor power work in municipal firms, and in Italy, it is almost 30%. In Sweden, 34% of the total number of employees of state-owned enterprises work in municipal firms (PWC 2015). Valach and Bumbalová (2020) state that in the Slovak Republic, the largest group (51.23%) consists of municipal firms with less than 10 employees. Based on this indicator, such firms belong to so-called microfirms. In contrast, there are only five municipal firms with more than 250 employees. In this context, in our research, we focused on the evaluation of the sales of municipal companies in terms of individual identification factors (region, number of employees, municipality size and longevity).

Hypothesis 3 (H3). *We assume statistically significant differences in the sales of municipal firms in terms of individual identification factors (a—region and b—number of employees).*

Hypothesis 4 (H4). *We assume a statistically significant linear dependence of the volume of sales of municipal firms on individual identification factors (a—municipality size and b—longevity).*

The establishment of a successful business in local self-governments is not only an ambitious but also an important step in maximizing the provision of services at the local level (Mbecke 2015). However, Rundesová (2008) expressed the opinion that many municipalities are in fact "forced" into business activities, which means that they allegedly carry out business activities "voluntarily by force", although ultimately, they increase their welfare. Therefore, according to Halásek et al. (2002), it is necessary for municipalities to make very careful decisions about the business activities of municipalities. The municipal authorities should have access to an analysis of the management of the municipal firm in order to reduce the level of risk to a minimum so that the property of the municipality invested in the joint venture is not impaired. Bumbalová (2011) notes that, among the most frequently used organizational and legal forms of entities that municipalities base on the implementation of business activities, are limited liability companies and joint stock companies. Valach and Bumbalová (2020) state that the vast majority of Slovak

municipal firms have the legal form of a limited liability company, while in more than 60%, their capital does not exceed EUR 50,000. Sýkora (2021), however, adds that the municipality is not obliged to create a specific liability company or joint stock company as a legal entity for the performance of business activities. Kuoppakangas (2013) also adds that, in accordance with legislation and policies adopted at the municipal level, these firms can use their own resources to support their development goals, even without the consent of the political actors involved, but only within the limits explicitly stated in the statutes. However, according to Kaliňák (2016), it is important to emphasize that the purpose of the business activities of municipal firms should not only be financial profit, but also non-financial profit. This means that their activities should increase the scope and quality of services provided in the framework of public benefit activities. Among some of the benefits of setting up a municipal firm according to Ledecký et al. (2014) are the cheapening and improvement of public services; emergency workers are "always at hand" in case of accidents and emergencies; a source of interpersonal relationship; irreplaceable help in organizing cultural sports and social life; starting and improving the business environment; the use of municipal resources; and the fact that the municipal firm is an important part of the development of the municipality. On the other hand, Rončák and Mateičková (2011) claim that the area of municipal firms is one of the areas that is the least controlled by the public. This increases opportunities for corrupt and non-transparent behavior (e.g., the process of creating firm bodies, rules for hiring firm employees, the method of public procurement and prices of selected commodities) of representatives of municipal firms.

3. Methodology

In the conditions of the Slovak Republic, the municipality can conduct business activities as a legal entity in its own name (mainly in the case of smaller municipalities), with the help of a contributory/budgetary organization, or as a business firm established by the municipality. The municipality can also use its property to support the business activities of other entities located in its territory.

The aim of this paper was the economic evaluation of the management of municipal firms at the level of rural local self-governments under the conditions of the Slovak Republic on the basis of selected available economic indicators—profitability and volume of sales. At the same time, we analyzed the relationship between these economic indicators and the size of the firm, longevity, or number of employees. For this purpose, we set research hypotheses, through which we tested the relationships between individual factors or differences based on them.

To answer the research question using the second economic indicator (volume of sales), one research hypothesis (H2) is defined, which is verified by means of four partial hypotheses focusing on individual identification factors as follows:

The individual hypotheses are processed in a dataset of 137 municipal firms with the following characteristics (see Table 1).

Table 1. Description of the selected variables.

Variable	Year	Average	Median	Coefficient of Variance (%)	Range
Profit	2015	10,796	626	558.42	649,672
	2016	13,680.7	872	524.98	651,041
	2017	13,342.7	798	572.60	875,153
	2018	12,021.1	852	652.28	704,251
	2019	8299.64	131	906.48	668,581
Sales	2015	238,182	80,129	146.24	1.87×10^6
	2016	245,704	89,364	142.69	1.83×10^6
	2017	260,714	94,816	148.43	1.93×10^6
	2018	275,617	87,213	152.65	2.43×10^6
	2019	271,957	86,234	155.57	2.51×10^6

Source: own processing.

Defining individual research hypotheses determines the apparatus of mathematical–statistical methods that are used for their evaluation. The basis was the verification of the normal distribution by means of the Shapiro–Wilk test (see Vavrek et al. 2020):

$$SW = \frac{(\sum u_i x_i)^2}{\sum u_i^2 \sum (x_i - \overline{x})^2} \quad (1)$$

where: $u_i$constant;
$x_i$value of i-th statistical unit;
$\overline{x}$average value of variable.

Due to the nature of the data for the evaluation of partial hypotheses (H1a, H1b, H3a, H3b), the Kruskal–Wallis test was used:

$$Q = \frac{12}{n(n-1)} \sum_{i=1}^{I} \frac{T_i^2}{n_i} - 3(n+1) \quad (2)$$

where: $n$number of observations and sample size, respectively;
$n_i$number of observations in i-th group;
T_i^2total number of orders in the i-th group.

Due to the nature of the data for the evaluation of partial hypotheses (H2a, H2b, H4a, H4b), a simple regression linear model calculated using the least squares method was used, while the explanatory value of the regression linear model thus created was verified using the coefficient of determination:

$$R^2 = \frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{\sum_{i=1}^{n} (y_i - \overline{y}_i)^2} \quad (3)$$

where: $y_i$measured value of dependent variable;
$\hat{y}_i$estimated value of dependent variable;
$\overline{y}_i$estimated value of dependent variable.

All analyses and calculations were processed using MS Excel, Statistica 13.4 and Statgraphics XVIII.

The reason for choosing rural municipalities is the fact that according to the OECD, the Slovak Republic is a rural country and the majority of the population lives in the countryside. This is also confirmed by Table 2, which shows that of the total number of municipalities in the Slovak Republic (2890), rural municipalities make up 95.33%, which represents 2755 municipalities out of the total number. There are 2,526,748 inhabitants in rural municipalities, who represent 46.30% of the total inhabitants of the Slovak Republic.

Table 2. Number of municipalities and number of inhabitants in municipalities in Slovak Republic on 31 December 2019.

Size Group	Number of Municipalities	Number of Inhabitants
199 inhabitants or less	415	51,743
From 200 to 499 inhabitants	710	247,719
From 500 to 999 inhabitants	755	538,214
From 1000 to 1999 inhabitants	570	800,062
From 2000 to 4999 inhabitants	305	889,010
From 5000 to 9999 inhabitants	63	425,207
From 10,000 to 19,999 inhabitants	34	480,213
From 20,000 to 49,999 inhabitants	28	799,759
From 50,000 to 99,999 inhabitants	8	549,627
From 100,000 and more inhabitants	2	676,319
Total number of municipalities	2890	5,457,873
Total number of municipalities up to 5000 inhabitants (rural municipalities)	2755	2,526,748
% share of municipalities up to 5000 inhabitants on total number of municipalities	95.33	46.30

Source: Statistical Office of the Slovak Republic, own processing.

In addition to being a rural country, the Slovak Republic is also characterized by a fragmented settlement structure (see also Vavrek 2015). This is also confirmed by Table 3, which shows that in terms of the number of small municipalities with less than 5000 inhabitants, most of them are located in the Prešov region, while the least rural municipalities are in the Bratislava region. The presence of a large number of small rural municipalities also has an impact on the overall economy of the region. In the Bratislava region, where the least small municipalities are located, the largest regional GDP per capita is generated. The Prešov region, with the largest number of municipalities with less than 5000 inhabitants, generates three times less regional GDP compared to the Bratislava region.

Table 3. Demographic and economic characteristics of Slovak regions on 31 December 2019.

Region	Number of Rural Municipalities	Number of Inhabitants in Rural Municipalities	Number of Municipal Firms in Rural Municipalities	Regional GDP (EUR Million)	Regional GDP Per Inhabitant (EUR)
Bratislava region (BA)	61	110,955	14	26,379.564	50,428.546
Trnava region (TT)	236	308,038	34	10,840.655	24,395.099
Trenčín region (TN)	261	277,048	50	8109.887	17,600.876
Nitra region (NR)	337	360,407	28	9940.255	18,697.530
Žilina region (ZA)	293	337,077	34	10,658.802	19,578.118
Banská Bystrica region (BB)	496	315,705	58	8175.239	16,064.697
Prešov region (PO)	646	451,834	61	8753.769	13,468.749
Košice region (KE)	425	365,684	39	11,007.006	17,459.668

Source: Statistical Office of the Slovak Republic, own processing.

In these rural municipalities (up to 5000 inhabitants), a total of 318 municipal enterprises were registered in 2021, based on data from the Register of Financial Statements. Most municipal firms were based in the Prešov region, and the least number in the Bratislava region. However, the base file database also included municipal firms with an incomplete range of data, municipal firms in bankruptcy or municipal firms that have already ceased to exist. For this reason, we decided to analyze a sample of municipal firms in the time period 2015–2019. A sample consisting only of municipal firms that fulfilled the following parameters was used: data are available for the entire reference time period 2015–2019; the entity is not in bankruptcy; the subject did not cease to exist on 1 January 2021 and is performing its activity, i.e., is active. The number of municipal firms which fulfilled all of the abovementioned parameters was 137.

4. Results and Discussion

In the conditions of Slovakia, the municipality as a legal entity has the right to conduct business through any form in accordance with act no. 513/1991 Coll.—Commercial Code as amended. Pursuant to the provisions of the Commercial Code, as of its entry into force on 1 January 1992, commercial firms may also be established by municipalities. The municipality can establish a business firm as the sole shareholder or as the sole companion. In such a case, the competence of the general meeting is performed by the statutory body of the municipality, which is the mayor of the municipality. The advantage of this form of management is that the municipality, based on the use of its own property for business purposes, can simultaneously ensure revenues to the municipal budget and also solve the problem of unemployment. The problem with this form of conducting business with municipal property is the big concentration of decision-making power of the mayor, who, on the one hand, acts as the statutory body of the municipality and, on the other hand, acts as the statutory body of the firm. It follows that, in the process of such a two-pronged decision, he may give priority to his private interest over the public interest. This form of business can lead to the targeted privatization of municipal property. In practice, only capital firms are appropriate for municipalities. According to the Commercial Code, a limited liability company can also be established by one person, and the company can have a maximum of 50 partners. The company is responsible for its liabilities with all its assets, and the partner is liable for the company's liabilities up to the amount of its

unpaid deposit entered in the Commercial Register. The value of the share capital must be at least EUR 5000; this share capital consists of cash and non-cash deposits, and the value of the shareholder's contribution must be at least EUR 750. If the company is founded by one founder, the base is a founding agreement; if there are several founders, then a partnership agreement is written. In the case of the participation of a municipality in such a company, the founding or social contract is signed by the mayor only with the consent of the municipal council. In this context, we consider it necessary to state that in some companies in which the municipality has an ownership interest, a larger number of partners in the position of various natural and legal persons can participate. Several companies are also registered, where only municipalities are the exclusive partners, in various numbers. An example of a large number of partners can be a company registered by the District Court of Nitra, which unites up to 12 municipalities, and whose subjects of business are mainly activities necessary for municipalities, e.g., waste management, construction activity, operation and maintenance of water supply and sewerage network. Other companies are registered by the District Court of Košice I, which concentrates 18 municipalities and whose subject of business is, in addition to waste management and production (Hudec 2011). Although these companies operate in a competitive market environment, their important mission is often to provide services to the population. Their purpose is not only financial gain, but also non-financial profit. This means that, in addition to financial gain, their activities can increase the scope and quality of services provided in the framework of public benefit activities. However, if they focused only on providing services to the inhabitants, and managing loss, the result would be the devaluation of municipal property and eventual bankruptcy. The profitability of municipal firms in individual regions of the Slovak Republic in 2019 is shown in Figure 1. We can observe differences mainly at the level of individual entities, not the group as a whole, which captures the occurrence of remote (or extreme) observations in all regions except the Bratislava region (BA).

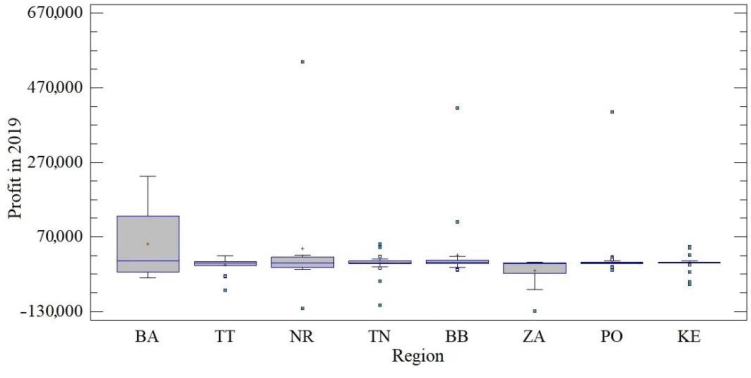

Figure 1. Profitability of municipal firms: by region, 2019 (hypothesis 1a). Source: own processing.

Statistically significant differences using the Kruskal-Wallis test (Table 4) indicate a different situation in the individual analyzed years, while in 2018 and 2019, the differences between the regions were not demonstrated.

Figure 2 shows the profitability of municipal firms according to the number of employees in 2019 (or size groups). The majority of firms are relatively balanced, but graphic differences can be identified in the number of remote (or extreme) values in individual groups, and in the municipal firms with significantly better or worse results compared to the results of others in the given size group.

Table 4. Results of verification of research hypothesis 1a.

Year	Kruskal–Wallis Test
2015	Q = 9.106; $p = 0.245$
2016	Q = 21.024; $p < 0.05$
2017	Q = 16.180; $p < 0.05$
2018	Q = 0.229; $p = 0.265$
2019	Q = 3.920; $p = 0.799$

Source: own processing.

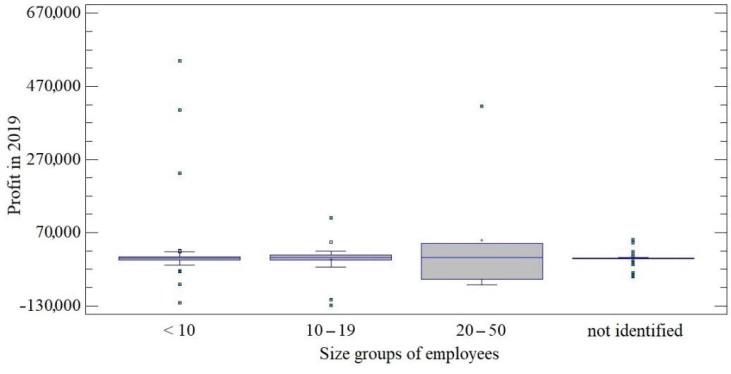

Figure 2. Profitability of municipal firms by number of employees in 2019 (hypothesis 1b). Source: own processing.

Differences in the mean value of profitability of individual groups of municipal firms (using the Kruskal-Wallis test) proved to be statistically significant only in the first of the evaluated years—in 2015. In other years, we did not register differences between municipal firms (see Table 5).

Table 5. Results of verification of research hypothesis 1b.

Year	Kruskal-Wallis Test
2015	Q = 9.639; $p < 0.05$
2016	Q = 6.879; $p = 0.075$
2017	Q = 4.807; $p = 0.186$
2018	Q = 7.508; $p = 0.057$
2019	Q = 2.754; $p = 0.431$

Source: own processing.

Based on the above, it is not possible to confirm partial research hypothesis 1a, which means that differences in the profitability of municipal firms from the point of view of the region in which the municipal firm operates are not statistically significant. The same conclusion can also be stated in the case of partial research hypothesis 1b, when the differences in the profitability of municipal firms in terms of the number of employees are also not statistically significant. Based on this evaluation of partial research hypotheses 1a, 1b, we also reject research hypothesis 1.

In partial research hypothesis 2a, we assume the dependence of the profitability of municipal firms on the size of the municipality in which the municipal firm is located, while the degree of this dependence in 2019 is shown in Figure 3. This dependence can be expressed by a linear regression model with Profit = 0.92936 × number inhabitants (R^2 = 0.09%).

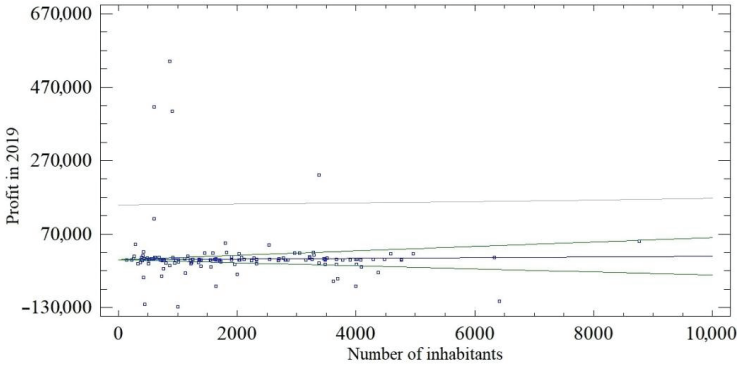

Figure 3. Dependence of profitability of municipal firms on the size of the municipality in 2019 (hypothesis 2a). Source: own processing.

In the individual analyzed years 2015–2019, we observe similar results, while each time the dependence of profitability on the number of inhabitants is positive, it means as the population of the municipality grows, so does the profitability of municipal firms in this municipality (Table 6). However, the regression models themselves reach a low significance value expressed by the coefficient of determination.

Table 6. Results of verification of research hypothesis 2a.

Year	Linear Regression Function	R^2 (%)
2015	Profit = 3.1774 × number of inhabitants	1.70
2016	Profit = 3.88885 × number of inhabitants	1.78
2017	Profit = 3.54442 × number of inhabitants	1.32
2018	Profit = 1.61885 × number of inhabitants	0.26
2019	Profit = 0.92936 × number of inhabitants	0.09

Source: own processing.

Within the second partial research partial hypothesis 2b, we assume an increase in profitability together with an increase in the time of operation of the municipal firm on the market—its longevity. The results in 2019 shown in Figure 4 and the regression function P_{2019} = 1.84035 × longevity indicate a positive dependence, which is, however, influenced by other factors that are not included in this model (R^2 = 2.74%).

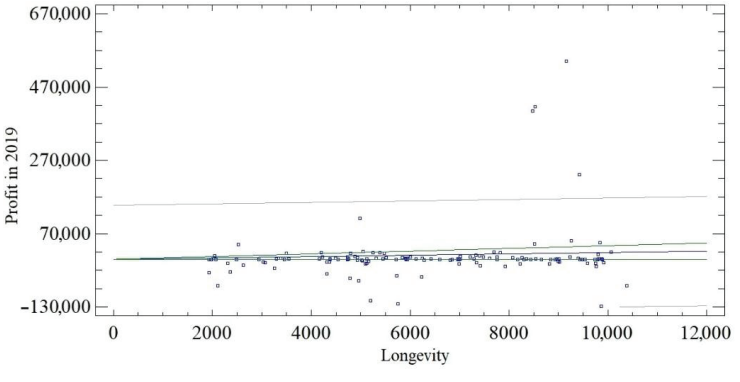

Figure 4. Dependence of profitability of municipal firms on its longevity in 2019. (hypothesis 2b). Source: own processing.

As in the previous case, in the individual analyzed years, 2015–2019, we can see similar results, while each time the dependence of profitability on the longevity of municipal firms on the market is positive, this means that the number of days a municipal firm operates on the market increases its own profitability (Table 7). Such an interpretation of the results is also influenced by their low explanatory power, as the variability of the dependent variable is significantly influenced by other factors.

Table 7. Results of verification of research hypothesis 2b.

Year	Linear Regression Function	R^2 (%)
2015	Profit = 2.11042 × longevity	5.49
2016	Profit = 2.55875 × longevity	5.67
2017	Profit = 2.19967 × longevity	3.72
2018	Profit = 2.37349 × longevity	4.14
2019	Profit = 1.84035 × longevity	2.73

Source: own processing.

Based on the above, especially very low values of the coefficient of determination (R^2), it is not possible to confirm the linear dependence of the profitability of municipal firms on the size of the municipality in which the municipal firm is located, and so partial research hypothesis 2a cannot be confirmed. We also observe very low values of the coefficient of determination in the case of the second partial research hypothesis 2b, so similarly, partial research hypothesis 2b cannot be confirmed. Based on this evaluation of partial research hypotheses 2a, 2b, we also reject research hypothesis 2.

The volume of sales of municipal firms in 2019 by individual regions is shown in Figure 5. With the exception of the Bratislava region (BA), we observe municipal firms in each of the regions, whose results deviate from other results in individual regions, which can be described as remote and extreme values, respectively.

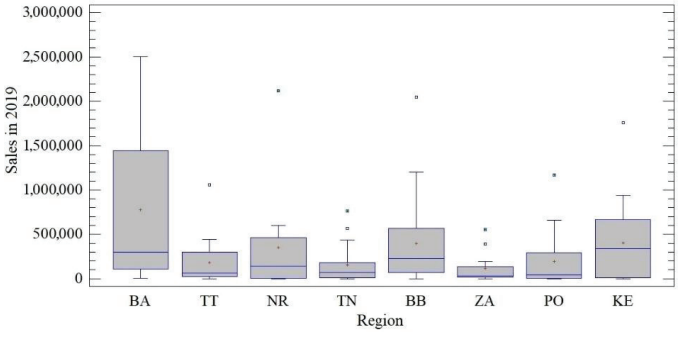

Figure 5. Volume of sales of municipal firms by region, 2019 (hypothesis 3a). Source: own processing.

The occurrence of such municipal firms with different results persists across the years 2015 to 2019, which we label as homogeneous. The differences between the individual regions did not prove to be statistically significant or stable, which we deduce from the absolute values captured in Table 8.

Based on Figure 6, we can state that with the growth of the number of employees (size group), the volume of sales of municipal firms also increases. The results, with the exception of the first group (up to 10 employees), are relatively balanced, as we do not observe the occurrence of remote (or extreme) results.

Table 8. Results of the verification of research hypothesis 3a.

Year	Kruskal-Wallis Test
2015	Q = 12.015; p = 0.100
2016	Q = 12.274; p = 0.091
2017	Q = 11.775; p = 0.108
2018	Q = 10.407; p = 0.166
2019	Q = 10.043; p = 0.186

Source: own processing.

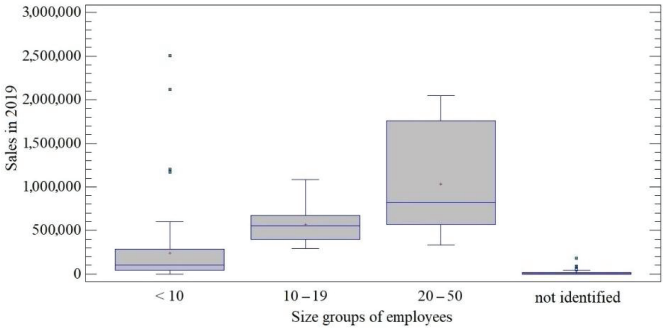

Figure 6. Volume of sales of municipal firms by number of employees in 2019 (hypothesis 3b). Source: own processing.

Differences in the mean value of the volume of sales of individual size groups (using the Kruskal–Wallis test) proved to be statistically significant in each of the evaluated years, 2015, 2016, 2017, 2018 and 2019. The size of the municipal firm is, therefore, a factor influencing the volume of sales (see Table 9).

Table 9. Results of verification of research hypothesis 3b.

Year	Kruskal-Wallis Test
2015	Q = 74.183; $p < 0.05$
2016	Q = 89.893; $p < 0.05$
2017	Q = 87.801; $p < 0.05$
2018	Q = 86.206; $p < 0.05$
2019	Q = 87.100; $p < 0.05$

Source: own processing.

Based on the above, it is not possible to confirm partial research hypothesis 3a—the differences in the volume of sales of municipal firms from the point of view of the region in which the municipal firms operate are not statistically significant. The exact opposite conclusion can be stated in the case of research hypothesis 3b—the differences in the volume of sales of municipal firms in terms of the number of employees are statistically significant. Therefore, based on the evaluation of partial research hypotheses 3a, 3b, it is not possible to unequivocally reject or confirm research hypothesis 3. This conclusion is also confirmed by the research of municipal firms in Sweden. Municipalities in this country employ on average 18% of the country's total workforce. In some municipalities, where municipal firms focus on social services in relation to the elderly or children, this share can be much higher, even at the level of 30%. If municipalities do not create municipal firms, but create conditions for business activities of private firms, this share is much lower. However, in such a case, there is no statistically significant correlation between employment in municipalities and employment in the vicinity of the municipality in terms of population density (Fölster et al. 2016). The situation is similar in all historical regions of Poland,

where more than four-fifths of local self-governments have taken measures to increase the number of local jobs, two-fifths of which were municipalities in Greater Poland. This area thus pursued a more dynamic development policy through the development of municipal business activity (Gorzelak 2019). Within partial research hypothesis 4a, we assume the dependence of the volume of sales of municipal firms on the size of the municipality in which the municipal firm is located (as well as in the case of their profitability). The degree of this dependence in 2019 is shown in Figure 7, while it can be expressed by a linear regression model with a function in the form S_{2019} = 85.1138 × number of inhabitants of the municipality (R^2 = 18.07%).

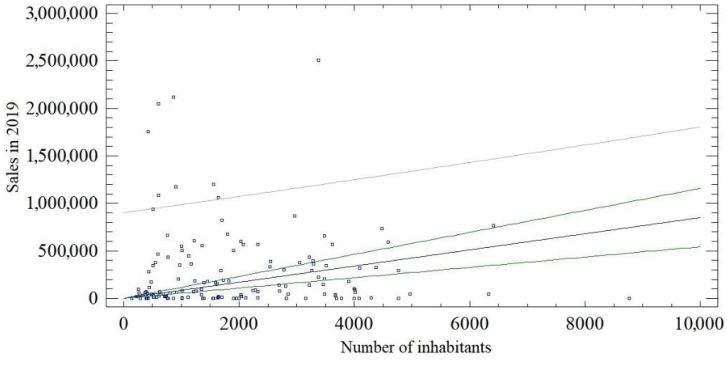

Figure 7. Dependence of profitability of municipal enterprises on the size of the municipality in 2019 (hypothesis 4a). Source: own processing.

In the individual analyzed years, 2015–2019, we observe similar results, while each time the dependence of profitability on the number of inhabitants is positive, it means that with the growth of the population in the municipality, the volume of sales of municipal firms in this municipality is also growing (Table 10). Low values of the coefficient of determination (R^2) indicate that the volume of sales of municipal firms is significantly influenced by other factors, not only the number of inhabitants in the municipality.

Table 10. Results of verification of research hypothesis 4a.

Year	Linear Regression Function	R^2 (%)
2015	Sales = 76.7863 × number of inhabitants	20.89
2016	Sales = 79.7422 × number of inhabitants	21.88
2017	Sales = 81.4638 × number of inhabitants	19.23
2018	Sales = 88.4628 × number of inhabitants	19.51
2019	Sales = 85.1138 × number of inhabitants	18.07

Source: own processing.

The second partial research hypothesis 4a assumes an increase in the volume of sales together with an increase in the time of operation of the municipal firm on the market—its longevity. The results in 2019 shown in Figure 8 and the regression function S_{2019} = 42.5075 × longevity illustrate positive dependence, which, however, can be marked as partial (R^2 = 33.02%).

In the case of partial research hypothesis 4b, we can see similar results in the individual analyzed years, 2015–2019, while the dependence of the volume of sales on the time of operation on the market (longevity of municipal firm) is significantly positive. As the number of days a municipal firm operates on the market increases, so does its profitability (Table 11).

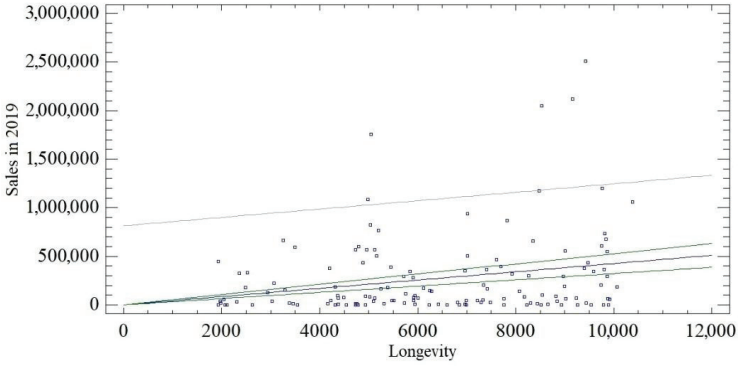

Figure 8. Dependence of the volume of sales of municipal firm on its longevity in 2019 (hypothesis 4b). Source: own processing.

Table 11. Results of verification of research hypothesis 4b.

Year	Linear Regression Function	R^2 (%)
2015	Sales = 38.0766 × longevity	37.63
2016	Sales = 38.5564 × longevity	37.48
2017	Sales = 40.6697 × longevity	35.11
2018	Sales = 43.1727 × longevity	34.05
2019	Sales = 42.5075 × longevity	33.02

Source: own processing.

Based on the above, especially the very low values of the coefficient of determination (R^2), it is not possible to confirm the linear dependence of the volume of sales of municipal firms on the size of the municipality in which the municipal firm is located. Therefore, partial research hypothesis 4a cannot be confirmed. The same conclusions are drawn in the case of the second partial research hypothesis, when we observe low values of the coefficient of determination, so partial research hypothesis 4b cannot be confirmed. The volume of sales of municipal firms with the population of the municipality as well as the time of operation on the market is growing, but these are not the only factors on which these results depend. Based on such an evaluation of partial research hypotheses 4a, 4b, we also reject research hypothesis 4.

5. Conclusions

In the Slovak Republic, rural areas represent 86% of the territory in which 43% of the population live. It is a heterogeneous area in which natural, human and economic resources are used. The Slovak countryside is characterized by a highly diverse physical environment, a wide range of economic activities, a characteristic network of social relations and centuries-old cultural traditions.

Economic activities in rural municipalities are developed not only by the private sector, but also by the municipalities themselves through their municipal firms. Analyses showed that in 2021, 318 municipal firms had their headquarters in rural municipalities. In the analysis of mutual relations of the most important economic indicators, profit and sales and number of employees, longevity or size, we found that differences in the profitability and sales volume of municipal firms from the perspective of the region in which the municipal firm operates are not statistically significant. It is also not possible to confirm the linear dependence of the profitability of municipal firms on the size of the municipality in which the municipal firm is located. However, it is possible to confirm the positive dependence between the growth of the population of the municipality and the growth of sales of municipal firms based in this municipality. However, low values of the coefficient

of determination (R^2) indicate that the volume of sales of municipal firms is significantly affected by other factors, not only the number of inhabitants of the municipality.

The results of the analysis confirm the fact that general enterprises are specific in comparison with traditional business entities, and it is not possible to analyze them with the general common ratio indicators of financial analysis, such as profitability indicators: ROE and ROA; indicators of activity; indicators of indebtedness; market value or liquidity. These indicators are of large importance from the point of view of comparing business entities, but from the point of view of municipal firms, they are not sufficiently informative, as the reasons for establishing municipal enterprises are different from those of commercial firms. While the business sector creates firms that it knows will make a profit as they provide services and goods that are in demand, it is different for municipal firms. Municipal firms often also provide services that the private sector does not want to provide precisely due to low profitability (e.g., small community services). Municipal firms are established primarily for the purpose of providing services to the population and creating jobs, and only then are they created for profit. The profit and revenue indicators that we analyzed in the case of municipal firms are important from the point of view of their sustainability, but also from the point of view of the financial management of municipalities. Through revenues, municipal firms cover their costs and thus reduce their dependence on the municipal budget, as in the event of a decrease in revenue, the municipality usually subsidizes such enterprises through subsidies from its budget. There are similar differences in the case of profit. Part of the profit is invested by municipal firms and part of it flows into the municipal budget. In this way, municipal firms play a significant role in the socio-economic development of the municipality.

Although the business activity of rural municipalities implemented through municipal firms enables revenues to the local budget, the area of business with municipal property is generally not given much attention under the conditions of the Slovak Republic. The reason for this is that there is no system for classifying firms owned by local self-governments. Likewise, legislation at the national but also at the local level does not recognize the concept of a municipal firm and its operation. The results of the analysis confirm that municipal firms are an important part of the local economy and, therefore, it would be appropriate to legislate the existence and functioning of municipal firms as a special form of business with local self-government property. As inspiration for legislation, we recommend EU legislation, which defines the concept of a public firm in Articles 106 and 345, Treaty on the Functioning of the EU, as a firm over which public authorities have a direct or indirect dominant influence.

The results of the analysis also showed that municipal firms, in addition to revenues to the local budget, also create employment in the municipality with a direct impact on local economic development. Nevertheless, insufficient information is available to assess social and other effects of municipal firms. Research in the field of municipal firms under the conditions of the Slovak Republic is still in its infancy. It can be assumed that in the future, other aspects of municipal business could be included in the model and examined, e.g., the Statistical Classification of Economic Activities is fully compatible with the European classification NACE Revision 2 (SK NACE), property information, demographic data and macroeconomic data of individual regions or districts.

By analyzing selected indicators, we aimed to highlight the specificity of business of municipal firms under the conditions of the Slovak Republic. The database for municipal firms is very limited, despite the fact that these firms are an important factor in the development of the territory. Therefore, in order to make the functioning of municipal firms more efficient, their activities and economic stability should be regularly monitored and evaluated, especially from the point of view of local development. Also, to clearly define the legislation adopted at the local level (resolution of the municipal council and principles on the disposal of municipal property), because the municipality's property creates not only economic but also social conditions in the municipalities.

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Modeling the Price Volatility of Cassava Chips in Thailand: Evidence from Bayesian GARCH-X Estimates

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Abstract: Thailand is a significant global exporter of cassava, of which cassava chips are the main export products. Moreover, China was the most important export market for Thailand from 2000 to 2020. However, during that period, Thailand confronted fluctuations in the cassava product price, and cassava chips were a product with significant price volatility, adapting to changes in export volumes. This study aims to analyze the volatility of the price of cassava chips in Thailand from 2010 to 2020. The data were collected monthly from 2010 to 2020, including the price of cassava chips in Thailand (Y), the volume of cassava China imported from Thailand (X1), the price of the cassava chips that China imported from Thailand (X2), the price of the cassava starch that China imported from Thailand (X3), the substitute crop price for maize (X4), the substitute crop price for wheat (X5), and Thailand's cassava product export volume (X6). The volatility and the factors affecting the volatility in the price of cassava chips were calculated using Bayesian GARCH-X. The results indicate that the increase in X1, X2, X3, X4, and X6 led to an increase in the rate of change in cassava chip price volatility. On the other hand, if the substitute crop price for wheat (X5) increases, then the rate of change in the volatility of the cassava chip price decreases. Therefore, the government's formulation of an appropriate cassava policy should take volatility and the factors affecting price volatility into account. Additionally, the government's formulation of agricultural policy needs to consider Thailand's macro-environmental factors and its key trading partners, especially when these environmental factors signal changes in the price volatility of cassava.

Keywords: cassava price; volatility; Bayesian; GARCH-X; Thailand

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1. Introduction

Thailand is a significant global exporter of cassava, and to meet increasing world demand for cassava, Thailand's cassava plantation area and yield have increased from 7,400,148 million hectares (yield 21,912,416 million tons) in 2010, to 9,319,718 million hectares (yield 32,357,741 million tons) and 9,439,009 million hectares (yield 28,999,122 million tons) in 2015 and 2020, respectively (Office of Agricultural Economics 2020). Cassava is an inexpensive crop compared to other starchy food crops, and is used as a raw material in the food industry, animal feed, bio-energy, and industries such as alcohol, citric acid, clothing, and chemicals. Consequently, the demand for cassava in the world market has continued to increase, and it has become an essential global economic crop after wheat, corn, rice, and potatoes. Meanwhile, global cassava production has also continued to increase. Between 2010 and 2019, global cassava output increased from 242.07 million tons to 277.07 million tons (FAO 2020).

Thailand's cassava products are processed into two product types, dried cassava (cassava chips, cassava pellets, and other types of cassava) and primary cassava products (native starch and modified starch). A total of 64% of cassava produced in Thailand is exported as different types of products (Office of Agricultural Economics 2020). In 2010, Thailand exported 4,611,976 million tons of cassava chips and 2,235,574 million tons of native starch. Through to 2020, Thailand's cassava product export structure remained the

same, with cassava chips being the most exported (3,063,671 million tons), followed by native starch (2,781,681 million tons) (Department of Business Development, Ministry of Commerce 2013). Thailand is still the world's largest exporter of cassava products, and European and Asian markets represent the main important export markets (Thai Tapioca Starch Association 2020). Yet the quantity of cassava exports to the European market has tended to decrease due to policies aiming to reduce imports of cassava pellets and substitutes to the EU market. The Asian market has thus become Thailand's primary export market for cassava products, replacing the EU market. China has been Thailand's most crucial cassava product export market since 2000, with 60% of Thailand's cassava product export volume being exported to China for use in the animal industry and for the production of alcohol, citric acid, and ethanol (Ministry of Commerce 2020).

The expansion of Thailand's cassava industry in the past ten years resulted in the expansion of the export market, especially the Chinese market, due to rising demand for cassava products in the animal industry. Additionally, from 2012 to 2014 the Chinese government supported ethanol production to develop biofuels and reduce dependence on oil imports. As a result, the demand for cassava chips for ethanol production increased significantly, since cassava prices were lower than other starchy food crops. However, in 2018, China introduced a policy to support maize instead of cassava in the ethanol production industry, resulting in a decline of the feed industry. Nevertheless, the prices of other starchy food crops declined and cassava demand in China decreased. This affected Thailand's cassava export volume which shrank by 26.1% in 2018 and 20.7% in 2019. The price of cassava in Thailand subsequently dropped sharply. Considering the price volatility of cassava products in Thailand between 2000 and 2020, cassava chips were clearly a product with significant price volatility, adapting to changes in export volumes during that period (The World Bank 2020).

The price volatility of cassava chip products in Thailand, especially the cassava chips that are the main export products, affect farmers' cassava planting plans, including setting up government policies to ensure farmers' income. Empirical evidence of what causes the price volatility of cassava products in Thailand will help improve the accuracy of policies developed by organisations. In the past, the characteristics of price volatility of agricultural products in Thailand and elsewhere has been widely studied using the GARCH models, both the symmetry model (e.g., GARCH [1,1]) and the asymmetry model (e.g., EGARCH, TGARCH and PGARCH), such as the rice price volatility by the generalized autoregressive conditional heteroscedastic (GARCH) method (Baharom et al. 2009). These resulted in findings of the relationship between purchasing volume and yield in the agricultural futures market using the GARCH Model (Boonvorachote and Thongsit 2013). The estimation of economic return and price volatility of agricultural exports in Indonesia (Hatane 2011) has been studied using both traditional symmetric (GARCH) and asymmetric models (EGARCH, TGACRH). The study found that analytical results from the symmetric GARCH model were the best estimation of parameters, which had similar results to price volatility of agricultural product found by Beck (2001), O'Connor et al. (2009), and Mahesha (2011), which also applied GARCH to analyze price volatility in agricultural products.

These models only consider the price volatility of agricultural products without considering other factors that affect price volatility. This is inconsistent with empirical evidence where the natural nature of prices does not cause fluctuations in agricultural prices, but the price volatility of each agricultural product is often affected by both domestic and foreign factors. The GARCH-X model is used to analyze the impact of factors affecting price fluctuations, such as the food price volatility in Greece resulting from macro-economic factors (Apergis and Rezitis 2011) using both the GARCH and GARCH-X models, and the price volatility of agricultural commodities in China affected by macro-economic factors (Xue and Sriboonchitta 2014). With the above empirical evidence, changes in the price of cassava products in Thailand are likely to be directly affected by Chinese government policies and the substitution of other starchy food crop prices. This study uses the GARCH-X model to analyze the impact of factors on the volatility of cassava products in Thailand.

Although the model considers the factors that cause price volatility, parameter estimation uses the maximum likelihood method to obtain fixed parameters, which are estimations obtained only through optimization. This study adjusts the estimations of parameters by adopting Bayesian estimation, which assumes that parameters are random variables that have a probability distribution. This provides a more accurate result where an estimator is closer to the true value, in particular, where volatility results are affected by a factor that is difficult to predict. Furthermore, Bayesian estimation is an excellent tool to estimate the parameters of the model and examine the uncertainty of estimation for appropriate affects and accurate analysis. Moreover, the model also benefits farmers and governments concerned with production planning and policy issuance to resolve problems arising from agricultural price fluctuations.

Previous studies of agricultural price volatility show continued modelling development, starting with a fundamental model such as the GARCH Model. The GARCH model has been used to analyze agricultural price volatility over various periods and situations, such as Yang et al. (2010) which studied the volatility of agricultural products due to free price policy or liberalization policies in the United States. The study found that the adoption of free trade policies in agriculture increased price volatility for three main agricultural commodities, corn, soybeans, and wheat, while it decreased the volatility of cotton fiber. The same applies to Sendhil et al. (2014) which studied the price volatility of maize, soybean, cottonseed, oilcake, castor, palm oil, cumin, and chili pepper in India. The results of that study found that having future markets in the country helped to reduce agricultural price volatility. Moreover, Čermák (2017) studied volatility through agricultural commodity market modelling in the Czech Republic (especially the price of agricultural commodities such as wheat and maize) in the period of global economic crisis in 2008. Čermák observed price volatility of corn and wheat. While the GARCH model has been used to study the price volatility of agricultural commodities continuously until the present, this model has limitations in that it does not consider factors related to volatility, and it only estimates the parameters of variables in fluctuation characteristics (Hwang and Satchell 2001).

The GARCH-X Model by Braun et al. (1995) is a model used to analyze agricultural price volatility since it considers external key factors that affect the volatility that occurs. For example, Apergis and Rezitis (2011) used the GARCH and GARCH-X models to analyze food price fluctuations affected by short-term changes in food prices and macroeconomic factors in Greece. The estimated results from the GARCH-X model showed a positive impact on food price volatility when the government intervened in allocating domestic resources. In addition, the GARCH-X model provides better estimation results than the GARCH model. Xue and Sriboonchitta (2014) studied how the volatility of China's agricultural price index was affected by macro-economic factors such as domestic price factors. The study indicated that domestic prices factors have important short-term effects on the price volatility of agricultural products in China. Moreover, the study compared the estimation efficacy of the GARCH-X model with the EGARCH, GJR-GARCH, and GARCH-t models. The results indicated that the GARCH-X model had the lowest value of AIC BIC (selection model). There was a cointegration relationship between macro-economic factors and domestic prices.

Although the GARCH-X model takes external factors into account as a fix for the GARCH model, the estimation of the GARCH-X model is based on the maximum likelihood estimation method, which has disadvantages. The maximum likelihood estimation is an optimization estimation which has a complex and sensitive approach to initial optimization, and the estimation can be inaccurate if the sample size is small (Virginia et al. 2020). Therefore, this study applies Bayesian estimation in GARCH-X modeling to obtain a qualified estimator, using an MCMC algorithm for sampling estimation to find parameters can approach true value even small sample size. In addition, parameters characteristics are random parameters, unlike the maximum likelihood estimation, which provides fixed parameters. This price volatility analysis of cassava chips uses the GARCH-X model through the Bayesian estimation method. The volatility model analysis is developed to

correct GARCH-X model deficiencies and obtain more accurate parameters that are not currently found in Thai agricultural commodity price volatility studies

2. Research Methodology

2.1. The Unit Root Test Using Bayesian Estimation

The unit root test was investigated using the ADF test, which shows the ratio between stationary data and the non-stationary data of the null hypothesis (Dickey and Said 1981). The significant statistical issues associated with the autoregressive unit root test (AR) are defined as

$$x_t = c + \rho x_{t-1} + \varepsilon_t,\ \varepsilon_t \sim N(0, \sigma^2), \tag{1}$$

The prior density of ρ is formulated and expressed as the following:

$$p(\theta) = p(\phi)p(a^*|\phi), \tag{2}$$

The marginal likelihood for ϕ is

$$l(\phi|D)\alpha \int l(\rho|D)\phi(a^*|\phi)da^*, \tag{3}$$

The consideration of the hypotheses of Bayesian estimation was combined with the Bayes factor to interpret the hypothesis of stationary data. The null hypothesis is defined by N_i and the alternative hypothesis is denoted by N_j. The ratio of the posterior odds of N_i and N_j is

$$\frac{p(M_i|y)}{p(M_j|y)} = \frac{p(y|M_i)}{p(y|M_j)} \times \frac{\pi(M_i)}{M_j}, \tag{4}$$

The Bayes factor can be interpreted in Table 1.

Table 1. The implication of Bayes factor of the Jeffrey guideline model.

Items	Interpretation
BF < 1/10	Strong evidence for M_j
1/10 < BF < 1/3	Moderate evidence for M_j
1/3 < BF < 1	Weak evidence for M_j
1 < BF < 3	Weak evidence for M_i
3 < BF < 10	Moderate evidence for M_i
10 < BF	Strong evidence for M_i

Source: modified from Jeffreys (1946) by authors.

2.2. The GARCH-X Using Bayesian Estimation

To model the volatility of the agricultural sector, especially in commodity prices, the autoregressive conditional heteroscedasticity (ARCH) of Engle (1982) and the generalized ARCH (GARCH) of Bollerslev (1982) are obvious ways to measure volatility. To understand the GARCH-X model, first, we introduce the GARCH model, which can be written as

$$h_t = \omega + \alpha\varepsilon_t^2 + \beta h_{t-1}, \tag{5}$$

where the variance of ε_t^2 is 1 and also this only works if $\alpha + \beta < 1$ and $\alpha > 0,\ \beta > 0,\ \omega > 0$. The GARCH-X model aimed to model the conditional variance. Then, the specification equation of GARCH model can be expressed as

$$h_t = \omega + \alpha\varepsilon_t^2 + \beta h_{t-1} + \gamma x, \tag{6}$$

where $\omega > 0,\ \alpha_1, \beta \geq 0$, the conditional variance is finite, and the restrictions on the GARCH parameters α_0, α_1 and β guarantee its positivity.

In order to write the likelihood function, we define the vectors $\varpi = (\varpi_1, \ldots, \varpi_T)$, $\alpha = (\alpha_0, \ldots, \alpha_t)$, $\beta = (\beta_0, \ldots, \beta_t)$, and $\gamma = (\gamma_0, \ldots, \gamma_t)$. We regroup the model parameters into the vector $\psi = (\omega, \alpha, \beta, \gamma)$. Then, upon defining the $T \times T$ diagonal matrix

$$\sum = \sum(\psi,) = diag\left(\{h_t(\omega, \alpha, \beta, \gamma)\}_{t-1}\right), \tag{7}$$

where $h_t(\alpha, \beta) = \alpha_0 + \alpha_1 y_{t-1}^2 + \beta h_{t-1}(\alpha, \beta)$, we can express the likelihood of (ψ) as

$$L(\psi|y)\alpha\left(\det\sum\right)^{-1/2}\exp\left[-\frac{1}{2}y'\sum^{-1}y\right], \tag{8}$$

The Bayesian approach considers (ψ) as a random variable that is characterized by a prior density denoted by $p(\psi)$. The prior is specified with the help of parameters called hyperparameters which are initially assumed to be known and constant. Moreover, depending on the researcher's prior information, this density can be more or less informative. Then, by coupling the likelihood function of the model parameters with the prior density, we can transform the probability density using Bayes' rule to get the posterior density $p(\psi|\,|y)$ as follows:

$$p(\psi|\,y) = \frac{L(\psi,|y)p(\psi)}{\int L(\psi|y)p(\psi)d\psi}, \tag{9}$$

This posterior is a quantitative, probabilistic description of the knowledge about the model parameters after observing the data. For an excellent introduction on Bayesian econometrics, we refer the reader to Koop (2003).

The joint prior distribution is then formed by assuming prior independence between the parameters, i.e.,

$$p(\psi) = p(a)p(\beta). \tag{10}$$

The recursive nature the GARCH-X variance equation implies cannot be expressed in closed form. There exists no (conjugate) prior that can remedy this property. Therefore, we cannot use the simple Gibbs sampler and need to rely on a more elaborated Markov Chain Monte Carlo (MCMC) simulation strategy to approximate the posterior density. The idea of MCMC sampling was first introduced by Metropolis et al. (1953) and was subsequently generalized by Hastings (1970). The sampling strategy relies on the construction of a Markov chain with realizations $\left(\psi^{[0]}\right), \ldots, \left(\psi^{[j]}\right), \ldots$ in the parameter space. Under appropriate regularity conditions, asymptotic results guarantee that as j tends to infinity, $\left(\psi^{[j]}\right)$ tends in distribution to a random variable. Hence, after discarding a burn-in of the first draws, the realized values of the chain can be used to make inferences about the joint posterior.

3. Empirical Results

3.1. Data Descriptive

The cassava price data and the other variables that were considered in this study consist of seven sets of agricultural data, including cassava chips prices in Thailand (y), China's cassava import volume from Thailand (X1), China's cassava chips import price from Thailand (X2), China's cassava starch import price from Thailand (X3), the substitute crop price of maize (X4), the substitute crop price of wheat (X5), Thailand's cassava products export volume (X6). All of the data was monthly data in 105 observations from 2010–2020. Basically, the basic information consists of a mean value, maximum and minimum values, standard deviation, skewness, kurtosis, Jarque–Bera, probability, summation and observations in Table 2.

Table 2. Summary statistics of key variables in Bayesian GARCH-X Model.

Statistics	Y	X1	X2	X3	X4	X5	X6
Mean	0.0019	0.0042	0.0016	0.0031	0.0019	0.0028	0.0019
Median	0.0110	−0.0172	0.0000	−0.0093	0.0010	0.0000	−0.0317
Max.	0.2943	3.4250	0.2877	3.3891	0.3236	0.2395	3.1231
Min.	−0.3044	−2.5720	−0.2881	−2.5388	−0.3332	−0.2332	−2.2706
Std.Dev.	0.1931	0.6841	0.1894	0.6777	0.1956	0.1886	0.6254
Skewness	−0.0578	0.7161	−0.0364	0.6982	−0.0516	−0.0121	0.7895
Kurtosis	1.5083	9.3457	1.5001	9.3080	1.5821	1.4137	9.1423
Jarque-Bera	9.6073	181.6222	9.6779	179.1358	8.6737	10.8018	172.6151
Probability	0.0082	0.0000	0.0079	0.0000	0.0131	0.0045	0.0000

Source: authors' estimation.

3.2. Stationary Testing

Empirically, all variables are included in the model are time series data. Therefore, the data should be tested to determine if it is stationary. In this paper, the unit root test based on the Bayesian method was used to investigate the stationary data, which is shown in Table 3. The null hypothesis (H_0) is non-stationary and the alternative hypothesis (H_1) is stationary. The results show that all variables are stationary or (I (0)).

Table 3. Unit root testing of key variables relies on the Bayesian inference.

Variables	Bayesian Factor Ratios (M1/M2)	Implication	Result
Cassava chip price of Thailand (Y)	1.65×10^{-31}	Strong evidence for Mj	I(0)
China's cassava import volume from Thailand (X1)	2.2×10^{-17}	Strong evidence for Mj	I(0)
China's cassava chips import price from Thailand (X2)	5.3×10^{-32}	Strong evidence for Mj	I(0)
China's cassava starch import price from Thailand (X3)	1.14×10^{-17}	Strong evidence for Mj	I(0)
Substitute crop price: maize (X4)	3.33×10^{-29}	Strong evidence for Mj	I(0)
Substitute crop price: wheat (X5)	3.97×10^{-39}	Strong evidence for Mj	I(0)
Thailand's cassava products export volume (X6)	2.24×10^{-16}	Strong evidence for Mj	I(0)

Source: authors' estimation.

3.3. The Estimation of GARCH-X(1,1) Using Bayesian Inference

In this study, we applied the GARCH-X model using Bayesian estimation to investigate the volatility of the cassava chip price, which is influenced by the factors. This study applies Bayesian estimation using the MCMC method because the estimated parameters from the MCMC method iares the most effortless procedure to obtain the posterior of the PDF condition, involving the computation of the expected value for the properties on the GARCH-X model. The number of iterations of the Markov chain sampling was 10,000, and we identified the first 2000 as burn-in; thus, the size of the Monte Carlo is 8000. The posterior means and the standard deviations are presented in Tables 4 and 5.

The empirical results show that for the ARCH term (α), all the six variables were tightly distributed around the value of unity, indicating that they follow the random walk. The posterior means and standard deviation show that the ARCH term (α) is statistically significant within the invertible region. In comparison, the intercept terms (ω) are extremely small for all of the six variables. For the properties of the GARCH term (β), the coefficients indicate exogenous factors influence the volatility of cassava chip price. The variable of China's cassava import volume from Thailand (X1) shows that the β coefficient is 0.0326, which is within the credible interval that is statistically significant. Moreover, the coefficients of the other variables including China's cassava chips import price from Thailand (X2), China's cassava starch import price from Thailand (X3), substitute crop price: maize (X4), substitute crop price: wheat (X5), and Thailand's cassava products export

volume (X6) were 0.0234, 0.3618, 0.0249, 0.0240, and 0.0233, respectively. The volatility reacts the ARCH term, and the GARCH term provides the persistence of overall volatility. Furthermore, the X term (γ) for most exogenous factors except the substitute crop price of wheat (X5), shows positive impact on the volatility of the cassava chip price. This indicates that increases in X1, X2, X3, X4, and X6 lead to increases of the change of volatility of the cassava chip price. On the other hand, if the substitute crop price of wheat (X5) increases, then it causes a decrease of the change of the volatility of the cassava chip price. Moreover, the posterior means of all the variables are also tightly within the credible interval value, indicating that they are statistically significant.

Table 4. The posterior means, standard deviation and credible intervals of the parameters.

Variables	X1		X2		X3	
	Coefficient	**95%CI**	**Coefficient**	**95%CI**	**Coefficient**	**95%CI**
ω	−0.0002 (0.000473)	(−0.0006, 0.0012)	0.0002 (0.0004)	(−0.0005, 0.0012)	0.0003 (0.0040)	(−0.0006, 0.0210)
α	0.0023 (0.100100)	(0.0021, 0.1927)	0.0025 (0.0990)	(0.0021, 0.1922)	0.0024 (0.0091)	(0.0021, 0.1920)
β	0.0326 (0.090000)	(0.0100, 0.6900)	0.0234 (0.0900)	(0.0960, 0.7100)	0.3618 (0.0910)	(0.0396, 0.9071)
γ	0.0006 (0.000494)	(0.0001, 0.0009)	0.0010 (0.0045)	(0.0009, 0.0015)	0.0001 (0.0005)	(0.00009, 0.0096)
Sigma2	0.0001 (0.000002)	(0.00009, 0.00024)	0.0002 (0.0010)	(0.00008, 0.0010)	0.0035 (0.0001)	(0.0006, 0.0140)

Note: figures in the parentheses are standard deviations. Source: authors' estimation.

Table 5. The posterior means, standard deviation and credible intervals of the parameters.

Variables	X4		X5		X6	
	Coefficient	**95%CI**	**Coefficient**	**95%CI**	**Coefficient**	**95%CI**
ω	−0.0029 (0.0005)	(−0.0065, 0.0013)	0.0037 (0.0050)	(−0.0067, 0.0062)	−0.0062 (0.0054)	(−0.0560, 0.0122)
α	0.0032 (0.0104)	(0.0020, 0.1935)	0.0025 (0.1004)	(0.0020, 0.1931)	0.0029 (0.0900)	(0.0019, 0.0640)
β	0.0249 (0.0800)	(0.0003, 0.7690)	0.0240 (0.0800)	(0.0090, 0.7000)	0.0233 (0.9990)	(0.0037, 0.9071)
γ	0.0600 (0.0019)	(0.0003, 0.0786)	−0.0210 (0.0207)	(−0.0411, 0.0030()	0.0102 (0.0006)	(0.0090, 0.0102)
Sigma2	0.0010 (0.0002)	(0.0076, 0.0035)	0.0100 (0.0100)	(0.00008, 0.0014)	0.0004 (0.0080)	(0.0008, 0.0078)

Note: figures in the parentheses are standard deviations. Source: authors' estimation.

4. Discussion

In this study, the empirical results found that all explanatory variables, including China's cassava import volume from Thailand, China's cassava chips import price from Thailand, China's cassava starch import price from Thailand, the substitute crop prices of maize and wheat, and Thailand's cassava product export volume were statistically significant and caused increased volatility in the price of cassava. Few studies have examined the volatility of cassava prices in Thailand, especially for factors that impact price fluctuation. This study differs from Headey and Fan (2008) and Treesilvattanakul (2016) in terms of the factors that considerably influence the volatility of cassava prices, as those studies only considered demand–supply factors. Although this study's methods and factor variables are different from those of previous studies, the results are similar in terms of the perspective of volatility caused by several interrelated factors. Various studies in Thailand have investigated the fluctuation of agriculture commodity prices. Moreover, studies of cassava are limited, despite it being an important agricultural commodity in Thailand which is exported around the world and Thailand is the world's second largest agricultural producer. Additionally, the results indicate that the factor of the substitute crop price of maize has the highest effect on the volatility of the cassava chip price when

compared with the other factors such as the volatility price of the wheat, similar to the study of present situation and future potential of cassava in China (Yinong, Xiong and Shuren), which shows that maize also plays important role in the market, especially in southern China and in some specific industries. Therefore, the price change of maize will influence the volatility of cassava prices.

The causes of the volatility of cassava prices are consistent with previous studies on the effects of government policies and macroeconomic factors on agricultural commodity price volatility. Those findings reflect how government policy affects the volatility of agricultural commodity prices, resulting in increased price volatility for three major gain commodities (corn, soybean, and wheat) (Yang et al. 2010) and reduced agricultural price volatility (Crain and Lee 1996). Meanwhile, macroeconomic factors affecting price volatility include money balances, real per-capita income, the real exchange rate, the real deficit-to-income ratio (Apergis and Rezitis 2011), the international price index of edible oil, and foreign exchange rates (Yeasin et al. 2020). These findings are crucial and useful in determining government policy for agricultural commodity prices.

5. Conclusions and Policy Recommendation

Thailand is a significant global exporter of cassava, in which cassava chips are the main export products. The expansion of Thailand's cassava industry in the past ten years has resulted of the expansion of the export markets, especially the Chinese market. Considering the price volatility of cassava products in Thailand between 2000 and 2020, cassava chips clearly have significant price volatility, adapting to changes in export volumes during that period. This study examined the price volatility of cassava chips in Thailand from 2010 to 2020 using Bayesian GARCH-X method. Through the results of the estimation of GARCH-X (1,1) using Bayesian inference, we applied Bayesian estimation to GARCH-X model to obtain the posterior of the PDF condition, involving the computation of expected values for the properties of the GARCH-X model. Additionally, the estimation of parameters was adopted through Bayesian estimation, which assumes that parameters are random variables and have a probability distribution. This resulted in more accurate results where an estimator is closer to the true value, in particular where volatility results are affected by a factor that is difficult to predict. Bayesian estimation is an excellent tool to estimate the parameters of the model and examine the uncertainty of estimation for appropriate effects and accurate analysis.

The main conclusions of this study are that the volume of export cassava to China, the export price of cassava to China, China's cassava starch import price from Thailand, the price of maize, and the total export volume affect the volatility of cassava chip prices in the same direction. An increase in these factors led to an increased change in cassava chip price volatility. However, it was found that the price of wheat impacts cassava chip prices in a different direction, in which price increases of wheat cause a decrease of the change in cassava chip price volatility.

The implications of the findings are critical for the future policy of the Thai government regarding its main agricultural commodity price. This is because Thailand's agricultural commodity policy in the past has always focused only on domestic factors, especially product demand and supply. The same approach has been applied to cassava policy, in that is focused on factors that determine demand (increasing demand for cassava in various forms) and factors affecting supply (increasing efficiency and reducing the cost of production). Government policies are aimed at the equilibrium price level in the market. However, what affects the long-term well-being of farmers does not depend solely on the market equilibrium price because the equilibrium price in the market at any moment may cause farmers to profit or experience loss. Nevertheless, the estimation findings using the Bayesian GARCH-X model reflect that the price volatility of cassava chips was directly affected (both positively and negatively) by both domestic environmental factors (substitute crop price: maize, substitute crop price: wheat, and Thailand's cassava product export volume) and foreign environmental factors (China's cassava import volume from Thailand,

China's cassava chip import price from Thailand, and China's cassava starch import price from Thailand). For domestic environmental factors, price changes of substitute crops such as maize and wheat, which are important raw materials in Thailand for its feed industry, inevitably affect feed producers, changing the need for cassava, and eventually affected Thailand's cassava exports volume.

For foreign environmental factors that are significant factors in the change in cassava prices (export-focused goods), the factors of trading partners like China affect the change of price volatility of cassava chips. China is a country that frequently changes agricultural policy, such as in 2014 when the Chinese government supported ethanol production to develop biofuels and reduce dependence on oil imports. In 2018, China had a policy to support maize instead of cassava in the ethanol production industry, which resulted in a feed industry decline. These changes in China's policies affected a change in demand for cassava in China, which eventually affected demand for cassava imports from Thailand.

Volatility and changes in volatility for cassava prices also affect the long-term income and livelihoods of cassava farmers. In other words, increased price volatility results in farmers' price predictions being misleading. This effect affects both future supply and demand and also results in welfare losses for producers and consumers (Apergis and Rezitis 2011). Therefore, appropriate government cassava policy formulation should consider volatility and factors affecting price volatility. This reflects a particularly appropriate approach to agricultural policy, especially for food and energy agricultural commodities such as cassava (export-focused commodity). Moreover, the government should also consider changes to Thailand's trading partners. If policymakers signal changes to the factors that affect the price volatility of cassava chips (all studied factors, except the price of wheat), they should increase intervention measures or support farmers' production (e.g., production factors, replacement crops, and production credit), marketing (marketing credit), and poverty due to rising cassava chip price volatility levels. The findings of the present study confirm that the government policy formulation for every agricultural commodity, especially export-focused commodities, must consider the macro-environmental factors of the country and its key trading partners, especially when these environmental factors signal changes.

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Cross-Correlations in Meat Prices in Brazil: A Non-Linear Approach Using Different Time Scales

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Abstract: Brazil is one of the world's largest producers and exporters of cattle, chicken and swine. Therefore, co-movements of Brazilian meat prices are important for both domestic and foreign stakeholders. We propose to analyse the cross-correlation between meat prices in Brazil, namely, cattle, swine and chicken, including also in the analysis information from some commodities, namely maize, soya beans, oil, and the Brazilian exchange rate. Our sample covers the recent period which coincided with extensive macroeconomic and institutional changes in Brazil, from 2011 to 2020, and is divided in two periods: (i) presidential pre-impeachment (P1), occurring in August 2016, and; (ii) post-impeachment (P2). Our results indicate that in P1, only the prices of swine and chicken showed a positive and strong correlation over time, and that cattle showed some positive correlation with chicken only in the short run. In P2, there was also a positive and consistent correlation between swine and chicken, and only a positive association with swine and cattle in the long run. For more spaced time scales (days), the changes in the degree of correlation were significant only in the long run for swine and cattle.

Keywords: correlation; detrended cross-correlation analysis; meat prices; time series

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1. Introduction

In recent years, the great volatility of meat prices has generated a stir in the Brazilian economic debate, including wide dissemination and discussion in the national and international media, due to the impact on foreign trade (Terazono et al. 2020). The effect of a shock in the price of a specific animal protein, as occurred with the price of pigs in China due to African fever, has global impacts on the world meat trade. The possible effects of price transmission among meats, as well as among other goods, are closely monitored by the Brazilian Central Bank, due to possible second-order inflationary effects and impacts in this relevant sector of world agribusiness (BCB 2019).

In the market of meat and other agricultural products, Brazil is an important global player, as seen in Table 1. Specifically for the meat sector, in 2018, according to ABIEC (2019), Brazil had approximately 214.7 million head of cattle, the largest herd in the world, ahead of India (186 million) and the USA (94.3 million). Considering cattle plus buffaloes, Brazil is the second largest global producer, with 216.1 million, behind only India with 300.3 million. In exports, Brazil is the world leader in quantity, with 2205.2 thousand tons, ahead of Australia (1535.2) and the USA (1329.9).

Table 1. Ranking of main commodities produced in Brazil and their importance in global trade and supply, in 2018. Source: Adapted from CNA (2019) and USDA (2019) database.

Product	Production Rank	Exports Rank	% International Trade
Chicken	1st	1st	32
Cattle	2nd	1st	21
Swine	4th	4th	8
Sugar	2nd	1st	34
Coffee	1st	1st	26
Orange juice	1st	1st	78
Soya bean	2nd	1st	52
Soya bean oil	4th	2nd	12
Soya bean meal	4th	2nd	23
Cotton	4th	2nd	15
Maize	3rd	3rd	17

Regarding chicken meat, according to (ABPA 2019), Brazil was the second largest supplier in the world in 2018, with 12,855 thousand tons, behind only the USA (19,361) and ahead of the European Union (EU) (12,200) and China (11,700). In exports, Brazil was again the leader, with 4101 tons, ahead of the USA (3244) and the EU (1429). Finally, in relation to pigs, Brazil was the fourth main producer, with 3974 thousand tons, behind China (54,040), the EU (24,300) and the USA (11,942). In exports, Brazil was also fourth (646), behind the EU (2934), USA (2663) and Canada (1330). In several other commodities, Brazil was also a leader in production and/or exports (see Table 1).

One of the few studies to analyse meat prices using similar methodologies is that of Pavón-Domínguez et al. (2013). The authors analysed the prices of sheep for five time series of prices in Andalusia, Spain, using MF-DFA (multifractal detrended fluctuation analysis) and concluded that these prices are multifractal in nature and that, therefore, this technique is an adequate tool to describe and characterize price fluctuation.

Economic studies on the meat market in Brazil have been developed basically around the price (own- and cross-price elasticities) and income elasticities of demand for meat, using classical econometrics techniques.

Bacchi and Spolador (2002) analysed the income elasticity of chicken meat in Brazil, in the main metropolitan areas. The authors found that the whole chicken was a normal good, with breast and legs as superior goods and the carcass as inferior. Sonoda et al. (2012) found that neither red meat nor chicken were the main substitutes for the demand for fish, but other foods in the consumption bundle, depending on the consumer's income range. Furthermore, it was found that the demand for fish was associated with low-income families in the North-Northeast region and middle-income ones in the Centre-South, and that the low demand is simply due to few families having the habit of consuming fish in Brazil.

Therefore, relevant literature about pricing co-movements in the Brazilian meat market is scarce. This is a surprising finding, if we bear in mind the importance of Brazilian exports in the world supply of animal protein. In this context, we seek to contribute by providing new evidence in this topic and stimulate the debate about the interdependence of meat prices in a big global supplier.

As highlighted by Fliessbach and Ihle (2021), the analysis of movement/synchronization of agricultural prices, and meat in particular, is important because, if this parallelism occurs, it exposes consumers, producers and other agents to similar incentives a priori. Thus, the greater the number of consumers and producers who are exposed to synchronized price movements, the greater the effects of supply and demand shocks, as these can be exacerbated due to the higher price correlation. In addition, a better understanding of synchronization mechanisms can help private agents monitor prices, develop risk diversification strategies (hedging practices), as well as public policies, in order to mitigate their adverse effects on the occurrence of supply or demand shocks.

Therefore, the main objective of this text is to analyse the correlation of meat prices in Brazil, namely: beef, pork and chicken. We also include in the analysis information from other commodities, namely maize, soya beans, in order to make our analysis robust, considering their importance in the gross value of agricultural production in Brazil and the fact they are commonly used as animal feed. We also consider oil price and the Brazilian exchange rate (to the USD) in our analysis. We use the DCCA of Podobnik and Stanley (2008) and the correlation coefficient proposed by Zebende (2011). The DCCA correlation coefficient is better than other coefficients, such as Pearson's, since it can capture non-linearities, can be used even between variables that are not stationary and allows analysis of the correlation for different time scales, rather than only the contemporary correlation (Kristoufek 2014; Zhao et al. 2017).

With a daily price database, we cover the recent period which coincided with extensive macroeconomic and institutional changes in the particular case of Brazil. We divide our whole time sample in two different periods: (i) Presidential pre-impeachment (P1), from 4 January 2011 until 31 August 2016; and (ii) Presidential post-impeachment (P2), from 1 September 2016 up to 30 December 2020. Our results indicate that in P1, only the prices of swine and chicken show a positive and strong correlation over time, and that cattle shows some positive correlation with chicken only in the short run, and a marginal positive association with maize in the long run. In P2, there is also a positive and consistent correlation between swine and chicken, and a positive association with swine and cattle only in the long run. In addition, swine showed a positive association with maize in the short run, and interestingly, the exchange rate shows a marginally significant negative association with swine in more time-spaced scales. Chicken shows no association with any commodity, and cattle only shows a marginally positive correlation with maize.

We also observed that for more spaced time scales (days), the changes in the degree of correlation were significant in the long run for swine and cattle, whereas for other combinations of meat substitution this was not the case. For meat and other commodities reported on this study, we observe a change in the correlation for: (a) swine with exchange rate (−); (b) chicken with soybean (−) and exchange rate (−); (c) cattle with oil (+) and soybean (+). Other combinations showed only short-run correlations or oscillations, with no clear pattern.

To the best of our knowledge, no study has analysed the behaviour of co-movements of meat prices in Brazil from the recent approach of statistical methods of physics. Moreover, our sample provides data with more frequency than previous studies dealing with the Brazilian market, with daily price series, covering the most recent post-crisis period in Brazil and the growing Chinese demand for imported meat.

This paper is organized as follows: after this introduction, Section 2 describes the methods and data used; Section 3 shows the main results and discusses them; and finally, Section 4 presents the final considerations.

2. Material and Methods

In this paper, we use the DCCA (detrended cross-correlation analysis) coefficient ($\rho DCCA$), an efficient coefficient (Zhao et al. 2017) and already applied widely in a variety of topics, not only in finance and economics. For example, among many others, see Ferreira et al. (2016) and Guedes et al. (2017), and especially with possible meat-related prices, see Quintino and Ferreira (2021a). In the next sub-section, we will detail the construction of the measure used.

2.1. Detrended Cross-Correlation Analysis (DCCA)

Podobnik and Stanley (2008) developed DCCA through 4 steps, namely:

a. for two different series x_t and y_t, with $t = 1, 2, \ldots, N$, both time series are integrated in order to obtain two new series, according to Equation (1)

$$xx_k = \sum_{t=1}^{k} x_t \text{ and } yy_k = \sum_{t=1}^{k} y_t \ , \ k = 1, 2, \ \ldots \ , \ N \tag{1}$$

b. both xx_k and yy_k are divided in $(N - s)$ overlapping boxes of equal length s, with $4 \leq s \leq N/4$;

c. based on the ordinary least squares, a local trend for each box is calculated, ($xP_i(k)$ and $yP_i(k)$), used to calculate the covariance of the residuals of each box as defined by Equation (2):

$$f^2_{xy}(s, i) = \frac{1}{s+1} \sum_{k=1}^{i+s} (xx_k - xP_i(k))(yy_k - yP_i(k)) \tag{2}$$

d. calculate the average for all boxes to obtain the covariance function of Equation (3):

$$F^2_{xy}(s) = \frac{1}{N-s} \sum_{i=1}^{N-s} f^2_{xy}(s, i) \tag{3}$$

Based on this and on the Detrended Fluctuation Analysis (DFA) proposed by Peng et al. (1994), Zebende (2011) proposes the ρDCCA given by Equation (4):

$$\rho_{DCCA}\ (s) = \frac{F^2_{xy}(s)}{F_{xx}(s) F_{yy}(s)} \tag{4}$$

where $F^2_{xy}(s)$ is the covariance function determined by Podobnik and Stanley (2008) and $F_{xx}(s)$ and $F_{yy}(s)$ are the autocorrelation functions defined by Peng et al. (1994).

Indeed, as in the Pearson correlation, $-1 \leq \rho_{DCCA}\ (s) \leq 1$ and the extremes mean perfect anti-cross correlation (-1) and perfect cross correlation (1), while the null value refers to the condition of non-cross correlation.

According to Podobnik et al. (2011), the coefficients can be tested statistically based on their critical values. Table 2 presents the critical values considering a 95% confidence level, which depend on sample size N and time window s. In our estimations we calculate the correlations for intermediate values of s, for which we calculate the respective critical values using a cubic interpolation (cubic spline) from the critical tabulated values.

Table 2. Critical values for the $\rho DCCA$ cross-correlation coefficient, with a 95% confidence level (Adapted from Podobnik et al. 2011).

	s = 4	**s = 8**	**s = 16**	**s = 32**	**s = 64**	**s = 128**	**s = 256**
N = 250	0.137	0.152	0.193	0.271	0.383	-	-
N = 500	0.096	0.106	0.138	0.184	0.266	0.384	-
N = 1000	0.070	0.077	0.097	0.132	0.185	0.261	0.377
N = 2000	0.049	0.055	0.068	0.093	0.131	0.186	0.269
N = 4000	0.034	0.038	0.049	0.067	0.093	0.132	0.185
N = 8000	0.024	0.028	0.035	0.046	0.063	0.091	0.129

As proposed by Silva et al. (2015) and used also, for example, by Pal and Mitra (2018) or Tilfani et al. (2021), we calculate the $\Delta\rho_{DCCA}(s) \equiv \rho^{after}_{DCCA}(s) - \rho^{before}_{DCCA}(s) \equiv \rho^{\mathcal{P}2}_{DCCA}(s) - \rho^{\mathcal{P}1}_{DCCA}(s)$, in our case P1 as pre-impeachment and P2 as post-impeachment, in order to verify the variation of the correlations between two different moments, considering the critical values from Table 3. This will allow us to analyse the change in different political and economic situations. Based on the difference in correlation between the periods, it will be possible to verify if there was a variation in the degree of correlation of meat prices in

the most recent years. This knowledge is extremely relevant for stakeholders, including government policy-makers.

Table 3. Critical values for the ΔρDCCA cross-correlation coefficient, with a 95% confidence level. (Adapted from Guedes et al. 2018a, 2018b).

	s = 4	**s = 8**	**s = 16**	**s = 32**	**s = 64**	**s = 125**	**s = 250**
N = 250	0.0029	0.0027	0.0027	-	-	-	-
N = 500	0.0021	0.0019	0.0019	0.0019	0.0019	-	-
N = 1000	0.0015	0.0014	0.0013	0.0013	0.0013	0.0014	-
N = 2000	0.0010	0.0010	0.0009	0.0009	0.0009	0.0009	0.0010

2.2. Data

The swine indicator refers to the live swine price, chicken corresponds to the frozen chicken indicator and cattle refers to the Cepea/B3 price indicator, which is a daily average of spot prices for live cattle and is the reference price for settlement of futures contracts at B3, the Brazilian Exchange. All the information for meat prices is for the state of São Paulo. Maize and soya bean are the reference spot prices for settlement futures contracts at B3, and also were collected at the Cepea-Esalq website (CEPEA 2021). To take the international influence on domestic commodity price into account, we also evaluate the impact of the exchange rate (to the USD) and oil prices on meat prices in Brazil. The exchange rate comes from the Brazilian Central Bank (BCB 2021) and refers to the daily spot prices and WTI oil prices originate from EIA (Energy Information Administration), USA (EIA 2021).

The total sample period is from 3 January 2011 to 30 December 2020, totaling 2411 observations. We started the sample in 2011, when the daily prices of swine started to be published systematically, on a daily basis, which did not occur between July and December 2010, when there were only 12 observations. Since 2011, therefore, daily prices have been systematically released. When there was a missing price of a commodity on a specific date for some specific reason, this date was not considered in the time series of returns. Nor did we consider returns referring to 20 April 2020, when WTI reached a negative price (−US$ 36.98) due to the impossibility of getting a negative log return.

Due to the change in economic policy in Brazil after the impeachment of ex-President Rousseff, we established Period 1, P1, the pre-impeachment phase (until 08/31/2016) with a total of 1368 observations, and Period 2, P2, between impeachment and the end of the sample period, with 1043 observations. The split in the sample will let us analyse whether there has been a change in the correlation of meat prices recently. Guedes et al. (2017) split the sample between pre and post-crisis period in order to calculate the differences of correlation in these periods. We followed this approach and, in our case, the relevant economic crisis was the transition between pre- and post-impeachment scenarios that occurred in Brazil.

Between these periods, in addition to the change in the orientation of economic policy, there was a change in the behaviour of fuel prices in Brazil due to the new pricing policy of Petrobras, as highlighted by David et al. (2020).

Therefore, we have used this sample cut in two Periods, P1 (pre-impeachment) and P2 (post-impeachment), to analyse if there was a change in the strength of the correlation between them. In this way, we have sought to understand whether the new political era in the Brazilian economy affected correlation among meat prices.

Figure 1 illustrates the behaviour of prices, identifying the split in the sample, the date on which the Rousseff administration ends. All the prices were transformed into index numbers and normalized as 100 in the first observation of the sample. For cross-correlation analysis, we considered the log returns from original prices series, defined as follows: r(t) = ln(pt) − ln(pt-1).

First, we can observe the great volatility of the exchange rate in the period, because of the Brazilian currency's devaluation against the dollar. This fact shows that, together with the increase in the recent demand for meat from China, the change in the exchange

rate made Brazilian exports more competitive. In this respect, the greater Chinese demand began to show a growth trend in the last decade, from 2010, especially in the final years of this period, post-2018, mainly due to the drop in domestic Chinese supply due to African fever (Terazono et al. 2020).

Figure 2 shows the correlations between the returns of the price series, in Period 1 (panel A) and Period 2 (panel B). It can be seen that there is no significant correlation in any of the commodities, with the exception of the exchange rate with soybeans in P2. This is not an unexpected result, given that local soybean prices are strongly influenced by international commodity exchanges, instead of corn and meat prices, which have stronger domestic determinants. This indicates there is no contemporary correlation between most of the analyzed commodities, including meats, with the exchange rate. However, there may be a correlation from detrended series with the time lag, with the strength of association depending on the time scale. Therefore, the DCCA coefficient is a tool to investigate this hypothesis more robustly.

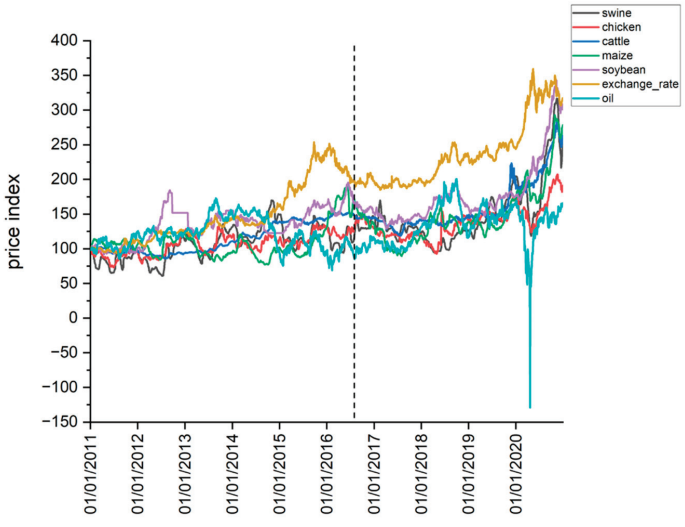

Figure 1. Price indices of meat and commodities. The vertical dashed line represents the moment of splitting the sample.

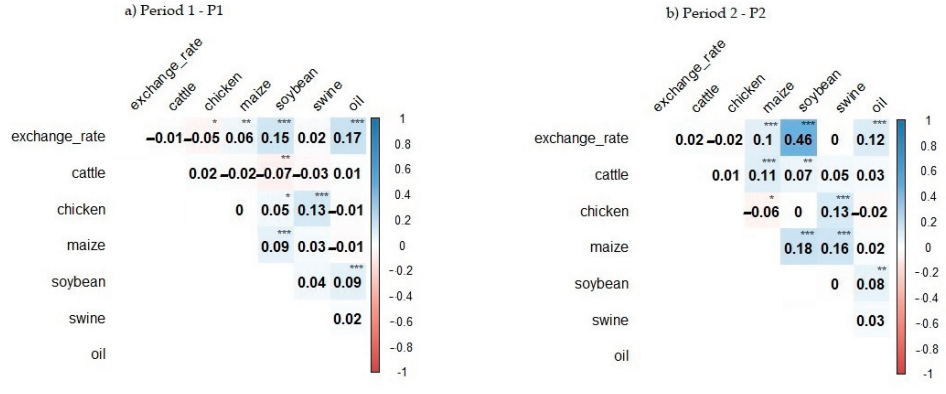

Figure 2. Pearson correlation of log returns from price levels. ***, ** and * denote, respectively, significance of the correlation coefficients for significance levels of 1%, 5% and 10%.

3. Results

Our analysis aims to evaluate the correlation between the prices of several commodities, dividing the study in the periods of the pre- and post-impeachment crisis, P1 and P2 respectively, analysing first the individual behaviour in both periods and then the changes in the correlation over time.

Starting in Period 1 (P1), Figure 3 shows the DCCA correlation coefficient of the prices of the three types of meat and the remaining prices (Panel A for swine, Panel B for chicken and Panel C for cattle). In the case of swine (Panel A), the only significant positive and increasing correlation occurs with the price of chicken. Regarding chicken prices (Panel B), we can see some initial positive correlation between chicken and cattle, but of little magnitude, being non-significant in the medium run and losing importance after some days. Finally, cattle prices (Panel C) show some positive correlation with corn prices, but only marginally significant in the long run.

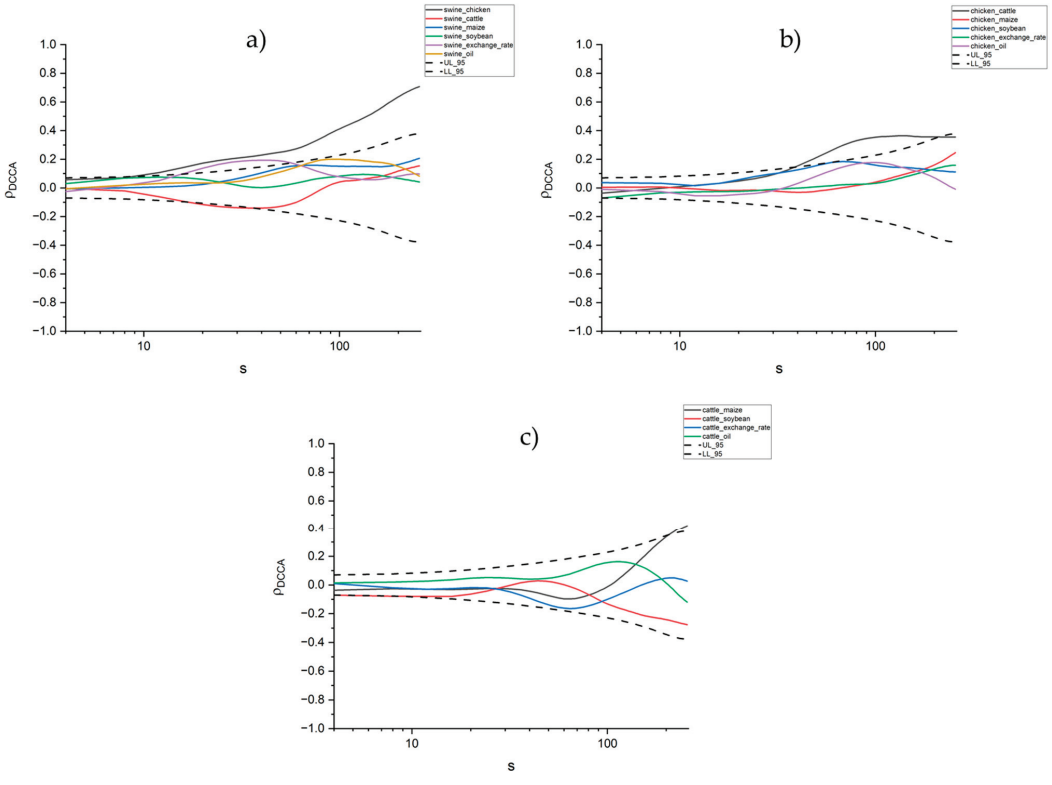

Figure 3. $\rho DCCA$ between swine (**a**), chicken (**b**) and cattle (**c**) with the remaining commodities, in P1, depending on the time scale (days). In red, lower and upper critical values test the hypotheses H0: $\rho DCCA = 0$ and H1: $\rho DCCA \neq 0$.

For P2, Figure 4 shows that regarding swine meat there is increasing correlation with chicken for all time scales, while in the case of cattle, the positive association is just significant for longer time scales (and negative marginally in relation to exchange rate), and with maize, there is a temporary significant positive association (Panel A). In Panel B we can see that the price of chicken has no significant correlation with any commodity. For cattle prices (Panel C) we do not observe any significant correlations with other any prices, except for cattle and maize positively, just at the beginning but with very low values, and marginally significant for longer time scales.

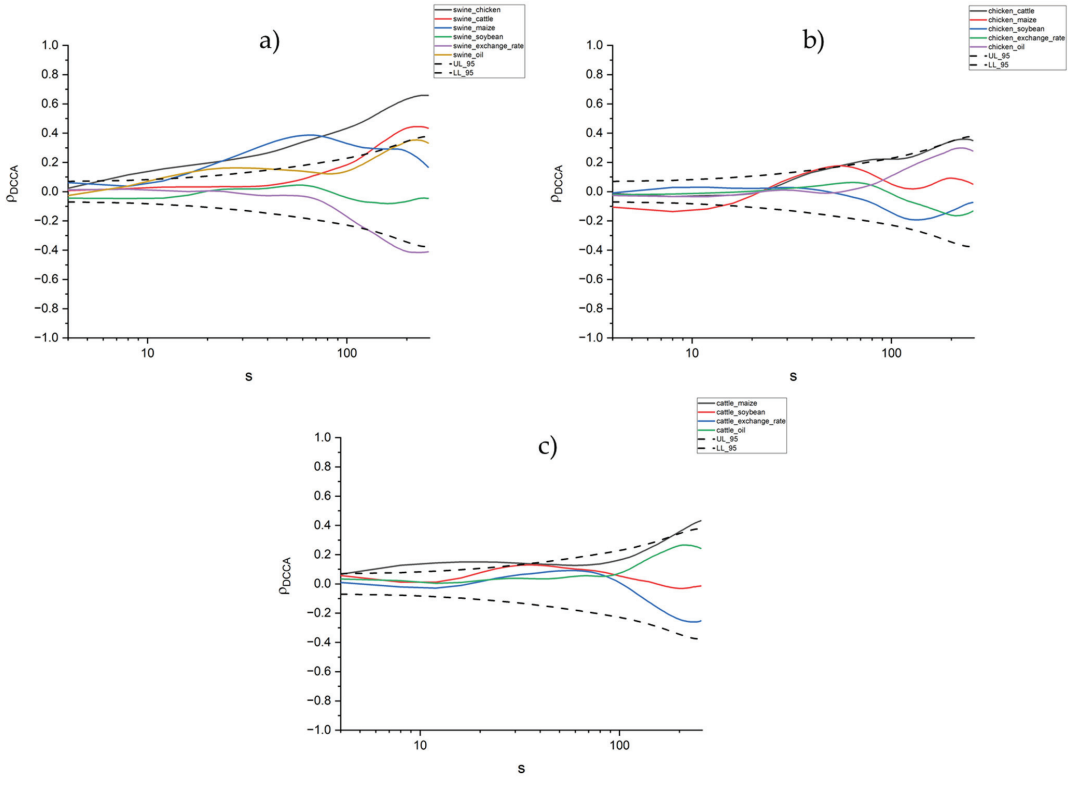

Figure 4. $\rho DCCA$ between swine (**a**), chicken (**b**) and cattle (**c**) with the remaining commodities, in P2, depending on the time scale (days). In red, lower and upper critical values test the hypotheses H0: $\rho DCCA = 0$ and H1: $\rho DCCA \neq 0$.

In a nutshell, it can be seen that meat prices show a consistent correlation in the most recent period, P2, as follows: (i) in the analysis of the correlation of meat prices with each other, we have swine with chicken and swine with cattle in the long run; (ii) between meat prices and possible related prices, we have swine with maize positively, but only in the short run, and swine with the exchange rate, but marginally significant with a negative association, and cattle and maize also marginally significant, in positive terms.

Referring to item (i), swine prices are cheaper than beef prices and thus they are possibly gaining an increasingly large market in exchange by consumers, in the sense that increases in beef prices tend to increase the demand for pigs, putting pressure on their prices.

With respect to item (ii), corn prices have had an impact on the cost of feed, and thus producers were able to pass on, at least in part, the cost increases in the case of swine. However, for chickens, it was observed that this correlation did not occur significantly. With regard to the exchange rate, it is expected that devaluation will encourage exports and, therefore, raise the prices of meat in the domestic market, in addition to putting pressure on the costs of inputs that are linked to the US dollar. In this case, other factors acted to weaken this expected correlation. Other points are that our analysis covers, on average, the period up to 1 year in terms of lag (256 days), and that the exchange rate response requires a longer time lag. However, these are conjectures and need to be analysed more, which is beyond the scope of the present investigation.

Regarding the relationship between oil and commodity prices, and meat especially, the evidence is mixed in the relevant literature. For example, on the one hand, Lucotte (2016)

found that in the post-boom period for commodities, after 2007, there was a strong movement between oil and food prices, including meat, something that had not been observed in the previous period.

On the other hand, Zmami and Ben-Salha (2019) studied the impacts of oil prices on the food price index through the ARDL and NARDL methodologies. The authors found that there is no long-term relationship between the meat index and oil prices. In the short term, there is an asymmetric effect of oil price shocks on the index, as meat prices react differently if there is an increase or decrease in oil prices. Our results are consistent with Zmami and Ben-Salha (2019) since we do not find a significant relationship between meat and oil prices.

The difference in the cross-correlations between P1 and P2 for swine, chicken and cattle is illustrated in Figure 5, through $\Delta\rho_{DCCA}(s) \equiv \rho^{\mathcal{P}2}_{DCCA}(s) - \rho^{\mathcal{P}1}_{DCCA}(s)$. We can see that, in the long run, the changes are: (a) for swine, changes in correlation with cattle were stronger (+), whereas exchange rate became weaker (−); (b) for chicken, exchange rate with soybean weaker; (c) for cattle, oil and soybean, stronger.

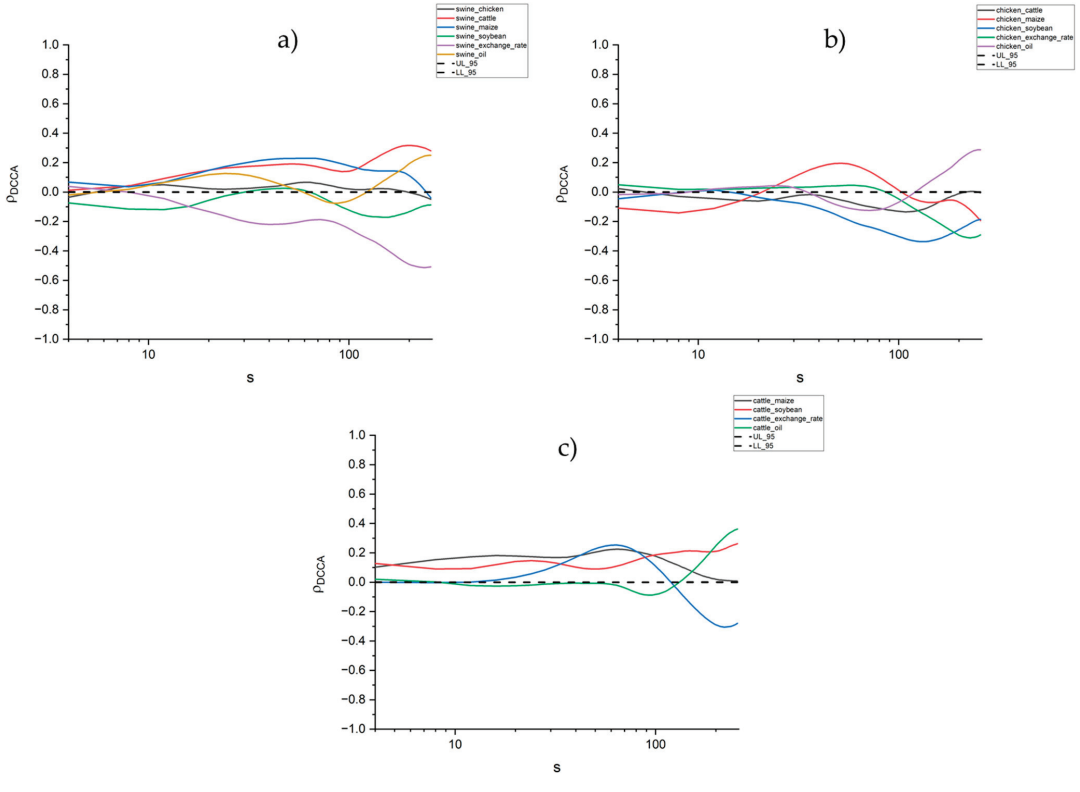

Figure 5. $\Delta\rho DCCA$ between swine (**a**), chicken (**b**) and cattle (**c**) with the remaining commodities, depending on the time scale (days). UL and LL represent upper and lower critical values (Guedes et al. 2018a, 2018b).

4. Discussion and Final Remarks

In this paper, we seek to analyse the degree of correlation of meat prices (cattle, swine and chicken) in Brazil, with daily price data, between January 2011 and December 2020. In addition to meat prices, we analyse the prices of the main grains produced in the country, soya beans and maize, a relevant source of animal feed, as well as the Brazilian exchange

rate and the price of WTI oil, a world reference, in order to have a more comprehensive comparison of the correlation of meat prices.

For this purpose, we use DCCA to analyse the correlations for different time scales. To the best of our knowledge, this is the first study to analyse the evolution of meat prices in Brazil based on daily data, in a new political-institutional framework, and with statistical physics tools that have shown robustness in empirical applications in various fields of knowledge, not only in physics and engineering, but also in applied social sciences such as economics and finance.

We found that, in the first period analysed, P1, pork prices are positively correlated with chicken prices, and chicken was correlated with cattle, only in the short run. In relation to the correlation of meat and other commodities, we have: swine and the exchange rate, positively in the short run, and cattle with maize also in positive terms, but only marginally significant in the long run (here understood as close to one year's time lag).

In the second period, P2, there is a positive correlation in the prices of swine with chicken, in the whole scale, and swine with cattle in the long run. We also observed a short-run correlation with swine and maize (+), and marginally significant with swine and the exchange rate (−). We also noted a marginally positive correlation with cattle and maize, in the long run. In this period P2, however, there was no significant correlation between chicken and any other commodity considered.

Finally, in analysing the change in the correlation between P1 and P2, it is noted that, between meat prices, the strength of correlation between pigs and cattle increased. Among meats and other commodities analyzed, we have changes in the correlation strength of soybean and corn, which largely consist of the cost of feed, as follows: weaker pork and exchange rate, as well as the chicken-soybeans and chicken-exchange rate pairs. The cattle–soybean and cattle–oil pairs became stronger, and as well as the cattle–maize, but only in the long term for the latter. As stated above, other combinations showed only short run correlations or oscillations, with no clear pattern.

It is important to note, as policy implications, that low-cost access to animal protein is essential to meet the growing demand for meat from developing countries, where access to meat can be hampered for low-income people. In the global context, Brazil has a prominent position in the supply of meat and, therefore, this study aims to assist in the understanding of the price relations of such goods.

Furthermore, excessive price fluctuations in agricultural products are unwanted by agents, as they can affect inflation and social stability in more extreme cases (Pavón-Domínguez et al. 2013). Specifically, in relation to inflation, the recent shock in meat prices is a matter of concern for the Brazilian government, due also to the second-order effects, that is to say, the impact these fluctuations may have on inflation expectations and, therefore, on the Central Bank's monetary policy.

In this sense, it is important to highlight that, after Petrobras' price realignment policy, which is more aligned with fluctuations in the international oil markets, the price of diesel began to fluctuate in Brazil, in all major regions of the country, especially at times of rising oil prices. At times of falling oil prices, however, there is evidence that they were not proportionally perceived by consumers, with a lower adjustment speed compared to increases, which would suggest behaviour already well known in the literature as the "rockets and feathers effect" (Quintino and Ferreira 2021b).

Furthermore, the logistics of agricultural products in Brazil, including meats that need an efficient refrigeration system due to their high perishability, is largely based on road transport, which in turn makes freight price logistics an important component of the competitiveness among meat-processing companies, where diesel occupies a relevant percentage. In this connection, Zingbagba et al. (2020) showed that shocks in diesel prices affect food prices in São Paulo.

From the consumer viewpoint, the greater the price correlation, the greater the difficulty in substituting one animal protein for another. This is particularly serious in emerging countries, where a significant portion of the population has a low income and may find

themselves in a situation of food insecurity, with deficits in nutrients needed for a healthy life. According to Sousa et al. (2019), the political and economic crisis that hit Brazil after the impeachment seriously affected the poorest strata of the population, making it extremely vulnerable and reflected in very serious food insecurity.

Finally, but importantly, it will be crucial for all stakeholders to continue monitoring the dynamics of COVID-19 and its social and economic impacts. The scenario of uncertainty tends to affect production chains severely, as well as the trade flows between the different links in the supply chain and export activities. This adverse shock, in addition to the impact on the income and employment of a multitude of agents, also affects other sectors that are linked to the meat industry in Brazil. Therefore, future research should investigate the sectoral impacts suffered by agribusiness, including meat as in our present investigation, due to such shocks. Another interesting line of research could be to disentangle the oil effects from other sources of shocks, using multiple detrended correlation as proposed by (Zebende and da Silva Filho 2018).

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Economic Impact of Tariff Rate Quotas and Underfilling: The Case of Canned Fruit Exports from South Africa to the EU

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Abstract: Export trade provided for under tariff rate quotas (TRQs) is an important contributor to improving South Africa's export access to European markets. The performance of exporter-administered TRQs has not received much research attention in the context of the below par market access utilisation of a given opportunity. The present study analysed how the country performed in terms of utilising its TRQ for canned pears, apricots, and peaches provided by the European Union (EU) for the period 2010 to 2019. The permit allocation system for TRQs in South Africa is described for further understanding of aspects of the TRQ system likely to affect quota fill. Performance was assessed in terms of yearly quota utilisation rates as well as welfare measured in equivalent variation calculated in a computable general equilibrium (CGE) trade model. The analysis found that the canned fruit TRQ exhibited a fill rate average of 61% for the past 10 years (2010–2019) and 49% for the period 2015–2019, thus falling far short of the goal of achieving full market access availed by the EU within the protocols of liberalised trade. The welfare effects of trade liberalisation confirmed the underutilisation of the TRQ indicated by a welfare loss, considering the difference in gains of an underutilised quota (USD 2497) and a fully utilised quota (USD 2530). The study highlights the importance of full utilisation of preferences.

Keywords: agriculture; fruit products; tariff rate quota; welfare; trade policy; TRQ administration

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1. Introduction

Open and fully liberalised trade is crucial for the South African fruit industry given its reliance on exports. The National Agricultural Marketing Council (NAMC 2017) noted that the fruit sector contributed the largest value share in the country's agricultural exports and that 90% of fruit production was exported internationally. Only 29% of the total fruit production in South Africa goes to processing, as noted in van Lin et al. (2018). Approximately 80% of canned fruit is exported annually by South Africa and the European Union (EU) market is reported among South Africa's major export destinations (Bertelsmann-Scott and Markowitz 2018; Research and Markets 2021). Evidently, scope exists for value addition in the sub-sector of canned fruits targeted for exports. Though the EU is among the major export destinations, processed fruit products face stiff entry barriers and this has been identified in studies such as Bertelsmann-Scott and Markowitz (2018), noting how African exporters are impacted by developed countries' trade policies.

South Africa's share in the exports of "sensitive"[1] agricultural products to the EU[2] is governed by the use of tariff rate quotas (TRQs) by the EU, which seeks to protect its agricultural market. TRQs are defined in Skully (2001) as "a two-tiered tariff system" in which in-quota imports face a lower tariff than out-of-quota imports. TRQs are considered in trade theory to be less restrictive than pure quotas, thus improving welfare to the extent of the quota fill. However, full TRQ liberalisation (zero in-quota tariff) has the potential to further liberalise trade and improve market access. The TRQ that consists of a combination of canned pears, apricots, and peaches (hereafter referred to as canned fruits[3] TRQ) is a major (70–80%) export value contributor (see Appendix A Table A1) among six EU fruit

products TRQs implemented and administered in South Africa through a permit allocation system managed by the then Department of Agriculture, Forestry and Fisheries (DAFF)[4] as part of the obligations and provisions on TRQs for fruit products contained in the EU–South Africa free trade agreement (TDCA 1999), the Trade Development and Cooperation Agreement (TDCA). The TDCA paved the way for South Africa to export fruit products on the EU's sensitive list and the provisions of the agreement are such that the TRQ is administered by the exporter. There are no studies describing the TRQ administration of a unilateral TRQ offered by the EU to a third country (a country other than an EU member state)[5] and the present study provides context by describing such a TRQ administration, thus contributing to a better understanding of the institutional context within which the trade policy instrument operates.

Though the canned fruits TRQ is the major earner amongst the fruit products TRQs, its performance (in terms of fill rates, the share in tariff line coverage of fruit TRQ exports to the EU, and welfare effects) needs to be more clearly understood. To this end, after describing the TRQ administration system of the exporting country, the paper assesses how the canned fruits TRQ performed focusing on the canned pears, apricots, and peaches tariff lines that correspond to the Harmonised System (HS)[6] of commodity description codes HS 2008.40/50/70. Tariff line coverage and fill rates of the TRQ were analysed to determine the extent to which the yearly TRQs were utilised and finally, a case study of the canned fruits TRQ was used for the empirical analysis of the welfare effects of TRQ liberalisation. Trade theory provides a framework to analyse trade policy instruments such as the TRQ implementation for which static effects can be determined in three different cases, namely, where exports are equal to the quota granted, exports are less than the quota granted, or exports exceed the quota granted (Abbott and Paarlberg 1998; Skully 2001). The case of the canned fruits TRQ in this study is the situation where exports are less than the quota granted, meaning that the effective instrument is the in-quota tariff. Hence, the goal of this study is to quantify the economic impact of the TRQ on welfare after considering a policy change where the in-quota tariff is fully liberalised. The hypothesis is therefore that the in-quota tariff impacts economic welfare. This paper uses the widely accepted static GTAP model to quantify economic welfare measured in equivalent variation. Additionally, the present study does not quantify the extent of impact of the TRQ administration system on TRQ fill but analyses the welfare impacts measured in equivalent variation (EV) in a comparison of scenarios of the filled and under-filled canned fruits TRQ.

The paper is organised as follows. The introduction section is followed by a literature review. The methodology is presented in Section 3, followed by findings and discussion in Section 4 and the conclusion in Section 5.

2. Literature Review

The theoretical literature on trade policy liberalisation focusing on the TRQ instrument, a synopsis of the global policy goals of TRQs, and the associated TRQ permitting systems as well as a summary of previous studies on TRQ liberalisation, are presented in this section. The implementation of the TRQ policy finds favour with exporters and importers for different reasons, especially in the context of sensitive agricultural products. TRQs arose under the Uruguay Round trade negotiations (1986–1994) on agriculture as a means to improve market access for imports (WTO Market Access Group 1993; Skully 2001; Pouliot and Larue 2012). Based on the same principles upon which TRQs were founded, the canned fruits TRQ discussed in this study was negotiated to achieve the main stated objective of achieving improved market access spelt out under the obligations of the TDCA. The challenge of frequent under-fill of quotas, however, as confirmed recently by Beckman et al. (2017), has dominated the agricultural market access debate. The World Trade Organisation reports (WTO Committee on Agriculture 2018, 2020) of the Committee on Agriculture note the existence of a total of 1128 schedules of TRQs and an annual average fill rate of 54% over all TRQs in 2016 and 46% in 2019. Skully (1999), at the onset, elaborated that the administration of quotas and quota fill is a principle of the General Agreement on Tariffs

and Trade (GATT) that declares that quota fill regulations need not act as trade barriers. Though the quota fill principle focuses on importer administration of TRQs, that same principle directs no particular attention to exporter administered TRQ rules, which are ideally the same rules that possibly inhibit quota fill as highlighted in some of the previous studies reviewed in Section 2.2.

2.1. Theoretical Framework

The assessment of possible welfare changes due to trade liberalisation has a theoretical basis in the analysis of policy changes credited to Harberger (1971) for identifying four sources of economic welfare induced by a policy change. The four sources identified were new technology, improved trading terms, new resources, and deadweight loss. The application of this theory was established by Huff and Hertel (1996) through implementing the conceptualisation by Harberger (1971) in the GTAP CGE model to decompose the equivalent variation welfare measure into the widely accepted sources indicated as changes in terms of trade, allocative efficiency, endowment effects, and technology effects that can be quantified following a policy shock to the model. The approach provides a mechanism to quantify economic welfare impacts of liberalising a tier of the TRQ, namely the in-quota tariff in the present study of the canned fruits TRQ. The tariff liberalisation is a policy change and the standard method in the GTAP model concerning sector aggregation is not practical to analyse the TRQ, hence the modification of the sector as stated in the methodology section was implemented for this study to accommodate the analysis of the canned fruits TRQ.

Skully (2001) provided a framework to understand the liberalisation of TRQs, identifying the liberalisation actions among which the reduction of in-quota tariffs and expansion of the quota was prescribed for persistently under filled TRQs. Furthermore, Bagwell and Staiger (2016) provided the basis to understand the terms of trade effects and explained that, once the domestic price and the terms of trade are determined, production as well as consumption and tariff revenue are all inferred. The decomposition of welfare changes in a GTAP model therefore enabled the investigation of welfare changes emanating from TRQ policy liberalisation in this present study. The pioneering study of Skully (2001) also acknowledges that the impact of different TRQ administration mechanisms[7] is not easy to capture in any model. Hence, this study provides a review of TRQ administration systems globally to provide further context.

2.2. Global TRQ Policy Expectations and Permitting Systems

Nagurney et al. (2019) explain that the world trade policy of TRQs is motivated by a national desire to protect domestic firms from competition and to reduce the domestic impact of such competition. The framework for the TRQ policies aimed at the agricultural trade is contained in the Agreement on Agriculture (AoA), which was negotiated during the Uruguay Round of trade negotiations and came into force in 1995 (WTO 2003). Agricultural products are defined in Article 2 of the AoA and the TRQ administration provisions to deal with the identified agricultural products are contained in the Ministerial Decision WT/MIN(13)/39 of the 2013 WTO Bali Ministerial Conference (WTO 2003, 2013b). TRQ administration as explained in WTO (2013a) refers to the methods used by governments to share quotas or quota licenses amongst traders. In the early 2000s, Gervais and Surprenant (2000) noted that some available studies indicated that the procedures to allocate licenses are arbitrarily chosen by the concerned countries. A WTO report explains that TRQ administration under the AoA was left to the importer countries to implement as they deemed appropriate, further noting that the TRQs had not improved market access for developing countries (WTO Committee on Agriculture 2000). Perhaps a rectification in recent times is what Beckman et al. (2017) describe, which is that in 2013, the rules for quota administration were brought under the WTO Agreement on Import Licensing Procedures (AILP). The rules as given under the AILP are expected to maintain some formality. The Bali Ministerial Decision WT/MIN(13)/39 categorised TRQ administration as a process

of import licensing. Thereafter, consensus was reached that the AILP would be fully applied in dealing with TRQ administration. The AoA together with the AILP indicate the following desiderata of a TRQ administration system: that it should be transparent, predictable, uniform, non-discriminatory, and fair, with clearly specified timeframes and published explanation by the governing authority of the granting of licenses and how they are granted, and mandating countries administering the licensing should notify the WTO of the procedures followed as well as any changes to the procedures. Though the TRQ administration system is deemed central to the filling of quotas, it is widely acknowledged that the AoA does not give a directive of what TRQ administration methods to use (WTO Committee on Agriculture 2000). Recognising the long-standing issue of TRQ under-fill, the Ministerial Decision also refers to mechanisms proposed to deal with under-fill (WTO 2013b; Jatkar and Mukumba 2014).

TRQ administration mechanisms can be identified by various methods detailing their manner of implementation. Currently, seven principal TRQ administration methods have been identified in a report of the WTO Committee on Agriculture (WTO Committee on Agriculture 2018). TRQ administration includes methods such as a first-come, first-served system; licenses on demand; auctions; state trading and, domestic purchase requirement (Barichello 2000; Skully 2001; WTO 2003; Khorana 2008). Export history and the TRQ use-percentages reported by exporters are also among the aspects considered in administering TRQs (Khorana 2008). Barichello (2000) noted that there is sometimes discrimination against new entrants based on historical allocations. Khorana (2008) indicated that a combination of the different TRQ administration methods stated above can be used in one particular administration system. The practise of combining TRQ administration methods has been criticised for creating mechanisms that are complicated and non-transparent (Khorana 2008; Lim and Babula 2013). Lim and Babula (2013) further note that the method of auctioning is considered a transparent TRQ administration method and is deemed to promote high quota fill rates. Joerin (2014) discusses TRQ auctions from the point of view of the importer and argues that TRQs should only be allocated in an auction system, because this system prevents rent-seeking behaviour where firms have interests in gaining quota rents.[8] The theoretical literature on TRQs, such as Miranda et al. (2010), suggests that they could be beneficial to exporters in improving market access and thus be welfare improving for both exporters and the consumers of the imported products. The notion of welfare improvement is grounded in the Bali Ministerial Decision WT/MIN(13)/39, which states that TRQ administration measures should ensure consistency with Article 3.2 of the AILP. In that disposition, the decision states that "importing Members shall ensure that unfilled tariff quota access is not attributable to administrative procedures that are more constraining" (WTO 2013b). The amenability of a TRQ administration system to such measures as stated in the AILP is thus important in furthering the goal of market access for exporters. The key question to therefore ask about TRQs provided under a free trade agreement, is whether the TRQ will be filled to ensure the full market access benefits.

The methods of TRQ administration give insights into the quota fill possibilities. The extent of fill of TRQs has been allied to a TRQ administration system in studies such as Herrmann et al. (2001), Monnich (2003), Miranda et al. (2010), and Loi et al. (2016). In an evaluation of TRQ fill rates, Monnich (2003) indicated that quota administration can be influential in quota fill. In a different study, Lim and Blandford (2009) found that quota administration methods significantly influence fill rates. In a report on the Swiss agricultural sector, Loi et al. (2016) indicated that nearly all of the 28 TRQs administered through methods that include auctioning, requirements on domestic purchases, historical imports, and first-come, first-served were filled. Loi et al. (2016) further indicate that TRQs and their administration system influence the quality composition of imports and their price. The occurrence of persistent under-fill is dependent upon a TRQ administration system and such under-fill is observed for most of the TRQ administration methods with the exception of the method considering historical imports as illustrated in the WTO Committee on Agriculture reports (WTO Committee on Agriculture 2013, 2018). There are

some contradictions, therefore, in the literature concerning under-fill of TRQs in relation to the historical imports administration method.

Beckman et al. (2017) reported that fill rates recorded across all WTO notified TRQs were at an average of 59% in 2013 and that concerns raised through the WTO Committee on Agriculture were dominated by TRQ under-fill concerns. In support of these concerns, some studies (Bendini et al. 2013; Beckman et al. 2017) have shown that TRQs provided through obligations of a free trade agreement do not translate into full market access improvements because of unfilled quotas. The EU was identified in Bendini et al. (2013) to be among the WTO members classified as having a persistent under-fill of TRQs meaning that TRQ fill rates were below 65% for three consecutive years. The WTO Committee on WTO Committee on Agriculture (2018) indicated an average fill rate of 57% in 2016 across all TRQs notified to the WTO. Unfilled TRQs mean that planned exports differ from actual exports where actual exports are lower than the guaranteed quota level.

The literature cited above relates to TRQ analysis on the importer side. There is scant literature on the export side studies relating to exporter-administered TRQs that detail the methods used in the distribution of the rights to export. Even though the use of TRQs is prevalent in trade agreements globally, published research on TRQs is still limited, especially in relation to the agreements signed between African countries and the European Union. In addition, the available studies (Monnich 2003; Khorana 2008; Li and Carter 2009) aside from not focusing on South Africa or Africa, researched TRQ administration on the importer side. This paper therefore fills the study gap by describing the TRQ administration system implemented by DAFF/DALRRD to manage exporter access to the EU fruit products (that include the canned fruits TRQ) markets and by so doing, sets the context for the assessment of tariff line coverage and fill rates. An illustrative case of the exporter administered TRQ system in the South African case is presented in the results section.

2.3. Summary of Previous Studies Modelling Welfare Impacts of TRQs

Various studies (Drogue and Ramos 2005; Decreux and Ramos 2007; Tsigas and Mora 2009; Meade et al. 2010; Narayanan et al. 2010; Bektasoglu et al. 2011) employed CGE as well as partial equilibrium (PE) models to analyse TRQ impacts. Particular studies such as Decreux and Ramos (2007) and Meade et al. (2010) indicated that welfare gains were realised in greater portion for out-of-quota tariff liberalisation than quota expansion and the opposite was found in van der Mensbrugghe et al. (2003). Bektasoglu et al. (2011) reported higher welfare changes when import tariffs were liberalised in a model with disaggregated sectors than a model with aggregated sectors. Economic loss on welfare has also been observed for the importer countries granting a TRQ and gains have been observed for the countries receiving a TRQ preference, but the level of welfare gains differs across sectors (Tsigas and Mora 2009; Meade et al. 2010).

3. Methodology

A case study of South Africa's pear, apricots, and peaches TRQ (referred to in this study as the canned fruits TRQ) was selected for its strategic export value importance among fruit products TRQ exports of South Africa to the EU. The canned fruits TRQ case was used as the basis for describing the exporter administered TRQ permit allocation system, assessing TRQ coverage in terms of the number of tariff lines included, analysing TRQ fill rates as well as the welfare effects associated with the TRQ liberalisation policy. The welfare effects measured in equivalent variation (EV) were analysed to compare performance in two scenarios of a filled and an unfilled TRQ. Following the description of data sources in Section 3.1, the data analysis methods are presented in Section 3.2. Figure 1 presents the framework contextualising the analysis of TRQ performance in this study.

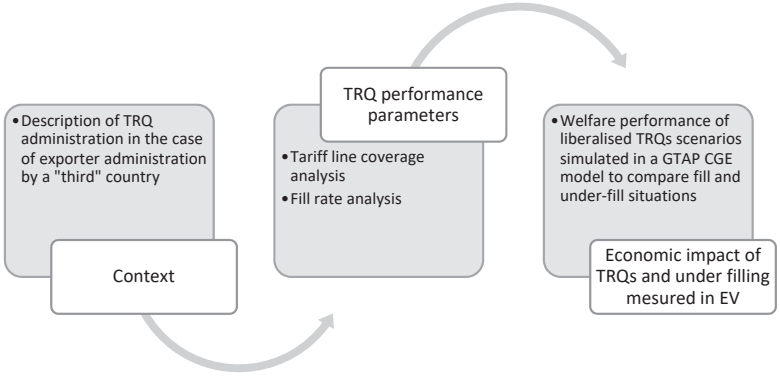

Figure 1. Framework contextualising the analysis of TRQ performance.

3.1. Data Sources

Secondary data were collected from two main sources, namely the Integrated Tariff of the European Union (TARIC) database and the Global Trade Analysis Project (GTAP) database version 9. The TARIC database provides annual reports on quota volumes for each TRQ that the EU has offered bilaterally and/or openly offered to all countries. The GTAP 9 database utilised in this study has the world economy represented for three different years, namely 2004, 2007, and 2011, and represents bilateral trade for 114 regions and 57 sectors. The GTAP 9 database reference year 2011 was the source of the bilateral trade flows of the TRQ exports analysed in this study. The exports were recorded at the HS 6-digit code where the codes HS2008.40; HS2008.50, and HS2008.70 identify the tariff lines relating to pears/apricots/peaches. Given that there are 114 regions in the model, and that the model is not a "plug and play" or an "off the shelf use", a step to aggregate the regions was undertaken to prepare the database to suit the problem being analysed in this study. To this end, the GTAPAgg software in combination with SplitCom (a GTAP utility) was used to aggregate the GTAP sectors to suit the analysis of the HS 6-digit code canned fruits TRQ enabling the introduction of the canned fruits TRQ as a standalone[9] sector of the GTAP model. Three regions (South Africa, EU28, and the Rest of the World) were demarcated for analysis to enable the implementation of trade liberalisation scenarios of the bilateral trade between South Africa and the EU. Given that the GTAP 9 version of the model represents the economy of the world in 2011 (which is the year prior to the full implementation of the TDCA), in order to analyse the changes in 2019 (the year prior to the COVID-19 crisis), the model was projected from 2011 (the baseline) to 2019 using gross domestic product (GDP) growth rates data of the International Monetary Fund (IMF 2020)—World Economic Outlook (WEO) database of 2020. Following Burfisher (2011), cumulative GDP growth rates were calculated for the period 2012 to 2019 and simulated as the exogenous input shocks to model the expected economic conditions in 2019 for each of the three regions—South Africa, EU28, and the Rest of the World. Additional data to those which are available in the GTAP database were therefore used to project the static GTAP database to the year 2019 for analysis of the welfare effects of TRQ liberalisation.

3.2. Data Analysis Methods

The coverage of the canned fruits TRQ is first described by comparing the number of tariff lines (HS 8-digit disaggregated levels) pre and post the implementation of the SADC-EU-EPA followed by the analysis of the utilisation of the TRQ quota allocation, measured by fill rates. The fill rates were calculated on a yearly basis as a ratio of the level of actual exports to the total quota allocation of the canned fruits TRQ. The GTAP model (fully described in Hertel 1997), which is a computable general equilibrium (CGE) model (that enables economy-wide impact analysis), was relevant to analyse welfare effects from the

TRQ liberalisation of canned fruits trade given that the model is the most commonly used model for analysing international trade liberalisation. In support of CGE models, Ciuriak and Chen (2007), indicated their suitability to compare the structure of the economy before and after a policy change simulation. To determine welfare effects, trade liberalisation simulations were carried out representing the under-fill and fill situations of the canned fruits TRQ. The first simulation involved the removal of the tariff in the existing case of the unfilled fruit products TRQ. The second simulation, which was implemented in two steps, involved first a shock to the quantity variable in the model to simulate a 100% quota fill level, followed by the removal of the tariff.

GEMPACK software was used in the modelling and the welfare effects were measured in equivalent variation (EV). Welfare change measured in EV was described as the change in money income that would produce the same effect on the country's utility as the policy shock (Plummer et al. 2011; Jensen and Sandrey 2013). In the static GTAP CGE model simulation, the EV measure is made up of predominantly the terms of trade and allocative efficiency effects. There is a welfare gain when EV is positive, and when it is negative, there is a welfare loss. Bowen et al. (2012) explained that CGE models perform the EV calculation by deriving the associated expenditure function from the assumed form of the utility function in the model and further illustrated that EV can be determined by finding the difference between the utility level that a country achieves under its current set of trade policy instruments and the utility level under a new set of trade policies. This is represented by the following equation:

$$EV = S(P_d, P_m, P_w, U_1) - S(P_d, P_m, P_w, U_0), \quad (1)$$

where:

S = expenditure function,
P_d = domestic price of domestic goods,
P_m = domestic price of imported goods,
P_w = world prices of domestic goods,
U_0 = country utility level at current trade policies, and
U_1 = country utility level under a new set of trade policies

4. Results and Discussion

This section describes and discusses the results drawn from the analysis conducted to establish the performance of the canned fruits TRQ. The discussion (in Section 4.1) of elements of the TRQ administration system adopted by DAFF helps to understand the interaction of the criteria of the administration system within the context of other studies that have assessed tariff line coverage and fill rates.

4.1. TRQ Administration—The South Africa Context

Trade under the TDCA occurred from 1999 to 2016 and at the end of 2016, the trade chapter of the TDCA was replaced by the Southern African Development Community–EU-Economic Partnership Agreement (SADC–EU-EPA) which is currently in force. The terms of the agreements are the same regarding the fruit products TRQ market access opportunity for South Africa in relation to implementation and management. The same permit allocation system prevails in the management of the TRQs of the SADC–EU-EPA. DAFF (now DALRRD) through its management of the TRQ permit allocation system is responsible for facilitating quota fill and ultimately market access. Given that WTO members with TRQs specified in their tariff schedules are required under WTO rules and principles to notify the WTO of TRQ administration and the volume of imports under TRQ management, the EU, with respect to the TRQs granted to South Africa, notified the WTO of the relevant TRQs from the importer perspective. However, the rules for notifying the WTO of TRQs do not require exporters (South Africa) to report TRQ administration. Could this be a shortcoming of the notification requirements? Whereas the TRQ administration system on the importer side is predisposed to hinder quota fill as a way to protect the

domestic industry, exporter-administered TRQ permit systems may also indirectly lead to quota fill inhibition when not managed properly. In addition to TRQ administration, various factors that inhibit quota fill have been identified in literature and these include product competitiveness, in-quota tariff rates, quota level, low import demand, and supply constraints (Monnich 2003; Khorana 2008; Li and Carter 2009). These identified factors do not form part of the scope of analysis in this study.

The canned fruits TRQ is a country-specific tariff quota allocation by the EU to South Africa and the trade arrangement is such that South Africa administers the quota on the export side of the trade agreement. The information summarised here comes from South Africa's *Government Gazette* from various years (2010–2019). South Africa's administrative system for TRQs combines various aspects of different TRQ administration methods but the auction method is excluded. The mechanism to allocate all fruit products TRQ shares/permits is published annually in the South African *Government Gazette* announcing the available quota quantities as well as the procedures for application to obtain quota permits. This practise of publishing available quotas together with information on the procedures to apply for permits is consistent with the basic criteria on quota administration set out in the AILP and targeted at importer countries. The available quota for canned fruits that was published or announced annually for the selected years from 2010 to 2019 is presented in the Appendix A Table A2 (ranging between 53,446 tons in 2010 to 60,866 in 2016 and reduced to 57,156 tons in the period 2017–2019). Further analysis of quota fill for the canned fruits TRQ is presented in Section 4.2 and conclusions can be reached from the standpoint of improving market access.

To manage the TRQs, South Africa put in place a system of managing the distribution of export shares among applicants. At the institutional level of the fruit products TRQ management, DAFF/DALRRD manages the license/permit allocation in collaboration/consultation with umbrella associations in the canned fruit and fruit juice sub-sectors which are the main beneficiaries of the fruit products TRQs market access opportunity. The South African Fruit and Vegetable Canners Association (SAFVCA) is the association that assists DAFF/DALRRD in allocating permits for the canned fruits TRQ. The collaboration is in terms of the assessment of quota use and administration as it relates to the members of SAFVCA. Given that member associations such as producer groups are tasked with serving member interests, those interests may not apply to many exporters outside the membership of the association and to this end, the fairness of the administration criteria may not be upheld. In general, it can be envisaged that an efficient TRQ system is administered in such a way as to encourage many exporters and no monopoly.

The applicants are categorised in terms of their export history. DAFF/DALRRD distinguishes between exporting companies with three or more years of exporting history and those with less than three years. The historical exporter of three or more years can apply for larger quantities. This method of considering historical imports has been criticised in Lim and Babula (2013) as a less transparent method of administering TRQs. Another layer in the criteria followed to allocate fruit products TRQ export shares has a basis in the Broad Based Black Economic Empowerment (BBBEE) scoring. BBBEE scoring, which as a policy aims at redressing some imbalances of the past regarding economic opportunities, has been included in the criteria as a way to promote accessibility of export shares in the fruit products TRQs. The nature of this practice does not provide enough detail to ascertain whether it violates the non-discriminatory criterion or obligation in administering TRQs. Special consideration is also given for new exporters and emerging exporters as indicated in the application procedures. Permits are allocated to applicants in two rounds annually, where the first-round targets BBBEE rated as compliant applicants and in the second round, reallocation of unused quota shares is carried out and BBBEE non-compliant applicants are included. The allocation of permits to applicants therefore considers the applicant's status in terms of historical export advantages/disadvantages, the applicant's desired quota quantity, and the available annual quota against the number of prospective applicants (Parliament of Republic of South Africa 2013; South Africa. Government Gazette 2014,

2015, 2018). In assessing this reallocation process, the information available does not imply that evidence is adduced on historic performances and supply capabilities, leaving the question of whether the administration procedure enables predictability on TRQ allocation. Lim and Babula (2013) consider the use of producer groups coupled with the historical allocation of quota shares to be less transparent as a method of administering TRQs.

The TRQ permit allocation system in South Africa described above could be consequential on the capacity of full quota use by quota holders. The level of an applicant's BBBEE compliance dictates the allocation amounts and it is not surprising therefore to find that an applicant may obtain the least share regardless of the applicant's export capabilities. Although the allocation of quota that is based on the BBBEE scoring has the intention to rationalise access to TRQ export quotas for the South African players, the system indirectly or unintentionally restricts the quota amounts to capable exporters, consequently with negative impacts on the filling of quotas. Even though the second-round reallocation of unused quotas includes BBBEE non-compliant applicants and possibly the historically advantaged applicants that had not received the full amount for their share application, there is no guarantee that underutilisation of quotas will be avoided. Exporters naturally deal with the uncertainty of access to TRQ export permits by making alternative decisions on exporting available stock to other available destinations to avoid a total loss of export revenue. Barriers presented through TRQ export permit allocation procedures cannot therefore be ruled out among other factors impacting TRQ fill. Thus, the inability to fill TRQs is not entirely attributable to the lack of supply, deficient import demand, or tariff levels. Literature such as Hasha (2004) and CBI (2015) asserts the existence of EU import demand for fruit and vegetables noting that the EU import regime runs at a deficit. On the other hand, Beckman (2021) notes that the WTO members often question EU quota allocations on fruits among other commodities such as vegetables and meat.

The market access performance under a trade agreement is measured in terms of quota fill (Beckman 2021), thus the quality of the TRQ permit system in administering export quotas is vital. The AILP places emphasis only on importing countries, leaving the exporter-administered TRQs in the hands of the exporters to govern the transparency and efficiency of their systems. However, assessing the South African TRQ administration system against the stipulations of the AoA and AILP obligations, it seems that the administration criteria are largely complied with. Historical allocations as the basis to allocate permits may be the hindrance to new entrants accessing the canned fruits TRQ. Such discrimination that may arise was long ago asserted in the study of Barichello (2000).

The importance of a trade agreement should not be spotlighted only by successful negotiations and the agreement's coming into force. The negotiated market access has to be utilised fully to deem the agreement a success. The TRQ concessions are not an end but a means to access the market, with the added expectation of improved welfare effects due to the TRQ liberalisation policy. The number of tariff lines combined in a TRQ as well as TRQ fill rates are the selected performance parameters considered in this study within the context of the TRQ administration system. Given that the competencies of a TRQ administration system in ensuring quota fill have not been established in this description of the present study and that administration methods do not indicate how the TRQ liberalisation policy has wholly performed, further analysis of the welfare effects of the canned fruit TRQ was undertaken in this paper to analyse TRQ performance.

4.2. Tariff Line Coverage and TRQ Fill Rate Analysis

The number of tariff lines (defined at the HS 10-digit code) included under the canned fruits TRQ increased from 63 (prior to the SADC–EU-EPA implementation) to 72 tariff lines (after the implementation of the SADC–EU-EPA). Therefore, the transition from the TDCA to the SADC–EU-EPA expanded the tariff line coverage by an additional 9 tariff lines. Figure 2a illustrates the annual increase of the TRQ volume from 2010–2016. The fill rate analysis is also presented in Figure 2a.

Figure 2. Canned fruits TRQ. (**a**) Yearly available quota and fill rates; (**b**) yearly used and unused quota.

The allocated quota was increased annually and reached a peaked in 2016 before the quota was reduced and capped at 57,156 tonnes at the onset of the SADC–EU-EPA. The volume of actual exports (illustrated as used quota in Figure 2b) consistently decreased from 2010 to 2019 (with only a slight uptick in 2017). The constantly decreasing fill rates from as high as 80% in 2010 to below 50% in 2019 illustrate the decreased performance of the TRQ as a tool for improved market access. Though the quota limits had been annually increased up to 2016, culminating with a broadened tariff line coverage from the end of 2016, that action did not result in increased fill rates nor any out-of-quota exports for the subsequent years. This suggests that not all the tariff lines included in the TRQ are utilised by exporters, thus failing to take advantage of the export market access opportunity. The unfilled canned fruits TRQ resonates with the case noted in Bendini et al. (2013), also noted in Beckman et al. (2017), that TRQs provided through a trade agreement have not translated into full market access.

The TRQ level in 2013 (which is the year after the full implementation of the TDCA) seems to have dictated the level of cap for the TRQ from 2017 onwards. At exactly the same level of quota, the fill rate in 2013 was about 66% compared to the 52% in 2017 and less than 50% for both 2018 and 2019. The results conform with the WTO Committee on WTO Committee on Agriculture (2020) report which found average fill rates for all TRQs taken into account for 2019 to be 46%. Therefore, this highlights that the under-filled canned fruits TRQ may not be an isolated problem, but a global issue for the TRQ policy. The year 2013 was the last year on record for which the fill rate for the canned fruits TRQ was close to 65%. The canned fruits exports currently under the SADC–EU-EPA have therefore failed to reach the TDCA levels of 2013 implying that the performance of the TRQ has worsened further in the wake of the reduced market access opportunity to the EU market that has been imposed through the capped TRQ. These findings indicate that the TRQ was performing above the average fill rate of 59% for all WTO notified TRQs in 2013 as reported in Beckman et al. (2017). However, by 2016, the fill rate of 48.6% was below the reported WTO average of 57% (WTO Committee on Agriculture 2018) across all TRQs. Comparing the fill rate of 2013 to the years 2017, 2018, and 2019 (all capped at 2013 quota levels), the performance in terms of fill rates declined further indicating that the cap on the TRQ can be justified in line with the rules of market access provisions under the WTO obligations, which stipulate that persistently under-filled quotas should be released and be reallocated. More tariff lines included in the canned fruits TRQ after the TDCA period should lead to better fill rates under the SADC–EU-EPA because the opportunity is broadened, but this has not been the case.

The period preceding 2016 depicts an interesting picture that can be associated with the impending end of the TDCA and beginning of the SADC–EU-EPA. There was a steady decrease in the used quota which reached the lowest level in 2016 illustrated in Figure 2b. Uncertainty of future trade prospects may have caused the slight uptick in 2017 as exporters anticipated some change to the rules. Past that period, the same pattern of persistent under-fill was observed. The manner of allocation of permits (detailed in Section 4.1) where for the first round, a certain portion of permits are reserved for BBBEE-compliant companies might unintentionally trigger the exporters with stock but no permits to redirect their stock or seek alternative export markets. In the reallocation phase, the likelihood that there is reduced or no supply capacity is therefore plausible.

One of the criteria in administering the canned fruits TRQ is the consideration of historical imports (dating back 3 years). As evident from the study results, the TRQ was still not filled under the circumstances. These findings are in contrast to the study of Loi et al. (2016) that indicated that historical import considerations as part of administration methods have led to filled quotas. A WTO Committee on Agriculture (2019) report of the Committee on Agriculture, also in contrast to this study's findings, highlighted that on average (2007–2016), the historical importation method had the highest fill rate compared to other methods of TRQ administration, further noting that a 100% fill rate was recorded on imports administered through the method of historical imports by Australia, Mexico, and Switzerland. The contrasting findings could be explained by this study having analysed an exporter-administered TRQ whereas the other studies analysed TRQ administration by the importer.

In summary, this study's findings on tariff line coverage and the associated fill rates, within the context of an exporter-administered TRQ system, demonstrate the argument advanced in de Gorter and Sheldon (2001) that when the TRQ is defined across a narrow category and covering a limited number of tariff lines, that might impact the fill rates. As indicated in Section 4.1, the notices for application to obtain TRQ permits indicate in most instances HS 8-digit codes but at administrative level, the EU has set tariff lines that are valid for the canned fruits TRQ at greater specificity of the HS 10-digit level. The broad categories such as HS 4-digit or HS 2008.40/50/70 at the 6-digit level would maximise access as there would be no further constraints for each category compared to the HS 10-digit level definitions of the allowed products used by the EU.

4.3. Welfare Results

The study analysed the full (100%) tariff liberalisation (i.e., the new set of policies set as U_1 in Equation (1)) of the canned fruits TRQ and the results of the two liberalisation experiments are reported in Table 1. Welfare effects of an unfilled quota set against the ideal situation of a filled quota were assessed and the welfare change results measured n EV are presented for all three regions in the model, but the main conclusions were drawn for South Africa, which is the region of focus in this paper. The simulated welfare results were assessed based on the complete removal of the in-quota tariff.

Table 1. Simulated welfare results for a 100% tariff liberalisation.

Region in the Model	EV Measured in Million USD	
	Unfilled Quota	Filled Quota
South Africa	0.002497	0.002530
EU	0.000126	0.000043
Rest of the World	−0.00051	−0.00052

Source: GTAP model results.

There is a positive welfare change under both liberalisation scenarios (filled and unfilled TRQ) for South Africa as well as the EU, confirming that the in-quota tariff acts as an added barrier to exports and this is widely acknowledged and supported in various trade literature such as WTO Committee on WTO Committee on Agriculture (2000) and Monnich (2003). The results of welfare improvement in both South Africa and the EU are therefore according to prior expectations. The findings are also supported in Miranda et al. (2010), noting that TRQs are welfare improving for both exporters and importers. In addition, and as can be expected for South Africa, the filled quota scenario presents a higher (USD 2530) welfare change than the unfilled quota scenario (USD 2497) implying that not all the market access benefits have been gained by South Africa given the status quo of the unfilled quota. The prevailing unfilled quota situation for the canned fruits TRQ has led to the achievement of less than the total welfare gains available under the new trade conditions. The filled quota scenario is ideally the scenario that grosses the full benefits from the advantage offered by the TRQ market access opportunity. Such a finding is consistent with the observation in van der Mensbrugghe et al. (2003) that welfare gains are realised in greater proportion under quota expansion.

A filled quota with a zero in-quota tariff rate, importantly, is a source of higher welfare gains than an unfilled quota and the source of these gains is linked to a change in prices. In the results presented in Appendix A Table A3, it can be seen that the full tariff liberalisation leads to a price decrease of 8.5% in the domestic price of canned fruits imported from South Africa to the EU. The export sales of canned fruits from South Africa to the EU increase by 34% and the industry output of canned fruits in South Africa increase by 0.04%. The low industry output in South Africa therefore does not fully support the increased exports potential and this could be the bottleneck that in the long run also leads to quota under-fill. The increased exports observed from the simulation are consistent with economic intuition following a price decrease such as that simulated in the EU market after a full tariff liberalisation. Notably, the increased exports after the simulation experiment are a likely contributor to the positive welfare, implying that the trade policy negotiators should aim to negotiate for complete removal of in-quota tariffs for the canned fruits TRQ. The findings of this study are consistent with Bektasoglu et al. (2011). The results on quota usage and quota fill analysis showed a decline in performance of the TRQ, hence, aside from the tariff, other non-tariff barriers such as standards could be contributing to quota under-fill. This is an area for further studies to determine the standards that may be presenting as barriers to trade flows.

4.4. Robustness Check

A systematic sensitivity analysis was performed to check the sensitivity of the results in response to changes in shocks to the model. The means and standard deviations were calculated for the endogenous variables of the model and selected results are presented in Table A4 in the Appendix A. After allowing for the variation in the shock to the tariff in both filled and unfilled scenarios, the results for the selected endogenous variables were significant at 95% confidence level, indicating that the simulation results are robust.

5. Conclusions

This paper described the TRQ administration system from the exporter administration perspective, highlighting the criteria applied idem under the TDCA and the SADC–EU-EPA. The main changes in the trade conditions from the TDCA to the SADC–EU-EPA and relevant for the canned fruits TRQ are the cap on the TRQ (no annual increments), the in-quota tariff reduction, and the expanded tariff line coverage of the TRQ. The performance of the TRQ has largely been below par in comparison to average fill rates of TRQs notified at the WTO. The TRQ administration that reserves certain portions for BBBEE beneficiaries makes the filling of quotas to be inefficient. At the country level, given the persistent under-fill, there is little justification for restricting permit allocations based on BBBEE principles. Uncertainty arises among applicants whenever there are no guarantees for acquiring quota export permits. Considerations should therefore be made to allocate the full quota applied for by an applicant in the first cycle of applications as long as the total requested quota by all applicants does not exceed the available quota. This would reduce the level of uncertainty that may lead to a decision by an applicant to supply alternative markets. The anticipated effect of a new trade agreement is improved market access, and a filled quota would enhance the trade gains. Had South Africa's canned fruits TRQ not been capped, on a global level, the situation would have perpetuated the inefficiency that arises where quotas are allocated to non-users as may be dictated within bilateral trade agreements. However, there is still scope to further liberalise trade through the complete removal of tariffs and this scenario was therefore simulated to gain an understanding of what is likely to happen in terms of trade gains measured in welfare. Welfare effects of tariff liberalisation of the canned fruit products TRQ were quantified using the GTAP model and reported as an EV measure of economic welfare changes. The filled TRQ improves welfare more than the unfilled TRQ. The results have demonstrated that full tariff liberalisation improves welfare and the benefits are larger for a filled TRQ. The welfare gains, though modest, indicate that the filled TRQ has a better performance; hence, the TRQ administration system should be designed to promote quota fill. Policies such as the TRQ policies are meant to give incentives to the exporters; hence, the policy makers need to ensure an enabling environment that allows exporters to utilise the market access opportunity.

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Appendix A

Table A1. EU imported value of fruit products from South Africa (2011–2019)—EUR.

TRQ 6-Digit HS Code	2011	2012	2013	2014	2015	2016	2017	2018	2019
Pears, apricots, and peaches HS2008.40/.50/.70	36,274,223	38,448,413	39,057,586	37,628,871	31,467,951	29,233,394	29,852,555	22,762,986	26,296,306
Strawberries HS 0811.10	0	0	0	0	0	0	6105	0	13
Mixtures of fruit * HS2008.97		5,788,307	6,188,509	4,684,266	2,889,246	2,792,839	2,632,205	2,529,164	4,017,844
Frozen orange juice HS2009.11	1,026,901	683,867	882,476	2,118,048	1,278,329	1,024,564	665,146	786,262	992,328
Pineapple, apple juice HS2009.41/.49 HS2009.71/.79	7,922,095	2,538,197	1,767,951	2,592,689	4,867,618	10,608,745	5,219,826	8,252,380	5,085,484
Total value (EUR)	45,223,219	47,458,784	47,896,522	47,023,874	40,503,144	43,659,542	38,375,837	34,330,792	36,391,975
% contribution of the pears, apricots, peaches TRQ	80	81	81	80	78	67	78	66	72

Source: Author's calculations based on European Commission (2020). * The canned fruit mixtures of fruit were granted under 2 TRQs—tropical and non-tropical.

Table A2. Allocated quota and fill rates (2010–2019) for the pears, apricots, and peaches TRQ.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total quota (tons)	53,446	54,682	55,919	57,156	58,393	59,630	60,866	57,156	57,156	57,156
Fill rate (%)	89.0	74.9	69.8	66.5	61.6	55.7	48.6	52.4	43.8	45.3

Source: Author's calculations and TARIC database.

Table A3. Simulation results for selected outcome variables.

	Experiment 1—Unfilled Quota, 100% Tariff Liberalisation (% Change)			Experiment 2—Filled Quota, 100% Tariff Liberalisation (% Change)		
Domestic price for canned fruits supplied from region r to s R = row, s = column	**SOUTH_AFRICA**	**EU_28**	**Rest of the World**	**SOUTH_AFRICA**	**EU_28**	**Rest of the World**
SOUTH_AFRICA	0.000026	−8.500278	0.000024	0.000003	−8.5003	0.000003
EU_28	−0.000001	−0.000001	−0.000001	0	0	0
Rest of the World	0	0	0	0	0	0
Export sales for canned fruits supplied from region r to s R = row, s = column	**SOUTH_AFRICA**	**EU_28**	**Rest of the World**	**SOUTH_AFRICA**	**EU_28**	**Rest of the World**
SOUTH_AFRICA	0.000013	33.952953	−0.000011	0.000013	33.95247	−0.000011
EU_28	0.000025	−0.048238	0.000001	0.000025	−0.04872	0.000001
Rest of the World	0.000024	−0.048239	0	0.000025	−0.04872	0
Industry output for canned fruits						
SOUTH_AFRICA		0.037334			0.037833	
EU_28		−0.001135			−0.001146	
Rest of the World		−0.000038			−0.000038	

Source: GTAP model results.

Table A4. Systematic sensitivity analysis.

Endogenous Variable	Experiment 1—Unfilled Quota, 100% Tariff Liberalisation				Experiment 2—Filled Quota, 100% Tariff Liberalisation			
	Mean	Standard Deviation	95% Confidence Interval		Mean	Standard Deviation	95% Confidence Interval	
			Min	Max			Min	Max
Output in South Africa	0.037334	0.007621	0.00326813	0.07139987	0.03795	0.007723	0.00342819	0.07247181
Exports for South Africa to EU	3,395,295	6,930,618	2,973,091	6,493,282	339,524	6,930,518	297,296,154	649,317,924
EU import prices	−0.02381	0.00486	−0.04553	−0.00209	−0.02405	0.004909	−0.04599223	−0.0021058

Notes

[1] Canned fruits are among a list of products included by the EU under its list of "sensitive agricultural products". Sensitive agricultural products are mainly viewed as products that require the protection of local producers from import competition. Such sensitive products, as observed in Perez and Jallab (2009), are the lines of products that are then ordinarily exempted from liberalisation. They are of strategic national importance, normally incur high tariffs, and their importation is conditional on supply management policies, as argued in Pouliot and Larue (2012).

[2] The EU28 before BREXIT.

[3] The EU TDCA offer to South Africa for the canned pears, apricots, and peaches comprises 3 tariff lines combined under a single TRQ. TRQ commitments are administered at different levels of commodity aggregation (Barichello 2000). In addition, a TRQ commitment can be defined across a broad commodity category (aggregated) such as fruits (HS 4-digit level), whereas in administrative terms, a TRQ is defined for specific (disaggregated) HS 6- or HS 8-digit level tariff lines differentiating various forms of product of a single HS 4-digit level commodity.

[4] The government in South Africa, specifically through DAFF (now the Department of Agriculture, Land Reform and Rural Development (DALRRD)), is involved in managing TDCA/SADC–EU-EPA fruit products exports through the allocation of export permits that enable exporters to access the EU market.

[5] https://www.bbc.com/news/54152583 (accessed on 5 September 2021).

[6] The World Customs Organisation (WCO), which developed the system of HS codes, describes the HS as a universal economic language and code for export goods that are internationally traded. Specific HS 6-digit codes are assigned to different variations of commodities (WCO 2019). The six fruit products of the TDCA comprise 10 tariff lines when defined at the HS 6-digit code.

[7] TRQ administration mechanisms are explained in Section 2.

[8] Quota rents are an economic welfare measure that are calculated by multiplying the quantity of the quota by the price difference between the world price plus in-quota tariff and the domestic price of the imported product (Lim and Babula 2013).

[9] In the standard GTAP database, the canned fruit products are part of the sector referred to as "other fruit products".

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External and Internal Shocks and the Movement of Palm Oil Price: SVAR Evidence from Malaysia

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Abstract: Movements in palm oil price give important signals to various stakeholders of the palm oil industry in Malaysia. Thus, understanding external and internal factors that may affect the palm oil price is vital to the industry players for sustainability of their activities. This study investigates relative importance of external and internal shocks on the movement of palm oil price in Malaysia. Employing a structural vector autoregressive (SVAR) model on quarterly data from 1990 to 2019, the findings reveal that external shocks are more dominant in affecting the palm oil price. Shocks to the crude oil price, the prices of substitution goods (soybeans oil, rapeseed oil, and sunflower oil), the world palm oil price, and foreign income significantly affect the palm oil price in the short and medium run. The results also indicate that a shock to soybean oil price has a more profound effect on the palm oil price than a shock to rapeseed oil or sunflower oil prices, respectively. Likewise, shocks to incomes from India as well as from Netherlands create greater impacts on the palm oil price than a shock to income from the other trading partners, respectively. The study has shown the importance of external factors in affecting the palm oil industry.

Keywords: palm oil price; domestic shocks; foreign shocks; Malaysia; SVAR model

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1. Introduction

Palm oil is Malaysia's main agricultural commodity, contributing 25.8% of the world's palm oil production and 34.3% of the world's palm oil export in 2020 (Malaysian Palm Oil Council (MPOC) (2021)). In 2019, palm oil contributed about 37.7% to the value added of Malaysia agriculture sector. From the total gross domestic product, the palm oil industry contributed around RM36.9 billion. Currently, Malaysia is the second largest producer of palm oil after Indonesia. Both Malaysia and Indonesia contribute about 80% of the world's palm oil supplies.

From the total global production of oils and fats in 2020, palm oil accounted for 31.4%. The other three major oils and fats cultivated are soybean oil, rapeseed oil, and sunflower oil. The production of these four oils and fats accounted for 76% of the global total oils and fats production in 2020. In the meantime, there is growing demand for oils and fats from the food and beverage, oleochemical, and biodiesel sector. This is in line with strong GDP growth, rising per capita income, rapid urbanization, and growing middle-class consumers in the major consumer countries (Hassan et al. 2021).

Palm oil sector contributes hugely to the socioeconomic development of Malaysia. There are more than 650,000 smallholders and over 2 million people who are highly dependent on the palm oil industry for the source of income (MPOB Palmnews 2019). Smallholders produced about 40% of Malaysia's palm oil output (Rahman 2020). Thus, it is expected that the stakeholders as well as the nation would be badly affected if there is a slump in the growth of the palm oil sector.

One of the indicators that would show meaningful development of the palm oil sector is the price of palm oil itself. A rise in palm oil price would benefit the stakeholders and

the nation's income through export revenue and vice versa. Thus, understanding the movement of the palm oil price and factors affecting it is very crucial for the policymakers as well as the stakeholders (Karia and Bujang 2011).

Figure 1 shows the movement of the Malaysia's palm oil price from 1990 to 2019. There are several sharp ups and downs. As can be seen, the price began to increase significantly beginning quarter 2, 2006 and had a significant peak at quarter 1, 2008 (USD1092 per metric ton). The price dropped significantly after that until it reached to previous level of 2016 (USD452 per metric ton) at quarter 4, 2008. This was the results of the global financial crisis originating from subprime crisis in the US. Most countries have been affected, and it has led to a decrease in the demand for palm oil. Figure 2 shows that the exports of Malaysia's palm oil to its top five trading partner countries in palm oil; namely, China, India, Pakistan, Turkey, and the Netherlands dropped significantly during the global financial crisis. Since quarter 4, 2008, the palm oil price started to have a positive trend until it reached the highest peak in quarter 1, 2011 (USD1213 per metric ton). The price then had several ups and downs in downward trending.

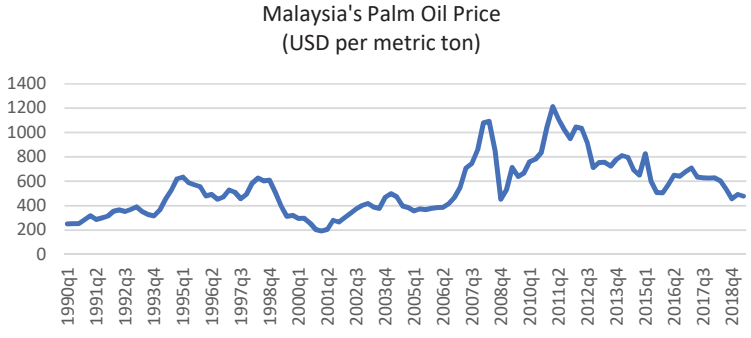

Figure 1. Malaysia palm oil price.

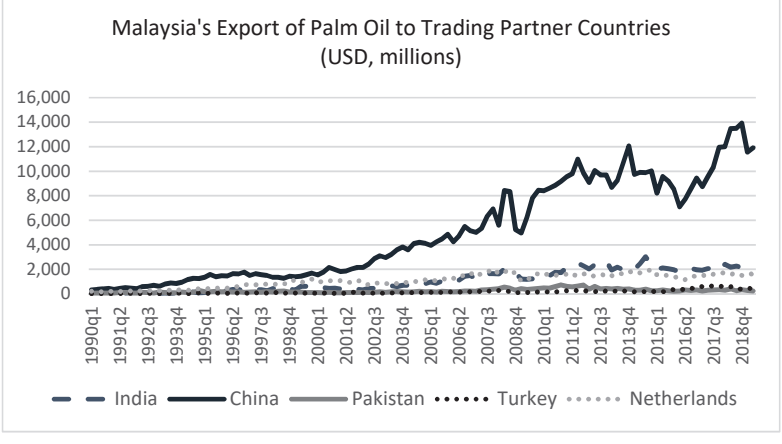

Figure 2. Export of Malaysia's palm oil to trading partner countries.

Figure 3 depicts the prices of substitution goods to palm oil, namely soybean oil, rapeseed oil, and sunflower oil. The trends of those prices resemble the ups and downs of the price of palm oil and this is an indication of how stiff the competition is among the oils and fats commodities.

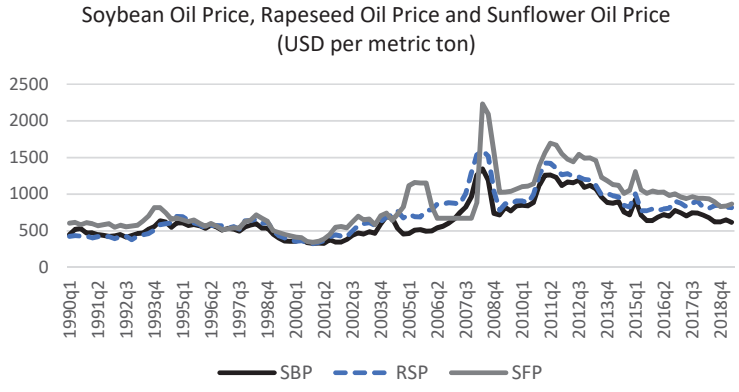

Figure 3. Prices of substitution goods.

Factors affecting the palm oil price can come from external and internal sources representing the demand as well as the supply factors. The external factors comprise the prices of palm oil's substitution goods such as soybean oil, rapeseed oil, and sunflower oil (Ismail et al. 2019; Wong and Ahmad 2017; Mahalik et al. 2014; Sehgal et al. 2013; Abdullah 2013), foreign importers' income (Zakaria and Nambiappan 2019; Wong and Ahmad 2017), the world palm oil price, and the crude oil price (Abdullah 2011; Nazlioglu and Soytas 2012; Khalid et al. 2018; Buyung et al. 2017). Meanwhile, the internal factors include the production of the palm oil, income of the nation (Zakaria and Nambiappan 2019; Zakaria et al. 2017; Kochaphum et al. 2013), and the palm oil export.

The fluctuation of palm oil raises concerns for those who deal with the risks and uncertainties in the palm oil industry and may affect smallholder income, thereby affecting the country's revenues in the future. Therefore, understanding the main factors that affect palm oil price movement is crucial to this industry's stakeholders, particularly for small-farmers, plantation firms, and businesses to plan their business and activities in this industry.

Previous studies on palm oil price focus on identifying its determinants where the relationship between palm oil price with its substitution goods price, especially the soybean oil price, is often being emphasized (Chuangchid et al. 2012; Mohammadi et al. 2015; Hassan and Nambiappan 2016). Other studies look at the aspects of forecasting (Khalid et al. (2018), Abdul Hamid and Shabri (2017), Arasim and Karia (2015) and Karia et al. (2013)) and volatility of the palm oil price (Mahalik et al. 2014; Ab Rahman et al. 2007).

One area that is missing in the previous studies is understanding the relative effect of external and internal shocks on the movement of the palm oil price. Most previous studies usually consider several factors that can have an impact on the price of palm oil. Those factors can be categorized as foreign and domestic factors. Understanding the relative importance of foreign and domestic factors on the movement of the palm oil price would be beneficial to governments and various stakeholders in strategizing actions for mitigating risks associated with the fluctuation of the palm oil price. Thus, realizing the gap, this paper examines relative importance of external and internal shocks on the movement of palm oil price in Malaysia.

The paper fills the literature gaps in the following ways. First, this study considers more relevant economic shocks (foreign and domestic) to understand further how the exogenous shocks affect the crude palm oil price movement. In total, there are four external shocks and four domestic shocks that would be investigated in the model. Second, this study improves the previous studies by Khalid et al. (2018), Kochaphum et al. (2013), Ab Rahman et al. (2013) and Abdullah (2011) which did not consider the elements of structural shocks in their model, by analyzing the propagation of the exogenous shocks through impulse response function (IRF) and forecast error variance decomposition (FEVD) on

the movement of the palm oil price. Third, this study investigates the relative effects of palm oil' substitution goods, namely soybean oil, rapeseed oil, and sunflower oil, on the Malaysia's palm oil price. Results of IRF and VD would indicate which substitution goods play a more dominant role in affecting the palm oil price. Fourth, the study examines how the shocks to foreign incomes of Malaysian major trading partners in the palm oil market, namely India, China, Pakistan, Turkey, and Netherlands influence the palm oil price movement. Besides measuring foreign income using the trade-weighted of India, China, Pakistan, Turkey, and Netherlands's incomes, following the approach of Zaidi et al. (2013), this study also considers each trading partner country's income to represent the foreign income measure, respectively. Various considerations in the modeling process might also serve as robustness checks.

This study contributes to the stakeholders of the palm oil industry and to the literature in the following ways. First, to the stakeholders, this study may encourage the policymakers to understand main factors that influence the palm oil price, so that they can react accordingly to lessen uncertainty of income for the small farmers and businesses, as well as to plan for stabilizing the palm oil price. Understanding the palm oil price movement's main factors is also crucial for the government to plan its strategic trade policy and implement a new strategy to diversify in the international market. It is vital for farmers and businesses to understand the main factors affecting the movement of the palm oil price because their future income depends on those factors; consequently, they can strategize to mitigate the adverse effect of the shocks on their income.

Second, to the literature, this study extends the existing literatures (Khalid et al. 2018; Abdul Hamid and Shabri 2017; Arasim and Karia 2015; Ab Rahman et al. 2013) that have focused on forecasting and volatility of the palm oil price and the factor that affects the movement of palm oil price in the Malaysia's context. The previous studies in the Malaysian context, nonetheless, have ignored how the propagation of an internal and external shock affects palm oil price movement. Thus, this study takes advantage of the SVAR methodology to examine these issues where the structural shocks' identification is based on the economic theory. Furthermore, the study implements block exogeneity restrictions in the SVAR specification to portray the real situation where the block of domestic variables from small open economy (Malaysia) would not affect, neither contemporaneously nor with lags, on the block of foreign variables. An exception is on the domestic production of the palm oil that is assumed to affect the world palm oil price since Malaysia is among the top producers of the palm oil.

The remainder of this paper is organized as follows. Section 2 describes the data and research design. Section 3 discusses the empirical results of the impulse response function and variance decomposition that have been estimated using the SVAR approach, and Section 4 concludes.

2. Data and Methodology

2.1. Data and Description of Variables

This study utilizes quarterly frequency data from 1990 to 2019. The period included several crises that may contribute to shocks in the palm oil price. Variables that have shown connections with the palm oil price as stated in the past literatures were considered for this study. Thus, the variables under investigation were crude oil price, prices of the palm oil substitution goods such as soybean oil, sunflower oil, and rapeseed oil, foreign income from Malaysia's major trading partners in palm oil (India, China, Pakistan, Turkey, and Netherlands), world and Malaysia palm oil prices, Malaysia's production of CPO, Malaysia's palm oil export, Malaysia's Gross Domestic Product, and real exchange rate. The details about the variables are summarized in Table 1.

Table 1. Description of variables.

Variable	Notation	Description
Crude Oil Price	CRO	Crude Oil Price in US dollar (USD) per barrel
Foreign Income	YF	Trade-weighted of Top 5 Malaysia's Trading Partner in Palm Oil *
India's Income	GDPI	India's Gross Domestic Product (USD)
China's Income	GDPC	China's Gross Domestic Product (USD)
Pakistan's Income	GDPP	Pakistan's Gross Domestic Product (USD)
Turkey's Income	GDPT	Turkey's Gross Domestic Product (USD)
The Netherlands' Income	GDPN	The Netherlands' Gross Domestic Product (USD)
Soybean Oil Price	SBP	Soybean Oil Price in US dollar (USD) per metric ton
Rapeseed Oil Price	RSP	Rapeseed Oil Price in US dollar (USD) per metric ton
Sunflower Oil Price	SFP	Sunflower Oil Price in US dollar (USD) per metric ton
World Palm Oil Price	CPOW	World Palm Oil Price in US dollar (USD) per metric ton
Crude Palm Oil Production	YCPO	Crude Palm Oil Production in a thousand ton ('000)
Crude Palm Oil Price	CPOM	Malaysia Crude Palm Oil Price in US dollar (USD) per metric ton
Crude Palm Oil Export	CPOX	Crude Palm Oil Export in a thousand ton ('000)
Domestic Income	GDPM	Malaysia Gross Domestic Product (USD)
Real Exchange Rate	REER	Malaysia Real Exchange rate

* The trade weightage is based on export of Malaysia to the five most important trading partner in palm oil.

All the data were gathered from Malaysia Palm Oil Board (MPOB), International Financial Statistic (IFS), International Monetary Fund (IMF), and Thomson Reuters. All variables are transformed into logarithm form.

2.2. Empirical Models

This study adapted structural vector autoregressive (SVAR) procedures employed by Amisano and Giannini (1997) and Khan and Ahmed (2014). The SVAR is used to capture exogenous economic shocks on Malaysia's palm oil price. The approach is useful to test the interdependent relationship between the variables under consideration. Moreover, the model enables us to determine the structural shocks based on economic theory and it gives relevant empirical results than other VAR classes.

There are in total 8 SVAR models to be estimated. Each model has nine variables. Table 2 shows the variables used in each model. Model 1 is the main model where the impulse response functions are generated and discussed in detail. The first model, following the approach of Zaidi et al. (2013), considers trade-weighted income variables of Malaysia's top five trading partners, namely India, China, Pakistan, Turkey, and the Netherlands, to represent the foreign income. The price of substitute goods of soybean oil (SBP) is considered since soybean oil is the perfect substitute good for palm oil as they have similarities in function. Model 2 and model 3 have the same variables as in model 1 except the substitute goods to palm oil are different. Model 2 utilizes RSP, while model 3 uses SFP. Models 4 to 8 have individual partner countries' GDP to represent the foreign income respectively. Comparing the IRF and FEVD of models 1 to 3 would indicate the relative importance of substitution goods to explain the variation in the palm oil price shock. Similarly, comparing the IRF and FEVD of models 4 to 8 would uncover the relative importance of the partners' countries income to reveal the variation in the palm oil price shock.

As with other VAR models, an optimal lag length is determined to remove serial correlation in the residuals. The selection of the lag length is based on the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). To test the stationarity of the time series, unit root tests of augmented Dickey–Fuller (ADF) and Phillip–Perron (PP) were performed on each variable. One of the concerns when using time series data is the occurrence of spurious regression when non-stationary time series are used in the regression

model. With regard to that, there are considerable discussions about whether to estimate the structural VAR in levels, first-differenced, or in a cointegration-imposed VAR. Some past literatures tend to suggest estimating a structural VAR in level even if the times series have unit roots (Sims et al. 1990; Christiano et al. 1996; Ramaswamy and Sloek 1997; Ashley and Verbrugge 2009; Basher et al. 2012). According to Sims et al. (1990), the estimated coefficients of a VAR are consistent, and the asymptotic distribution of individual estimated parameters is standard when variables are not stationary and the cointegration relationship might exists in some of the variables. Since the primary aim of SVAR is to determine interdependence among the variables, it may not be crucial to use differenced variables, although the unit root might exist (Sims 1980; Sims et al. 1990). Moreover, differentiating variables can exclude signals related to the co-movement of data (Enders 2004).

Table 2. Variables used in each SVAR model.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
1	CRO	CRO	CRO	CRO	CRO	CRO	CRO	CRO
2	YF	YF	YF	**GDPI**	**GDPC**	**GDPP**	**GDPT**	**GDPN**
3	**SBP**	**RSP**	**SFP**	SBP	SBP	SBP	SBP	SBP
4	CPOW	CPOW	CPOW	CPOW	CPOW	CPOW	CPOW	CPOW
5	YCPO	YCPO	YCPO	YCPO	YCPO	YCPO	YCPO	YCPO
6	CPOM	CPOM	CPOM	CPOM	CPOM	CPOM	CPOM	CPOM
7	CPOX	CPOX	CPOX	CPOX	CPOX	CPOX	CPOX	CPOX
8	GDPM	GDPM	GDPM	GDPM	GDPM	GDPM	GDPM	GDPM
9	REER	REER	REER	REER	REER	REER	REER	REER

This study would primarily use impulse response function and forecast error variance decomposition to examine the interrelationship between the time series. The impulse response functions from the VAR model are consistent estimators of their true impulse response functions for the short and medium run only (Basher et al. 2012). Phillips (1998) shows that, in the long run, the standard impulse responses do not converge to their true values and are thus not consistent in the unrestricted VARs with some unit roots. To address this issue, this study also considers alternative impulse responses based on local linear projections as suggested by Jorda (2005) as the approach is robust to the problem. This study would mainly discuss the impulse response functions for the short run and the medium run.

Following Amisano and Giannini (1997) and Khan and Ahmed (2014), the SVAR is written as:

$$AY_t = C + \left(\Gamma_1 L + \Gamma_1 L^2 + \ldots\ldots + \Gamma_k L^k\right) Y_t + \varepsilon_t. \quad (1)$$

The equation shows the dynamic relationships for the selected economic variables in the SVAR approach where A is a square matrix that captures the structural contemporaneous relationships among the economic variables. Y_t represents n-vector of relevant variables as follows:

$$Y_t = (CRO_t\ ,\ YF_t\ ,SBP_t\ ,CPOW_t\ ,YCPO_t\ ,CPOM_t\ ,\ CPOX_t\ ,GDPM_t\ ,REER_t)'$$

C is a vector of deterministic variables while Γ(L) represents a kth-order matrix polynomial in lag operator L. The structural shocks are denoted by $\varepsilon_t = \left(\varepsilon_t^{lcro},\ \varepsilon_t^{lyf},\varepsilon_t^{lsbp},\varepsilon_t^{lcpow},\varepsilon_t^{lycpo},\varepsilon_t^{lcpom},\varepsilon_t^{lcpox},\ \varepsilon_t^{lgdpm},\varepsilon_t^{lreer}\right)'$.

The SVAR model cannot be estimated directly because it correlates with the other endogenous variables in one equation. Therefore, by pre-multiplying Equation (1) with A^{-1}, it will produce a reduced form VAR equation:

$$Y_t = A^{-1}C + A^{-1}\left(\Gamma_1 L + \Gamma_1 L^2 + \ldots\ldots + \Gamma_k L^k\right)Y_t + A^{-1}\varepsilon_t \quad (2)$$

where $e_t = A^{-1}\varepsilon_t$ shows the reduced form VAR residual. It satisfies the $E(e_t) = 0$, $E(e_t e'_s) = \sum_e . \sum_e$ is a positive and definite $(n \times n)$ symmetric matrix which can be estimated efficiently. The residuals are also presumed to be white noise, but they may be correlated with each other because of the variables' contemporaneous effect across the equation. The variance-covariance matrix of the estimated residuals, $\sum_e$ and the variance-covariance matrix of the structural innovations, $\sum_\varepsilon$ is related as follows:

$$\sum_{\varepsilon} = E(\varepsilon_t \varepsilon'_t) = E\left(Ae_t e'_t A' \right) = AE(e_t e'_t)A' = A\sum_{e} A' \quad (3)$$

Sufficient restrictions must be imposed for the system to be identified to recover all the parameters in the structural equations. For $(n \times n)$ symmetric matrix of $\sum_e$, the unknowns are $(n^2 + n)/2$. Thus, additional restrictions of $(n^2 + n)/2$ must be imposed to exactly identify the system.

2.3. The Structural Model

Structural innovations ε_t and the reduced-form residuals et are related by $Ae_t = \varepsilon_t$. The elements above the matrix's diagonal in A are all set equal to zero in a purely recursive SVAR model.

The set of restrictions that are imposed on the contemporaneous parameters of the SVAR model of the Malaysia palm oil price is indicated by Equation (4). The coefficient a_{ij} shows the contemporaneous effect of variable j on variable i. The diagonal coefficients are normalized to unity and there are 44 zero restrictions on the coefficients to make the model over-identified.

$$AY_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 & \alpha_{45} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & 1 & 0 & 0 & 0 \\ 0 & \alpha_{72} & \alpha_{73} & \alpha_{74} & \alpha_{75} & 0 & 1 & 0 & 0 \\ \alpha_{81} & \alpha_{82} & 0 & \alpha_{84} & 0 & 0 & \alpha_{87} & 1 & 0 \\ \alpha_{91} & \alpha_{92} & \alpha_{93} & \alpha_{94} & \alpha_{95} & \alpha_{96} & \alpha_{97} & \alpha_{98} & 1 \end{bmatrix} \begin{bmatrix} CRO_t \\ YF_t \\ SBP_t \\ CPOW_t \\ YCPO_t \\ CPOM_t \\ CPOX_t \\ GDPM_t \\ REER_t \end{bmatrix} \quad (4)$$

The construction of the structural identification is based on empirical findings of previous literature and economic theory. There are two blocks of variables, namely the foreign block and the domestic block. The variables in the foreign block are the price of crude oil, foreign income, world palm oil price, and the price of palm oil's substitute goods such as soybean oil prices. Meanwhile, palm oil production, palm oil price, palm oil export, domestic income, and real exchange rate represent variables in the domestic block. The crude oil price is assumed to be exogenous and does not react to any demand and supply shocks because it is the one which affects demand and supply factors. Foreign variables are generally exogenous to domestic variables, which means the domestic variables are assumed not to contemporaneously affect the foreign variables since the Malaysian economy is relatively small and, therefore, unlikely to impact foreign variables. An exception is on Malaysia's palm oil production. Since Malaysia is among the largest producers of the palm oil, Malaysian palm oil production is assumed to affect the world palm oil price contemporaneously as well as with lags. The palm oil price however reacts immediately to shocks to all foreign variables and the production of palm oil itself. Export of palm oil price is assumed to respond contemporaneously to foreign income, palm oil substitute goods (i.e., soybean oil price), world palm oil price, and the palm oil production shocks. In the meantime, the domestic income reacts immediately to shocks to crude oil price, foreign

income, world palm oil price and palm oil export. Lastly, since real exchange rate is a fast-moving variable, it responds contemporaneously to all variables' shocks. It would only affect other variables above it with lags as demand and supply factors could not be materialized immediately.

The IRF is carried out to track each variable's current and future responses due to the change or shock of a particular variable and the variable's time to the shock until the effect disappears or returns to its original state. A bootstrapping technique is used to generate one standard error confidence bands for the impulse response where a total of 2500 random samples (with replacement) are drawn from the original sample data. FEVD is also conducted to track the transmission channel to determine which shock has had a major role in explaining each variable in the model. FEVD predicts the percentage contribution of each variable due to changes in certain variables in the VAR system. This analysis will help determine relative importance of internal and external shocks in affecting the crude palm oil price in Malaysia.

3. Empirical Results and Discussion

This section first briefly explains the optimum lag of the chosen model which is model 1, before analyzing the propagation of the internal and external shocks on the movement of palm oil price. The optimum lag length has been identified using Akaike's information criterion (AIC) and Schwarz Bayesian criterion (SBC). As reported in Table 3, SBC criteria selects one lag while AIC criteria selects two lags as optimum. The study employs two lags in order to have dynamics in the system. For stability tests, all the eigenvalues from the selected model are less than one; therefore, the estimation model of SVAR is stable.

Table 3. Results of lag length test.

Number of Lags	AIC	SBC
0	−11.13	−10.92
1	−27.72	−25.71 *
2	−27.81 *	−24.31
3	−26.65	−22.05
4	−25.10	−19.92

* indicates optimal lag length.

3.1. Results of Stationarity Tests

Table 4 shows results of the unit root tests on each time series. Based on the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests, all the time series were stationary at first difference or I(1). Further tests of stationarity with structural break on the time series, as shown in Table 5, indicate that almost all the time series were I(1) except for GDPT, GDPP, SFP, YCPO, and REER which were I(0). GDPP appeared to be I(2). Nevertheless, all variables used in the selected model (model 1) were either I(0) and I(1). As mentioned, the study proceeded to use the impulse response function and variance decomposition from the SVAR model. According to Ramaswamy and Sloek (1997), there was a tradeoff between the loss of efficiency when the VAR was estimated in levels, without enforcing any cointegrating relationships, and the loss of information when the VAR was regressed in first differences. They suggest not to impose cointegration restrictions on the VAR model in cases where there is no prior economic theory that can imply either the number of long-run relationships, or how they should be explained. A similar approach has been undertaken by Basher et al. (2012). This paper thus specifies the SVAR model in levels.

Table 4. Results of the unit root tests.

Augmented Dickey–Fuller				Phillips–Perron			
Level Form		1st Difference		Level Form		1st Difference	
CRO	−1.5948 [1]	DCRO	−8.5776 [0] ***	CRO	−1.2484 [4]	DCRO	−8.5970 [4] ***
YF	0.0199 [3]	DYF	−5.7478 [2] ***	YF	0.0881 [4]	DYF	−10.2202 [4] ***
GDPI	0.5012 [1]	DGDPI	−7.6977 [0] ***	GDPI	0.4675 [4]	DGDPI	−7.8293 [4] ***
GDPC	−0.2859 [0]	DGDPC	−4.3002 [4] ***	GDPC	−0.2923 [4]	DGDPC	−10.3379 [4] ***
GDPP	−0.3419 [4]	DGDPP	−3.2483 [4] **	GDPP	−0.2228 [4]	DGDPP	−3.6825 [4] ***
GDPT	−0.9232 [4]	DGDPT	−4.5443 [4] ***	GDPT	−1.1745 [4]	DGDPT	−8.1201 [4] ***
GDPN	−0.9965 [4]	DGDPN	−6.4458 [3] ***	GDPN	−1.3940 [4]	DGDPN	−7.9228 [4] ***
SBP	−1.9093 [1]	DSBP	−8.6148 [0] ***	SBP	−1.8341 [4]	DSBP	−8.5915 [4] ***
RSP	−1.8597 [1]	DRSP	−8.1809 [0] ***	RSP	−1.7086 [4]	DRSP	−8.1982 [4] ***
SFP	−2.4756 [1]	DSFP	−7.2524 [2] ***	SFP	−2.0251 [4]	DSFP	−7.7241 [4] ***
CPOW	−2.5248 [1]	DCPOW	−7.7252 [0] ***	CPOW	−2.3451 [4]	DCPOW	−7.6616 [4] ***
YCPO	−1.8013 [4]	DYCPO	−10.0225 [3] ***	YCPO	−1.0115 [4]	DYCPO	−14.0748 [4] ***
CPOM	−2.6196 [1] *	DCPOM	−7.6484 [0] ***	CPOM	−2.4187 [4]	DCPOM	−7.5765 [4] ***
CPOX	−1.7274 [4]	DCPOX	−7.9244 [4] ***	CPOX	−0.9613 [4]	DCPOX	−17.1749 [4] ***
GDPM	−1.3760 [4]	DGDPM	−5.6023 [4] ***	GDPM	−1.2720 [4]	DGDPM	−5.9665 [4] ***
REER	−2.0245 [0]	DREER	−12.5555 [0] ***	REER	−1.8947 [4]	DREER	−12.7707 [4] ***

Notes: Figures in parenthesis are the optimal lag based on AIC. *, ** and *** denote statistical significant at the 10%, 5% and 1% levels, respectively.

Table 5. Results of unit root test with structural break.

Minimize Dickey Fuller					
Level Form		Break Date	1st Difference		Break Date
CRO	−3.8227 [1]	2003:3	DCRO	−8.9497 [0] ***	1991:1
YF	−2.5938 [4]	2001:4	DYF	−10.4014 [0] ***	1991:3
GDPI	−2.6001 [8]	2003:1	DGDPI	−9.8200 [0] ***	1991:3
GDPC	−2.8657 [4]	2004:3	DGDPC	−14.4766 [0] ***	1994:1
GDPP	−2.1527 [12]	2003:1	DGDPP	−3.8439 [0]	1992:1
GDPT	−5.1577 [4] ***	2002:3	DGDPT	−8.2369 [0] ***	1993:2
GDPN	−4.2763 [4] *	2002:1	DGDPN	−8.8629 [0] ***	2008:4
SBP	−3.0427 [10]	2006:3	DSBP	−8.6394 [0] ***	1993:3
RSP	−3.6425 [1]	2002:2	DRSP	−9.1371 [0] ***	2008:4
SFP	−4.4217 [1] *	2004:2	DSFP	−7.8786 [0] ***	1993:3
CPOW	−3.9223 [1]	2006:2	DCPOW	−9.1731 [0] ***	2008:4
YCPO	−4.8783 [12] **	1999:1	DYCPO	−11.8639 [0] ***	1993:2
CPOM	−3.9653 [1]	2006:2	DCPOM	−9.0800 [0] ***	2008:4
CPOX	−3.9139 [5]	1999:1	DCPOX	−14.0710 [0] ***	1991:1
GDPM	−2.7975 [3]	2003:3	DGDPM	−6.6120 [0] ***	2008:4
REER	−5.0674 [0] ***	1997:2	DREER	−13.9084 [0] ***	1997:4

Notes: Figures in parenthesis are the optimal lag based on AIC. GDPP appears to be I(2) after further investigation. *, ** and *** denote statistical significant at the 10%, 5% and 1% levels, respectively.

3.2. Impulse Response Function

Figures 4 and 5 show the responses of palm oil price to external and internal shocks respectively. The external shocks are represented by shocks to the world crude oil price, the foreign income, the soybean oil price, and the world palm oil price. On the other hand, internal shocks are represented by Malaysia's palm oil production, Malaysia's palm oil

export, Malaysia's domestic income, and the exchange rate. In explaining the impulse response functions, the study only emphasizes the short run and the medium run impact. Appendix A show the impulse response functions from the SVAR estimation as well as the impulse response functions based on local projections as suggested by Jorda (2005). It can be seen that the impulse responses from local projections in the long run are quite different from that of the impulse responses from the SVAR.

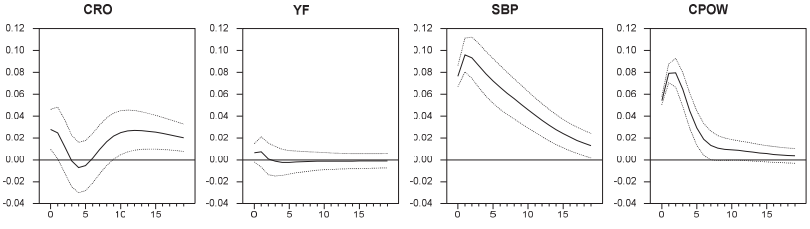

Figure 4. Response of palm oil price to external shocks.

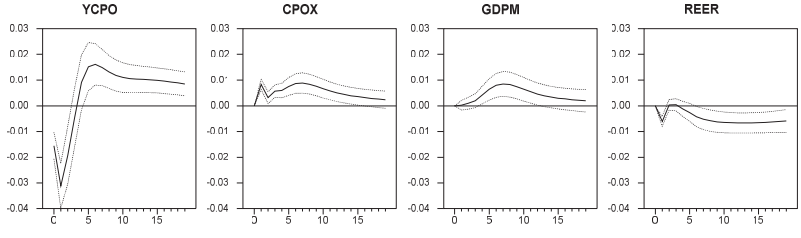

Figure 5. Response of palm oil price to internal shocks.

From Figure 4, a shock to the world crude oil price significantly affects the palm oil price movement in Malaysia. The palm oil price initially shows a positive and significant response in the first quarter before subsiding in the second quarter. It responds positively and significantly again after the eight quarters. This indicates the importance of the crude oil price in influencing Malaysia's palm oil price movement. According to Buyung et al. (2017), the crude oil price impacts the demand and supply of the commodity price.

Meanwhile, a shock to the foreign income (trade weighted income from 5 major palm oil importers) does not give significant impact on the palm oil price even though the palm oil price responds positively to the foreign income shock. Investigating the impact of each trading country's shock on the palm oil price movement might give some indications about the importance of a particular foreign country on the palm oil price. This is discussed later in this section.

On the other hand, a shock to the soybean oil price significantly affects the palm oil price movement. The highest magnitude of the palm oil price response is in the first quarter before subsiding gradually. This indicates that the soybean oil price has an immediate large effect on the palm oil price movement. Theoretically, an increase in the price of soybean oil leads to an increase in the demand for palm oil and in turn has a positive impact on the palm oil price. This finding is supported by most of the past literature (Ismail et al. 2019; Zakaria et al. 2017; and Hassan and Nambiappan 2016) which reveals that the palm oil substitute goods is the main factor that affects the movement of palm oil price.

Similarly, the world palm oil price also plays a vital role in affecting the palm oil price movement. A shock to the world palm oil price significantly and positively impacts the Malaysia's palm oil price for most of the quarters under study. This finding indicates that the Malaysia's palm oil price also responds to the movement of the world palm oil price, although Malaysia is one of the largest producers and exporters of the palm oil in the world market.

Figure 5 shows the responses of the palm oil price to the internal shocks. As depicted, the most significant domestic variables that impact the palm oil price movement is the production of the palm oil itself. A shock to the production of palm oil has a negative and significant impact on the palm oil price movement for about four quarters. This might be due to the excess supply of the palm oil in the short run. However, the palm oil price responds positively and significantly beginning the fifth quarter.

Responses of the palm oil price to the palm oil export and to the domestic income shocks are mainly positive. The positive magnitude of the responses to both shocks are about the same. Palm oil export portrays the demand for palm oil in the market; therefore, theoretically, an increase in the demand for the palm oil leads to an increase in the palm oil price. Wong and Ahmad (2017), however, uncovered a negative relationship between palm oil and export. As Malaysia is one of the largest countries to export the palm oil, this study indicated that a shock in the palm oil export affects the palm oil price positively. Similarly, a shock to the domestic income would lead to an increase in the demand for the palm oil thru an increase in consumption. This in turn affects the palm oil price positively. In line with Zakaria and Nambiappan (2019), domestic income brings a positive effect to palm oil demand.

Meanwhile, a shock to the exchange rate has significantly led to a decrease in the palm oil price in the first two quarters. In other words, an appreciation in Ringgit Malaysia has led to a decrease in the palm oil price. This is in line with Ismail et al. (2019) study where the exchange rate has short term negative effect on the palm oil price.

Figure 6 depicts the responses of the palm oil price to a shock to the rapeseed oil price as well as to a shock to the sunflower oil price. Apparently, the effect of soybean oil price shock is bigger than the other two shocks in the short run. This further proves that soybean oil price is important in describing the movement in the palm oil price. Similar findings are reported in Ismail et al. (2019), Zakaria et al. (2017) and Hassan and Nambiappan (2016).

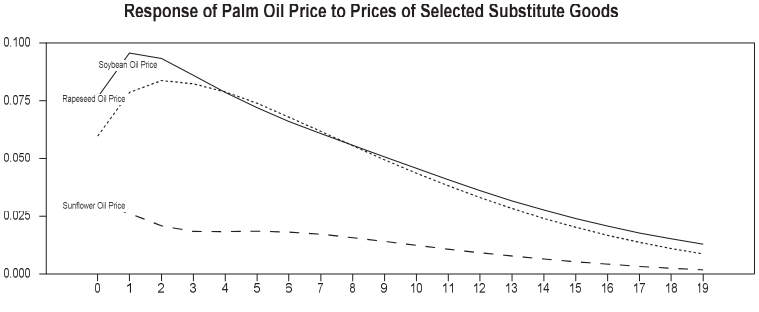

Figure 6. Response of palm oil price to prices of selected substitute goods.

Responses of the palm oil price to a shock in the foreign income from the major Malaysian trading partners in palm oil, namely India, China, Pakistan, Turkey, and the Netherlands, on the movement of palm oil price are summarized in Figure 7. As can be seen, a shock to India's income and a shock to the Netherlands' income bring about the same significant positive short run effects on the movement of the palm oil price. The effect of Turkey's income comes next, and it is followed by Pakistan's income and China's income, respectively. Thus, using individual country's income indicates better responses of the palm oil price to a foreign income shock. Consequently, the study contributes to reveal the importance of investigating the effect of individual trading partner countries on the palm oil price movement.

Model 1 in Table 6 summarizes the results of FEVD for propagating external and internal shocks on the movement of palm oil price. As can be seen, foreign shocks explain most of the variation in palm oil price movement. For example, within 20 quarters, foreign shocks contributed about 94.1% (the sum of the proportions of forecast error variance of

palm oil price explained by CRO, YF, SBP, and CPOW) compared with domestic shocks that only contributed 5.9%. These findings imply that external factors play a dominant role than internal factors in influencing Malaysia's palm oil price movement. The most critical foreign factor is the soybean oil price, which has contributed about 57.9% of the palm oil price variation even at the first quarter. Model 2 and model 3 reveal variance decomposition of the palm oil price when other substitute goods of the palm oil, namely rapeseed oil price and sunflower oil price are in place, respectively. Comparing those three models indicates that the soybean oil price has contributed the biggest proportion than the other substitution goods' prices in explaining the variation in the palm oil price.

Table 6. Variance decompositions for the palm oil price from various measurement of substitute goods prices.

Decomposition of Variance for Series CPOM—Model 1										
Step	**Std Error**	**CRO**	**YF**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1005	7.676	0.417	**57.862**	28.953	2.374	2.717	0	0	0
5	0.2512	2.522	0.163	**59.026**	34.28	2.666	1.015	0.232	0.036	0.06
10	0.2939	2.841	0.136	**65.046**	26.885	3.135	0.832	0.564	0.374	0.187
15	0.3130	6.015	0.127	**64.308**	24.013	3.324	0.736	0.639	0.45	0.388
20	0.3211	8.251	0.126	**62.768**	22.919	3.573	0.7	0.649	0.457	0.558
Decomposition of Variance for Series CPOM—Model 2										
Step	**Std Error**	**CRO**	**YF**	**RSP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1033	6.213	0.707	**33.325**	50.704	6.331	2.72	0	0	0
5	0.2584	2.098	0.488	**44.553**	41.22	10.36	0.925	0.184	0.003	0.168
10	0.3011	3.082	0.662	**54.239**	32.268	8.246	0.841	0.251	0.087	0.324
15	0.3175	6.308	0.883	**54.555**	29.223	7.452	0.796	0.271	0.131	0.382
20	0.3259	9.051	1.137	**52.804**	28.346	7.078	0.772	0.272	0.142	0.398
Decomposition of Variance for Series CPOM—Model 3										
Step	**Std Error**	**CRO**	**YF**	**SFP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1026	6.933	0.349	**8.66**	75.269	6.113	2.677	0	0	0
5	0.2613	2.651	0.12	**3.965**	80.337	11.343	1.234	0.221	0.015	0.114
10	0.2972	4.67	0.105	**4.668**	79.116	9.402	1.162	0.485	0.247	0.146
15	0.3122	8.755	0.096	**4.698**	75.753	8.577	1.066	0.55	0.368	0.136
20	0.3190	11.508	0.094	**4.565**	73.486	8.23	1.022	0.555	0.383	0.156

Table 7 compares FEVD for the palm oil price from model 1, and model 4 through model 8. Various foreign income variables were used to see the effect of each foreign income as well as the aggregate one in explaining the variation in the palm oil price. Assessing those models reveals that India's income as well the Netherlands' have more profound effects on the palm oil price as compared to income shocks from the other trading partners. As shown, at the end of five quarters, India's income explains about 12.8% while the Netherlands' income explains about 19.9% of the variation in the palm oil price. In the meantime, the trade-weighted foreign income only explains 0.1% of the variation in the palm oil. Thus, the study indicates that employing individual foreign income in the model would give clearer picture of the impact of a particular foreign country's income on the palm oil price.

Table 7. Variance decompositions for the palm oil price from various measurement of foreign incomes.

Decomposition of Variance for Series CPOM—Model 1										
Step	**Std Error**	**CRO**	**YF**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1005	7.676	**0.417**	57.862	28.953	2.374	2.717	0	0	0
5	0.2512	2.522	**0.163**	59.026	34.28	2.666	1.015	0.232	0.036	0.06
10	0.2939	2.841	**0.136**	65.046	26.885	3.135	0.832	0.564	0.374	0.187
15	0.3130	6.015	**0.127**	64.308	24.013	3.324	0.736	0.639	0.45	0.388
20	0.3211	8.251	**0.126**	62.768	22.919	3.573	0.7	0.649	0.457	0.558
Decomposition of Variance for Series CPOM—Model 4										
Step	**Std Error**	**CRO**	**GDPC**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1003	7.74	**0.189**	56.627	30.271	2.475	2.697	0	0	0
5	0.2500	2.551	**0.095**	56.139	36.565	2.729	1.41	0.359	0.056	0.097
10	0.2918	3.127	**0.213**	61.484	29.019	3.109	1.316	0.899	0.527	0.306
15	0.3107	6.648	**0.311**	60.347	25.82	3.276	1.234	1.098	0.686	0.579
20	0.3186	9.042	**0.345**	58.653	24.594	3.455	1.217	1.185	0.732	0.776
Decomposition of Variance for Series CPOM—Model 5										
Step	**Std Error**	**CRO**	**GDPI**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1004	7.894	**6.445**	49.99	30.463	2.694	2.514	0	0	0
5	0.2530	2.829	**12.947**	44.82	35.117	3.3	0.766	0.166	0.009	0.046
10	0.2949	4.031	**13.875**	50.553	27.864	2.636	0.591	0.271	0.103	0.075
15	0.3145	8.576	**13.215**	49.938	24.723	2.445	0.521	0.281	0.131	0.169
20	0.3231	11.597	**12.799**	48.517	23.475	2.434	0.495	0.282	0.142	0.259
Decomposition of Variance for Series CPOM—Model 6										
Step	**Std Error**	**CRO**	**GDPP**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1010	7.785	**1.85**	54.482	31.607	2.102	2.175	0	0	0
5	0.2490	2.865	**0.887**	55.495	37.524	2.317	0.673	0.166	0.026	0.048
10	0.2888	3.921	**2.45**	59.758	30.398	2.442	0.528	0.32	0.082	0.101
15	0.3111	9.171	**3.191**	57.167	27.036	2.367	0.468	0.335	0.087	0.179
20	0.3238	13.413	**3.183**	54.573	25.359	2.35	0.469	0.312	0.11	0.231
Decomposition of Variance for Series CPOM—Model 7										
Step	**Std Error**	**CRO**	**GDPT**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.1007	7.074	**2.944**	56.025	28.302	2.871	2.784	0	0	0
5	0.2508	2.497	**2.362**	58.521	32.361	3.065	0.799	0.248	0.089	0.06
10	0.2898	2.418	**2.4**	65.767	25.343	2.789	0.612	0.326	0.255	0.089
15	0.3035	4.19	**2.689**	65.839	23.214	2.706	0.565	0.317	0.252	0.228
20	0.3085	5.691	**2.955**	64.616	22.52	2.728	0.55	0.311	0.259	0.371
Decomposition of Variance for Series CPOM—Model 8										
Step	**Std Error**	**CRO**	**GDPN**	**SBP**	**CPOW**	**YCPO**	**CPOM**	**CPOX**	**GDPM**	**REER**
1	0.0993	7.037	**6.067**	51.238	29.787	3.053	2.818	0	0	0
5	0.2495	2.274	**14.181**	45.506	32.136	4.51	0.994	0.269	0.065	0.064
10	0.2881	2.686	**16.216**	50.423	25.477	3.394	0.82	0.464	0.415	0.107
15	0.3041	5.029	**17.659**	49.566	22.888	3.051	0.739	0.483	0.485	0.101
20	0.3126	6.186	**19.924**	47.506	21.744	2.898	0.701	0.469	0.477	0.096

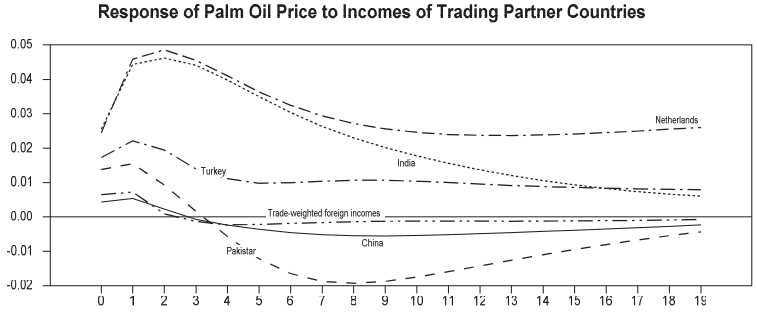

Figure 7. Response of palm oil price to specific foreign income shocks.

3.3. Robustness Test

As mentioned, several alternative substitution goods prices and foreign income variables are used in the SVAR model to see their impacts on the palm oil price. This has served for sensitivity analysis or robustness test to the selected model (model 1). The study has also reordered CRO and FY, where FY is placed at the top in the identification scheme shown in Equation (4), indicating that foreign output to have contemporaneous effect on the crude oil price. In addition, the study has also assumed that CRO and FY might influence each other. In other words, in the identification structure, CRO could have contemporaneous effect on the foreign income and foreign income could have an impact on the CRO from the perspective of the demand side. This would made α_{12} to be non-zero in the identification matrix [4].

Interestingly, the results of IRF to changes in the alternative variables as well as in alternative identification approaches do not differ significantly from the IRF of the chosen model especially with respect to impulses responses of Malaysia's palm oil to external and internal factors. Consequently, this shows that the SVAR model is robust to alternative selection of variables as well as of identification structures.

4. Conclusions

This paper examines the relative importance of foreign shocks (crude oil price, foreign income, substitute good of palm oil, and world palm oil price) and domestic shocks (palm oil production, palm oil export, domestic income, and real effective exchange rate) on the movement of Malaysia's palm oil price. A non-recursive SVAR identification scheme has been used to examine the propagation of the exogenous shocks (foreign and domestic shocks) to the palm oil price using IRF and FEVD approaches. Specifically, IRF indicates the effect of external and internal factors' shocks on the movement of the palm oil price while the FEVD show which factors explain the most of the variation in the palm oil shock.

The main findings reveal that foreign factors play a crucial role in influencing Malaysia's palm oil price. In particular, the palm oil's substitute goods' price, such as soybean oil price, plays a dominant role in explaining the palm oil price movement. These findings are aligned with the standard demand theory and the previous literatures which state that an increase in the price of the palm oil substitute goods would increase palm oil demand and in turn increase the palm oil price. Furthermore, foreign income shocks from major trading partners, namely India and the Netherlands, are also important in influencing the movement of Malaysia's palm oil price. Shocks to internal factors are also important in affecting the movement of the palm oil price. Nevertheless, the magnitudes of the effects are rather small as compared to the external factors' shocks.

The findings of the study have several implications for the stakeholders in the palm oil industry. First, since the external shocks play a crucial role in influencing the palm oil price, the small farmers and the palm oil-oriented firms need to take precautions to the changes in the external factors in managing and strategizing their palm oil production activities. This is because any shocks to the external factors would influence the palm

oil price and in turn affect the small farmers' future income and the palm oil-oriented firms' profit. Thus, to mitigate the adverse income flow consequences of the external factor shocks, the small farmers and the palm oil-oriented firms need to plan alternative use of their palm oil production, for example, making it as intermediate goods for other palm oil related products.

Second, the policymakers in the palm oil sector, particularly the Malaysian Palm Oil Board (MPOB) and Ministry of Plantation Industries and Commodities can take advantage of the findings to further understand the magnitude and the signs of the external and internal shocks that affect the palm oil price. This is important for the policymakers to assist affected smallholders' groups during adverse shocks of the external factors that directly affect the palm oil sector's performance. Proper dissemination of knowledge about the adverse effects of external and internal factors to smallholders might help them strategically plan for alternative activities.

Third, since foreign incomes, mainly from India and the Netherlands, affect the palm oil price quite substantially, Malaysia exporters need to diversify and find new market to avoid high dependency on the traditional markets. Diversifying export of the palm oil into new markets can reduce income uncertainty from a conventional market. For example, Malaysia could aggressively market the palm oil to other MENA countries (other than Turkey) which have shown increasing interest in the palm oil products. Finally, taking into consideration the related external factors, policy makers can strategically control domestic palm oil output in order to maintain the palm oil price.

Nevertheless, the study has some limitations. First, the study did not go through pre-testing of cointegration. Following the approaches of Ramaswamy and Sloek (1997), and Basher et al. (2012), the study proceeded to use the SVAR model. The primary concerned was not at the coefficients of the estimation themselves, but rather the interrelationship among the variables through the IRF and FEVD analysis. Interestingly, the SVAR model was structured with block exogeneity restriction, according to real situation, where the domestic variables do not affect the external variables either contemporaneously or with lags since Malaysia is a small open economy. An exception is on the LYCPO where the Malaysia's production of palm oil is assumed to have an impact on the world palm oil since Malaysia is the second largest palm oil producer. Second, as mentioned the validity for the impulse response functions from the SVAR estimation are for the short run and the medium run only. For the long run, the impulse response functions should be referred to local projection suggested by Jorda (2005). This is showed in Appendix A. For future research, researchers might want to investigate in details how various substitution goods' prices such as soybean oil price, rapeseed oil price and sunflower oil price affect volatility of the palm oil price. Similarly, researchers can also look at the volatility of the palm oil price that might be caused by various trading partner countries' income.

Author Contributions: Conceptualization, M.A.S.Z., Z.A.K. and N.A.Z.; methodology, M.A.S.Z. and Z.A.K.; software, M.A.S.Z. and Z.A.K.; validation, M.A.S.Z., Z.A.K. and N.A.Z.; formal analysis, M.A.S.Z., Z.A.K. and N.A.Z.; investigation, M.A.S.Z., Z.A.K. and N.A.Z.; resources, M.A.S.Z. and N.A.Z.; data curation, M.A.S.Z. and N.A.Z.; writing—original draft preparation, M.A.S.Z., Z.A.K. and N.A.Z.; writing—review and editing, M.A.S.Z., Z.A.K. and N.A.Z.; visualization, M.A.S.Z., Z.A.K. and N.A.Z.; supervision, M.A.S.Z. and Z.A.K.; project administration, M.A.S.Z. and Z.A.K.; funding acquisition, Z.A.K. and M.A.S.Z. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Impulse Responses based on SVAR Model and Linear Projections

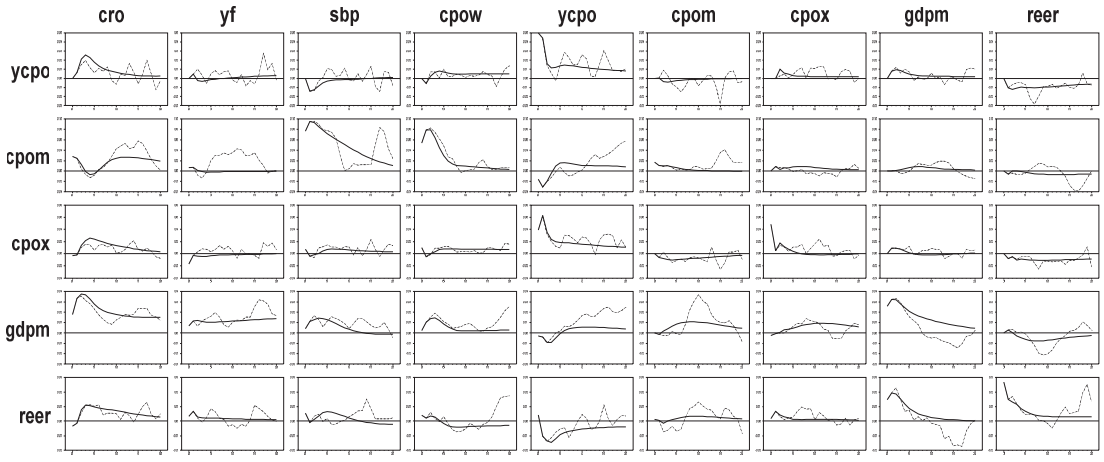

Figure A1. Impulse Responses based on SVAR Model and Linear Projections. Note: The black line is the impulse response function from the SVAR while the dotted line is the impulse response functions based on the local projection.

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Socio-Economic Impact of the Interest-Free Community Investment Fund: A Case Study of Rural Sindh, Pakistan

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Abstract: This study aims to measure the impact of an intervention, the Community Investment Fund (CIF), on the socio-economic life of rural women. CIF is a community-managed fund aimed at improving the living standards of women by empowering them to undertake income-generating projects to become financially more stable and self-governed in the Khairpur, Shikarpur, Kandhkot-Kashmore and Jacobabad districts of Sindh, Pakistan. This study used a quasi-experimental design approach that involved two groups, i.e., the treatment group (beneficiaries) and control group (non-beneficiaries). The sample size of this study was 708 respondents including the treatment and control group. The results of comparison of mean indicate that there is a significant difference between treatment and control group in terms of socio-demographic variables (including monthly income and consumption, saving amount, total asset value, an asset purchased value and household diet) and women empowerment's indicators, thereby suggesting that CIF has resulted in women empowerment. Concerning the results of the poverty scorecard, the higher graduation of beneficiaries (treatment group) asserts that the intervention of CIF has also a positive impact on targeted beneficiaries. In particular, the findings indicate that 72% of beneficiaries (treatment group) have graduated from one poverty band to another higher band compared to 59.4% of non-beneficiaries (control group) in poverty score. In addition, the findings of the logistic regression analysis confirmed that participation in the CIF program empowers women beneficiaries. This study will support policymakers to further improve CIF so that it can become more effective and sustainable.

Keywords: interest-free community investment fund; rural women empowerment; case study; logit model

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1. Introduction

There are many social issues that people are dealing with around the world, but the most key issue regarding women is the issue of women's empowerment. Despite being the largest proportion of the population, women still have very low status and involvement in decision-making. In countries where a male-dominated society is predominant, females have been restrained through socio-cultural boundaries. In many ways, women have been deprived of access to material resources such as credit, property and money, and access to social resources such as education (Cheston and Kuhn 2002). Microfinance institutions have come up to formulate different ways to make a change in the lives and status of women. However, it is not possible to address all the challenges of women's empowerment through access to microfinance, but Cheston and Kuhn (2002) argue that suitable and flexible designed microfinance programs can contribute to women's empowerment. Through these programs, women would easily access capital and earn independent earnings. In this manner, women would contribute financially to the betterment of their families and

communities to a larger extent. Financial institutions have been the major aspect of the economic development of any country.

Microfinance institutions appear to be contributing more and more to this purpose. Through productive loans, women will earn extra income and control their household resources. However, microcredit programs can at best facilitate such types of problems. These microcredit programs help women to increase their autonomy and reduce their socio-economic dependence on men (Parmar 2003). Ruhul Ruhul Amin et al. (1998) stated that microfinance may increase women's prestige and their importance in the eyes of their husbands.

The microfinance strategy of the Government of Pakistan has been framed to achieve three main objectives to deal with and ease the large development deficit that is in the country, in particular to reduce the high existence of poverty that is projected about one-third of the population of Pakistan; to endorse the empowerment of women by encouraging them to undertake income-generating projects in order to become self-sufficient and financially more independent; and to support and encourage the small and medium enterprise sector (Zaidi et al. 2007). Since starting, the microfinance sector has undertaken rural development projects funded by donors with the aim of reducing poverty in rural areas of Pakistan, in general. Akhuwat is also one of the organizations that work to eliminate poverty by providing interest-free loans to poor families to make them self-reliant. It focuses on women's empowerment as the study conducted by Khandker (2005) suggests that microfinance helps to reduce poverty, especially when the loan is given to the woman. Agha Khan Rural Support Program (AKRSP) was initially initiated to reduce poverty and improve the quality of life for poor people of Gilgit Baltistan. Seeing the success of these community-based financing opportunities for rural women poverty alleviation, the same model was adopted at the national and provincial level through Rural Support Program (RSP), National Rural Support Program (NRSP) in 1992, Punjab Rural Support Program (PRSP) in 1997, and Sindh Rural Support Program (SRSO) in 2003. However, along with poverty alleviation, micro-finance has been considered a tool for women's empowerment in Pakistan. Government and some rural support programs believe that by providing loans to women, which they use for income generation and consumption purposes, their social and economic status at the household level and in the community can be improved (Zaidi et al. 2007). SRSO has undertaken many initiatives, i.e., social mobilization, natural resource management, micro-finance and others to reduce poverty, enhance the living standard, and improve the socio-economic status of rural households in 12 districts of northern Sindh. The Union Council Based Poverty Reduction Program (UCBPRP) is one of those initiatives funded by the Sindh Government and it was started in 2009. Under UCBPRP, an interest-free Community Investment Fund (CIF) program has been initiated and it is a rural community-managed and revolving fund aimed at enhancing the living standard and empowering the poorest women. CIF has disbursed PKR 996 million, which has covered 4122 villages in four districts of Sindh province of Pakistan. It is widely believed that micro-finance is beneficial and therefore everybody needs and demands it (Hussein and Hussain 2003). However, there is not much questioning about the benefits of microfinance or micro-grants. There has not been attention in trying to measure the impacts of such interventions, especially in the Sindh province of Pakistan.

To our knowledge, this is the first study of its type that conducted an impact assessment of Community Investment Fund under union council-based poverty reduction Program (UCBPRP) in the Sukkur, Shikarpur, Kandhkot-Kashmore and Jacobabad districts of Sindh. This impact assessment of the CIF program helps donors, the provincial government and other stakeholders to know the impact in terms of poverty alleviation and women's empowerment in the above-mentioned four districts of Sindh and provide some corrective measures for its future effectiveness.

2. Structure of the SRSO Program

In Pakistan, dependence on microfinance as an instrument for poverty reduction and female empowerment has been increasing (Hussein and Hussain 2003). Similarly, the poverty discount method of the Government stresses the provision of micro deposit as a primary function of its poverty reduction strategy. Microfinance has remained a key component of the poverty discount method of NGO quarters for decades in Pakistan. For instance, Agha Khan Rural Support Program (AKRSP) was the first to decrease poverty and improve the quality of life for poor people of Gilgit Baltistan. Then, the same model was once adopted at the national and provincial level through the Rural Support Program (RSP) and the Sindh Rural Support Program (SRSO) was established in 2003.

As SRSO is a rural support organization, its key role is supposed to mobilize, organize and motivate the community to take part in development activities. Further, it believes that social mobilization is pivotal to all activities and the success and sustainability of the program related to rural development depend on it. This involves creating a proactive community informed of their problems and capable of resolving them. To achieve the objectives of the CIF program, SRSO has adopted a three-tier social mobilization network model to form community organizations (COs) at the neighborhood level, village organizations (VOs) at the village level and local support organizations (LSOs) at the union council level. CO is a group of 15–25 members and is an important forum for capitalizing on the people's potential to take an active role in the management of development activities. COs ordinarily carry out activities such as household-level development planning, training, savings, microcredit and micro-investment. CO members meet on a fortnightly or monthly basis to discuss their plans and problems, thereby enhancing existing social capital and becoming more development oriented. VO has been introduced in the social mobilization approach and strategy. This is an umbrella organization having more than one CO in its fold. The objectives of VO are to: ensure capacity building of activists of COs members and participation of villagers in the decision making about the use of local resources, boost membership of at least 80% village households in the COs and strengthen coordination with NGOs and Government organization. Lastly, Village Organization (VO) is further federated at the union council level to form a Local Support Organization (LSO). Federating COs into VOs and LSOs provides rural communities with the opportunity to mobilize their villages as well as the entire union council. The LSOs, in particular, with their union council level structure, not only aggregate the collective requirements of its member villages but also form linkages with those external organizations and government line departments that best serve the developmental requirements of its communities. The power of social mobilization, therefore, provides poor communities with a unified vision and voice for availing resources and services which were previously inaccessible to them.

In prospects of the three-tier social mobilization network model, SRSO has initiated CIF to provide the fund to marginalized and socially excluded groups whose poverty score ranges from 0–23. It complements the social mobilization process by ensuring the financial viability of the network of COs/VOs/LSOs since CIF is utilized and not consumed and managed at the VO level. Objectives of CIF are to contribute to improve the livelihoods and lives of CO members and to empower poor women. Currently, under UCBPRP, SRSO is implementing CIF in three districts of Shikarpur, Kandhkot-Kashmore and Jacobabad. The members of these organizations are rural women. CIF fund is given by VOs to beneficiaries on the recommendation of COs based on PSC score (0–23). The CIF fund is for income generation activities, and it is meant to be invested and not spent. Under this initiative, 85,000 members of COs of Shikarpur, Kandhkot-Kashmore and Jacobabad have accessed PKR 996 million under CIF, out of which PKR 617 million have been revolved among 50,000 members in three districts.

3. Literature Review

Microfinance has helped the poor not only to strengthen financial conditions such as increased savings and assets but also helped them to strengthen their non-financial

conditions, which include their health, security of food, good nutrition, education, housing, job creation and women's empowerment (Van Rooyen et al. 2012; Hermes and Hudon 2018). The focus of this study is on the effects of micro credit on women's empowerment. The term "empowerment" refers to the ability to make choices; thus, "woman empowerment" is the process through which the ability to make choices is retained by a woman who has been denied this ability earlier (Kabeer 1999). The other way to think of empowerment is through "power" which also means autonomy, where autonomy refers to the ability to take one's own decisions, without the permission and consultation of others (Acharya et al. 2010; O'Hara and Clement 2018). Likewise, her control over materials, her knowledge and information access, her control over her own life, her say in the home affairs, her freedom of mobility and her ability to make independent decisions all are the aspects of empowerment.

Furthermore, there are many aspects of empowerment which can be categorized as the economic, socio-cultural, interpersonal, legal, political and psychological (Rehman et al. 2015). Whereas, Al-Shami et al. (2017b) concluded that AIM microcredit has a positive impact on the monthly income of women and empowers women in household decision making (mobility, daily expenditure, loan order decision, children's schooling and health expenditure) in Malaysia. However, another study has reported women's empowerment with four aspects which are self-esteem, role in decision making, mobility and control over resources and identified its impacts on rural development (Baig et al. 2017).

The "social empowerment" entails to increase woman's status in her family, community and society in a way that she has chance to participate in decision-making specifically to take decision regarding marriage, family planning and schooling of her children, to obtain better health and to protect herself from domestic violence (Ahmad and Ahmad 2016). Therefore, microcredit programs are increasing women's decision making in the household and strengthening her social position (Al-Shami et al. 2017a). Microfinance organizations are providing social empowerment to socially excluded poor women, give them the opportunity to belong to a particular group, lead them to the achievement of their experience and social change, letting them work in a group, interact with the group and share knowledge with a group (Kabeer 2005).

Existing literature clearly supports the idea of economic empowerment of women by microcredit. The "economic empowerment" refers to the access over the resource, control over resources, asset's ownership, greater purchasing power, more opportunities, training and skills of a woman (Ahmad and Ahmad 2016). Moreover, economic empowerment is also denoted as the economic security which involves her own income, her property rights over her husband's property, her contribution in household expenses, her savings and her ability to borrow money in case of emergency (Al-Mamun et al. 2014). Thus, microcredit programs help a woman to increase her economic empowerment in a way that it strengthens her economic condition because better conditions lead to better quality of her life by the generation of more income (Mazumder 2015; Tasos et al. 2020). However, a woman should be given equal importance in the economic community along with a man because she is the key stakeholder of the industry, and micro finance institutes should guarantee that women can have a life which can be matched with basic human dignity (Naser and Crowther 2016).

Very limited studies exist for the empowerment of women politically, particularly in the case of Pakistan. That is the reason we have included this aspect of empowerment in our studies for the valuable contribution in this field of research because it's also impacting women empowerment. The "political empowerment" includes the ability to make and to have freedom on political choices which can impact on her life, community or society as a whole (Bayulgen 2008). Moreover, along with other aspects of empowerment, it is also essential to measure the political aspect because women face inequality in political life along with other aspects of life (Rehman et al. 2015; Al-Qahtani et al. 2020). However, political empowerment can be further divided into two aspects i.e., political awareness and political participation, where political awareness refers to the level and access to information regarding politics and their rights as a citizen, whereas political participation refers to the

involvement in public decision making such as participation in COs, campaigns, petitions, protests and unionizations (Bayulgen 2008).

4. Research Methodology

This study is designed to assess the impact of an interest-free Community Investment Fund (CIF) under the union council-based poverty reduction Program (UCBPRP) in the Khairpur, Shikarpur, Kandhkot-Kashmore and Jacobabad districts. As per the nature and requirement of the study, a quantitative research approach is used to measure various objectives mentioned above. A quantitative methodology makes use of statistical representations rather than textual pictures of the phenomenon (Kabungaidze et al. 2013). However, this study does not only report descriptive statistics but also examines the impact of CIF on socio-economic changes of Community Organization (CO) members in four districts (Khairpur, Shikarpur, Kandhkot-Kashmore and Jacobabad).

4.1. Research Design

This study aims to measure the impact of CIF on women CO members in villages of four selected districts by using a poverty scorecard as well as a quasi-experimental design in which the sample includes women (CO members) who have received CIF fund and non-member women who have not received a loan under union council-based poverty reduction Program from the villages under study. In a quasi-experimental design, there are two groups, i.e., (1) the treatment group which consists of beneficiaries of intervention and (2) the control group which contains non-beneficiaries. The quasi-experimental design has been used for similar studies by many researchers including (Bhuiya et al. 2016; Khan 2004; Khandker 2005). Furthermore, we used cross-section data on various socio-economic variables that were identified from objectives to capture the impact of the community investment fund on the living standards and livelihood of women members of the program in four targeted districts.

4.2. Data Collection and Sampling Method

Primarily, the survey method was used to collect data. The survey was conducted in the Khairpur, Shikarpur, Kandhkot-Kashmore and Jacobabad districts where community investment funds were distributed under a union council-based poverty reduction Program. The target population of intervention is 85,000 beneficiaries. Referring to the sample size table of Krejcie and Morgan (1970), the sample size of this study was selected as 383 out of 85,000 beneficiaries of intervention at 95% confidence level and 5% of margin of error. Similarly, 383 of the control group (non-beneficiaries) respondents were selected using the same approach. Due to the unavailability of respondents, we were able to collect the data of 356 beneficiaries (treatment group) and 352 non-beneficiaries (control group). The sampled population is divided into strata by using a stratified random sampling method. Each stratum is formed on Union Council (UC) level in every district. There is a total of 113 UCs in five districts, such as Khairpur 3, Shikarpur 33, Kandhkot-Kashmore 37 and Jacobabad 40. Further, three villages were randomly selected from each union council and at least four beneficiaries from each village were selected by using a systematic random sampling approach. In particular, the randomly selected sample of respondents from the study areas was based on following formula:

$$nth = \frac{N}{n}.$$

nth = every nth respondent from the list of beneficiaries (non-beneficiaries in case of control group) in a village.
N = Total number of beneficiaries (non-beneficiaries in case of control group) in a village.
n = targeted respondents from the total number of beneficiaries (non-beneficiaries in case of control group) in a village.

4.3. An Instrument for Data Collection

A survey questionnaire was used to collect data for this research from the respondents. According to Babbie (2013), a questionnaire contains questions and other types of items designed to seek appropriate information for data analysis. There are two data collection tools, i.e., (1) to measure the graduation level of women (CIF beneficiaries) in terms of poverty using the poverty scorecard tool to assess the impact of interest-free microfinance on empowering women politically, socially, economically and on the health and education of their families. The latter questionnaire, used by Hashemi et al. (1996) (Garikipati 2008; Al-Shami et al. 2017a, 2017b), has been adopted and refined according to the objectives of this research. After the development and adoption of assessment tools, five data collection teams were formed. Each team consisted of two female enumerators and one supervisor. The enumerators and supervisors were hired using an in-house trained database of the institute. Two days were dedicated to the training of teams and questionnaire pilot testing. Further, for the actual survey, the one-day classroom training was arranged for data collection teams to understand modified questionnaires and educate them about scope of the study. Another day was used for pre-testing the questionnaires in the field before conducting the actual survey. The actual survey took three weeks to complete. Quantitative collected data was entered and analyzed in the latest SPSS (Statistical Package for Social Scientists) software.

4.4. Logistic Regression Model

The logistic regression model was used to apply to the binary dependent variable (dichotomous). This study adopted the logit model to analyze the impact of microfinance on women empowerment from the perspective of socio-economic and political. In this study, we determined the factors of women's empowerment and predicted its likelihood. Women's empowerment, which is the dependent variable, is measured by the dichotomous response (1—a woman is empowered, 0—a woman is not empowered). In logistic regression, the probability of women's empowerment is reflected to be a function of independent variables in the model. The logistic regression function can be written in the following form:

$$P = E(y)\frac{e^{C_0+C_1X_1+C_2X_2+\ldots C_kX_k}}{1+e^{C_0+C_1X_1+C_2X_2+\ldots C_kX_k}}. \quad (1)$$

where P is the likelihood of women's empowerment, $E(y)$ is the anticipated value of the dependent variabley, C_0 is a constant to be estimated. C_i is a coefficient to be estimated for each independent variable X_i. Equation (1) is a logistic regression function that can be transformed into Equations (2) and (3) which is known as logit transformation:

$$Logit(p) = Log_e\left(\frac{P}{1-P}\right) \quad (2)$$

$$Logit(p) = C_0 + C_1X_1 + C_2X_2 + \ldots C_kX_k \quad (3)$$

5. Empirical Results and Analysis

5.1. Descriptive Statistics

Table 1 shows thenumber of districts, tehsils and villages that were included in the sample. The study was conducted in four districts of rural Sindh, i.e., Jacobabad, Shikarpur, Khairpur and Kandhkot-Kashmor. Four tehsils of Jacobabad, four tehsils of Shikarpur, one tehsil of Khairpur and one tehsil of Khandhkot-Kashmor could be reached. Furthermore, 11 villages from Jacobabad, 18 from Shikarpur, 4 from Khairpur, 1 from Kandhkot-Kashmor, for a total of 34 villages, were reached for the survey.

Table 1. No. of districts, tehsils & villages in the sample.

Districts	No. of Tehsils	No. of Villages
Jacobabad	4	11
Shikarpur	4	18
Khairpur	1	4
Khandhkot-Kashmor	1	1
Total	10	34

5.2. Household Size

Table 2 shows the household size frequencies and percentages in each group. It shows that 111 (31.5%) respondents in the control group and 62 (17.4%) respondents in the treatment group, respectively, had 1 to 5 members in the family who cook and eat together, whereas 180 (51.1%) and 190 (53.4%) respondents in the control and treatment group respectively had a household size of 6 to 10 members. Furthermore, 48 (13.6%) and 88 (24.7%) respondents had 11 to 15 members, 11 (3.1%) and 11 (3.1%) respondents had 16 to 20 members and 2 (0.6%) and 5 (1.4%) respondents had 21 and above members in the family in the control and treatment group, respectively. Overall data indicates that the majority of the respondents have a household size of 6 to 11 members which mostly consists of their spouse, children and parents.

Table 2. Household size status in each group.

Household Size	Control		Treatment		Total	
	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency
1 to 5	31.5%	111	17.4%	62	24.4%	173
6 to 10	51.1%	180	53.4%	190	52.3%	370
11 to 15	13.6%	48	24.7%	88	19.2%	136
16 to 20	3.1%	11	3.1%	11	3.1%	22
21 & above	0.6%	2	1.4%	5	1.0%	7
Total	100.0%	352	100.0%	356	100.0%	708

5.3. Poverty Scorecard Analysis

The analysis of the poverty scorecard was performed on the cut-off band score and the category of poor, as shown in Table 3. Based on those bands, the graduation level of respondents for each band was measured. The cut-off band and categories of poor were adopted from the assessment of measuring the impact of PPAF (Pakistan poverty alleviation fund) interventions using the Pakistan poverty scorecard (PPAF 2012), where the categories are (1) extremely poor, who are the poor who are at less than or equals to 50% of the poverty line, (2) chronically poor, who are the poor who will remain poor due to their basic characteristics, has structural poverty and are at 50–75% of the poverty line, (3) transitory poor, who are the poor whose level of poverty transition changes due to income or expenditure shocks and are at 75–100% of the poverty line, (4) transitory vulnerable, who are the poor whose level of poverty is susceptible due to income or expenditure shocks and are at 100–125% of the poverty line, (5) transitory non-poor, who are the poor who are at 125–200% of the poverty line and (6) non-poor, who are the people who have a low chance of being poor and thus enjoy a high level of consumption and are at above 200% of the poverty line (Finance Division 2008; Haq et al. 2008; Sean O'Leary et al. 2011; World Bank 2007).

Table 3. Poverty score bands matrix and cut-off.

Band	Cut-Off Band Score	Category
1	0–11	Extremely poor
2	12–18	Chronically poor
3	19–23	Transitory poor
4	24–34	Transitory vulnerable
5	35–50	Transitory non-poor
6	51–100	non-poor

The categories of poverty starting from extremely poor to non-poor were identified by PRSP-II (Finance Division 2008) for further analysis of the severity of poverty (Sean O'Leary et al. 2011). Haq et al. (2008) and Sean Sean O'Leary et al. (2011) have also used these six categories of poverty for the analysis and classifications of poor people. Although initially these categories were developed based on expenditure per adult, PPAF (2012) has modified and developed these categories based on poverty score with the help of the world bank's guidelines.

Furthermore, interventions such as microcredit or social mobilizations in Pakistan use a poverty scorecard as a tool to assess the beneficiaries. That is why many reports on poverty or impacts of such types of interventions have performed their analysis with poverty scorecards, including BISP and SRSO. Likewise, in this study, the poverty scorecard has been used for the achievement of the second objective of the study, which was to measure the graduation of respondents on poverty score. As such, these bands and categories of poverty shown in Table 3 adopted from (PPAF 2012) were the perfect tools for the analysis and measurement of the poverty score and severity of the poverty. In this study, a total of 708 respondents were surveyed, among those 356 (50.3%) were beneficiaries (treatment group) of CIF and 352 (49.7%) respondents were non-beneficiaries (control group).

Figure 1 represents the comparison of the old and new poverty scorecard of the control group. It shows that in the old poverty scorecard only 16 households (respondents) were in the first category of the poverty band (0–11) named as extremely poor, whereas in the new poverty scorecard there are only 10 households (respondents) in this band. Likewise, it is also shown that 53 households (respondents) were in the second band (12–18) and were chronically poor in the old poverty scorecard, whereas only 27 households (respondents) are in this band in the new poverty scorecard. Furthermore, 8 households (respondents) in the third band (19–23), 15 households (respondents) in the fourth band (24–34) and 7 households (respondents) in the fifth band (35–50) and 2 households (respondents) in the sixth band (51–100) entitled as transitory poor, transitory vulnerable, transitory non-poor and non-poor respectively are available in the new poverty scorecard.

Table 4 presents the detailed figures for the graduation of the control group in each band. The results show that 69 new respondents' poverty scorecard could be matched with the old poverty scorecard of the control group. Of those 69 respondents, only 41 (59%) respondents graduated on the poverty scorecard. Furthermore, as shown in the table, initially there were 16 households in the first band (0–11), but as per the new poverty scorecard only 2 (12.5%) households remained extremely poor, and 14 (87.5%) households graduated. Among those 14 graduated households, 9 (56.3%) moved to the second band (12–18), 2 (12.5%) moved to the fourth band (24–34), 3 (18.8%) moved to the fifth band (35–50) and were entitled as chronically poor, transitory vulnerable and transitory non-poor, respectively. Likewise, in the second band (12–18) initially, 53 households were there. Among them, 27 (50.9%) households have graduated to the next levels. From those 27 graduated households, 8 (15.1%) moved to the third band (19–23), 13 (24.5%) moved to the fourth band (24–34), 4 (7.5%) moved to the fifth band (35–50) and 2 (3.8%) moved to the sixth band and became transitory poor, transitory vulnerable, transitory non-poor and non-poor, respectively. The overall results show that out of 69 only 2 households have completely come out of poverty and moved to the non-poor category in the control group.

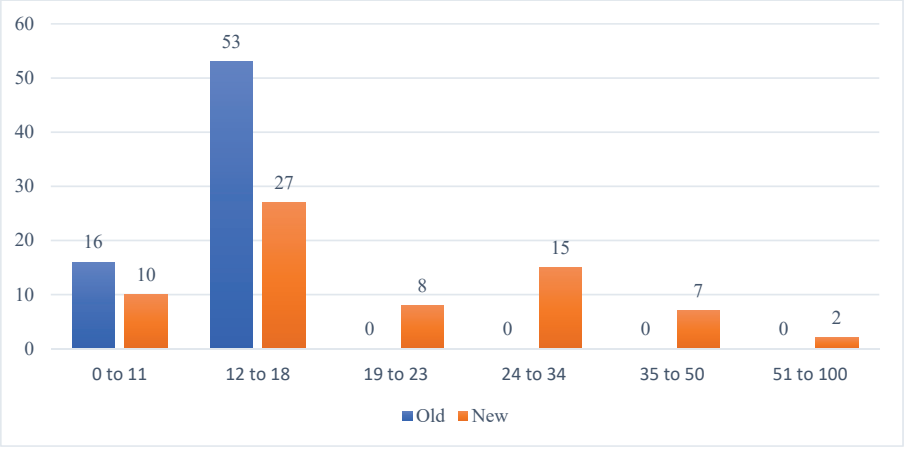

Figure 1. Comparison of old and new poverty score (control group).

Table 4. The graduation of the control group in each band.

PSC Band (Old)		PSC Band (New)						
		0 to 11	12 to 18	19 to 23	24 to 34	35 to 50	51 to 100	Graduation
Total	69	10	27	8	15	7	2	41
0 to 11	16	2	9	0	2	3	0	14
12 to 18	53	8	18	8	13	4	2	27
Total	100%	10	27	8	15	7	2	59%
0 to 11	23.2%	12.5%	56.3%	0.0%	12.5%	18.8%	0.0%	87.5%
12 to 18	76.8%	15.1%	34.0%	15.1%	24.5%	7.5%	3.8%	50.9%

Note: PSC bands (old) are shown vertically whereas PSC bands (new) are shown horizontally in the table.

Figure 2 shows the comparison of the old and new poverty scorecard of the treatment group. As per the old poverty scorecards, 93 households (respondents) were there in the first band (0–11), currently, 21 households are found in the first band (0–11). However, in the second band (12–18) only 63 households were there in the old poverty scorecard and, currently, 51 households are there in the poverty scorecard. Furthermore, in the third band (19–23) only 10 households were found, and 31 households are found in the old and current poverty scorecard respectively. Whereas 44 households in the fourth band (24–34), 18 households in the fifth band (35–50) and 1 household in the sixth band (51–100) are found in the current poverty scorecard.

The further break-up of the figures for the graduation of the treatment group in each category is given in Table 5. In the treatment group, 166 households' old poverty scorecard was found and matched with the new one, among them 120 (72%) households (respondents) have graduated to the next levels and the remaining 46 households have either not changed their position or gone down.

Moreover, it indicates that in the first band (0–11), 93 households are there, and among them, 14 (15.1%) remained extremely poor, 27 (29%) moved to the second band (12–18), 18 (19.4%) moved to the third band (19–23), 25 (26.9%) moved to the fourth band (24–34) and 8 (8.6%) to the fifth band (35–50), and only 1 (1.1%) moved to the sixth band (51–100) and became chronically poor, transitory poor, transitory vulnerable, transitory non-poor and non-poor, respectively. Furthermore, in the band (12–18) only 5 (7.9%) households have moved downward and became extremely poor, 20 (31.7%) households remained in the same band as chronically poor, 12 (19%) households moved to the third band (19–23), 16 (25.4%) households moved to the fourth band (24–34) and 10 (15.9%) households moved

to the fifth band (35–50). However, in the band (19–23), 2 (20%) households have moved down to the first band (0–11), 4 (40%) households have moved down to the second band (19–23), 1 (10%) household remained in the same band and only 3 (30%) households have been graduated to the fourth band (24–34). The overall results show that although 120 (72%) households have graduated in the treatment group, only 1 household has come out of poverty and moved to the non-poor category.

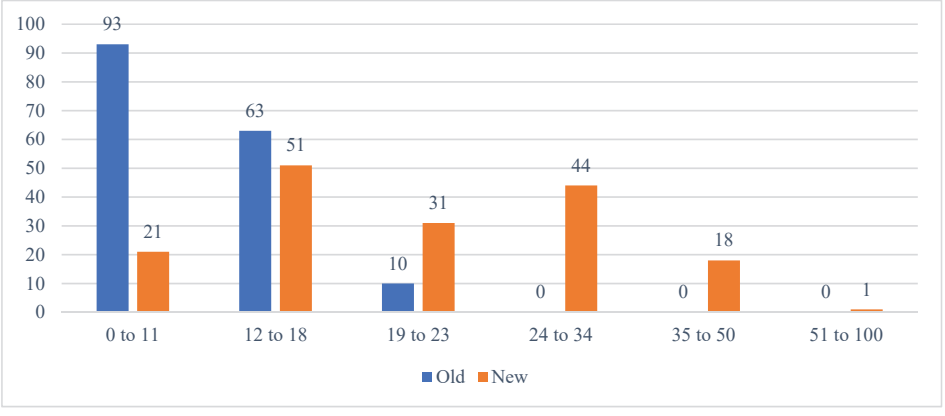

Figure 2. Comparison of old and new PSC (treatment group).

Table 5. The graduation of treatment group on each band.

PSC Band (Old)		PSC Band (New)						
		0 to 11	**12 to 18**	**19 to 23**	**24 to 34**	**35 to 50**	**51 to 100**	**Graduation**
Total	166	21	51	31	44	18	1	120
0 to 11	93	14	27	18	25	8	1	79
12 to 18	63	5	20	12	16	10	0	38
19 to 23	10	2	4	1	3	0	0	3
Total	100%	21	51	31	44	18	1	72%
0 to 11	56.0%	15.1%	29.0%	19.4%	26.9%	8.6%	1.1%	84.9%
12 to 18	38.0%	7.9%	31.7%	19.0%	25.4%	15.9%	0.0%	60.3%
19 to 23	6.0%	20.0%	40.0%	10.0%	30.0%	0.0%	0.0%	30.0%

Note: PSC bands (old) are shown vertically whereas PSC bands (new) are shown horizontally in the table.

Figure 3 represents the comparison of the graduation of both groups. It shows that only 59.4% of households in the control group graduated as per the new poverty scorecard, whereas 72.3% of households from the treatment group graduated as per the new poverty scorecard.

The finding of the study confirms with the study of Imai and Azam (2012); Shirazi (2012); Rashid and Makuwira (2014); Agbola et al. (2017) that the microcredit intervention has a positive impact on the reduction of the poverty. Therefore, it can be inferred that respondents in the treatment group who have graduated to the next band have done so due to the CIF microcredit program intervention. Graduation in the control group has also been witnessed and this can be attributed to natural growth rates, other poverty alleviation tools such as BISP, and other microcredit programs, and families striving for income and food, education of their children, more income earners, and more opportunities for earning. Even so, it is indicated that microcredit has also played a vital role in the reduction of poverty and improving the poverty score of the beneficiaries to move from one category of poor to another upper category. Microcredit has a positive impact on income and consumption (Imai and Azam 2012), along with income microcredit increases the savings

and living standards of the beneficiaries (Agbola et al. 2017). Microcredit programs have a significant impact on per capita income and per capita consumption expenditure (Cuong 2008), enhanced livelihood in rural areas (Rashid and Makuwira 2014) and increased assets, i.e., fans, bicycles and sewing machines (Shirazi 2012). However, 17.7% of respondents have either not graduated or their status has worsened. The possible reason is that poor people borrow to fulfill their consumption (Shirazi 2012). They may be tied up with the wrong type of farming activities and units (Bateman 2012). However, from overall results, it can be suggested that after getting microcredit from CIF, a woman and her family's poverty reduces, and her wellbeing increases.

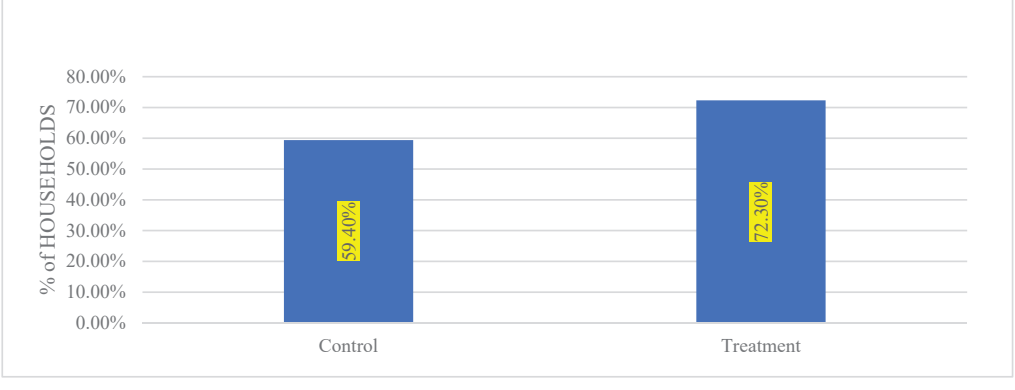

Figure 3. Comparison of the graduation of both groups.

The overall comparison of the graduation of both groups on all the levels is not sufficient to see the impact of microcredit on the graduation of women's poverty score, because graduation to the next level does not confirm the wellbeing of respondents and they are still living under the poverty line. Therefore, the study conducted a detailed analysis and measured graduation on the last three bands of the poverty scorecard. The last three bands were selected for further analysis of graduation because respondents on these bands live above the poverty line and Mark Schreiner 2016 () also identified that the poverty score of respondents that ranges from 25 to 34 has a 47.1% to 39.5% likelihood of being below the poverty line on the national poverty line of Pakistan. Respondents having poverty score ranges of 35 to 49 have 29.8% to 16.9% likelihood and the poverty score range of 50 to 100 have a 10.7% to 0% likelihood of being below the poverty line on the national poverty line of Pakistan (Mark Schreiner 2016).

Table 6 shows the comparison of the graduation of both groups on the last three bands. It indicates that only 15 (62.5%) respondents in the control group and 44 (69.8%) respondents in the treatment group have graduated in the third band (24–34), whereas 7 (29.2%) respondents in the control group and 18 (28.6%) respondents in the treatment group have graduated in the fifth band (35–50). However, only 2 (8.3%) respondents and 1 (1.6%) respondent have graduated in the sixth band (51–100) in the control and treatment group, respectively. The overall results indicate that there is not a big difference in the graduation of the treatment and control group.

As shown in Table 7, only 34.8% of respondents in the control group and 38% of respondents in the treatment group graduated to the last three bands of the poverty scorecard. The overall results suggest that the difference between graduation of treatment and control is 3.2% only, which is insignificant. Our findings confirm the study of Sayvaya and Kyophilavong (2015), which concluded that microcredit has a positive impact on poverty, but that impact is not significant. Therefore, we can infer that although microcredit is impacting woman poverty but not significantly and there are other factors as well, such

as BISP and other social mobilizing support to rural women, which are reducing their poverty and increasing the graduation level.

Table 6. Comparison of the graduation of both groups on the last three bands.

Bands	Control		Treatment	
	Percentage	Frequency	Percentage	Frequency
24 to 34	62.5%	15	69.8%	44
35 to 50	29.2%	7	28.6%	18
51 to 100	8.3%	2	1.6%	1
Total Graduated	100.0%	24	100.0%	63

Table 7. Overall graduation in last three bands in each group.

Groups	Control	Treatment
Total Respondents	69	166
Total Graduated in the last three bands	24	63
Total Graduated in the last three bands %	34.8%	38.0%

5.4. Socio-Demographic Characteristics

Table 8 presents the socio-demographic characteristics of the treatment group who received microfinance loans and the control group who have not taken loans, and it further indicates that both groups based on their characteristics were divided into unmatched and matched samples by using the propensity score matching technique. It shows the t-statistics of comparing the mean of treatment and control groups, which differs significantly. According to unmatched samples, women in the treatment group are likely to be older and have significantly larger household size. In particular, with an average monthly income per family of approximately PKR 17,723.68, women's family monthly income in the treatment group is significantly higher than the control group, which is having an average of approximately PKR 6692.92 per family, whereas, in matched samples, the average monthly income per family of women in the treatment group is approximately PKR 13,207.28, and is significantly higher than the control group, having an average of approximately PKR 11,722.61 per family. This indicates that the treatment group on average earns more income than the control group. Therefore, it suggests that microfinance has helped women to advance the level of their income. This finding is consistent with the study of Al-Shami et al. (2017a, 2017b) which states that microfinance has a positive impact on the monthly income of women. Similarly, with an average monthly consumption per family of approximately PKR 14,603.68, the treatment group in the matched sample is significantly higher than the control group, having an average of approximately PKR 12,571.57 per family. Similarly, with an average monthly consumption per family of approximately PKR 23,447.37, the treatment group in the unmatched sample is significantly higher than the control group, having an average of approximately PKR 8152.05 per family. In the unmatched sample, women who have a savings account are significantly more likely to join microfinance programs. In the matched sample, women who have a savings account have a significantly higher possibility to join microfinance programs earlier. This indicates that women in the treatment group have more savings accounts than the control group, as there is a requirement to open at least one bank account before applying for a microfinance loan from SRSO. Moreover, women also need a savings account to save their money earned from the business which was started from the loan amount. Similarly, Agbola et al. (2017) argue that microfinance has a moderately positive effect on poverty alleviation by the increased saving of its clients than non-clients. Women in the treatment group are less educated than the control group but there is no significant difference between them. According to the unmatched sample, women in the treatment group have significantly more total assets'

value and asset purchased value than non-borrowers, whereas, in the matched sample, total asset value and asset sold value of women in the treatment group are higher than the control group. Women participation in microfinance increases the value of their assets as they invest in different businesses and earn reasonable profit, which is also supported by the findings of Hashemi et al. (1996) that participation in microcredit increases women ownership of assets.

Table 8. Socio-demographic characteristics of the control and treatment group.

Variables	Unmatched Samples			Matched Samples		
	Control Group	Treatment Group	*t*-Test	Control Group	Treatment Group	*t*-Test
Age	35.52	48.21	−6.802 ***	42.78	43.38	−0.543
Household's size	5.14	10.99	−9.55 ***	8.01	8.4	−1.275
Income earners	1.05	3.25	−6.79 ***	1.93	2.07	−1.287
Monthly Income	6692.9178	17,723.6842	−5.921 ***	11,722.606	13,207.279	−1.651 *
Monthly Consumption	8152.0548	23,447.3684	−3.6 ***	12,571.566	14,603.676	−2.02 **
Loan amount other than CIF	1000	328.9474	0.857	691.1765	632.3529	0.158
Saving Account	0.03	0.13	−2.364 **	0.07	0.08	−0.486
Saving Amount	3315.0685	539.5263	1.014	185.6654	451.8493	−2.027 **
Education	1.6	1.29	1.512	1.25	1.24	0.2
House type	1.92	3.08	−1.967 *	2.2	2.18	0.399
Total Assets Value	132,657.53	256,053.947	−2.901 ***	165,644.485	214,036.029	−2.543 **
Asset Purchased Value	410.9589	6894.7368	−2.228 **	3752.2059	4937.8676	−0.744
Asset Sold Value	452.0548	2881.5789	−1.715 *	1091.9118	2644.489	−1.657 *
Political Empowerment	0.0137	0	1.02	0.011	0.0294	−1.523
Social Empowerment	0.0822	0.3289	−3.867 ***	0.1471	0.1949	−1.481
Economic Empowerment	0.0274	0.2105	−3.549 ***	0.1471	0.1838	−1.153
Political Awareness	0.0137	0.0132	0.028	0.0184	0.0478	−1.921 *
Political Participation	0.0137	0.1184	−2.594 **	0.0882	0.114	−0.995
Say In Decision	0.1507	0.4211	−3.789 ***	0.2059	0.3051	−2.667 ***
Mobility	0.4521	0.8026	−4.726 ***	0.6324	0.7316	−2.495 **
Household Asset and Income	0.1918	0.3684	−2.427 **	0.2978	0.3676	−1.73 *
Control Over Minor	0.0274	0.2632	−4.271 ***	0.1324	0.2096	−2.4 **
Control Over Major	0.0548	0.25	−3.401 ***	0.1728	0.1728	0
Composite Empowerment	0.0137	0.1316	−2.804 ***	0.0882	0.1507	−2.253 **
Children of school-aged (5–16 years)	1.7	3.68	−6.143 ***	2.69	3.1	−2.255 **
Children currently attend school, full or part-time	1.03	2.13	−4.4 ***	1.58	1.66	−0.572
Children that never attended school	0.58	1.49	−3.343 ***	1.01	1.37	−2.559 **
Highest grade level of your children	2.19	4.84	−4.218 ***	3.49	4.21	−2.057 **
Monthly medical expenditure	3701.3836	3369.7368	0.434	3604.9632	2891.5074	0.846
Family needed medical attention during last one month	0.73	0.7	0.361	0.75	0.72	0.721
Money to pay medical cost	3.33	3.13	0.566	3.39	3.03	2.042 **
Lack the money for medical treatment in the last year	0.59	0.55	0.387	0.45	0.54	−1.822 *
Household's diet	1.84	2.16	−3.302 ***	1.88	1.99	−1.908 *
Health Condition Worsened	3.47	4.09	−0.594	3.87	4.2	−0.673
Health Condition Improved	2.5	2.91	−0.365	4.18	3.85	0.643
Health8	0.59	0.59	−0.031	0.61	0.58	0.493
Health10	3.39	3.52	−0.174	2.9	2.63	0.804
Poverty Scorecard	23.71	21.61	1.233	21.34	21.44	−0.116
Poverty Scorecard (Loan cycle 3 and above)	23.71	23.33	0.147	21.34	21.78	−0.331

Note: ***, ** and * show statistical significance at 1%, 5% and 10% level, respectively.

In the unmatched sample, women in the treatment group have significantly higher social empowerment with an average score of 32.89%, higher economic empowerment with an average score of 21.05% and relatively high political participation with an average score of 11.84%, than women in the control group with an average score of 8.22%, 2.74% and 1.37%. While social and economic empowerment and political participation are not significant in the matched sample. Table 8 also shows a significant difference of the unmatched sample in

women say in decision making with an average score of 42.11%, mobility with an average score of 80.26%, control over resources minor with an average score of 26.32% and control over major resources with an average score of 25% in the treatment group while 15.07%, 45.21%, 2.74% and 5.48% in the control group, whereas women in the treatment group have significantly more political awareness with more control over minor resources in the matched sample. These findings are consistent with a study of Rehman et al. (2015) which states that access to microcredit makes women more empowered in terms of health and education (the health and education of their children), social empowerment (social aspects of life), economic empowerment (decisions regarding purchases of households items), and political empowerment (aware of their rights). The composite empowerment in both unmatched and matched groups is significant but high in women of the treatment group in the unmatched sample. Moreover, children of age between 5 and 16 years of women in the treatment group have a significantly high enrollment rate in school with more children in the highest grade level. This finding is consistent with the study of Mahmood (2011) who finds that after getting microfinance, women are more empowered in household decisions such as the education of their children.

There is no significant difference between the two groups of women concerning both overall poverty scorecard including all loan cycles and poverty scorecard with loan cycle 3 and above in both matched and unmatched samples as their resultant t-statistics is not significant with an approximately same value of both treatment and control group. This indicates that the bias of treatment and control group was reduced and both groups are now comparable based on the selected pretreatment characteristics.

5.5. Logistic Regression Analysis

The analysis begins with the sample survey data. Logistic regression was performed to assess the impact of interest-free microfinance on the likelihood of women empowerment. The models contain eleven independent variables: four controlled variables (beneficiary, age, education, and occupation) and seven main independent variables (monthly income, monthly consumption, loan amount, BISP, saving amount, total assets values and asset purchased value). The independent variables are identified along the vertical axis of the logit model tables. The B values provided in the second column of logit model tables are coefficients for the constant that is used to identify the direction of the relationship between the independent variable and dependent variable. The *p*-value is used to predict whether an independent variable would be significant in the model. *p*-values are shown in the third column of logit model tables. The test that is used here is known as the Wald test. Wald is basically t^2 which is Chi-Square distributed with "df (degree of freedom)" equal to 1. This tests the null hypothesis that the constant equals 0. This hypothesis is rejected if the *p*-value is smaller than the critical p-value. Wald test is labelled in column fourth of logit model tables. The "e^B" values are represented in the fifth column of logit model tables. "e^B" is the exponentiation of the B coefficient and represents odds ratios for each independent variable. The odds ratio is defined as the change in odds of being in one of the categories of the outcome when the value of a predictor increases by one unit (Barbara et al. 2007). The Cox & Snell R Square and the Nagelkerke R Square values suggest the amount of variation in the dependent variable explained by the model, and it ranges between 0 and 1. The Cox & Snell R square is based on the log-likelihood for the model compared to the log-likelihood for a baseline model, whereas Nagelkerke R Square is an adjusted version of the Cox & Snell R-square. The models also adjust for the socio-demographic characteristics discussed above, but as we are not concerned here with the magnitude of their effects on women empowerment, their estimates are not shown.

Table 9 provides the last logistic regression model results of composite empowerment which is a combination of the previous ten models. At the 10% significance level, the likelihood of composite empowerment of women increases when total asset value increases. In this model, other variables reliably associated with composite empowerment of women are age, occupation type, i.e., farming, labour and SME owner and asset purchased value.

The likelihood that composite empowerment of women declines as women's age increases at a 10% significance level, shows that young women have more composite empowerment. The strongest predictor of reporting women composite empowerment is occupation type labour, recording an odd ratio of 4.896. This indicates that women working in labour are over 4.896 times more likely to report composite empowerment than other occupations, controlling all other factors in the model. The odds ratio of 2.404 and 3.987 for occupation type farming and SME owner is more than 1, indicating that for every additional increase in the number of women working in farming and SME owner are 2.404 and 3.987 times more likely to report having women composite empowerment, controlling for other factors in the model. The odds ratio of 0.979 for age is less than 1, indicating that for every additional year is 0.979 times less likely to report having women composite empowerment, controlling for other factors in the model. In other words, young women are 1.021 (1/0.979) times more likely to have composite empowerment, controlling for other factors in the model.

Table 9. Logistic model 11.

Predictors	Composite Empowerment			
	B	**P**	**Wald's X2**	**Exp(B)**
Beneficiary (1)	−0.446	0.251	1.320	0.640
Age	−0.021	**0.080**	3.055	0.979
Monthly Income	0.000	0.881	0.022	1.000
Monthly Consumption	0.000	0.810	0.058	1.000
Loan Amount	0.000	0.275	1.193	1.000
BISP (1)	−0.426	0.130	2.288	0.653
Saving Amount	0.000	0.250	1.325	1.000
Education	0.005	0.979	0.001	1.005
Occupation		0.000	29.057	
Occupation (1)	0.877	**0.037**	4.362	2.404
Occupation (2)	1.588	**0.001**	12.034	4.896
Occupation (3)	1.383	**0.044**	4.046	3.987
Occupation (4)	−0.460	0.317	1.000	0.631
Total Assets Value	0.000	**0.067**	3.363	1.000
Asset Purchased Value	0.000	**0.006**	7.424	1.000
Constant	−1.711	0.035	4.434	0.181
Test				
−2 Log likelihood	419.178			
Model Chi Square	12.125	0.146		
R^2	0.082/0.164			
% Correctly Predicted	89.1			

Note: Significance level is "< or = 0.10" and bold values are significant. Predictors are the independent variables while Political Empowerment is the dependent variable.

Furthermore, the odds ratio of 1 for total asset value and asset purchased value indicate that for every additional asset purchased value and asset sold value is 1 time less likely to report having women composite empowerment, controlling for other factors in the model. The two values 0.082 and 0.164 of R Square suggest that the variability in composite empowerment of women is between 8.2% and 16.4%. Overall, the model correctly predicted 89.1% of the cases.

The process of women's empowerment is complex. This is confirmed by the results of the present analysis. The complexity of empowerment is apparent when comparing the relationships between independent and dependent variables. From the logistic regression results, we find that the various dimensions of empowerment (political empowerment, political awareness, political participation and ownership of household assets and income) are not necessarily related to the determinants (predictors) consistently. For example, the women having education have a negative relationship with ownership of household assets and income even though they are more likely to have ownership of household assets and

income. Moreover, the composite score is lower for older women and higher for young women.

Concerning the exposure to the CIF microcredit program, the results suggest that occupation types have a positive impact on women empowerment as the number of women working as labour increases, the probability of social and economic empowerment in women increases. Women who work as labour are more likely to have greater freedom of mobility and are more likely to have control over minor and major resources. Women working as SME owners increases the probability of economic empowerment in women with more control over minor resources and ultimately leads to the probability of women overall empowerment as indicated by the composite score. Women as housewives show a negative relationship with the social empowerment of women due to several cultural norms and stereotypes, as in rural areas the mostly male-dominated society does not involve women to participate in different decision making. Women remain at home and perform household tasks. Further, results indicate that housewives do not have ownership of household assets and incomes because women are not allowed to work outside the house and earn some money to own any asset. Education is a very important indicator of women empowerment. There is considerable evidence for the claim that access to education can bring about changes in the cognitive ability of humans, especially women. The results of this study suggest that the increase in the education level of women increases the probability of political empowerment and political awareness in women whereas the probability of ownership of household assets and income decreases as the education level of women improves because while getting an education, women are unable to work and earn. This makes women more dependent on other family members for earnings.

Mostly, the CIF program helps women to increase their total asset value, and the results propose that if the total asset value increases the probability of economic and social empowerment in women increases. An increase in the total asset value also increases the women's ownership of household assets and incomes as well as control over minor resources. Microcredit helps women to become independent in society by giving more control over resources. This results in increasing the probability of women overall empowerment as indicated by the composite score. For exposure to the CIF program, the results suggest that as the asset purchased value of family increases, the probability of political, social and economic empowerment of women, political participation and control over resources increases. For the control variables, the results suggest that if women's age increases, the probability of women's say in decision-making decreases while the mobility of women increases. In the other words, young women have more ease of mobility from outside the home. This study suggests that not only CIF programs empower women by strengthening their political, social and economic roles but also other indicators such as education level and occupation type have a strong impact on women empowerment.

6. Conclusions

Microcredit has been seen as the most powerful tool to empower women and reduce poverty because it provides lending, which helps a poor woman to increase her earnings and status in society and home. This study aims to measure the graduation level of women in terms of poverty using the poverty scorecard tool and to assess the impact of interest-free microfinance on empowering women socially, economically, politically, and on the health and education of their families. The findings show that women in the treatment group are likely to be older and have significantly larger household size and more income earners than the control group in the unmatched sample. Moreover, respondents in the treatment group have a higher income and consumption range than the control group and the difference is statistically significant in both unmatched and matched samples. Furthermore, respondents in the treatment group have higher total assets value in an unmatched and matched sample, whereas respondents in the treatment group have also purchased assets more in the unmatched sample as compared to the control group thus participation in microfinance increases the value of their total assets. Similarly, the number

of children of respondents attending school is significantly greater in the unmatched sample and has attained a higher grade level in the treatment group than in the control group in both samples. However, the percentage of social empowerment, economic empowerment, political participation, and control over major resources in the unmatched sample and political awareness in the matched sample is significantly higher in the treatment group as compared to the control group. Percentage of say in decision making, mobility, ownership of household assets, control over minor resources and an overall composite of empowerment is significantly higher in the treatment group as compared to the control group in both samples.

Secondly, the results of the study suggest that microcredit has positively impacted women beneficiaries in terms of reduced poverty and improved their family wellbeing. The family rosters in poverty scorecard indicate that beneficiaries are purchasing productive assets or income-generating assets such as sewing machines, cattle and so on and sending their children to schools. Although 72% of beneficiaries (treatment group) have graduated from one poverty band to another higher band than 59.4% non-beneficiaries (control group) in poverty score, their graduation does not confirm their wellbeing and lower poverty because initial three bands (see Table 5) of poverty score still implicate the score of respondents below the poverty line. Thus, the real graduation was considered if the respondents have graduated in the last three bands (see Table 5) of the poverty scorecard, which is 38% in the treatment group and 34.8% in the control group. Furthermore, results of the logistic regression analysis illustrate that the involvement of the CIF program does empower rural women of Sindh, Pakistan but the empowerment process does not necessarily occur simultaneously across all dimensions. Women's participation in the CIF program increases women's ownership of household assets and income, say in decision making, mobility outside the home, socio-economic empowerment and composite empowerment. Despite the CIF program, occupation types, i.e., labour and SME owners have also a strong impact on women empowerment in the perspective of socio-economic and composite empowerment as a whole whereas housewives have low social empowerment. Similarly, literate women are more politically empowered as they have more access to information regarding politics and their rights as a citizen than illiterate women. Based on the findings of the study, policymakers, donors, government and other stakeholders will be able to make decisions on the investment for interest-free microfinance intervention. Furthermore, they should focus on other aspects such as education, employment opportunities for women and other social mobilization activities along with microfinance interventions for poverty reduction and empowerment.

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Effects of Insurance Adoption and Risk Aversion on Agricultural Production and Technical Efficiency: A Panel Analysis for Italian Grape Growers

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Abstract: This article aims to evaluate the effect of insurance on production, technical efficiency, and input use of Italian specialised-quality grape growers. A panel instrumental variable stochastic frontier approach is applied over the years 2008–2017 using data from the Farm Accountancy Data Network. The results show the requirement to correct for the endogeneity that stems from insurance adoption. Insurance has an enhancing effect on production and efficiency and reduces the use of intermediate inputs. It suggests that insurance helps to diminish the risk-averse farmers' suboptimal input use due to the presence of uncertainty. Crop insurance leads risk-averse farmers to behave as if they were risk neutral and employs the profit-maximising input vector. Therefore, by reducing the risks linked to the uncertainty of outcomes, crop insurance leads grape growers to go in the direction of profit maximisation.

Keywords: endogenous stochastic frontier; crop insurance; viticulture

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1. Introduction

Agricultural production has always had to cope with uncertainty (Moschini and Hennessy 2001). Farmers make their resource allocation decisions in a complex environment made up of poorly controllable biological (diseases, insects, pests, weeds), environmental (i.e., weather, soil, and water conditions), and institutional (i.e., markets, legislation) factors. Additionally, economic, and financial markets, as well as the political and institutional environment, can be sources of uncertainty. In the future, it is expected that the exposure to risk in agriculture is likely to increase due to upcoming challenges related to land degradation and climate change (IPCC 2013; Raimondo et al. 2021). Such a situation explains the wide array of farming practices and management approaches available to the farmers to manage their risks at the farm level, basically involving three broad areas of farming decisions: production, marketing, and financial (Boehlje and Trede 1977; McConnell and Dillon 1997). These management approaches and practices include, among others: on- and off-farm diversification of income-generating activities (Chavas and Kim 2010; Corsi and Salvioni 2012; Bellon et al. 2020), inputs intensification (Foudi and Erdlenbruch 2012; Pagnani et al. 2021), varietal diversification (Di Falco and Chavas 2006; Gotor et al. 2021), vertical integration and contract farming (Hennessy 1996; Otsuka et al. 2016), forward contracting and futures hedging (Asplund et al. 1989), and finally crop insurance (Ahsan et al. 1982; Nelson and Loehman 1987; Ramaswami 1993). In this paper, we specifically focus on the latter, since crop insurance has recently been gaining the attention of policymakers, especially in the European Union with the recent development of the Common Agricultural Policy (CAP) (Enjolras et al. 2012; Santeramo et al. 2016;

Vigani and Kathage 2019). Furthermore, crop insurance might cover different sources of uncertainty, supporting farmers in the process of adaptation to climate challenges (Di Falco et al. 2014).

Crop insurance represents one of the most investigated subjects in agricultural economics. There is a large amount of literature addressing crop insurance demand (Enjolras et al. 2012; Santeramo et al. 2016), pricing and subsidies (Skees et al. 1997; Lusk 2017), impact on farming decisions (Ahsan et al. 1982; Nelson and Loehman 1987; Ramaswami 1992; Mieno et al. 2018) and moral hazards (Horowitz and Lichtenberg 1993; Quiggin et al. 1993; Smith and Goodwin 1996). Additionally, there is wide range of literature examining the effect of crop insurance on input use (Wu 1999; Goodwin et al. 2004; Möhring et al. 2020a, 2020b) and input demand under crop insurance (Ramaswami 1993; Babcock and Hennessy 1996). More recently some attention, though still limited, has been directed towards the effective economic impact of crop insurance in terms of farming productivity (Vigani and Kathage 2019) or technical efficiency (Roll 2019). For instance, Roll estimated a stochastic production frontier to investigate whether insurance affects Norwegian salmon farming in terms of inputs use, productivity, and technical efficiency. Looking at the literature, the effects of insurance on input use are largely an empirical issue. Some authors found that insurance is positively related to input intensity (e.g., Horowitz and Lichtenberg 1993), while other studies found a negative relation (e.g., Quiggin et al. 1993; Smith and Goodwin 1996; Babcock and Hennessy 1996). Finally, Goodwin et al. (2004) found a positive and negative effects depending on the crop analysed.

In this paper, we intend to add to this latter stream of literature. Similar to Roll (2019), we explore the effect of expenditure in crop insurance on the production and technical efficiency of a nationally representative sample of Italian grape growers. More specifically, this paper aims to clarify whether insurance adoption might solve the risk-averse farmers' suboptimal input use due to the presence of uncertainty. Of course, there is no simple answer to this: on one hand, crop insurance, by making risk-averse farmers prone to being risk neutral (Nelson and Loehman 1987; Ramaswami 1993), should facilitate optimal resource allocation, allowing farmers to maximise profit, enhance the production level, and to specialise their production (Ahsan et al. 1982), consequently improving their technical efficiency (Roll 2019). However, on the other hand, insurance adoption may incentivise farmers in reducing the number of safety measures against harm as a consequence of moral hazard (Horowitz and Lichtenberg 1993; Quiggin et al. 1993). This would result in a major exposure to risk and might reduce the production level and technical efficiency.

From a methodological point of view, using data from the Farm Accountancy Data Network (FADN), a panel stochastic frontier estimation approach is implemented on a sample of commercial Italian farms specialising in the production of quality grapevines[1] over the period 2008–2017. Different from previous studies, we account for the potential endogeneity of insurance, therefore providing more reliable parameter estimates (Karakaplan and Kutlu 2017a).

The dominant insurance schemes in Italian agriculture, as for grape growing, are single-peril (mainly hail) and multi-peril crop insurance (ISMEA 2018). Farmers pay a premium to cover yield damages caused by one or more eligible events listed in the Italian Insurance Plan. Premium per hectare varies in relation to the risk exposure of the farmer. A specific focus has been given to the grape growers because crop insurance has been widely adopted in this sector in Italy, which represents around 27% of the Italian crop insurance market in terms of monetary values and 14% in terms of land (ISMEA 2018). Additionally, it is widely assumed that the viticulture sector is exposed to many risks which are progressively increasing due to climate change. Global warming causes increases in temperature in grapevine regions. This may cause changes to the grape chemistry, and an increase in insects and insect-borne diseases (Mozell and Thachn 2014). Additionally, the increase in the frequency of extreme weather events such as rainfall, late frost, or hailstorms (IPCC 2013) has potentially negative effects on yields and wine quality, and increases income variability (Holland and Smit 2010).

The rest of this article is organised as follows. In the next section, we present a brief literature review on the role of risk in production choices. Then we introduce the methodology utilised with a focus on the endogeneity problem. Successively, we show the dataset and the model specification. We then show and discuss the results. The conclusions are presented in the final section.

2. Theoretical Background

Farmers choose the level of inputs to maximise profit before knowing the true state of nature; therefore, productive factors are allocated according to farmers' risk perception and aversion (Roosen and Hennessy 2003). Risk-taking or risk-loving farmers would take an opportunity to gain a higher profit rather than taking a safer position, with the chance of sustaining a large loss. Vice versa, the risk-averse farmers prefer to avoid the worst possible outcome. Finally, risk-neutral farmers would hypothetically consider the weighted expected outcome of the different expected states of nature. Thus, risk aversion has direct consequences on the optimum resource-use level. To maximise profit, farmers should operate at the profit-maximising point, i.e., where the expected marginal value product of input equals the marginal factor cost. This is the risk-neutral farmer's choice, while the risk-averse farmer operates at the position where profit is not being maximised except in "bad" seasons. In other words, risk aversion results in suboptimal economic decisions with respect to input allocation. The difference in input use of risk-averse and risk-neutral farmers depends on the marginal risk premium (MRP) (MacMinn and Holtmann 1983), which is the wedge between input cost and expected marginal product at the optimum level of input use. In general, the sign of MRP depends on risk preferences and technology. MRP is positive if the use of the input increases the production uncertainty (risk increasing input). MRP is negative when the input is risk-decreasing (MacMinn and Holtmann 1983; Ramaswami 1992). Consequently, in the single-input single-output case, the risk-averse level of input use is higher (lower) than the risk-neutral level of input use if the input is risk-decreasing (increasing) (Nelson and Loehman 1987). In farm decision-making, fertilisers are often considered risk-increasing inputs (Just and Pope 1979; Pope and Kramer 1979) while pesticides and herbicides are usually considered risk-decreasing (Möhring et al. 2020b).

This study aims to evaluate the effect of crop insurance on grape producers' decision-making process. Crop insurance has the potential to affect both the input (Nelson and Loehman 1987; Ramaswami 1993) and output choices (Ahsan et al. 1982) with consequences for production and technical efficiency (Roll 2019). On one hand insurance may enhance the farming results, allowing input choice independent of the farmer's preference function over uncertain outcomes (Nelson and Loehman 1987). The purchase of insurance induces risk-averse farmers to behave as if they were risk neutral and choose the optimal quantity of inputs by setting the expected marginal product of inputs to its opportunity cost (Ahsan et al. 1982). According to Ramaswami (1993), this is due to the risk reduction effect of the insurance adoption, which reduces the wedge between expected marginal product and input price and makes farmers adjust input application in the direction of risk-neutral levels, i.e., to increase the level of input if risk-increasing and to decrease the input use if risk-decreasing. The risk reduction effect implies that the mean output could increase or decrease depending on the nature of the production technology.

On the other hand, the possible existence of a moral hazard may alter insured farmers' optimal decisions (Quiggin et al. 1993). More specifically, a moral hazard may reduce the input used independently of whether it is risk-reducing or risk-increasing (Ramaswami 1993). Moral hazard decreases the mean expected output because the insurance contract reduces the loss associated with the insured event and may change the farmer's behaviour. As a result, farmers reduce the precautions to cope with risk since there are much fewer consequences for an incident. Therefore, when the input is risk-decreasing, insurance increases the riskiness of output and decreases the expected output, while if it is risk-increasing this effect will depend on the effect of moral hazard and risk reduction effects.

With regards to output choice, farmers tend to allocate more resources to insured cultivation and, in more detail, will specialise in the production of higher-value risky activities that can be insured (Ahsan et al. 1982) According to this view, Roll (2019) found that insured farmers might gain from greater specialisation since they do not need to diversify their activities to manage their idiosyncratic risk. The higher specialisation achieved by insurance adoption might explain the increase in technical efficiency. On the other hand, the moral hazard could lead to a change in the farmers' ordinary behaviour, influencing the quality and the intensity of the production factors. These actions, including the managerial effort devoted to farming activities, will have a direct consequence on technical efficiency, limiting the impact of the specialisation achievable by insurance (Kirkley et al. 1998).

This paper aims to tackle the above-mentioned dilemma about the effect of crop insurance on inputs use and technical efficiency of a nationally representative sample of Italian grape growers. The following section will clarify the methodological approach employed and the data used for the analysis.

3. Data and Methodology

3.1. Methods

The foundations of efficiency analysis started from the contribution of Farrell (1957), and since the 1960s it was extensively applied to analyse the way production inputs are combined into valuable outputs. Efficiency analysis can involve a parametric estimate of the production function as independently proposed by Aigner et al. (1977) and Meeusen and van Den Broeck (1977) through the stochastic frontier models. These models are composed of a deterministic part identifying the frontier (i.e., the maximum output obtainable, given the available technology and input levels) and of a stochastic part including a two-sided error term, and a one-sided inefficiency error term: the latter identifies the distance from the stochastic frontier. Battese and Coelli (1995) implemented a stochastic frontier production function for panel data, which accounts for potential unobserved heteroscedasticity, and includes environmental variables in the inefficiency distribution. Accordingly, the frontier equation was specified as:

$$\ln y_{it} = \beta_0 + \sum_k \beta_k \ln x_{kit} + v_{it} - u_{it} \quad (1)$$

where y_{it} is the logarithm of the output of the i-th farm at time t; x_{kit} is a vector of k inputs and other explanatory variables of the i-th farm at time t; β is a vector of k unknown parameters to be estimated; v_{it} is a two-side error term capturing the standard random errors, and u_{it} is a non-negative error term associated with the technical inefficiency effects. In turn, the variance of technical inefficiency (u_{it}) can be assumed to be a function of a set of s explanatory variables (z_{sit}), a conformable vector of coefficients to be estimated (δ), and a random term (ω) as in the following equation:

$$\sigma^2_{uit} = \delta_0 + \sum_s \delta_s \ln z_{sit} + \omega_{it}. \quad (2)$$

When analysing production and efficiency it is important to account for the potential endogeneity of the explanatory variables to obtain unbiased estimates of technical efficiency (Shee and Stefanou 2014; Amsler et al. 2016; Karakaplan and Kutlu 2017b). According to Vigani and Kathage (2019), there are different potential endogeneity sources regarding insurance adoption in the estimation of the production frontier. Potential endogeneity may arise due to reverse causality between the adoption of risk management tools and productivity (Ramaswami 1993). For instance, bigger farms are more likely to have the financial and human resources to adopt risk-management practices (Vigani and Kathage 2019). As for Italian farmers, the adoption of crop insurance has been demonstrated to be influenced by farm performance, total assets, and financial leverage (Enjolras et al. 2012; Santeramo et al. 2016). Furthermore, insurance adoption is voluntary and not randomly assigned and therefore may be adopted by farms that find it most useful. This means that insured farmers are self-selected, i.e., they have common unobservable characteristics

influencing both the performance and adoption choice. This will lead to inconsistent estimates of the impact of insurance on farm production (Di Falco and Veronesi 2013). To deal with endogeneity issues, we follow the general maximum likelihood-based approach proposed by Karakaplan and Kutlu (2017a). These authors start from the model proposed by Battese and Coelli (1995) described in Equations (1) and (2) above and developed an endogenous panel stochastic frontier model which handles endogenous variables in both the frontier and/or in the inefficiency by using an instrumental variable approach. Unlike the standard control function methods where estimations are performed in two stages, authors estimated the parameters using a single maximum likelihood function, gaining statistical efficiency[2]. Additionally, a potential source of endogeneity may arise from the substitution effect between insurance and inputs since the adoption of insurance can increase the use of risk-increasing inputs and decrease the level of risk-decreasing inputs (Nelson and Loehman 1987; Ramaswami 1992). The most popular production functions used in the stochastic frontier analysis are Cobb-Douglas and translog. In this study we consider the translog functional to capture the substation effect of insurance.

Finally, to avoid the potential endogeneity due to omitted variables, we included other risk management tools in the model specification, namely irrigation and on-farm diversification. Previous studies have shown that farmers often adopt different risk management strategies and that the global risk mitigation effect is not necessarily equal to the sum of the effects of adopting each strategy separately (Wu and Babcock 1998).

3.2. Data

We used farm-level data for vine growers specialising in quality grape production, located in Italy and observed from 2008 to 2017. The data have been extracted from the FADN, which provides high-quality and consistent datasets of commercial farms, i.e., farms with an economic size, in terms of *standard output*[3], exceeding EUR 8000 in the case of Italy. FADN consists of an annual survey aimed to provide representative data, harmonised among EU member states, along three dimensions: the region, economic size, and type of farming. Due to the rotation over the years of the observed farms in the sample, the dataset is an unbalanced panel.

By excluding observations with null or inconsistent values on the main variables of interest, our dataset was composed of 9419 observations of 2587 farms. The descriptive statistics of the variables included in the model are reported in Table 1.

Table 1. Descriptive statistics.

Variable and Abbreviation		Description	Mean	Standard Deviation
		Output and Inputs		
y	Production	Total Gross Production (EUR)	57,338	136,247
x_1	Land	Utilised Agricultural Area (ha)	8.92	17.30
x_2	Capital	Amount of Capital (EUR)	472,696	1,446,921
x_3	Intermediate Inputs	Intermediate Inputs Costs (EUR)	11,908	37,635
x_4	Labour	Total number of hours worked per year (h)	2418	4511
		Risk Management Strategies		
ins	Insurance	Expenditure on crop insurance (EUR)	891	5168
d_{ins}	Insurance Dummy	One for insured farm, zero otherwise	0.22	0.41
irr	Irrigation	Percentage of irrigated land over total land (%)	0.28	0.43
d_n	Non-agricultural Diversification	Dummy for services diversification	0.11	0.32
d_a	Agricultural Diversification	Dummy for crop or livestock diversification	0.74	0.44

Table 1. *Cont.*

	Variable and Abbreviation	Description	Mean	Standard Deviation
		Control Variables		
es_1	Economic Size (1) [base category]	One for small farms, zero otherwise	0.13	0.33
es_2	Economic Size (2)	One for medium-small farms, zero otherwise	0.21	0.41
es_3	Economic Size (3)	One for medium farms, zero otherwise	0.28	0.45
es_4	Economic Size (4)	One for medium-large farms, zero otherwise	0.32	0.47
es_5	Economic Size (5)	One for large farms, zero otherwise	0.06	0.24
alt_1	Altimetry (1) [base category]	One if located in the plain, zero otherwise	0.24	0.42
alt_2	Altimetry (2)	One if located in the hill, zero otherwise	0.59	0.49
alt_3	Altimetry (3)	One if located in the mountain, zero otherwise	0.17	0.37
loc_1	Location (1) [base category]	One for farms located in the South, zero otherwise	0.12	0.33
loc_2	Location (2)	One for farms located in the Central, zero otherwise	0.25	0.43
loc_3	Location (3)	One for farms located in the Northeast, zero otherwise	0.32	0.47
loc_4	Location (4)	One for farms located in the Northwest, zero otherwise	0.31	0.46

Production refers to the total gross production of the grape, measured in euros. We use the monetary value of the output produced considering that grape growing in Italy evolved significantly towards higher-quality production (Urso et al. 2018). Land is measured in hectares and refers to the Utilised Agricultural Area (UAA). Capital is an aggregate, measured in euros, formed by working capital and real estate, less the farmland value to avoid problems of multicollinearity with land. Intermediate inputs, measured in euro, refer to expenditures on water, crop certification, fertilisers, pesticide, services, energy (fuel, electricity, and heating), marketing (materials, transport, and intermediation), and other generic expenses. Labour[4] refers to the total number of hours worked per year in grape growing.

To investigate the insurance's relation to production and efficiency we use expenses in crop insurance. Many previous studies used dummy variables to represent the farmers' insurance decisions (e.g., Horowitz and Lichtenberg 1993; Smith and Goodwin 1996). Similar to Weber et al. (2016) and Möhring et al. (2020b), we use the intensity of insurance (measured by the amount of insurance premiums paid) to capture changes in the input use at different levels of insurance expenditures. Given that a significant number of observed farms have no expenses in crop insurance, we added the value one for uninsured farms to obtain the logarithm and not to incur biased results as suggested by Battese (1997). Battese (1997) has also shown that simply adding a small number may not be the most appropriate solution and proposed the inclusion of a dummy variable that takes a value of one when the input, insurance in our case, is not used. If the coefficient of such a dummy is statistically significant, then the intercepts of insured and uninsured farms are not equal, and the absence of the dummy will provide biased results. Additionally, to mitigate possible omitted variables bias we include a set of variables referring to risk-management tools that are an alternative to insurance, namely irrigation and on-farm agricultural and non-agricultural diversification. Irrigation is the percentage of irrigated over total land. Non-agricultural diversification is a dummy variable taking a value of one when the farm is producing non-agricultural services (agritourism, educational, etc.) in addition to farming. Agricultural diversification is a dummy variable taking a value of one when the farm produces other crops or livestock in addition to grape, and the value zero otherwise. The inclusion of such different risk mitigating strategies in addition to insurance allows us to avoid omitted variables bias since the global effect of adapting different risk strategies is not necessarily equal to the effect of adopting each strategy separately (Wu and Babcock 1998).

We also included a set of variables to control for additional sources of heterogeneity due to the environmental and economic characteristics of the farm. As for the location of the farm, there are three dummy variables referring to altimetry (plain, hill, and mountain) and four dummy variables for farms located in the Southern, Central, North-eastern, and North-western regions. Economic size is defined based on standard output and is divided into

five classes: small (less than 25,000 euros), medium-small (25,000–50,000 euros), medium (50,000–100,000 euros), medium-large (100,000–500,000 euros), and large farms (over than 500,000 euros).

Table 2 shows the mean and standard deviation values of all variables included in the model, dividing the sample into insured and uninsured farms. As shown in Figure 1, production and input use are larger in terms of absolute value in insured than uninsured farms. Insured farms have a higher percentage of irrigated land, while there is no difference in the participation in both the agricultural and non-agricultural diversification strategies of the larger the economic size and the greater the percentage of insured farms. Finally, most of the insured farms are in the North-Eastern regions while insurance is less diffused in the South.

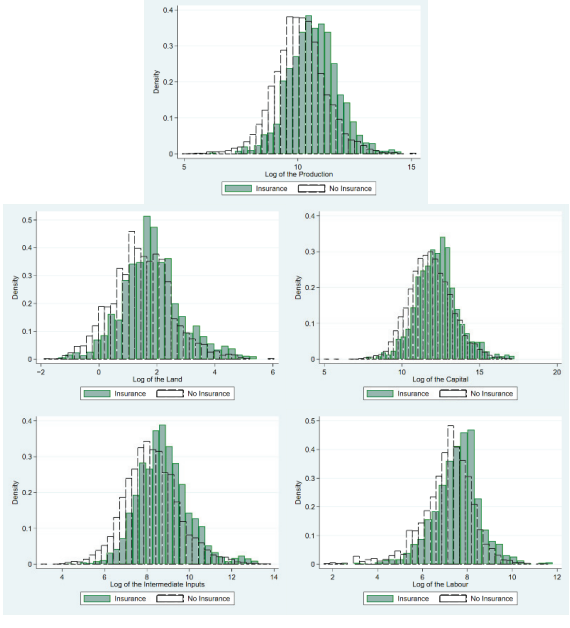

Figure 1. The graphs show the distribution of the mean values of the logarithm of output and input levels for insured and uninsured farmers over all observations from 2008 to 2017.

Table 2. Descriptive statistics (insured vs. uninsured farms).

Variable	No Insurance		Insurance	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Output and Inputs				
Production	50,024	130,627	83,761	151,990
Land	8.07	16.03	11.98	20.99
Capital	410,406	1,116,236	697,727	2,256,782
Intermediate Inputs	10,439	33,155	17,215	47,099
Labour	2146	3462	3399	7025
Risk Management Strategies				
Insurance	0	0	4110	10,489
Irrigation	0.24	0.41	0.39	0.47
Non-agricultural Diversification	0.11	0.31	0.11	0.31
Agricultural Diversification	0.74	0.44	0.73	0.44

Table 2. *Cont.*

Variable	No Insurance		Insurance	
	Mean	Standard Deviation	Mean	Standard Deviation
	Control Variables			
Economic Size (1)	0.15	0.35	0.07	0.25
Economic Size (2)	0.23	0.42	0.15	0.35
Economic Size (3)	0.28	0.45	0.29	0.45
Economic Size (4)	0.29	0.46	0.40	0.49
Economic Size (5)	0.05	0.22	0.09	0.29
Altimetry (1)	0.23	0.42	0.26	0.44
Altimetry (2)	0.62	0.48	0.49	0.50
Altimetry (3)	0.15	0.35	0.25	0.43
Location (1)	0.15	0.35	0.06	0.24
Location (2)	0.24	0.43	0.28	0.45
Location (3)	0.28	0.45	0.46	0.50
Location (4)	0.33	0.47	0.20	0.40

3.3. Empirical Strategies

The translog production frontier is specified as follows:

$$\ln y_{it} = \beta_0^{*} + \sum_k \beta_k \ln x_{kit} + 1/2 \sum_k \sum_j \beta_{kj} \ln x_{kit} \ln x_{jit} + \beta_{ins} \ln ins_{it} + 1/2\, \beta_{ins}{}^2 \ln ins^2{}_{it} + \sum_k \beta_{kins} \ln x_{kit} \ln ins_{it} + \beta_{irr}\, irr_{it} + \beta_{dn}\, d_{nit} + \beta_{da}\, d_{ait} + \beta_t\, t + 1/2\, \beta_{tt}\, t^2 + \sum_k \beta_{kt} \ln x_{kit}\, t + \beta_{tins} \ln ins_{it}\, t + v_{it} - u_{it} \quad (3)$$

where the dependent variable is the gross production of the i-th farm at time t. β are the parameters to be estimated. $\beta_0{}^{*}$ contain the effects of constant term and control factors, i.e., economic size, altitude, and location. Four inputs (x_{kit}) are included in the model: land, labour, capital, and intermediate inputs. Since the translog functional form, we also include inputs squares and interactions. In addition, we included the effect of the insurance expenditures (ins_{it}), its square, and the interactions with other inputs. The other risk management strategies, i.e., the percentage of irrigated land (irr_{it}) and the two dummy variables referred to non-agricultural (d_{nit}) and agricultural diversification (d_{ait}), are also included. Finally, a time trend (t) has been added to control for any technological change or innovations during the period analysed and to measure the effect of insurance on technological change (β_{tins}).

The variance of technical inefficiency is specified as follows:

$$\sigma^2{}_{uit} = \delta_0{}^{*} + \delta_{ins} \ln ins_{it} + \delta_{irr}\, irr_{it} + \delta_{dn}\, d_{nit} + \delta_{da}\, d_{ait} + \delta_t\, t + \omega_{it} \quad (4)$$

where the variance of the non-negative error term u_{it} is a function of expenditure in insurance (ins_{it}), irrigation (irr_{it}), non-agricultural (d_{nit}) and agricultural diversification (d_{ait}), and time trend (t) As before, $\delta_0{}^{*}$ includes the effects of constant term and other control factors, i.e., economic size, altitude, and location. The coefficient δ_{ins} indicates the effect of insurance on technical efficiency. Since we estimate an inefficiency effect, a negative sign indicates that insurance increases efficiency and vice versa.

Finally, to deal with the potential endogeneity of insurance, we need to identify proper instrumental variables. Valid instruments need to be correlated with the endogenous variables, insurance expenditure, but uncorrelated with the error or inefficiency terms. Enjolras et al. (2012) have shown that the cost of insurance, i.e., the premium per hectare, has an influence on the demand for crop insurance in Italy. At the same time, the decision to become insured does not affect the overall demand for crop insurance at the provincial level. Hence, the insurance premium paid by each farmer affects both the production and efficiency. On the contrary, the average insurance premium at the provincial level is correlated with the endogenous variable (insurance), but it is uncorrelated with the error or

inefficiency terms. Therefore, the average premium per hectare measured at the province level has been used to instrument insurance in the frontier and the efficiency equations.

As proposed by Karakaplan and Kutlu (2017a), another equation is estimated simultaneously to include the relationship between the endogenous variable, the instrumental variable, inputs included in the production frontier, time trend, and other risk-management tools. As in the previous equations, the effect of control variables is in the constant term.

4. Results

The endogeneity test indicates that insurance is endogenous, and correction is needed ($X^2 = 21.25$; $p < 0.0001$)[5]. Therefore, we implemented the IV panel approach as proposed by Karakaplan and Kutlu (2017a). First, we assessed the instrument's strength. The chi-squared statistic of the instrument in the prediction equation of insurance is 484.13, which is greater than 10 and passes the rule of thumb for not being a weak instrument. Additionally, we checked if the inclusion of the dummy variable is needed to allow for different intercepts for insured and uninsured farms and avoid biased results, as proposed by Battese (1997). The z statistic of the coefficient estimated for the dummy is −0.47 ($p = 0.635$). This indicates that the intercepts of insured and uninsured farms are equal, and the inclusion of the dummy is not necessary to obtain unbiased coefficient estimates.

The estimated parameters of the production frontier are presented in Table 3 while output elasticities with respect to inputs are calculated and reported in Table 4. Estimated output elasticities are statistically significant and positive for all inputs. The estimated elasticity of the time trend shows that there is a positive and significant technological change during the period under analysis.

Table 3. Production function.

Variable	Parameter	Estimate	Standard Error	z	P > |z|
		Inputs			
Land	β_1	0.3457	0.1447	2.39	0.017
Capital	β_2	0.3934	0.0898	4.38	0.000
Int. Inputs	β_3	0.2889	0.0806	3.58	0.000
Labour	β_4	−0.0158	0.0638	−0.25	0.805
Trend	β_t	−0.0196	0.0251	−0.78	0.437
Land^2	β_{11}	−0.0560	0.0238	−2.35	0.019
Capital^2	β_{22}	−0.0018	0.0087	−0.20	0.838
Int. Inputs^2	β_{33}	0.0124	0.0084	1.47	0.140
Labour^2	β_{44}	0.0031	0.0057	0.54	0.586
Trend^2	β_{tt}	0.0038	0.0015	2.61	0.009
Land ∗ Capital	β_{12}	0.0216	0.0112	1.94	0.053
Land ∗ Int. Inputs	β_{13}	0.0227	0.0109	2.09	0.036
Land ∗ Labour	β_{14}	−0.0075	0.0093	−0.81	0.420
Land ∗ Trend	β_{1t}	−0.0084	0.0035	−2.38	0.017
Capital ∗ Int. Inputs	β_{23}	−0.0297	0.0080	−3.72	0.000
Capital ∗ Labour	β_{24}	0.0072	0.0057	1.27	0.204
Capital ∗ Trend	β_{2t}	−0.0113	0.0021	−5.27	0.000
Int. Inputs ∗ Labour	β_{34}	−0.0026	0.0066	−0.39	0.694
Int. Inputs ∗ Trend	β_{3t}	0.0211	0.0026	8.14	0.000
Labour ∗ Trend	β_{4t}	−0.0015	0.0021	−0.71	0.479
		Risk-Management Strategies			
Insurance	β_{ins}	**0.0640**	**0.0260**	**2.46**	**0.014**
Insurance^2	$\beta_{ins}{}^2$	**0.0076**	**0.0019**	**3.92**	**0.000**
Land ∗ Insurance	β_{1ins}	**−0.0018**	**0.0034**	**−0.53**	**0.594**
Capital ∗ Insurance	β_{2ins}	**−0.0006**	**0.0020**	**−0.33**	**0.745**

Table 3. *Cont.*

Variable	Parameter	Estimate	Standard Error	z	P > |z|
Risk-Management Strategies					
Int. Inputs ∗ Insurance	β_{3ins}	**−0.0056**	**0.0027**	**−2.05**	**0.041**
Labour ∗ Insurance	β_{4ins}	**−0.0021**	**0.0020**	**−1.04**	**0.300**
Trend ∗ Insurance	β_{tins}	**0.0002**	**0.0007**	**0.32**	**0.750**
Irrigation	β_{irr}	0.0389	0.0301	1.29	0.196
Non-Agr. Diversification	β_{dn}	−0.0983	0.0350	−2.81	0.005
Agr. Diversification	β_{da}	−0.0731	0.0253	−2.89	0.004
Control Variables					
Medium-Small	β_{es2}	−0.0782	0.0371	−2.11	0.035
Medium	β_{es3}	−0.0781	0.0445	−1.75	0.079
Medium-Large	β_{es4}	−0.0493	0.0529	−0.93	0.352
Large	β_{es5}	0.0549	0.0792	0.69	0.488
Hill	β_{alt2}	0.1468	0.0288	5.10	0.000
Mountain	β_{alt3}	0.2830	0.0447	6.34	0.000
Centre	β_{loc2}	−0.1345	0.0385	−3.49	0.000
Northeast	β_{loc3}	0.1731	0.0388	4.46	0.000
Northwest	β_{loc4}	0.2391	0.0399	6.00	0.000
Constant	β_0	4.4803	0.6203	7.22	0.000

Note: The coefficients related to insurance expenditure are shown in bold.

Table 4. Output elasticity.

Variable	Estimate	Standard Error	z	P > |z|
Land	0.5926	0.0284	20.87	0.000
Capital	0.1427	0.0145	9.85	0.000
Int. Inputs	0.1312	0.0194	6.78	0.000
Labour	0.0358	0.0150	2.38	0.017
Insurance	0.1065	0.0156	6.85	0.000
Trend	0.0219	0.0056	3.98	0.000

The output elasticity with respect to insurance (ϵ_{ins}) has been calculated as the partial derivative of the logarithm of the production function with respect to the logarithm of the crop insurance expenditure:

$$\epsilon_{ins} = \delta \ln y_{it} / \delta \ln ins_{it} = \beta_{ins} + \beta_{ins}{}^2 \ln ins_{it} + \sum_k \beta_{kins} \ln x_{kit} + \beta_{tins}\, t \quad (5)$$

ϵ_{ins} mean value is positive and statistically significant, indicating an enhancing effect of insurance on production.

We are also interested in investigating whether insurance affects the use of inputs. We intend to analyse the substitutability between insurance and other inputs, i.e., the ability to substitute insurance for another input without affecting the output level, in more detail. The technical relationship between insurance and other inputs depends on the curvature of the isoquant. Measures of substitution possibilities between inputs are obtained with elasticities of intensity (Diewert 1974). As shown by Roll (2019) the elasticity of intensity between insurance and other inputs is given by:

$$\delta\, \epsilon_{ins} / \delta \ln x_{kit} = \beta_{kins} \quad (6)$$

where k are the inputs land, capital, intermediate inputs, and labour. Negative elasticity indicates a substitute relationship, while positive elasticity indicates a complementary one. We find that the coefficients of the interaction terms are all statistically non-significant apart from the interaction term between insurance and intermediate inputs, which is statistically significant, negative, but close to zero. This latter finding indicates that insurance is a very

weak substitute for intermediate inputs. This presumes right-angled isoquant with inputs used in nearly fixed proportions to each other. As for the interaction among inputs, the signs of these coefficients show that land is complementary for capital and intermediate inputs, while capital is a substitute for intermediate inputs. Finally, land and capital usage decreased over time, while the use of intermediate inputs increased. The parameter β_{tins} measures the effect of insurance on technological change. As seen from Table 3, this is found to be positive but not statistically significant, indicating that insurance expenditures have not affected the technological change. Regarding risk-management tools different from insurance, the percentage of irrigated land has a positive but not significant effect on production, while both agricultural and non-agricultural diversification negatively affect production in accordance with what was previously found (Vidoli et al. 2016). Furthermore, in terms of economic size, medium and medium-small farms are less productive with respect to the smaller farms. The production level grows with the growing of altimetry and farms located in the South produce more than farms located in the Centre and less than farms located in the North.

The results of the efficiency function are presented in Table 5. Since we are estimating the inefficiency function, a negative parameter indicates that the variables considered have a positive effect on technical efficiency. Like Roll (2019), our estimates show that insurance has an enhancing effect on efficiency. Irrigation has a statistically significant and positive effect on efficiency. This may be related to the fact that irrigation decreases the variability of yields, and hence the variability of income (Foudi and Erdlenbruch 2012) allowing farmers to invest to enhance efficiency. Agricultural and non-agricultural diversifications do have not a statistically significant effect on efficiency. The estimated parameter of the time trend indicates that efficiency decreased during the analysed period. This result may be due to some events such as pests, rainfall, and drought, etc., that negatively influenced the efficiency. As for economic size, the significant coefficient of the medium-smaller farms shows that this group of farms is more efficient than the smaller farms[6]. The coefficients of the other size classes are not statistically significant. This result could be due to the fact that there is an important presence of small and highly specialised farms in the market (Kim et al. 2012). Farms operating in Southern areas of Italy were found to be more efficient compared to the farms operating in Northern areas, similar to what was found by Urso et al. (2018). Finally, farms located in the hilly areas are less efficient compared to those located in the plain areas. There is no statistical difference in the mountain compared to the lowland areas.

Table 5. Inefficiency estimates.

Variable	Parameter	Estimate	Standard Error	z	P > |z|
Insurance	$\mathbf{\delta_{ins}}$	−0.0226	**0.0111**	**−2.03**	**0.042**
Irrigation	δ_{irr}	−0.2783	0.1188	−2.34	0.019
Non-Agr. Diversification	δ_{dn}	−0.0119	0.1168	−0.10	0.919
Agr. Diversification	δ_{da}	0.0416	0.0931	0.45	0.655
Trend	δ_{t}	0.0617	0.0134	4.62	0.000
Medium-Small	δ_{es2}	−0.2647	0.1176	−2.25	0.024
Medium	δ_{es3}	−0.1670	0.1212	−1.38	0.168
Medium-Large	δ_{es4}	−0.0034	0.1260	−0.03	0.978
Large	δ_{es5}	0.0881	0.2024	0.44	0.663
Hill	δ_{alt2}	0.4653	0.1271	3.66	0.000
Mountain	δ_{alt3}	−0.1931	0.1878	−1.03	0.304
Centre	δ_{loc2}	−0.0439	0.1586	−0.28	0.782
Northeast	δ_{loc3}	0.4336	0.1553	2.79	0.005
Northwest	δ_{loc4}	0.2443	0.1593	1.53	0.125
Constant	δ_{0}	−1.6218	0.2227	−7.28	0.000

Note: The coefficients related to insurance expenditure are shown in bold.

5. Discussion

This article aims to clarify the effect of expenditure in crop insurance on the production, technical efficiency, and input use of commercial grape-growing farms in Italy. Crop insurance might be an important tool for enhancing farm performances by reducing suboptimal input use (Ahsan et al. 1982; Nelson and Loehman 1987; Ramaswami 1993). On the contrary, insurance adoption may lead to inefficient farming actions driven by moral hazard, which causes non-optimal economic results (Horowitz and Lichtenberg 1993; Kirkley et al. 1998; Quiggin et al. 1993).

The net result of risk reduction and moral hazard effects on input use and output is indeterminate and remains an empirical issue. Our study intends to add to this stream of the empirical literature. We focus on the Italian grape growers' sector because it is the type of farming with the highest participation in the crop insurance program in Italy (ISMEA 2018). Using FADN data, we estimated the impact of crop insurance on input use, production, and efficiency by using the endogenous panel stochastic frontier model proposed by Karakaplan and Kutlu (2017a).

Similar to Roll (2019), our results show that insurance has a boosting effect on both production and technical efficiency. With regards to the insurance effect on input use, we find that insurance does not have a statistically significant impact on labour, land, and capital while it has a significant influence on the use of intermediate inputs. The non-significant effect on labour and land was expected as labour is a quasi-fixed input in household farms and the quantity of land is fixed in the short-medium term in the case of perennial crops as grapevines. The results on land are not in line with those of Enjolras and Aubert (2020), who found a reduction in land allocated to grape production in France. Moreover, the statistically insignificant effect on capital does not confirm the enhancing investment effect of insurance found by Vigani and Kathage (2019) in French and Hungarian farms specialising in wheat. Finally, the negative, significant effect of insurance on intermediate inputs indicates that insurance is a substitute for intermediate goods. In our sample, most of the expenses in intermediate inputs are tied to the purchase of crop protection chemicals. Hence, the choice to purchase intermediate inputs in our sample is largely dominated by the choice about the use of crop defence chemicals, i.e., fungicide, pesticides, and herbicides. Our results contribute to the growing literature on the intensive margin relations of insurance and pesticide use (Horowitz and Lichtenberg 1993; Quiggin et al. 1993; Smith and Goodwin 1996; Babcock and Hennessy 1996; Möhring et al. 2020a, 2020b), showing that, contrary to that which was found by Enjolras and Aubert (2020) in France, in the case of grape production in Italy, insurance decreases the intermediate input use while increasing output. Our results differ from that which was previously found by Enjolras and Aubert (2020) in the case of French grape growers (no insurance effect on chemical inputs) and by Möhring et al. (2020b) for French arable crops (insurance's positive effect on pesticides use). This highlights that insurance and pesticide policies need to account not only for the heterogeneity of pesticide type as showed by Möhring et al. (2020a), but also the heterogeneity due to the specific condition in which each sector operates (Goodwin et al. 2004). Hence, it is not possible to give a policy indication based on the observation of what happens in a single sector (Möhring et al. 2020b).

The causes of the changes found in input use and supply, as explained in Section 2, can be the risk reduction and moral hazard effects induced by insurance. As for the risk reduction effect, as described in earlier work by Ahsan et al. (1982), a Pareto optimal insurance program that provides full coverage has a risk-reduction effect which causes risk-averse farmers to reduce (increase) the use of risk-decreasing (increasing) inputs toward (away from) the optimal level of risk-neutral farmers and improve (reduce) output. However, in reality, crop insurance is often affected by information asymmetries (Just et al. 1999) that lead to opportunistic behaviour. Under such circumstances, farmers undertake actions that change the probability of loss relative to what the losses might be if the farmer were uninsured, in this way deviating from Pareto optimality (Nelson and Loehman 1987). Moral hazard reduces the use of all inputs and decreases mean output (Ramaswami 1993).

Therefore, the net effect of the two adjustments induced by insurance depends on the degree of farmers' risk aversion and the effect of the input on the probability of low yields (Horowitz and Lichtenberg 1993; Ramaswami 1993; Babcock and Hennessy 1996).

As for the risk preferences of grape growers, previous work has shown they are risk averse (Aka et al. 2018). This risk-averse attitude is mainly due to the existence of sunk costs related to high investments in land and capital equipment. In consideration of this aversion to risk, the increase in output found in this study suggests that in the case of grape production, the risk reduction effect dominates the moral hazard effect. In other words, the reduction in input use induced by insurance can be interpreted as a re-optimisation of input use rather than the effect of moral hazard. This conclusion is supported by the fact that when crop insurance targets specific weather hazards, such as insurance contracts in use in Italy and France, moral hazard does not play an important role as a driver of intensive margin effects (Möhring et al. 2020b) because there are hardly any agronomical adjustments possible to cause an insurance pay-out (Quiggin et al. 1993). Moreover, the decision to participate in a crop-insurance program must be made before the beginning of the season to avoid an opportunistic farmer taking out insurance after the observation of unfavourable conditions (Aubert and Enjolras 2014).

The decrease in the use of chemicals induced by insurance in grapevine production in Italy is good news for the success of the EU Commission's strategy aimed at reducing pesticide use. Grape production is characterised by the highest level of pesticide use per hectare (Aka et al. 2018) mainly fungicide (Mailly et al. 2017), followed by insecticides and herbicides. At the same time, the grapevine is the agricultural sector where insurance has been widely adopted both in the EU and Italy (ISMEA 2018). The reduction in the use of defence chemicals induced by insurance can contribute both to reducing production costs and external costs attributed to farmers' health and environment, in addition to preventing pest resistance (Wilson and Tisdell 2001). Moreover, the relevant increase in intermediate input used during the period analysed may be associated with the impact of global warming on grapevine regions (Mozell and Thachn 2014). For example, it may be reasonable for the overuse of pesticides due to the increase in insects and insect-borne diseases. Therefore, insurance may have the potential to be an instrument that contributes to the reduction in environmental and health adverse effects derived from the risk-averse farmers' suboptimal input allocation (Möhring et al. 2020b).

Furthermore, the input use optimisation due to insurance adoption may also explain the increase in efficiency. By changing the use of inputs, insurance allows risk-averse grape growers to decrease the use of efficiency-reducing inputs due to the uncertainty of outcomes. Additionally, insurance may provide farmers with the possibility to invest in efficiency-improving practices. For example, grape growers may invest in precision agriculture to predict the field-specific optimum requirement of resources such as irrigation, fertilisers, pesticides, and herbicides (Bhakta et al. 2019). Likewise, they may change the rate of replanting perennial crops, thereby affecting the age distribution of the orchard and the yield. Moreover, improvement in efficiency may also be related to the fact that insurance allows farms to specialise in insured crop production (Ahsan et al. 1982) since they do not have to diversify to manage their idiosyncratic risk (Roll 2019)

Finally, our findings show the requirement to treat endogeneity of insurance to estimate unbiased parameters. The importance of considering endogeneity is due to different aspects. First, the endogeneity test provided by Karakaplan and Kutlu (2017b) shows the endogeneity presence due to self-selection and reverse causality in our model. Second, the significance of the substitution effect between insurance and intermediate input use shows that the adoption of the translog specification is also necessary. Lastly, the significance of the coefficients of the variables referred to the risk management tools alternative to insurance underlines the importance of including them to avoid omitted variables bias.

6. Conclusions

This article analysed how insurance affects the production decisions of commercial grape-growing farmers in Italy through the estimation of an endogenous panel stochastic frontier. More specifically, we investigated the crop insurance's effect on production, technical efficiency, and input use in Italian grape-growers' farms. Similar to Roll (2019), our findings show that insurance has a positive impact on production and efficiency, while it reduces the use of intermediate inputs. These results are fully consistent with neoclassic theory and indicate that insurance can play an essential role in the reduction of suboptimal input use due to the presence of uncertain outcomes. The increase in output found in this study suggests that in the case of grape production in Italy, the risk reduction effect dominates the moral hazard effect. In other words, the reduction in input use induced by insurance can be interpreted as a re-optimisation of input use rather than the effect of moral hazard. Furthermore, the input use optimisation due to insurance adoption may explain the gain in efficiency. Finally, we find that controlling for endogeneity in the causal relationship between insurance and production is needed to avoid biased parameters estimates.

A limitation of the study is related to the not fully reliable data in terms of labour. First, there is a high rate of missing values in hours worked in grape growing in during the years 2008 to 2010. Second, data referring to labour generally contain measurement errors because of the presence of factors such as illegal employment. Last, we have not considered the quality of labour distinguishing, for example, between skilled and unskilled labour or family and hired labour.

The main limitation of the study, though, is due to the different risk profiles of inputs included in the intermediate inputs that do not allow us to investigate the effect of insurance on the use of input with different attributes.

Since the substitution effect between insurance and intermediate inputs and the different nature of the inputs included in this variable in this study, further studies are needed to investigate the relationship between insurance and specific intermediate inputs used in the grape-growing sector.

Our findings have several policy implications. First, our results differ from that which was previously found in different crops and countries. This suggests that insurance and pesticide policies need to account for heterogeneity due to the specific condition in which each sector operates. Hence, it is not possible to give a policy indication based on the observation of what happens in a single sector. Second, the decrease in the use of intermediate inputs induced by insurance is good news for the success of the EU Commission's strategy aimed at reducing pesticide use. Insurance can contribute to reducing the external costs attributed to farmers' health and environment, in addition to preventing pest resistance.

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Notes

1 This paper defines "quality grapevines" as those certified by the EU quality certification scheme.

2 Proofs and more technical details are provided in (Karakaplan and Kutlu 2017a, 2017b).

3 In the FADN the "standard output" (SO), of an agricultural product (crop or livestock) is the average monetary value of the agricultural output at farm-gate price. The SO excludes direct payments, value added tax and taxes on products.

4 In total, 27% of the observations for the total number of hours worked on grape growing were missing in the sample. Most of these missing values are related to some specific years and provinces. When the information of farm labour was available for a specific farm in at least one year, then the missing value has been replaced by the hours obtained based on the proportion between hours worked on grape growing and total hours worked on the farm. When hours worked on grape growing were missing in all years for one farm, we replaced them with an approximation based on year and location (province, region, and altimetry) specific mean.

5 A test similar to the Durbin–Wu–Hausman test has been used to assess the correlation between the instrumented variables and the two-side error term vit. This test examines the joint significance of the components of the bias correction terms (see Karakaplan and Kutlu 2017a, 2017b for more details). If the bias correction terms components are not jointly significant, one would conclude that correction for endogeneity is not necessary, and the variables can be estimated by the traditional frontier models.

6 Please note that being more efficient does not necessarily imply that farms are more productive. In fact, technical efficiency is a part of productivity, along with technical change and scale economies (Coelli et al. 2005). We find that smaller farms are more productive but less efficient than the medium-small farms. The explanation of such differences in the productivity and efficiency of different size classes deserves a specific study that is beyond the scope of our analysis.

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Spatial Market Integration: A Case Study of the Polish–Czech Milk Market

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Abstract: Analyses of spatial market integration contributes to the knowledge about market efficiency and provides information to policymakers, as the spatial integration of markets contributes to competitiveness and economic development. Although the integration of agri-food markets is widely discussed in the economic literature, research on the dairy sector is relatively limited. This paper fulfils the research gap with an in-depth investigation of spatial milk and dairy product market integration between two neighboring countries—Poland and Czechia—using regional data, and including both production and processing levels. The econometric analysis of time series covering the period 2001–2021 reveals that only long-run milk and skimmed milk powder (SMP) price relationships are between the Czech Republic and Poland. The results of the study confirm that the factors influencing spatial price relationships between the Czech Republic and Poland are: strong trade ties, the common moment of accession to the EU, a close distance between markets, and region specialization.

Keywords: spatial integration; market; cointegration; milk; dairy products; Poland; Czechia

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1. Introduction

The dairy sector is one of the major contributors to the agri-food economy in the European Union (EU). According to Eurostat (2021a), milk production represents 14% of total agricultural output and the manufacture of dairy products contributes 18% to the total food production value and 17% to the total food industry turnover (Čechura and Kroupová 2021). Poland is one of the five major European milk producers, accounting for 8% of total European milk production (Eurostat 2021a) and contributing 5% to European dairy production (Eurostat 2021b). Since supply exceeds consumption in the Polish dairy market, Poland is one of the European member states considerably contributing to the EU dairy export (Ministry of Agriculture, Nature and Food Quality 2018). Polish exports are mainly oriented towards the European market and among member states; Germany, with 19% of the Polish dairy export value, the Czech Republic (6%), and Italy (5%) are the main recipients of Poland's dairy products (Ministry of Agriculture, Nature and Food Quality 2021). For the Czech Republic, imports of Polish milk and dairy products account for 25% of all imports of milk and dairy products. Moreover, 6% of Czech exports of milk flows to Poland. With these shares, Poland is the Czech Republic's second most important foreign partner (after Germany) on the milk market. Cheese dominates the volume and the value of imports from Poland to the Czech Republic (Ministry of Agriculture of the Czech Republic 2021) and in the value of exports to Poland from the Czech Republic, while milk dominates in volume (Czech Statistical Office 2021).

Similarly to Poland, milk and dairy products historically generate a significant proportion of the Czech agri-food sector output (Zdráhal and Bečvářová 2018). Moreover, the dairy sectors in Poland and Czechia were shaped by the same major events; namely the adoption of the market mechanism in 1989, the accession to the EU in 2004, and the

abolishment of the dairy quota in 2015 (Sobczyński et al. 2015). The adoption of the market mechanism in 1989 fundamentally changed the dairy sector, and both countries faced an initial contraction of milk production; it decreased from 15,860 ths tonnes in Poland, and 4946 ths tonnes in Czechia, in 1989, to 11,927 ths tonnes in Poland, and 2725 ths tonnes in Czechia, in 2003 (Eurostat 2021c). After the accession to the EU on 1 May 2004, milk production began to increase slowly within the limits permitted by the Common Agricultural Policy (CAP). Production reached 13,002 ths tonnes in Poland and 2934 ths tonnes in Czechia in 2014. After the abolition of the milk quotas in April 2015, production continued to increase, reaching 14,831 ths tonnes in Poland, and 3268 ths tonnes in Czechia, in 2020 (Eurostat 2021c). All of this period can be characterized by a considerable decrease in the number of dairy cows. Since 1999 the number of dairy cows has decreased by 35% in both countries (Eurostat 2021d). Despite this considerable decrease in the dairy cow herd, the level of milk production confirms that the yield per cow has been steadily increasing since 1990 (Čechura et al. 2021).

However, the Polish and Czech dairy sectors are quite heterogeneous regarding size and industrial structure (Philippidis and Waschik 2019). In the Czech Republic, milk production is carried out by large farms. According to Farm Accountancy Data Network (FADN 2021), the average Czech farm specializing in milk production had 117.2 LU (livestock unit) of cows, with a milk yield of 7872 kg/cow, in 2019. Conversely, in Poland, the average farm specializing in milk had 17.3 LU of cows with a milk yield of 5901 kg/cow. It should be noted that more than 2/3 of Czech milk production is produced by farms with mixed production (crops and livestock). While the high degree of diversification allows minimization of the potential risks arising from the dynamics of development on individual commodity markets (Bórawski et al. 2020a highlighted the price volatility in the milk market), specialization of farms can bring the advantage of more knowledge and a higher level of skills (Trnková and Kroupová 2020; Zdráhal and Bečvářová 2018). The low specialization, together with the predominant localization of Czech milk production to less favorable areas, is considered to be the reason why Czech milk production is characterized by significantly higher technical inefficiency than Polish production (Trnková and Kroupová 2020; Rudinskaya et al. 2019). Furthermore, the catching up of Polish best practice is leading to an increase of Polish competitiveness on the international milk and dairy market (Sobczyński et al. 2015), while Czech milk production exhibits a decreasing trend in productivity and competitiveness (Čechura et al. 2021). Technical efficiency and productivity are also important for facing price volatility, which has gained momentum as a result of market liberalization (Thorsøe et al. 2020). According to Bórawski et al. (2020b), the prices for milk paid to farmers have become the most important element of the market, shaping the production of milk and dairy products after the quota abolishment. Milk production has developed well in countries and regions that have met the requirements of the common market and have been competitive.

The regional differences are visible in milk production and processing in both countries. Thorsøe et al. (2020) considers the regional polarization a consequence of dairy market liberalization. Since quotas had limited structural adjustment—in other words, limits to the market mechanisms that force milk production to move to regions with favorable environmental and economic conditions—milk production began to concentrate in regions with a mild climate and a high proportion of grassland after quotas were abolished, as these regions have a comparative advantage. In recent years, 79% of milk production has taken place in six regions (voivodships) from 16 regions of Poland: Mazowieckie (22%), Podlaskie (21%), Wielkopolskie (13%), Warmińsko-Mazurskie (8%), Kujawsko-Pomorskie (8%), and Łódzkie (7%) (Statistics Poland 2021), see Table 1. These voivodships have developed processing capacity (dairies and dairy cooperatives are concentrated there according to Zuba-Ciszewska 2018), the transportation distance from farmers to processors is relatively short, and they are located close to major cities with considerable consumption capacities (Sobczyński et al. 2015). In the Czech Republic, 71% of milk production is gained from six regions (see Table 1), namely: Vysočina (19%), Prague and Central Bohemia (13%),

South Bohemia (11%), Pilsen (11%), Pardubice (9%), and Hradec Králové (8%) (Ministry of Agriculture of the Czech Republic 2020). Similarly to Poland, these are regions characterized by short distances to processing capacities, close to agglomerations and also to the border, especially with Germany and Poland.

Table 1. Raw milk production (the percentage share of total raw milk production in 2020).

Poland	**%**	**Czechia**	**%**
Mazowieckie	22	Vysočina	19
Podlaskie	21	Prague and Central Bohemia	13
Wielkopolskie	13	South Bohemia	11
Warmińsko-Mazurskie	8	Pilsen	11
Kujawsko-Pomorskie	8	Pardubice	9
Łódzkie	7	Hradec Králové	8
Lubelskie	6	Olomouc	7
Pomorskie	3	South Moravia	6
Malopolskie	2	Moravian-Silesian	6
Opolskie	2	Zlín	5
Ślaskie	2	Liberec	2
Świetokrzyskie	2	Ústí nad Labem	2
Dolnoślaskie	1	Karlovy Vary	1
Zachodniopomorskie	1		
Podkarpackie	1		
Warszawski stoleczny	1		
Lubuskie	1		

Source: own study based on Statistics Poland (2021) and Ministry of Agriculture of the Czech Republic (2020).

This paper empirically explores the linkages existing between the Polish and Czech milk and dairy product markets, i.e., between markets that are characterized by geographic proximity; this proximity leads to significant foreign trade flows not only in a homogeneous raw material such as milk, but also in homogeneous dairy products (butter, Edam, SMP). The spatial integration of these markets, which can be understood as the flow and transmission of goods and price information across spatially separated markets (Pan and Li 2019), takes place through two channels: (i) the trade flow of unprocessed raw milk and (ii) the trade flow of processed goods—dairy products. The horizontal type of integration has received substantial attention among academics and policymakers over the past decades. The interest in the analysis of the interrelations between geographically separated objects is motivated by the potential welfare and policy implications (Roman 2020). The spatial price behavior of the homogenous product is an important indicator of overall market performance (Kumar and Mishra 2017). Since producer decisions are based on market price information, poorly integrated markets may convey inaccurate price information, leading to inefficient product movements and sub-optimal allocation of resources (Goodwin and Schroeder 1991); this is connected with a reduction in the possibility for a full specialization of countries or regions (Jacks et al. 2011). Poorly integrated markets also choke on the prospective gains from technological change, since without good access to distant markets that can absorb excess local supply, firms' adoption of improved production technologies will tend to cause producer prices to drop; this erases the gains from technological change and thereby dampens incentives for firms to adopt new technologies that can stimulate economic growth (Barrett 2008; Hou and Song 2021). In contrast, strong spatial integration brings benefits. A well-integrated market allows for efficient movement of trade flow that

stabilizes market prices and reduces the price risk, thanks to flows of surplus to locations characterized by deficits (Gitau and Meyer 2018). According to Hamulczuk et al. (2019), the factor-price equalization theorem stemming from the Heckscher–Ohlin model argues that the full integration of spatially separate product markets should lead to the spatial integration of markets of production factors; consequently, there should be equalization in the wages of workers, rents earned on capital, and prices of land throughout geographically separated objects (e.g., regions or countries). Serra et al. (2006) sum up the benefits of spatial market integration as improvement in the efficiency of resource allocation, reduction in social costs, and maximization of social welfare. Contrarily, spatial market segmentation represents self-sufficiency without trade, has negative effects on the healthy development of markets, increases the deadweight loss incurred by society, and reduces overall economic efficiency (Pan and Li 2019). The benefits of market integration have also been recognized by policymakers and, to facilitate the spatial integration of agri-food markets within the individual member states, enhancing price discovery mechanisms has become one of the most important targets of the European Union's (EU) Common Agricultural Policy (CAP) (Bakucs et al. 2019).

Agri-food market integration has been discussed extensively in the economic literature (e.g., Serra et al. 2006; Frederico 2007; Ihle et al. 2012; Gitau and Meyer 2018; Sobczak et al. 2018; Hamulczuk et al. 2019), both because of the specific nature of agri-food products—which are characterized by seasonality, perishability, and specific production requirements—and because of the importance of agri-food market integration, as the market efficiency associated with integration enhances the development of rural areas. For example, seasonal production of milk cause seasonality of milk and dairy product prices. According to Kussaiynor and Zhakupova (2019), the prices of milk and dairy products remain high in autumn and winter and decrease in spring and summer. Milk market integration was previously analyzed, especially at the level of vertical market integration (e.g., Fallert et al. 1978; Fałkowski 2010; Serra and Goodwin 2003; Reziti 2014; Kharin 2018; Antonioli et al. 2018; Bełdycka-Bórawska et al. 2021; Bórawski et al. 2021). Research on the spatial integration of the milk market is relatively less frequent (e.g., Goodwin et al. 1999; Jha et al. 2013; Fousekis and Trachanas 2016; Fousekis 2018; Chalmers et al. 2019; Jaramillo-Villanueva and Palacios-Orozco 2019; Xue et al. 2021). Moreover, the results of these studies cannot be generalized, due to their diversity in terms of methodology, commodities, periods, and countries.

The most important studies that evaluated the spatial integration of milk and dairy product markets in the EU are listed in Table 2. The majority of these studies evaluate market integration employing the price method based on the Law of One Price (LOP) and national price data.

A focus on Poland's milk market (Bakucs et al. 2010) investigated the retail milk price integration in Poland and Hungary between April 1997 and March 2009, employing a Vector Error Correction Model (VECM) and a Threshold Error Correction Model (TECM). Their results confirm neither strong nor weak conditions of the Law of One Price, suggesting that milk price integration between Hungary and Poland is not perfect. More recently, Bakucs et al. (2019) confirmed this result by employing Vector Autoregression Models (VAR) to analyze the spatial integration of the milk market based on a monthly series of raw cows' milk prices from January 2000 to February 2014 in 20 European member states; they found that the so-called New Member States were less integrated compared to the Old Member States and Euro Area member states. Their results also revealed that milk price cointegration is less pronounced than cointegration in other agricultural sectors (e.g., pork prices), and also raised questions about the applicability of national price data. Although the authors believe that regional prices would almost certainly change the results, few studies employed regional price data to analyze spatial market integration of milk and dairy products. One of these studies is by Roman (2020), and assesses the processes of spatial integration on the Polish raw milk market in the period 1999–2018. Her results confirmed a long-term balance between prices in various voivodeships in Poland

and the role of distance—the closer the voivodeships are to one another, the greater the co-variability of prices is between them. Moreover, she found that Poland's integration processes were associated with: a strong concentration of milk production; the elimination of the smallest farms; investments to improve the competitiveness of dairy farms and processing enterprises; and the association of farmers in producer organizations, in the analyzed period.

Table 2. Empirical studies of spatial milk market integration in Europe.

Study	Commodity	Level	Country	Years
Bakucs et al. (2019)	raw milk	national	AT, BE, CZ, DE, DK, ES, FI, FR, HU, IE, IT, LV, LT, NL, PL, PT, RO, SK, SW, UK	2000–2014
Bakucs et al. (2010)	milk	national	PL, HU	1997–2009
Bakucs and Fertö (2007)	milk	regional	HU	2004–2006
Domagała (2020)	SMP	national	PL, OC, BE, CZ, DE, IE, LV, NL	2004-2016
Domagała (2021)	butter	national	PL, BE, CZ, DE, IE, LT, NL, SK, IT, FR	2004-2017
Hillen and von Cramon-Taubadel (2019)	raw milk, butter, milk powder, cheese	national	DE, CH	2006–2015
Katrakilidis (2008)	raw milk	national	BE, DE, DK, FR	1980–2003
Klepačka et al. (2021)	butter and curd	regional	PL	2010–2017
Roman (2017)	butter	national	BE, CZ, DE, FR, IR, IT, LV, NL, PL, SK, UK	2007–2016
Roman and Roman (2020)	raw milk	national	AT, BE, BG, CZ, CY, DE, DK, EE, EL, ES, FI, FR, HU, IE, IT, NL, LT, LU, LV, PL, PT, SI, SK, SW, UK	2005–2018
Roman (2020)	raw milk	regional	PL	1999–2018
Tłuczak (2012)	raw milk	national	CZ, DE, FR, PL, SK	2004–2010

Note: AT = Austria, BE = Belgium, BG = Bulgaria, CH = Switzerland, CY = Cyprus, CZ = Czechia, DE = Germany, DK = Denmark, EE = Estonia, EL = Greece, ES = Spain, FI = Finland, FR = France, HU = Hungary, IE = Ireland, IT = Italy, LV = Latvia, LT = Lithuania, LU = Luxembourg, NL = the Netherlands, OC = Oceania, PL = Poland, PT = Portugal, RO = Romania, SI = Slovenia, SK = Slovakia, SW = Sweden, UK = the United Kingdom.

Instead of the monthly prices used by Roman (2020); Klepačka et al. (2021) used weekly observations from 3 January 2010 to 5 November 2017, to test butter and curd market integration between two neighboring regions with large dairy sectors in Poland (Northern and Central region). Butter and curd have been chosen for their contrasting characteristics: high storability of butter and high perishability of curd. Employing VECM they found that both regions (the surplus-producing North, and the Central with its deficit) were highly integrated in the butter market. Furthermore, based on impulse response analysis, they revealed that the effect of shocks on butter prices was mostly absorbed in two weeks, and prices returned to full equilibrium in about four to five weeks. Contrary to butter, the adjustment of curd prices in one region in reaction to prices in the other region was almost unnoticeable, and the prices of curd seem not to be integrated. The causes of the observed lack of spatial curd price integration could be related to the relatively low price of curd as compared to butter. It seems that the dairy processors adjust curd production after allocating raw milk to the production of butter or other, relatively higher value products.

The relationship between the Polish and the Czech milk markets was investigated by Tłuczak (2012) who also explored the trade linkages existing between the Polish and the Slovakian/German/French raw milk markets. Applying Vector Autoregressive Models to data from May 2004 to October 2010, she found that milk prices in Poland were dependent on prices in the Czech Republic, Germany, France and Slovakia, while milk prices in the Czech Republic were not dependent on Polish prices. The relationship between the Polish and the Czech raw milk markets (among 24 other member states) was also investigated by Roman and Roman (2020). Employing the VAR model on monthly raw milk prices in 2005–2018, the authors revealed that the Polish and the Czech raw milk markets were integrated and this linkage was strengthening over time. Moreover, contrary to Tłuczak (2012), they confirmed the bidirectional causality of raw milk prices in Poland and Czechia; however, the key countries determining the price variation in Poland were Germany, Ireland, France, and Slovakia. Integration of the Czech and the Polish markets can also be observed at the level of dairy products. The degree of association between butter prices in Poland and the Czech Republic among 10 selected EU countries using monthly prices was examined by Roman (2017) for the period 2007–2016. Her results confirmed the strong integration of the Czech and the Polish butter prices in the period 2012–2016, and also revealed evidence for the bidirectional causality of butter prices in Poland and Czechia.

It is clear that there is a gap in the research on the assessment of market integration between neighboring EU countries such as Poland and the Czech Republic, where milk production is a traditional part of agri-food production. Filling this research gap requires an analysis of market integration based on regional data, as existing research highlights that the degree of integration is influenced by geographical distance. At the same time, it is appropriate to analyze integration at multiple levels of the value chain. On this basis, this paper attempts to fill a gap in the research on spatial market integration by (i) analyzing spatial market integration between neighboring countries based on regional data; (ii) analyzing market integration on both levels of the value chain—the raw milk market and the processed milk market. The results of this analysis provide important information for the decision-making sphere. Knowing the level of regional market integration allows policy instruments to be targeted to support the building of regional comparative advantage and to promote regional economic development.

The aim of this paper is to assess the spatial integration processes on the milk and dairy product market between Poland and the Czech Republic. As part of the main aim, the authors have sought answers to the following questions: What is the long-run dependence between milk and milk product prices in Poland and the Czech Republic? Is there a long-run balance of milk prices in different regions of Poland and the Czech Republic? In which regions do milk prices have a dominant influence on prices in other areas of Poland and the Czech Republic? What is the direction of the dependence of dairy product prices?

The rest of the paper is organized as follows: Section 2 provides the theoretical background of the spatial market integration; Section 3 introduces the research methodology and datasets; Section 4 presents the results of this study and its discussion; and Section 5 summarizes our findings and provides concluding remarks.

2. Theoretical Background

Market integration is a multi-dimensional concept that relates to the flow of goods and information across space, time, and form (González-Rivera and Helfand 2001). The first definition of this concept is attributed to Cournot ([1838] 1897) who stated that an integrated market is an entire territory, the parts of which are so connected by relations of unrestricted trade that prices readily and quickly take the same level throughout the territory. In line with the definition, market integration has three dimensions: vertical (along the supply chain), horizontal (between locations) and intertemporal (between the spot and future or forward markets) (Hamulczuk et al. 2019; Goodwin et al. 2021).

The concept of horizontal or spatial market integration, which is what this paper focuses on, is based on the spatial arbitrage theory and the Law of One Price (McNew

1996). The process of spatial arbitrage between two spatially separated competitive markets each having their own supply and demand for a homogenous good is described by Van Campenhout (2007) as a process of clearing a common market. If local prices of the homogenous good (P_i and P_j) differ between the two markets by more than the cost of transferring the goods between these markets (T_{ij}): $|P_i - P_j| > T_{ij}$, where i and j indicate two spatially separated markets, arbitrageurs will exploit the profit-making opportunities by shipping the good from the market with the low price (P_j) to the market with the high price (P_i). This transfer of goods will increase the demand for goods in the low-price market while increasing supply in the high-price market. The increase in demand with unchanged supply in the low-price market will drive up the price (P_j), while the increased supply at a given level of demand will decrease the price (P_i) in the high-price market. The process of arbitrage will continue until actual prices differ by exactly T_{ij} (Van Campenhout 2007) and arbitrage opportunities are zero (García-Hiernaux et al. 2016). That is, the spatial arbitrage ensures a reaching of unique equilibrium, where local prices in spatially separated markets differ by no more than transportation and transaction costs (Goodwin and Schroeder 1991); these may be determined by, for example, the distance between markets, quality and quantity of transport infrastructure, search costs, and market risk (Svanidze et al. 2021), and no profiting opportunities that would be exploited by arbitrageurs exist (Listorti and Esposti 2012). The lack of arbitrage opportunities is reflected in market efficiency (Dwyer and Wallace 1992). As Frederico (2007) adds, the market is defined as efficient if prices take into account all publicly available information, and there are no opportunities for profit from the exploitation of some information.

The consequence of spatial arbitrage is the Law of One Price, defining that homogeneous goods tend to have the same net price of transportation and transaction costs, when the prices are expressed in the same currency, in markets linked by trade and arbitrage (Fetter 1924). As Hamulczuk et al. (2019) added, the definition of the LOP presented above can be viewed as a weak (relative) notation of the LOP, that can be defined as $P_{i,t} - P_{j,t} = T_{ij,t}$, where t denotes time (Baulch 1997). The strong (absolute) notation does not take into account transfer costs, and assumes full and immediate price transmission with zero price differences, that is: $P_i = P_j$ in any time t (Hamulczuk et al. 2019; García-Hiernaux et al. 2016). The LOP can be viewed as a criterion of market integration (Gluschenko 2021), and an important condition for the efficient functioning of markets under assumptions of the lack of: trade barriers, market power, product heterogeneity and perishability, exchange rate risks, and imperfect flow of information (Listorti and Esposti 2012). A violation of the LOP is an instance of inefficiency which may delay specialization according to the comparative advantage and, thus, cause welfare losses (Frederico 2007).

In this paper, the LOP is applied to analyze the spatial integration of Poland and Czech milk and dairy product markets. According to Van Campenhout (2007) and Frederico (2007) we define these markets as integrated if prices in these countries are determined simultaneously in the long-run, since the dynamics of economic processes can lead to temporary deviations from equilibria (e.g., due to seasonality of agricultural commodities McNew 1996); this means that in the short-run, price differences may exceed the transfer costs in competitive markets (Roman 2020). Two relevant mechanisms are behind this price adjustment: physical trade of the good, and information flow that occurs between the locations (Hamulczuk et al. 2019); according to Listorti and Esposti (2012), the information flow might explain price transmission even more than physical trade flows.

Empirical analyses use several methods to evaluate spatial market integration based on price adjustment between markets. According to Van Campenhout (2007), the first attempts at this evaluation were based on the strong notation of the LOP and took price correlation coefficient as a measurement of the degree of market integration. This simple regression and correlation analysis has been criticized due to two main conceptual and practical problems: the endogeneity of prices and the dynamism of price adjustments associated with temporary deviations from equilibrium (Fackler 1996). As a reaction to this criticism, dynamic regression models gained increasing attention because they allow

representation of contemporaneous and lagged price linkages, and take price endogeneity into account (Van Campenhout 2007). The dynamic model framework (e.g., Ravallion 1986) applied in this study assesses market integration employing cointegration analysis. In addition, the authors used the Error Correction Model (ECM), the Granger causality test to examine the direction of the relationship, and the Impulse Response Function (IRF) to determine the response to price shocks of individual dairy products. This allowed us to investigate the short-run dynamics that are consistent with the long-run relationship (Goodwin et al. 2021).

The analysis of market integration can provide a lot of economically and politically important information. The measurement of market integration is an essential tool for understanding the functioning of markets (Ravallion 1986). Knowledge of spatial integration helps economists explain whether the market moves commodities towards their higher value users, whether it is able to absorb large shocks without breakdown, and whether the market fosters development through specialization (Fackler 1996). With the knowledge of market integration, it is possible to evaluate the speed of transmission, which makes it easier to forecast prices in particular markets (Roman 2020). Moreover, the understanding of spatial markets also increases the knowledge of price relationships in a vertical chain, since spatial transformations are representative of input/output relationships (Fackler 1996). Cognition of the level and strength of market integration is also essential for economic policy aimed at creating the conditions to achieve an efficient market system (Hamulczuk 2020) and for the building of comparative advantages (Hou and Song 2021). An efficient agricultural and food market is a prerequisite for food security (Habte 2017; Svanidze et al. 2021) as it reduces the exposure of producers and consumers to unexpected fluctuations in local supplies of raw materials and processed products (Hamulczuk 2020).

3. Methodology

The integration analysis was conducted on the monthly prices of four dairy products: fresh milk, butter, Edam cheese, and skimmed milk powder (SMP). The temporal scope of the study covered the period 2001–2021 at the national level, and the period 2013–2021 at the regional level. The time ranges were selected based on available data. The quantitative analysis is based on logarithmic transformations of prices (log-prices) and their first differences (log-returns). Country-level data were obtained from Italian Dairy Economic Consulting (CLAL.IT 2021) and Food and Agriculture Data (FAO 2021). Data at the regional level were obtained from the Czech Statistical Office (2021) and Polish Statistical Office (2021). Country and region abbreviations have been used in the presentation of results: Czech Republic (CZ), Poland (PL), Jihočeský kraj (JHC), Jihomoravský kraj (JHM), Karlovarský kraj (KVK), Kraj Vysočina (VYS), Královéhradecký kraj (HKK), Liberecký kraj (LBK), Moravskoslezský kraj (MSK), Olomoucký kraj (OLK), Pardubický kraj (PAK), Plzeňský kraj (PLK), Středočeský kraj (STC), Zlínský kraj (ZLK), Dolnośląskie Voivodeship (DOL), Kujawsko-Pomorskie Voivodeship (K-P), Łódzkie Voivodeship (LDZ), Lubelskie Voivodeship (LBL), Lubuskie Voivodeship (LBU), Małopolskie Voivodeship (MLP), Mazowieckie Voivodeship (MAZ), Opolskie Voivodeship (OPO), Podkarpackie Voivodeship (PKR), Podlaskie Voivodeship (PDL), Pomorskie Voivodeship (POM), Śląskie Voivodeship (SL), Świętokrzyskie Voivodeship (SW), Warmińsko-Mazurskie Voivodeship (W-M), Wielkopolskie Voivodeship (WLK), Zachodnio-Pomorskie Voivodeship (Z-P). The locations of Polish and Czech regions are shown in Figure 1.

One of the first analyses was cointegration testing, according to which nonstationary time series are integrated if their linear combination is stationary. Then, we speak of a long-run equilibrium relationship between the price series being studied. Cointegration means that analyzed prices move closely together in the long-run perspective, while in the short-run they may drift apart. For this purpose, the Johansen procedure, which is based on a vector autoregression (VAR) model, was used. The general form of the VAR model is as follows (Neusser 2016):

$$X_t = C + \sum_{i=1}^{p} A_i X_{t-i} + e_t, \tag{1}$$

where X_t is the endogenous variable vector, C is the constant vector, A_i forms the coefficient matrix, and e_t is the white noise vector that is independently and identically distributed with $e_t \sim IID(0,\Sigma)$, where Σ is the positive definite matrix.

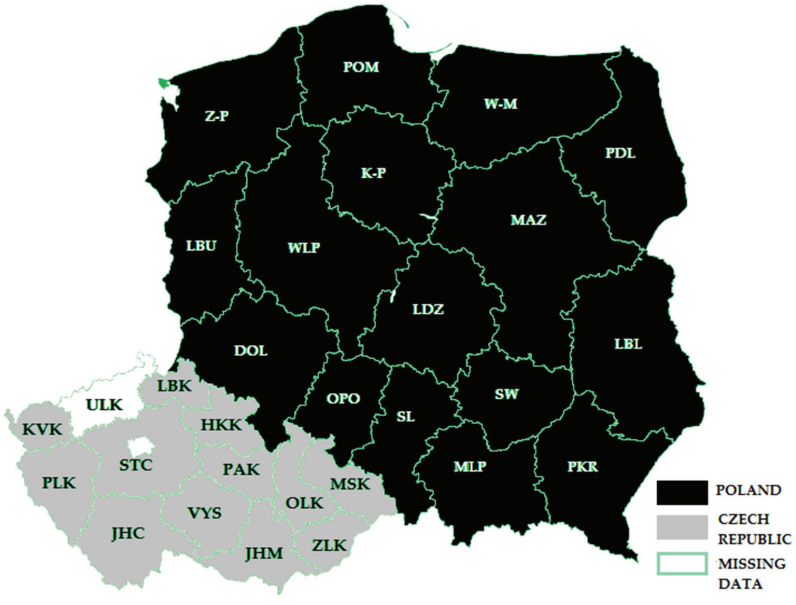


Figure 1. Map of analyzed regions.

In this work, the price cointegration analysis covered a maximum of two markets (A and B). The VAR model, with an intercept and without other deterministic variables for product prices in markets A and B, can be written as a system of two equations:

$$X_{At} = \alpha_{A0} + \sum_{i=1}^{p} \alpha_{Ai} X_{At-i} + \sum_{i=1}^{p} \beta_{Ai} X_{Bt-i} + e_{At}, \tag{2}$$

$$X_{Bt} = \alpha_{B0} + \sum_{i=1}^{p} \alpha_{Bi} X_{At-i} + \sum_{i=1}^{p} \beta_{Bi} X_{Bt-i} + e_{Bt}, \tag{3}$$

where: α, β are the parameters of the model in the equation of prices on market A and prices on market B.

Before the analysis of long-run relationships, statistical properties of price series were carried out. Unit root tests are applied to residuals from the cointegrating regression which are used for checking that price series have the same order. If both analyzed price series have the same integration order, then a test for cointegration can be performed. The modified Augmented Dickey–Fuller test (ADF-GLS) and the Phillips–Perron (PP) test were used to evaluate the unit root. In both tests, the null hypothesis was that the time series are nonstationary; the alternative hypothesis was that they are stationary. The ADF-GLS test is a modification of the ADF test suggested by Elliott et al. (1996). In the first step, the y_t series is trendless and decreased using a generalized least squares method. In the second, the remainders of the equation ($\widetilde{y}_t$) are used to test the unit root using the ADF equation:

$$\Delta\widetilde{y}_t = \rho\widetilde{y}_{t-1} + \sum_{i=1}^{p} \delta_i \Delta\widetilde{y}_{t-p} + \varepsilon_t \tag{4}$$

where: ρ and δ are the model coefficients, ε_t is the random component, and p is the maximum augmentation lag. The Phillips–Perron unit root test is also a modification of the Dickey–Fuller test. Instead of accounting for autoregressive structure, the PP test corrects for any series correlation and heteroscedasticity in the errors by modifying the Dickey–Fuller test statistics in a non-parametric manner (Phillips and Perron 1988). The lag length for the tests was selected using the Akaike Information Criterion (AIC). Details of the time series tested and verification of the degree of integration are provided in Table A1 in Appendix A. Note that all the time series were integrated at order I(1), except for monthly cheese prices in Poland and the Czech Republic, whose order was I(0).

If the variables are cointegrated, the Equation (1) can be represented in the vector error correction model (VECM) ($p-1$) (Neusser 2016):

$$\Delta(X_t) = C + \Pi X_{t-1} + \sum_{i=1}^{p-1} \tau_i \Delta(X_{t-1}) + e_t, \tag{5}$$

where: $\Pi = \sum_{i=1}^{p-1} A_i - I$ (I: identity matrix); $\Gamma_i = -\sum_{j=i+1}^{p-1} A_i$; Π is the long-run matrix coefficient, Γ_i is the short-run matrix coefficient. The VECM model (with an unlimited constant) for two series of prices in locations A and B, assuming that the cointegration vector has the form [1, −1], can be written as a system of the following two equations:

$$\Delta(X_{At}) = \alpha_{A0} + \rho_A(X_{At-1} - X_{Bt-1}) + \sum_{i=1}^{p-1} \alpha_{Ai}\Delta X_{At-i} + \sum_{i=1}^{p-1} \beta_{Ai}\Delta X_{Bt-i} + e_{At,} \tag{6}$$

$$\Delta(X_{Bt}) = \alpha_{B0} + \rho_B(X_{At-1} - X_{Bt-1}) + \sum_{i=1}^{p-1} \alpha_{Bi}\Delta X_{At-i} + \sum_{i=1}^{p-1} \beta_{Bi}\Delta X_{Bt-i} + e_{Bt,} \tag{7}$$

where: ρ is the parameter of the model in the equation of prices on market A and prices on market B, with the rest of the markings as in Equations (1)–(3).

One of two tests are used in the Johansen procedure: the trace test (LR_{trace}) or the maximum eigenvalue test (LR_{max}):

$$LR_{trace}(r) = -(T-p)\sum_{i=r+1}^{k} n(1-\lambda_i), \tag{8}$$

$$LR_{max}(r) = -(T-p)\ln(1-\lambda_{r+1}), \tag{9}$$

where: r is the number of cointegrating relationships, T is the sample size, k is the number of variables, λ_i is the i-th largest canonical correlation, p is the maximum augmentation lag. The LR_{trace} tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The LR_{max} tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r + 1$ cointegrating vectors.

As a result of applying the Johansen test, we may have the following situations: (1) the rank of the matrix Π is equal to 0 and then the Equation (5) is a VAR model for increments of variables in which there is no long-run dependence; (2) the rank of the matrix Π is greater than 0 but less than r, then the number of cointegration vectors is equal to this rank; (3) the matrix Π is of full rank, then the series of variables is stationary and, thus, the Equation (5) is a VAR model for the levels of variables.

In the next step, a VAR or VECM model was estimated depending on the results from the Johansen test. In the next step, if significant coefficients from endogenous variables were found by estimation, the Granger causality test and impulse response function (IRF) test were performed. It allowed assessment of the possible direction of price transmission. The Granger causality test detects the causal relationship between the variables being studied. In this test, variable X is a cause, in the Granger sense, of variable Y, when the values of variable Y can be better predicted given the future value of variable X than without those values. This test can be described by the following equations (Granger 1969):

$$Y_t = \beta_0 + \sum_{j=1}^{m} \beta_j Y_{t-j} + \sum_{k=l}^{n} \beta_k X_{t-k} + u_t, \quad (10)$$

$$X_t = \beta_0 + \sum_{j=1}^{m} \beta_j X_{t-j} + \sum_{k=l}^{n} \beta_k Y_{t-k} + u_t, \quad (11)$$

where: Y_t is the value of variable Y; X_t is the value of variable X; β denotes the structural parameters of the model; t is the change in time; u_t is the random component of the model.

The impulse response function indicates how fast a price shock at one price transmits towards another price. It is the response of one price variable to a sudden and temporary change in another price variable.

4. Preliminary Analysis of Polish and Czech Milk and Dairy Markets

4.1. Trade Exchange

The degree of integration of separate markets can be characterized using an analysis of changes in trade. The flow of products between different markets expresses the flow of supply and demand impulses that occur between countries/regions (Hamulczuk 2020). Both the Czech Republic and Poland are increasing their trade volume in all dairy products year by year. Milk and dairy products are perishable products with low transport and storage susceptibility. Therefore, they require continuous cold chain maintenance which can limit the transportation distance of these products. However, it is worth noting that advances in logistics have significantly increased the ability to transport milk and dairy products, with low transport and storage vulnerability over much longer distances (Roman 2018).

However, the main trading partners of the Czech Republic and Poland are mostly neighboring countries (Table 4). In addition, the Czech Republic and Poland are also key partners for each other. Czechs imported cheese (25% of import value), butter (24% of value), milk (10% of value), and SMP (9% of value) from Poland. Depending on the product, Poland is the first, second, or, in the worst case, third largest supplier for the Czech Republic in terms of import value. Poland imported the most of the SMP (22% of value), milk (20% of value), and cheese (7% of value) from Czech Republic. The Czech Republic is the second, third, or fourth largest supplier of dairy products in terms of import value.

Table 3. Dairy product exports and imports from/to the Czech Republic and of Poland from/to other countries (five best trade partners by value), in %.

Export								Import							
Czech Republic				Poland				Czech Republic				Poland			
Code	**2005**	**2013**	**2019**	**Code**	**2005**	**2013**	**2019**	**Code**	**2005**	**2013**	**2019**	**Code**	**2005**	**2013**	**2019**
Milk, whole fresh cow milk															
DE	0.71	0.59	0.72	DE	0.93	0.64	0.53	SK	0.39	0.42	0.39	LT	0.00	0.66	0.40
SK	0.17	0.18	0.10	CN	0.00	0.02	0.14	DE	0.08	0.43	0.37	DE	0.23	0.15	0.29
IT	0.07	0.10	0.05	LT	0.02	0.04	0.04	PL	0.50	0.06	0.10	CZ	0.34	0.15	0.20
PL	0.01	0.04	0.04	UK	0.00	0.04	0.04	BE	0.00	0.01	0.05	AT	0.00	0.00	0.04
HU	0.02	0.05	0.03	ZA	0.00	0.00	0.03	FR	0.00	0.07	0.02	NL	0.00	0.01	0.03
OTH	0.02	0.05	0.06	OTH	0.05	0.26	0.22	OTH	0.02	0.01	0.06	OTH	0.42	0.03	0.03
Butter, cow milk															
SK	0.19	0.38	0.64	CZ	0.02	0.18	0.20	PL	0.06	0.19	0.44	NL	0.04	0.34	0.32
IT	0.06	0.31	0.23	DE	0.24	0.12	0.11	DE	0.37	0.43	0.24	DE	0.25	0.34	0.27
PL	0.02	0.02	0.05	NL	0.17	0.11	0.10	SK	0.10	0.18	0.16	IE	0.00	0.05	0.10
HU	0.05	0.05	0.02	SK	0.03	0.14	0.09	BE	0.03	0.12	0.11	BE	0.14	0.05	0.09
ES	0.00	0.00	0.02	BE	0.18	0.07	0.01	NL	0.07	0.04	0.02	DK	0.02	0.06	0.07
OTH	0.68	0.25	0.05	OTH	0.35	0.38	0.49	OTH	0.36	0.04	0.03	OTH	0.54	0.16	0.16

Table 4. Dairy product exports and imports from/to the Czech Republic and of Poland from/to other countries (five best trade partners by value), in %.

Export								Import							
Czech Republic				Poland				Czech Republic				Poland			
Code	**2005**	**2013**	**2019**	**Code**	**2005**	**2013**	**2019**	**Code**	**2005**	**2013**	**2019**	**Code**	**2005**	**2013**	**2019**
Cheese, whole cow milk															
IT	0.27	0.34	0.43	DE	0.20	0.12	0.15	DE	0.34	0.44	0.37	DE	0.39	0.46	0.39
SK	0.19	0.25	0.23	CZ	0.15	0.12	0.13	PL	0.34	0.27	0.25	NL	0.05	0.12	0.14
PL	0.02	0.09	0.12	IT	0.14	0.11	0.10	SK	0.18	0.09	0.14	IT	0.08	0.09	0.11
AE	0.10	0.05	0.03	UK	0.03	0.06	0.07	IT	0.03	0.06	0.09	CZ	0.01	0.06	0.07
SA	0.04	0.03	0.03	SK	0.05	0.08	0.07	NL	0.03	0.06	0.05	FR	0.09	0.08	0.07
OTH	0.38	0.25	0.16	OTH	0.43	0.52	0.46	OTH	0.08	0.08	0.10	OTH	0.38	0.19	0.23
Milk, skimmed cow milk															
SK	0.67	0.39	0.54	DE	0.31	0.04	0.53	DE	0.11	0.22	0.44	LT	0.95	0.36	0.25
DE	0.28	0.16	0.23	CN	0.00	0.02	0.09	SK	0.78	0.17	0.32	CZ	0.00	0.36	0.22
PL	0.00	0.08	0.13	IT	0.00	0.02	0.08	PL	0.09	0.59	0.09	BE	0.00	0.00	0.20
IT	0.02	0.11	0.04	FR	0.00	0.00	0.05	NL	0.00	0.00	0.09	DE	0.00	0.10	0.19
RO	0.00	0.06	0.03	RO	0.00	0.02	0.05	UK	0.00	0.01	0.03	SW	0.00	0.00	0.05
OTH	0.02	0.19	0.03	OTH	0.69	0.89	0.20	OTH	0.01	0.01	0.03	OTH	0.05	0.18	0.09

Note: Country codes are based on ISO 3166: AE = the United Arab Emirates, AT = Austria, BE = Belgium, CN = China, CZ = Czech Republic, DE = Germany, DK = Denmark, ES = Spain, FR = France, HU = Hungary, IE = Ireland, IT = Italy, LT = Lithuania, NL = the Netherlands, OTH = Others, PL = Poland, RO = Romania, SA = Saudi Arabia, SK = Slovakia, SW = Sweden, UK = the United Kingdom, ZA = South Africa. Source: own calculation (FAO 2021).

In 2019, Czechs exported the most of the SMP (13% of export value) and cheese (12% of value) to Poland. In the case of Poland, the Czech Republic's share in butter exports amounted to 20% and, at the same time, it was the main foreign recipient of this product. Moreover, 13% of the cheese exported from Poland went to the Czech Republic, which was the second largest trade partner with respect to this product.

Therefore, on the basis of trade flows, it would be reasonable to conclude that these countries are characterized by a long range of linkages, continuously present. Therefore, this means that there are strong grounds with respect to the integration of the two markets.

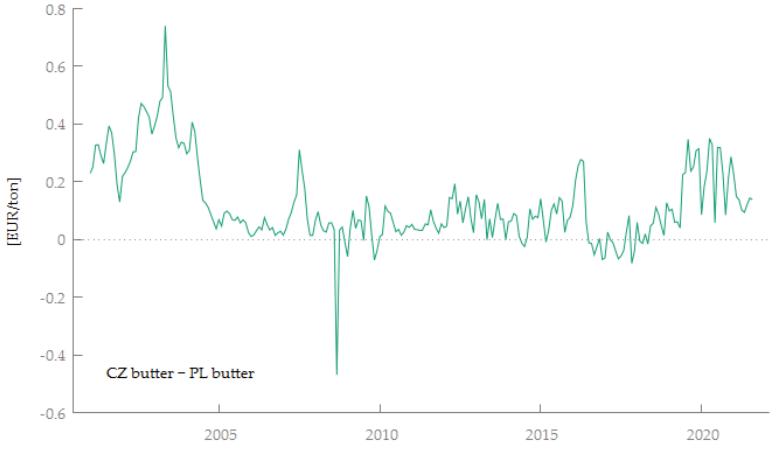
4.2. The Linkage of Milk Prices between Regions in Poland and the Czech Republic

The preliminary analysis of market integration can be also conducted based on price analysis. If there are significant price differences between the analyzed markets, then there is a weak integration. Moreover, these differences often increase as distances between the separate markets being analyzed increase (Roman 2020). Average deviations of logarithms of Polish milk prices from Czech prices over the entire period ranged from −9.1% to +3.2%, with an average of −2.0% (Figure 2). In addition, note the sub-period of the largest price deviations occurring between 2002 and 2005, i.e., especially before the accession of both countries to the EU. Over a longer period, milk prices in Poland were only higher than milk prices in the Czech Republic in 2016–2017. This may have been due to changes in the CAP, including the abolition of milk quotas and the period of adjustment to the new milk market situation (Eurostat 2021e). Decreasing differences in milk prices in time are probably a consequence of the influence of various factors, such as the increase in the foreign trade of milk and dairy products between Poland and the Czech Republic. In addition, the change in milk price differences was influenced by a more efficient information flow after both countries joined the EU, as well as by the increasing price integration across EU countries (Benedek et al. 2017; Fousekis 2018).

Figure 2. Differences between Czech and Polish milk prices in 2001–2021 (logarithm price). Source: own calculation (Czech Statistical Office 2021; Polish Statistical Office 2021).

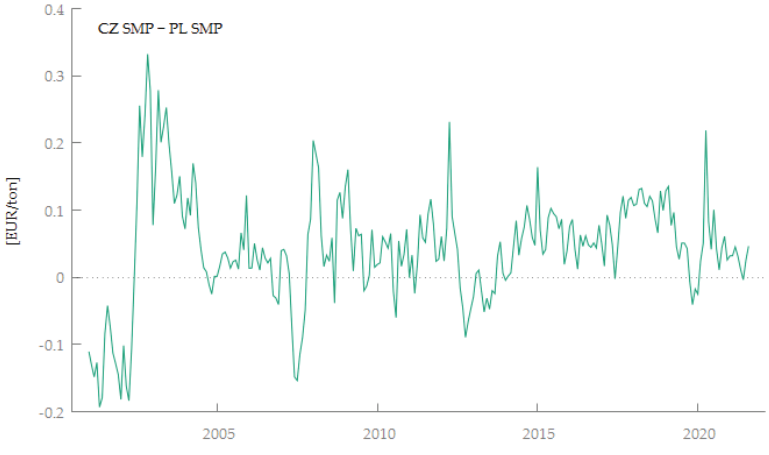
4.3. Linking the Prices of Dairy Products between the Polish and Czech Markets

The final part of the preliminary analysis focuses on the price linkages of dairy products between the Czech Republic and Poland. The average deviations of the logarithms of Polish butter prices from Czech prices over the entire period ranged from −9.2% to +6.4%, with an average of −1.5% (Figure 3a). The largest variation in butter prices occurred between 2002 and 2005, which was similar for milk prices. The average deviations of the logarithms of Polish SMP prices from Czech prices over the entire period ranged from −4.4% to +2.5%, with an average of −0.6% (Figure 3b). Thus, it should be said that the price differences were the smallest for this product. The largest SMP price deviations occurred between 2002 and 2005. The average deviations of the logarithms of Polish Edam cheese prices from Czech prices over the entire period ranged from −4.4% to +2.7%, with an average of −1.6% (Figure 3c). The largest SMP price deviations also occurred between 2002 and 2005.

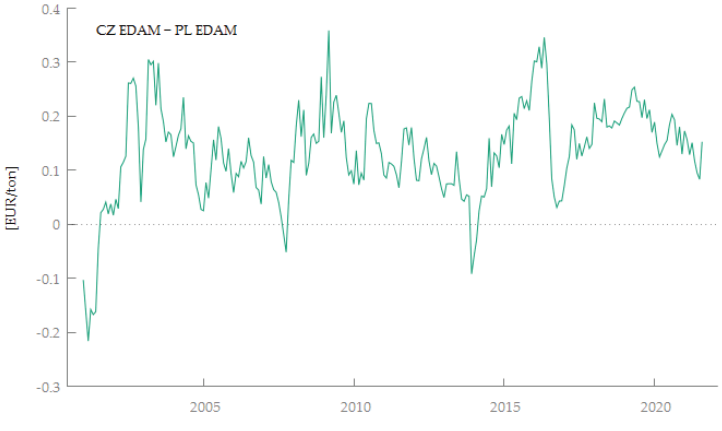


(**a**)

Figure 3. *Cont.*



(**b**)



(**c**)

Figure 3. The price difference between dairy products: (**a**) butter, (**b**) SMP, (**c**) Edam, in Poland and the Czech Republic. Source: own calculations (CLAL.IT 2021).

5. Results and Discussion

5.1. Milk Market Integration of Regions in Poland and the Czech Republic

Since the milk price series were characterized by first-order I(1) integration, the first step was to perform a Johansen cointegration test. The test was used to verify the long-run relationship between milk price at the national level, then at the regional level. The results of the cointegration test for milk prices at the national level are summarized in Table 5. Note that the statistical values of the tests are greater than their critical values at $p = 0.05$. This means that there is a long-run cointegration relationship between the Czech milk price and the Polish milk price at the national level. Since there was one cointegrating rank in the milk price relationship, the VECM model was used. It can be seen that the coefficient estimates in the long-run equilibrium relationship range from 0.51 to 0.67. The coefficient in the long-run relationship in the model with a limited trend and an unlimited constant is 0.67, which indicates that, in the long-run relationship, a 1% increase/decrease in milk prices in the Czech Republic is reflected by 0.67% increase/decrease in milk prices in Poland. Czech milk prices are an exogenous variable for Polish milk prices, as the only

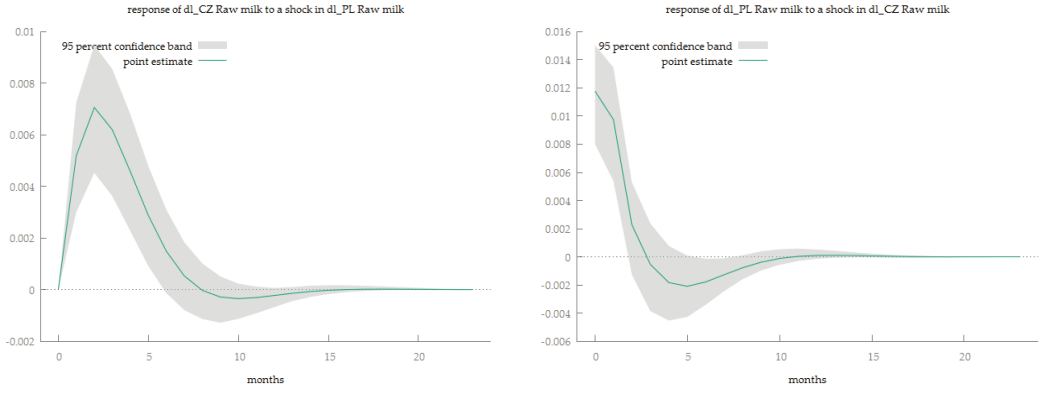
significant coefficient with deviations from long-run equilibrium (EC) is in the Czech milk price equation. Imbalances due to shocks in the price system are corrected during the month by 6.3% through the Czech Republic's response, and by 2.5% through the Polish price response. Moreover, in the light of the Granger test performed, it can be concluded that future prices in the Czech Republic are a cause, in the Granger sense, of future milk prices in Poland and vice versa. Thus, we identify a two-way causality. Moreover, the reaction of Czech milk prices to Polish milk prices is positive and stable over 8 months (Figure 4). However, the reaction of milk prices in Poland to milk prices in the Czech Republic is shorter and lasts about 3 months.

Table 5. Cointegration testing results and selected VECMs statistics for the Czech Republic and Poland's raw milk price series.

Test	H_0	H_1	Model with an Unlimited Constant	Model with a Limited Trend and Unlimited Constant
			Stat.	Stat.
LR trace	$r = 0$	$r = 1$	19.934 ***	28.777 ***
	$r \leq 1$	$r = 2$	2.961	11.244
LR max	$r = 0$	$r = 1$	16.973 ***	17.533
	$r \leq 1$	$r = 2$	2.961	11.244
Selected statistic for VECM models				
AIC			−9.798	−9.799
BIC			−9.597	−9.599
Long-run relationship:			1×l_CZ Raw milk-0.508×l_PL Raw milk	1×l_CZ Raw milk-0.665×l_PL Raw milk×time
EC (l_CZ Raw milk)			−0.062 ***	−0.063 ***
EC (l_PL Raw milk)			−0.045	−0.025
Granger causality tests				
dl_CZ Raw milk ≠ > dl_PL Raw milk			3.928 **	3.902 **
dl_PL Raw milk ≠ > dl_CZ Raw milk			19.294 ***	19.292 ***

Note: r = rank; l = price logarithm; dl = first differences of price logarithms; 1*l_CZ Raw milk-0.508*l_PL Raw milk which indicates that, in the long-run relationship, 1% increase/decrease in milk prices in the Czech Republic is reflected by a 0.508% increase/decrease in milk prices in Poland; EC (l_CZ Raw milk) = error correction component for Czech raw milk prices; EC (l_PL Raw milk) = error correction component for Polish raw milk prices; dl_CZ Raw milk ≠ > dl_PL Raw milk means whether future milk prices in the Czech Republic are the cause, in the sense of Granger, of future milk prices in Poland; dl_PL Raw milk ≠ > dl_CZ Raw milk means whether future milk prices in Poland are the cause, in the sense of Granger, of future milk prices in the Czech Republic. ** $p < 0.05$, *** $p < 0.01$. Source: own calculation (Czech Statistical Office 2021; Polish Statistical Office 2021).

Results of cointegration testing at the regional level are shown in Table A2 in Appendix A. Cointegration testing for the regions involved a pairwise analysis of each Czech region with each Polish region. In this case, the highest number of long-run relationships was identified for the Czech side: Liberecký kraj (11 long-run linkages), Královéhradecký kraj (8 linkages), and for the Polish side: Warmińsko-Mazurskie Voivodeship (9 linkages) and Podlaskie Voivodeship (8 linkages). In the case of the Czech Republic, these are the regions closest to Poland. The importance of distance was also confirmed by analyzing the correlation of milk prices in each region and the distance between these regions (Figure 5). According to this, as distance increases, the degree of milk price linkage decreases. However, in the case of Poland, the highest number of long-run linkages was obtained by regions farthest from the Czech border; however, in turn, these regions are key from the point of view of Polish milk production. Thus, both the distance and the specialization of the region can be considered as a factor influencing the integration processes of separate markets.



(**a**) (**b**)

Figure 4. Impulse response function between raw milk prices: (**a**) response of the Czech Republic to a shock in Poland; (**b**) response of Poland to a shock in the Czech Republic. Source: own calculation (Czech Statistical Office 2021; Polish Statistical Office 2021).

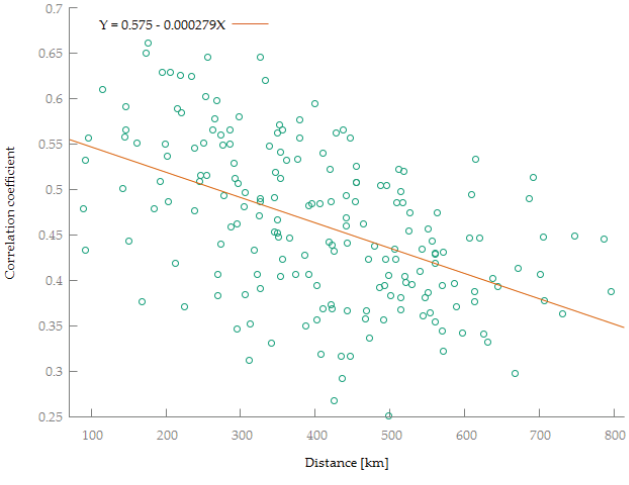


Figure 5. Pearson's linear correlation coefficients between milk prices (logarithm increases) and distance between Czech and Polish regions in the years 2013–2021. Source: own calculation (Czech Statistical Office 2021; Polish Statistical Office 2021).

In the next step, a Granger causality test was performed to examine whether milk prices in Czech regions have predictive power on milk price variation in Polish regions and vice versa (Table 6). There is a one-way (→) or two-way (↔) relationship between Czech and Polish milk prices in the short term. It can be concluded that future milk prices in Poland were the Granger cause of milk prices in all Czech regions. In contrast, for only 50% of the relationship, Czech milk prices were the cause, in the Granger sense, of milk prices in Poland in the analyzed period.

In the light of the Granger causality test, the most exogenous Czech milk prices were in the following regions (Figure 6): Plzeňský kraj, Jihomoravský kraj, Moravskoslezský kraj. In the case of milk prices in Poland, the most exogenous prices in the following voivodeships should be recognized: Mazowieckie, Kujawsko-Pomorskie, Wielkopolskie. The positions of Polish voivodeships seem to be justified mainly by the region's specialization in milk production (statistically significant positive correlation between coefficient F (Granger

causality test statistics) and milk production of 0.53. However, in this case, the relationship between the distance of the region and the summed coefficient F was not confirmed for either the Czech Republic or Poland.

Table 6. Direction of dependence based on Granger's causality.

Region	STC	JHC	PLK	KVK	LBK	HKK	PAK	VYS	JHM	OLK	ZLK	MSK
DOL	→	↔	↔	↔	→	→	↔	↔	↔	↔	↔	→
K-P	↔	→	↔	↔	→	→	↔	↔	↔	→	↔	↔
LDZ	→	↔	↔	↔	→	→	→	→	→	↔	↔	↔
LBL	↔	→	↔	↔	→	→	→	→	↔	↔	↔	↔
LBU	→	→	↔	→	→	→	→	→	↔	↔	→	↔
MLP	↔	↔	→	↔	→	↔	→	↔	↔	↔	→	→
MAZ	→	→	↔	↔	→	→	→	↔	↔	↔	↔	→
OPO	↔	↔	→	→	→	→	→	→	↔	→	↔	→
PKR	→	→	↔	→	→	→	→	→	↔	→	↔	→
PDL	→	→	→	→	→	→	↔	→	→	→	→	↔
POM	→	↔	↔	↔	→	→	↔	↔	↔	↔	↔	↔
SL	↔	↔	↔	↔	→	→	→	↔	→	→	→	↔
SW	→	↔	↔	↔	→	→	→	↔	↔	↔	↔	→
W-M	→	→	→	↔	→	→	↔	→	→	→	→	↔
WLK	→	↔	↔	↔	→	→	→	→	↔	↔	↔	↔
ZP	→	↔	↔	↔	↔	↔	↔	↔	↔	↔	→	↔

Source: own calculation (Czech Statistical Office 2021; Polish Statistical Office 2021).

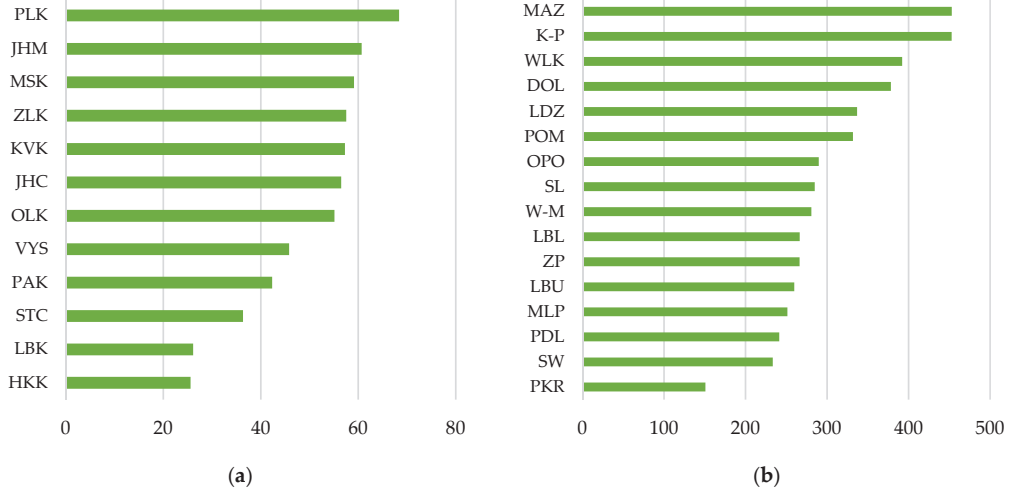


Figure 6. Summary of Granger causality testing results between milk price series in the Czech Republic and Poland: (**a**) Czech regions, (**b**) Polish regions (sum of *F* test statistics). Source: Source: own calculation (Czech Statistical Office 2021; Polish Statistical Office 2021).

5.2. Dairy Products Market Integration of Poland and the Czech Republic

The final part of the analysis focuses on dairy products. Since the butter and SMP price series were integrated at order I(1), the Johansen cointegration test was performed in the next step. The results of the cointegration test are summarized in Table 7. Note that the statistical values of the tests are greater than their critical values at $p = 0.05$ for SMP prices only. This means that there is a long-run relationship between the price of SMP in the Czech Republic and the price of SMP in Poland. Thus, the results are consistent with the findings of Domagała (2020), who analyzed price relationships over the period 2004–2016. In contrast, there is no long-run relationship between butter prices in these countries.

Table 7. Cointegration testing results and selected VAR/VECM statistics for the Czech Republic and Poland's dairy products price series.

Butter			
Test	**H_0**	**H_1**	**Stat.**
LR trace	$r = 0$	$r = 1$	23.557
	$r \leq 1$	$r = 2$	7.8594
LR max	$r = 0$	$r = 1$	15.698
	$r \leq 1$	$r = 2$	7.8594

Selected statistic for VAR models	**Coef. dl_CZ butter**	**Coef. dl_PL butter**
dl_CZ butter (−1)	−0.243 ***	0.109 **
dl_CZ butter (−2)	−0.243 **	0.131 **
dl_PL butter (−1)	0.529 ***	0.327 ***
dl_PL butter (−2)	−0.038	−0.144 **
Constant	0.001	0.001
R^2	0.151	0.162

Granger causality tests	**Stat.**
dl_CZ Butter ≠ > dl_PL Butter	4.237 **
dl_PL Butter ≠ > dl_CZ Butter	19.963 ***

SMP			
Test	**H_0**	**H_1**	**Stat.**
LR trace	$r = 0$	$r = 1$	42.161 ***
	$r \leq 1$	$r = 2$	7.598
LR max	$r = 0$	$r = 1$	34.563 ***
	$r \leq 1$	$r = 2$	7.598

Selected statistic for VECM models	**Stat.**
AIC	−7.094
BIC	−6.951
Long-run relationship:	1*l_CZ SMP-0.907*l_PL SMP*time
EC (l_CZ SMP)	−0.181 ***
EC (l_PL SMP)	0.099 **

Granger causality tests	
dl_CZ SMP ≠ > dl_PL SMP	0.591
dl_PL SMP ≠ > dl_CZ SMP	33.540 ***

Edam		
Selected statistic for VAR models	**Coef. l_CZ Edam**	**Coef. l_PL Edam**
l_CZ Edam (−1)	0.610 ***	0.195 ***
l_CZ Edam (−2)	0.219 ***	−0.162 ***
l_PL Edam (−1)	0.349 ***	1.389 ***
l_PL Edam (−2)	−0.236 ***	−0.472 ***
Constant	0.484 ***	0.395 **
R^2	0.888	0.946

Granger causality tests	
l_CZ Edam ≠ > l_PL Edam	5.671 ***
l_PL Edam ≠ > l_CZ Edam	21.571 ***

** $p < 0.05$, *** $p < 0.01$. Note: r = rank; l = price logarithm; dl = first differences of price logarithms; 1×l_CZ SMP-0.907×l_PL SMP×time which indicates that, in the long-run relationship, 1% increase/decrease in SMP prices in the Czech Republic is reflected by a 0.907% increase/decrease in SMP prices in Poland; EC (l_CZ SMP) = error correction component for Czech SMP prices; EC (l_PL Raw milk) = error correction component for Polish SMP prices; dl_CZ butter ≠ > dl_PL butter means whether future butter prices in the Czech Republic are the cause, in the sense of Granger, of future butter prices in Poland; dl_PL butter ≠ > dl_CZ butter means whether future butter prices in Poland are the cause, in the sense of Granger, of future butter prices in the Czech Republic; the same applies to SMP and EDAM cheese. Source: own calculation (CLAL.IT 2021).

Since there was one cointegrating rank in the SMP price relationship, the VECM model was used. The coefficient in the long-run relationship in the model with a limited trend and an unlimited constant is 0.91; this indicates that, in the long-run relationship, a 1% increase/decrease in SMP prices in the Czech Republic is reflected by 0.91% increase/decrease in SMP prices in Poland. Long-run relationship coefficients close to 1 reflect the validity of LOP in the spatial markets analyzed. Both Czech SMP prices are an exogenous variable for Polish SMP prices, and Polish SMP prices for Czech SMP prices, as the coefficients with deviations from long-run equilibrium (EC) present in the equation of Czech and Polish SMP prices are statistically significant. Imbalances due to shocks in the price system are corrected during the month by 18.1% through the Czech Republic's response, and by 9.9% through the Polish price response. Moreover, in the light of the Granger test performed, it can be concluded that future prices of SMP in Poland are a cause, in the Granger sense, of future SMP prices in the Czech Republic. Thus, this trend continues as confirmed by Domagała's (2020) studies. Moreover, the reaction of Czech SMP prices to Polish SMP prices and vice versa is positive and stable over 5 months (Figure 7).

Since there was no cointegration between the butter price series, a VAR model was estimated. According to the AIC, the minimum lag length in the VAR model was $p = 3$. Since all the endogenous variables of this study are integrated on the first order that is not cointegrated, the VAR $(p - 1)$ model is estimated, so the lag length is 2 $(p - 1 = 2)$. The R2 value for each VAR model indicates that the overall quality of fit is not satisfactory. For example, about 15% of the variability in Czech butter prices can be explained by Czech and Polish butter prices. Regarding the short-run butter price relationship, there is a two-way result given by the Granger causality test. This means that future butter prices in the Czech Republic are a cause, in the Granger sense, of future butter prices in Poland, and vice versa. Thus, the results of Roman (2018) and Domagała (2021), who examined the price linkage over the period 2012–2016, are confirmed. It should be noted that prior to this year, only butter prices in Poland influenced future butter prices in the Czech Republic. Further evidence of a short-run relationship between butter prices in the analyzed countries can be inferred from the IRF test. The reaction of butter prices in the Czech Republic to butter prices in Poland and vice versa is positive. The impact change occurs after month 2 for Czech butter prices and after month 4 for Polish butter prices.

In the case of cheese, the time series were integrated at order I(0); therefore, no cointegration tests were performed, only the VAR model was estimated. The R2 value for each VAR model indicates that the overall quality of fit is satisfactory. For example, about 89% of the variability in Czech cheese prices can be explained by Czech and Polish Edam prices. As for the short-run butter price relationship, we have a two-way result here as well, following the Granger causality test. This means that future cheese prices in the Czech Republic are a cause, in the Granger sense, of future cheese prices in Poland, and vice versa. In the case of the results from the impulse response analysis, the response of cheese prices in the Czech Republic to cheese prices in Poland, and vice versa, is positive and long-lasting.

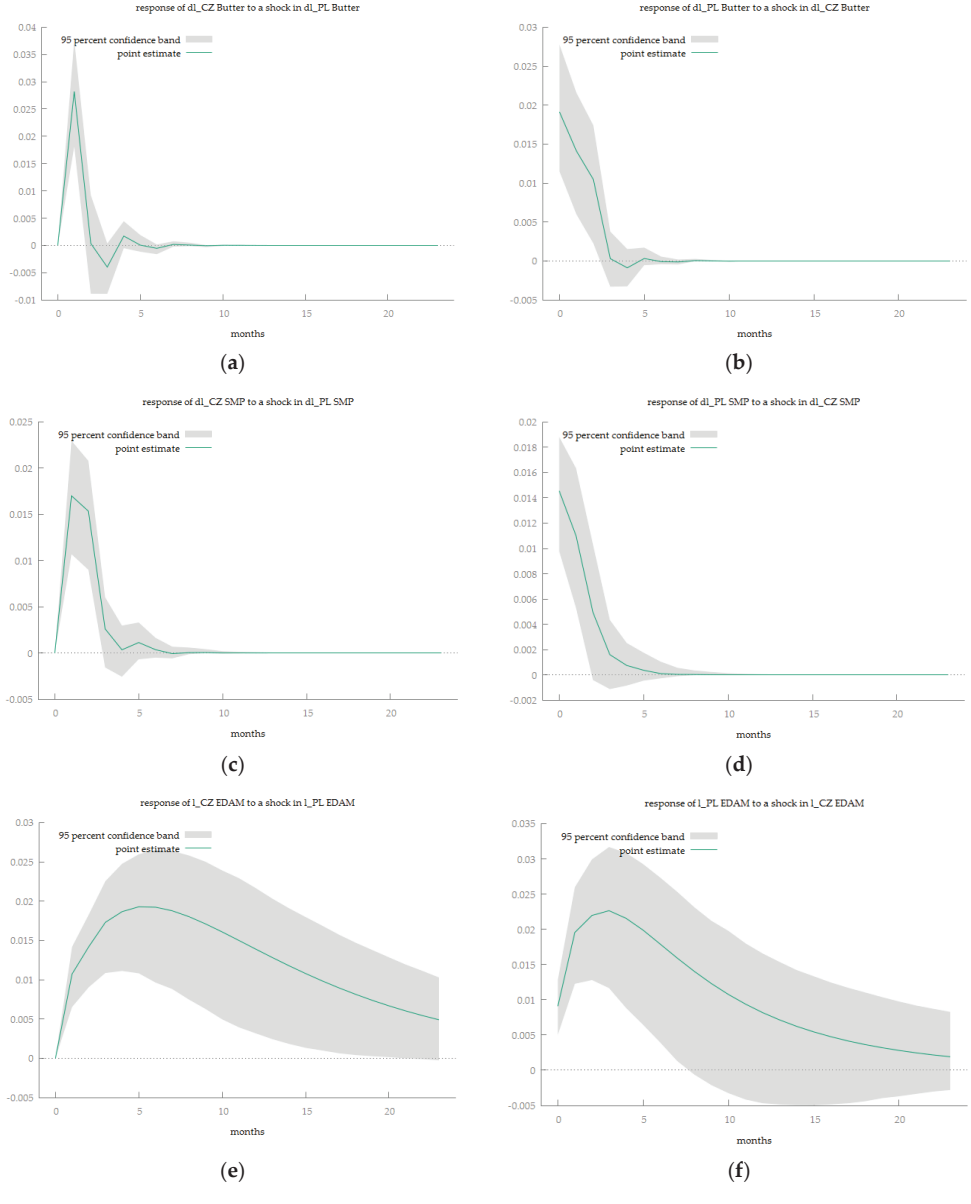


Figure 7. Impulse response function between butter prices: (**a**) response of Czech Republic to a shock in Poland; (**b**) response of Poland to a shock in the Czech Republic; SMP prices: (**c**) response of Czech Republic to a shock in Poland; (**d**) response of Poland to a shock in the Czech Republic; Edam prices: (**e**) response of Czech Republic to a shock in Poland; (**f**) response of Poland to a shock in the Czech Republic. Source: own calculations (CLAL.IT 2021).

6. Conclusions

The integration of markets and the equalization of prices in EU countries is one of the main objectives of the Common Agricultural Policy. This paper evaluates the processes of spatial integration in the market of milk and dairy products between Poland and the

Czech Republic. Among other things, the countries share a long history of trade in dairy products, proximity, and the same moment of accession to the EU.

To achieve the aim of the paper, methods of evaluating spatial integration processes based on trade flows and prices were used. The analysis was conducted for a 21-year period at the national level and a 9-year period at the regional level. Four markets were selected for analysis: raw milk, butter, SMP, and Edam cheese.

Based on the research conducted, it can be noted that: (1) on the basis of the results of trade flows, one would have to conclude that the Czech Republic and Poland are characterized by a long range of linkages, which is a strong indication of the integration of these two markets for all analyzed products; (2) based on the analysis of price differences, in most cases, the prices of dairy products in the Czech Republic were higher than the prices of these products in Poland; the smallest differences were found in the prices of SMP (on average −0.6%), and the highest differences were found in the prices of milk (on average −2.0%); (3) a long-run price relationship between the Czech Republic and Poland was confirmed by the Johansen cointegration test for milk and SMP only; (4) in the light of the Granger test performed for milk, butter, and Edam cheese prices, there was a two-way causality, while in the case of SMP prices, only future SMP prices in Poland were the cause, in the Granger sense, of future SMP prices in the Czech Republic; (5) despite the long-run relationship of milk prices at the national level, in the case of regional analysis, for only half of the analyzed pairs of Czech and Polish regions was such a relationship also long-run; in the case of the Czech Republic, these were the regions closest to Poland, which, thus, confirmed the importance of distance. In the case of Poland, the highest number of long-run linkages was obtained by regions specializing in milk production; (6) the results of the study confirmed that the factors influencing the spatial price relationships between the Czech Republic and Poland are: strong trade ties, a common moment of accession to the EU, a close distance between markets, and region specialization.

Despite meeting the purpose of the article, it should also be noted that our study is not without limitations. In such analyses, the length of the time series matters; an analysis using weekly data of product prices would even more effectively estimate linkages. Despite some limitations, our study provides an interesting starting point for future research. The methodology used in this article can be replicated and evaluated for the phenomenon being studied in another few years. Another suggestion would be to use nonlinear models to assess spatial integration processes between the two markets, as well as regional analysis for other separate markets.

Author Contributions: Conceptualization, M.R. and Z.Ž.K.; methodology, M.R.; software, M.R.; validation, M.R.; formal analysis, M.R.; investigation, M.R. and Z.Ž.K.; resources, M.R. and Z.Ž.K.; data curation, M.R. and Z.Ž.K.; writing—original draft preparation, M.R. and Z.Ž.K.; writing—review and editing, M.R. and Z.Ž.K.; visualization, M.R.; supervision, M.R.; project administration, M.R.; funding acquisition, M.R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Unit root testing results.

Product/Region	Price Logarithms ADF-GLS Stat.	Price Logarithms Phillips–Perron Z Stat	First Price Differences ADF-GLS Stat.	First Price Differences Phillips–Perron Z Stat	Decision
			2001–2021		
CZ raw milk	−1.258	−2.668 *	−4.707 ***	−6.948 ***	I(1)
PL raw milk	−0.874	−1.856	−6.733 ***	−8.132 ***	I(1)
CZ butter	−1.669 *	−2.597 *	−6.123 ***	−17.077 ***	I(1)
PL butter	−1.629 *	−2.318	−8.458 ***	−10.577 ***	I(1)
CZ SMP	−1.877 *	−2.281	−4.699 ***	−14.627 ***	I(1)
PL SMP	−1.950 *	−2.408	−3.088 ***	−8.572 ***	I(1)
CZ Edam	−0.938 *	−3.215 **	−2.936 ***	−18.623 ***	I(0)
PL Edam	−3.807 ***	−3.141 **	−3.283 ***	−9.515 ***	I(0)
			2013–2021		
STC	−1.721	−1.851	−4.021 ***	−4.203 ***	I(1)
JHC	−1.991	−1.972	−4.359 ***	−4.513 ***	I(1)
PLK	−2.159	−1.974	−3.619 ***	−4.695 ***	I(1)
KVK	−1.753	−2.174	−3.686 ***	−5.081 ***	I(1)
LBK	−1.696	−1.745	−4.419 ***	−6.754 ***	I(1)
HKK	−1.795	−1.814	−3.327 ***	−5.301 ***	I(1)
PAK	−1.659	−1.854	−3.765 ***	−4.725 ***	I(1)
VYS	−1.952	−1.906	−3.228 ***	−4.176 ***	I(1)
JHM	−1.588	−1.868	−3.629 ***	−4.340 ***	I(1)
OLK	−1.649	−1.933	−4.039 ***	−4.308 ***	I(1)
ZLK	−1.752	−1.846	−3.221 ***	−4.473 ***	I(1)
MSK	−2.043	−1.820	−3.020 ***	−5.195 ***	I(1)
DOL	−1.068	−1.904	−3.952 ***	−5.041 ***	I(1)
K-P	−0.960	−1.636	−3.726 ***	−4.395 ***	I(1)
LDZ	−1.100	−1.634	−4.687 ***	−4.861 ***	I(1)
LBL	−1.456	−1.900	−4.735 ***	−6.669 ***	I(1)
LBU	−1.381	−1.947	−4.259 ***	−8.449 ***	I(1)
MLP	−1.284	−1.617	−2.836 ***	−7.068 ***	I(1)
MAZ	−1.247	−1.821	−4.152 ***	−6.020 ***	I(1)
OPO	−1.030	−1.874	−4.829 ***	−5.010 ***	I(1)
PKR	−1.201	−1.706	−3.836 ***	−9.154 ***	I(1)
PDL	−1.906	−1.915	−5.083 ***	−6.490 ***	I(1)
POM	−1.427	−1.969	−4.318 ***	−5.247 ***	I(1)
SL	−1.549	−1.995	−4.140 ***	−5.487 ***	I(1)
SW	−1.424	−1.807	−4.197 ***	−6.334 ***	I(1)
W-M	−1.387	−1.975	−4.849 ***	−5.983 ***	I(1)
WLK	−1.305	−1.787	−5.028 ***	−5.153 ***	I(1)
Z-P	−1.744	−2.009	−3.900 ***	−6.527 ***	I(1)

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: own calculations.

Table A2. Cointegration results.

Region	H_0: Rank	l_STC	l_JHC	l_PLK	l_KVK	l_LBK	l_HKK	l_PAK	l_VYS	l_JHM	l_OLK	l_ZLK	l_MSK
l_DOL	0	22.304 [0.1312]	23.532 [0.0944]	17.194 [0.4086]	21.391 [0.1654]	24.559 [0.0707]	22.921 [0.1115]	20.969 [0.1834]	22.712 [0.1178]	23.709 [0.0899]	21.748 [0.1513]	14.224 [0.6442]	20.214 [0.2192]
	1	5.673 [0.5126]	9.696 [0.1444]	6.391 [0.4230]	9.323 [0.1650]	5.549 [0.5289]	6.940 [0.3609]	5.022 [0.6002]	6.834 [0.3724]	7.083 [0.3458]	8.899 [0.1916]	5.488 [0.5370]	4.9325 [0.6126]
l_K-P	0	22.762 [0.1163]	24.974 [0.0626]	20.498 [0.2051]	22.732 [0.1172]	29.464 [0.0151]	25.272 [0.0574]	29.100 [0.0171]	22.201 [0.1347]	30.090 [0.0122]	22.558 [0.1227]	17.168 [0.4105]	23.733 [0.0893]
	1	8.716 [0.2040]	8.351 [0.2309]	7.845 [0.2726]	7.742 [0.2818]	6.617 [0.3966]	6.607 [0.3977]	7.997 [0.2595]	8.462 [0.2224]	7.574 [0.2972]	9.073 [0.1803]	5.891 [0.4844]	7.004 [0.3541]
l_LDZ	0	20.108 [0.2246]	23.661 [0.0911]	16.820 [0.4366]	14.211 [0.6453]	27.491 [0.0289]	21.358 [0.1668]	25.515 [0.0534]	20.139 [0.2230]	23.290 [0.1009]	20.454 [0.2073]	13.832 [0.6755]	30.035 [0.0125]
	1	8.521 [0.2180]	10.35 [0.1133]	7.408 [0.3130]	4.851 [0.6238]	7.896 [0.2682]	5.376 [0.5520]	6.269 [0.4375]	9.742 [0.1420]	10.20 [0.1196]	8.429 [0.2249]	4.967 [0.6079]	9.441 [0.1583]

Table A2. *Cont.*

Region	H_0: Rank	l_STC	l_JHC	l_PLK	l_KVK	l_LBK	l_HKK	l_PAK	l_VYS	l_JHM	l_OLK	l_ZLK	l_MSK
l_LBL	0	33.71 [0.0033]	33.59 [0.0035]	22.928 [0.1113]	21.276 [0.1702]	43.052 [0.0001]	36.389 [0.0012]	36.424 [0.0012]	23.310 [0.1003]	24.551 [0.0708]	34.417 [0.0026]	19.643 [0.2493]	41.542 [0.0002]
	1	9.767 [0.1407]	10.744 [0.0978]	6.782 [0.3781]	8.921 [0.1901]	8.123 [0.2490]	9.188 [0.1732]	9.348 [0.1636]	8.854 [0.1945]	7.941 [0.2643]	11.609 [0.0699]	6.0223 [0.4680]	10.331 [0.1143]
l_LBU	0	24.199 [0.0783]	16.048 [0.4967]	17.027 [0.4210]	14.971 [0.5836]	31.322 [0.0080]	11.251 [0.8562]	13.784 [0.6793]	14.427 [0.6278]	16.113 [0.4916]	14.562 [0.6169]	14.412 [0.6290]	19.842 [0.2385]
	1	9.045 [0.1820]	7.765 [0.2797]	8.088 [0.2519]	6.052 [0.4642]	8.242 [0.2394]	4.465 [0.6773]	5.231 [0.5717]	5.544 [0.5296]	5.226 [0.5723]	5.591 [0.5234]	7.007 [0.3538]	6.871 [0.3684]
l_MLP	0	17.178 [0.4098]	23.692 [0.0903]	27.930 [0.0251]	22.927 [0.1113]	17.505 [0.3859]	17.616 [0.3780]	18.268 [0.3331]	19.318 [0.2677]	15.779 [0.5182]	21.068 [0.1790]	15.535 [0.5379]	28.159 [0.0233]
	1	6.777 [0.3787]	9.269 [0.1682]	10.783 [0.0963]	6.965 [0.3583]	6.299 [0.4339]	8.491 [0.2203]	8.557 [0.2154]	5.960 [0.4757]	6.748 [0.3819]	8.426 [0.2251]	6.145 [0.4527]	9.569 [0.1511]
l_MAZ	0	28.888 [0.0183]	17.855 [0.3612]	19.509 [0.2569]	16.042 [0.4972]	22.233 [0.1336]	25.902 [0.0475]	25.031 [0.0616]	16.997 [0.4232]	17.928 [0.3561]	15.898 [0.5087]	15.412 [0.5478]	23.096 [0.1063]
	1	10.674 [0.1004]	6.479 [0.4126]	6.040 [0.4657]	6.621 [0.3962]	4.595 [0.6593]	5.372 [0.5526]	6.326 [0.4306]	5.934 [0.4790]	6.344 [0.4285]	6.589 [0.3998]	5.236 [0.5710]	5.292 [0.5634]
l_OPO	0	23.178 [0.1040]	28.070 [0.0240]	29.701 [0.0140]	21.595 [0.1572]	30.632 [0.0101]	25.838 [0.0484]	25.213 [0.0584]	23.874 [0.0858]	24.875 [0.0645]	22.466 [0.1258]	15.199 [0.5651]	31.558 [0.0073]
	1	7.837 [0.2734]	10.232 [0.1186]	9.565 [0.1514]	8.923 [0.1899]	6.733 [0.3836]	7.777 [0.2787]	7.511 [0.3031]	8.502 [0.2194]	8.151 [0.2468]	9.406 [0.1603]	6.350 [0.4278]	8.604 [0.2120]
l_PKR	0	26.385 [0.0410]	18.901 [0.2926]	19.851 [0.2380]	33.371 [0.0038]	29.026 [0.0175]	29.363 [0.0156]	18.248 [0.3344]	28.023 [0.0244]	32.385 [0.0054]	31.694 [0.0070]	16.214 [0.4836]	19.955 [0.2325]
	1	10.204 [0.1198]	6.604 [0.3982]	6.713 [0.3858]	6.559 [0.4033]	8.789 [0.1990]	10.348 [0.1136]	7.598 [0.2949]	9.795 [0.1393]	11.661 [0.0685]	9.678 [0.1453]	4.216 [0.7117]	7.113 [0.3426]
l_PDL	0	25.760 [0.0496]	27.917 [0.0252]	32.342 [0.0055]	24.246 [0.0773]	33.068 [0.0042]	30.856 [0.0094]	19.461 [0.2595]	24.869 [0.0646]	27.117 [0.0326]	26.089 [0.0449]	16.997 [0.4233]	40.286 [0.0003]
	1	8.388 [0.2281]	9.194 [0.1728]	9.881 [0.1350]	8.823 [0.1966]	6.842 [0.3715]	7.908 [0.2671]	6.217 [0.4438]	8.498 [0.2197]	7.930 [0.2652]	9.311 [0.1657]	7.106 [0.3434]	10.276 [0.1166]
l_POM	0	28.919 [0.0182]	20.036 [0.2283]	19.507 [0.2570]	30.122 [0.0121]	38.705 [0.0005]	22.231 [0.1337]	28.950 [0.0180]	28.415 [0.0215]	20.239 [0.2179]	21.114 [0.1770]	17.457 [0.3894]	21.383 [0.1657]
	1	9.456 [0.1574]	7.280 [0.3256]	6.914 [0.3638]	10.175 [0.1211]	7.400 [0.3138]	7.948 [0.2637]	7.823 [0.2746]	9.680 [0.1452]	6.093 [0.4591]	7.833 [0.2737]	6.385 [0.4237]	8.083 [0.2523]
l_SL	0	22.922 [0.1114]	25.524 [0.0532]	17.675 [0.3738]	22.314 [0.1308]	29.375 [0.0156]	26.386 [0.0409]	25.498 [0.0536]	23.027 [0.1083]	25.281 [0.0572]	23.240 [0.1022]	15.631 [0.5301]	18.734 [0.3030]
	1	7.803 [0.2763]	10.334 [0.1141]	5.847 [0.4901]	9.969 [0.1307]	6.427 [0.4186]	7.867 [0.2707]	7.614 [0.2935]	7.969 [0.2619]	8.310 [0.2340]	9.622 [0.1483]	6.079 [0.4608]	5.217 [0.5736]
l_SW	0	24.351 [0.0750]	16.321 [0.4751]	17.351 [0.3970]	16.724 [0.4440]	21.458 [0.1627]	31.123 [0.0085]	16.405 [0.4686]	15.703 [0.5243]	21.876 [0.1465]	15.460 [0.5439]	14.306 [0.6376]	34.361 [0.0026]
	1	10.830 [0.0946]	6.684 [0.3891]	6.514 [0.4085]	5.414 [0.5470]	5.535 [0.5308]	9.634 [0.1477]	6.261 [0.4385]	5.599 [0.5223]	6.028 [0.4672]	5.699 [0.5092]	4.705 [0.6441]	9.779 [0.1401]
l_W-M	0	27.677 [0.0273]	29.602 [0.0144]	34.640 [0.0024]	29.814 [0.0134]	35.363 [0.0018]	32.241 [0.0057]	21.254 [0.1711]	26.435 [0.0403]	31.416 [0.0077]	28.360 [0.0218]	17.902 [0.3579]	40.418 [0.0002]
	1	8.393 [0.2276]	8.980 [0.1862]	9.862 [0.1359]	9.715 [0.1434]	6.844 [0.3714]	7.946 [0.2639]	5.828 [0.4926]	8.491 [0.2203]	8.269 [0.2373]	9.515 [0.1541]	6.671 [0.3906]	9.798 [0.1391]
l_WLK	0	23.138 [0.1051]	17.864 [0.3605]	19.508 [0.2569]	22.221 [0.1340]	29.172 [0.0167]	12.097 [0.8036]	15.540 [0.5374]	21.883 [0.1462]	24.831 [0.0653]	22.397 [0.1280]	14.719 [0.6041]	20.686 [0.1962]
	1	9.658 [0.1464]	7.497 [0.3045]	6.823 [0.3736]	8.971 [0.1868]	7.354 [0.3183]	3.858 [0.7600]	6.103 [0.4579]	9.792 [0.1394]	9.358 [0.1630]	10.282 [0.1164]	5.472 [0.5392]	6.757 [0.3810]
l_ZP	0	26.275 [0.0424]	19.584 [0.2526]	18.994 [0.2870]	30.259 [0.0115]	35.563 [0.0017]	13.488 [0.7025]	16.775 [0.4401]	17.891 [0.3587]	15.833 [0.5139]	18.793 [0.2993]	16.564 [0.4563]	23.658 [0.0912]
	1	9.891 [0.1345]	8.695 [0.2055]	4.804 [0.6303]	10.460 [0.1089]	7.546 [0.2998]	4.626 [0.6550]	4.962 [0.6084]	5.440 [0.5434]	5.669 [0.5132]	8.538 [0.2168]	7.376 [0.3162]	7.455 [0.3085]

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Promotion of European Wines in Third Countries within the Common Market Organisation Framework: The Case of France

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Abstract: The international wine market has undertaken important structural changes in the first decades of the 21st century, both in terms of demand and offer. In order to mitigate the effect deriving from the increase in competition, the European Union (EU) continues to allocate important resources to increase the competitiveness of the winemaking sector by means of its Common Agricultural Policy (CAP) and the Common Market Organization (CMO). This paper aims to understand which factors have an influence on the correct implementation of the CMO measure of promotion in the principal wine exporter country: France. A fuzzy-set model (fs/QCA) has been utilized, studying a period of 10 years since 2009. Results show that is it possible to obtain a better execution ratio of measure of promotion by adapting some key factors, such as CMO budget allocation. These findings could support French national and regional authorities in the task of planning. Moreover, other Member States (MS) could also benefit, since in the new CAP approach, a higher participation in strategic plans is required for them by the EU.

Keywords: Common Market Organization; wine; third countries; measure of promotion; wineries; Common Agricultural Policy

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1. Introduction

The international wine market has displayed notable changes since the 20th century (Anderson and Nelgen 2011; Mariani et al. 2012). Although the most recent research introduces concepts such as "third world wines" (Banks and Overton 2010) or "emerging regions" (Lecat et al. 2019), both professionals and researchers from the sector continue to divide the world into two macro-areas: the "old world" and the "new world" (Thorpe 2009; Remaud and Couderc 2006; Bernetti et al. 2006). The "old world" name would refer to the European countries with a long winemaking tradition. This area shares a common heritage, which is reflected in the varieties held in their territories, as well as the indigenous consumption habits. On the other hand, that known as the "new world" or the new winemaking countries gathers and groups those that have recently been appearing on the international scene throughout the 20th century. Their modern harvesting techniques, adapted to extreme climate conditions, as is the case in Chile or New Zealand, for example, differentiate these wines from those better known "old world" wines (Sarturi et al. 2016; Barker et al. 2001). A more aggressive and competitive pricing strategy, combined with the work performed by their promotion agencies (Campbell and Guibert 2006; Giovannucci 2004), grant a leading role to these countries and their business fabric, forcing the "old world" producers to pursue more agile and flexible entrepreneurial policies.

Foreign trade and exports to new markets have become priorities for wineries and for all the European productive fabric, due to the reduction of wine consumption in the internal market (Gual and Colom 1997; Castriota 2020) and the constant growth in sales in new world countries (Medina-Albaladejo et al. 2014).

However, the European productive fabric is formed by small-scale businesses and/or family businesses who must face a dynamic and competitive environment (Ayyagari et al. 2007;

Kusa et al. 2021; Fuentes-García et al. 2019). As such, as stated by Sellers and Alampi-Sottini (2016), not only may the export and internationalization process towards new markets not be considered a simple task for the entrepreneurs and their small or medium organizations but for wineries as well.

In order to support their businesses, the European Union (EU) has put in place economic policies that look to increase the international competitiveness of its wineries (Planas 2017; Meloni and Swinnen 2013). The specific policy for the winemaking sector takes the name of the Common Markets Organization (CMO) and is framed in the first pillar of the famous Common Agricultural Policy (CAP).

The main goal of this study is to analyze the performance of the CMO grant for the wine sector in France, a country chosen due to being the most represented in terms of exports and aid from the CAP. At the same time and more specifically, we analyze the eight measures available to the sector in order to improve competitiveness by means of CMO funds, with particular reference to the measures of promotion.

The studies conducted regarding this topic acquire characteristics that are more focused on conclusions of a legal or professional nature and do not focus on the specific measure of promotion, analyzing the CMO as a whole (ECA 2014; Agrosynergie GEIE 2018). As such, a gap has been detected in the literature regarding this topic; in other words, it is considered timely to clarify the debate regarding the function and use of these tools, which consume large investments year after year.

The latest reform of the CAP from 2020 and its economic measures, including the promotion in third countries, are designed to provide the Member States (MS) with more flexibility and weight when it comes to defining their strategic plans (Pomarici and Sardone 2020). Despite the impact on the European productive sector, there is no specific scientific research regarding the measure; this study intends to clarify the debate regarding it, analyzing the first decade of implementation (2009–2018).

As a result of all that mentioned above, the following questions have arisen:

Q1. Is there a relationship between exports and the policy for developing the wine sector?
Q2. Which factors may influence the more efficient use of resources?

The structure of this research is based on the evolution of French exports and CMO grants implementation. After a review of the literature and context introduction, the methodology of the study is presented, consisting of the development of a fs/QCA model. The results obtained it made possible to reveal specific findings about the importance of measure's budget allocation and the relationship between wine exports and the implementation of the measure of promotion.

2. Theoretical Background

The agricultural sector has been and continues to be considered a primary sector for the interests of European member states (Guth et al. 2020; Van Zanten et al. 2014). Zobbe (2001) explained how the Second World War caused severe production problems in the old continent, which forced the group of countries to seek solutions for what was then held up as the main sector of the European economy.

The original idea of the CAP intended to support and guarantee a reasonable quality of life for the farmers and livestock farmers supporting themselves in the efforts of the MS "as intermediaries" and through a policy of prices decided by the European institutions at a central level. However, globalization and multi-lateral treaties for the liberalization of assets and services between states lead to a debate on the protectionist system that reined in Europe in those decades (Kahler 1985), which is why the CAP has also been modifying its approach and strategy.

By means of the various reforms undertaken, a direct and specific action regarding the prices of products evolved towards a direct support to the productive fabric, that is to say, towards the farmers and their entrepreneurial activity, with the aim of improving their competitiveness in international markets (García-García 2020).

Table 1 shows how the instruments used have evolved and adapted to the age (Compés and García 2009; Cejudo and Maroto 2010). Direct payments, more focused on maintaining producers' income, have been reduced in favors of more active policies, which predict the commitment of the beneficiary. The formal introduction of the latest reform to follow is pending; the unexpected COVID-19 pandemic has forced the European Commission (EC) to postpone the entry of the new reform, originally expected for 2020.

Table 1. Stages and reforms of the CAP.

Reform.	Year	Main Characteristics
1st	1957–1962	Beginning of CAP. Intervention on the prizes to protect the producers from the international competition.
2nd	1992	"Mac Sharry" period. Direct payments to the farmers are initiated to promote their income. The concept environment is considered for the first time.
3rd	1999	The role of rural development and the competitiveness of producers as a tool for their economic growth takes center stage.
4th	2003	The concept of decoupling aid from production is introduced.
5th	2008	Improvement of the 2003 reform, with a practical approach to the environment after the Kyoto protocol of 2005.
6th	2013	It coincides with Croatia's entry into the EU. GIs quality scheme and depopulation of rural areas become more important.
7th	2023	It has already been adopted but its implementation is pending. A new strategic approach to the MS is required and the Green Economy assumes a key role in the strategic objectives

Source: Own elaboration.

These changes have been influenced by international pressures and repeated criticism of the CAP. From an external point of view, the members of the World Trade Organization (WTO) criticize the CAP because it is too protectionist and clashes with the principles of liberalization that they share (Tamames 2012; Heredero 2001). From an internal point of view, other sectors of the European economy criticize its heightened budget assignment and its real impact on the sustainability of the continent's economy (Volkov et al. 2019). Authors such as Hart and Bas-Defossez (2018) and Recanati et al. (2019) considered it to be a policy too focused on the socio-economic situation of the first post-war decades, obsolete and isolated from reality.

In order to carry out the goals of the CAP in each primary European sub-sector, the CMO was created. Gaeta and Corsinovi (2014) defined it as a group of EU regulations, grants and agreements that intend to homogenize the agricultural production of the old continent, integrating a series of mechanisms and guarantees that regulate the production and competitiveness of European agricultural products.

The current system of budget distribution appears in 2009 and is divided into cycles of five financial years, defined as the National Support Program (NSP); the winemaking sector is one of the most relevant sectors in terms of the CMO and the CAP in general. As explained by Pomarici and Sardone (2020), there are three ideas around which its support for the sector is articulated:

(a) Since 2013, all the producers with vineyards may benefit from direct payments (optional in terms of the decision adopted by each MS).
(b) Similar to other sub-sectors, the actors of the winemaking sector may also benefit from the resources assigned to rural development policies, implementing co-financed projects that look to increase the competitiveness of specific geographic areas.
(c) The winemaking sector is linked to the line of financing known as "market measures", by which there are tools to strengthen the marketing campaigns and support the sector in case of disturbances on the markets.

The measures for the resolution of the European productive fabric are framed within this last idea. In the first NSP (2009–2013), the petitioners could choose from 11 different measures; however, after the second NSP (2014–2018), the new regulation n° 1308/2013 reduces the measures to 8, progressively removing the sole payment measure as well. In addition to this, each MS has the obligation to select the measures that shall be adopted in its own national plan, forcing it, as such, to define the budget for each one.

The measure for the promotion in third country markets is aimed at the wineries and sector stakeholders (Pomarici and Sardone 2020); the General Directorate of Agriculture (DG AGRI) intends to support the productive tissue in order to increase its promotion activity by means of a return of up to 50% of the costs sustained. This measure was introduced in 2009 representing 12% of the budget in the NPS for 2009–2013 and experiencing a growth up to 18% in the second NPS (2014–2018), with the third NPS (2019–2023) not having finished yet at the date of writing this paper (Tables A1 and A2). Despite its importance at European level, no scientific work has been detected that only focuses on the measure for promotion and its impact.

The Measure of Promotion to Third Countries in France

The leadership of France as a wine exporter on a global level has been widely described in the literature (Ayuda et al. 2020; Ugaglia et al. 2019; Candau et al. 2017). However, despite being the main European exporter and the main beneficiary of the CAP, France is not the main beneficiary of the measure for the promotion to third countries.

Figure 1 shows how the value of French bottled wine exports to third countries (blue line) displays a growing trend in the 2009–2018 period, with a 123% increase. However, although notable increases have also been registered for the budget and spending level during the period described (117% and 132%, respectively), strong ups and downs in the evolution are also observed.

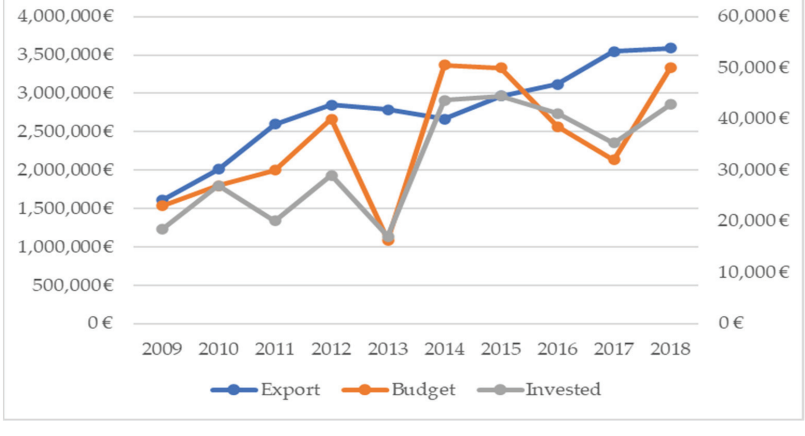

Figure 1. Evolution of exports, budget and implementation of the measure of promotion in France (data in thousands of €). Source: Own elaboration based on TRADEMAP data and DG AGRI reports.

With a total of €357,345,000 during the first ten years, France is in third place with 20.80% of the budget, behind Spain (24.15%) and Italy, which is the main beneficiary of this specific measure with 41.36% of the budget (Table 2).

Table 2. Distribution of the CMO budget by MS (data in thousands of €).

MS	1st NSP (2009–2013)	2nd NSP (2014–2018)	Total Budget (2009–2018)	Budget Evolution in between NSP	Share of the Budget among MS
Austria	7000	13,000	20,000	85.71%	1.16%
Bulgary	4870	5439	10,309	11.68%	0.60%
Croatia	-	4716	4716	N.P.	0.27%
Cyprus	-	602	602	N.P.	0.04%
France	**136,300**	**221,045**	**357,345**	**62.18%**	**20.80%**
Germany	6640	8224	14,864	23.86%	0.87%
Greece	18,167	35,785	53,952	96.98%	3.14%
Hungary	-	3600	3600	N.P.	0.21%
Italy	232,312	478,256	710,568	105.87%	41.36%
Lithuania	202	195	397	−3.47%	0.02%
Portugal	43,289	38,000	81,289	−12.22%	4.73%
Romania	3617	29,200	32,817	707.30%	1.91%
Slovakia	70	350	420	400.00%	0.02%
Slovenia	4444	7700	12,144	73.27%	0.71%
Spain	166,836	248,000	414,836	48.65%	24.15%
Total	623,747	1,094,112	1,717,859	75.41%	100%

Source: Own elaboration based on DG AGRI reports.

With an increase of 62% in the budget aimed for this measure, between the first and second NSP, the French productive fabric has not managed to execute 100% of the funds. At the end of the first two NPS, €318,951,000 has been granted, with 90% of the budgets assigned, leaving more than €38 million without being used and forcing the public administration to relocate these funds into other CMO measures.

The budget management of the public funds is related to three important functions: redistribution, allocation and stabilization (Musgrave 1969; Oates 1972). Lindner and Tordoir (2021) defined the allocation as the possibility of using legal instruments for the most efficient management of the resources. Within each period with a duration of 7 years, defined as the Multiannual Financial Framework (MFF), each MS has precisely the possibility of adapting their own budget in terms of the needs and priorities agreed. The same criteria are followed for the distribution of the budget in the frameworks of the NSP in each MS.

Table 3 shows the effects of the budget adaptation in France for measures of promotion. With the exception of the first year that the grant was put in place (2009), France has managed to implement almost the entirety of the CMO funds for the sector every year, showing its interest through the group of measures and its great ability for management within the CMO, reaching an average execution of 99.06%.

Table 3 shows how, on average, France has assigned 13.73% of its CMO wine budget to the measure for promotion; however, calculating the same ratio with amounts that were really executed, this ratio is lowered to 12.29%. The authors define, as such, the Execution Budget Gap (EBG) as the difference between the two quotas, highlighting that France has assigned, on average, 1.44% more of the budget than the productive fabric has shown to really need throughout the first two NSPs.

Table 3. Breakdown of the CMO wine budget in France (data in thousands of €).

Year	Budget	Execution Measure of Promotion	Execution Ratio	Execution (All CMO Measures)	Execution Ratio (All CMO Measures)	Share of Measure of Promotion of CMO Wine Budget: A	Share of Measure of Promotion of CMO Wine Costs: B	EBG (B-A)
2009	23,000	18,426	80.11%	155,744	90.55%	13.37%	11.83%	−1.54%
2010	27,000	27,004	100.01%	226,835	100.02%	11.90%	11.90%	−0.00%
2011	30,000	20,056	66.85%	224,055	100.02%	13.39%	8.95%	−4.44%
2012	40,000	29,014	72.54%	284,267	99.99%	14.07%	10.21%	−3.86%
2013	16,300	17,098	104.90%	280,310	100.00%	5.82%	6.10%	0.28%
2014	50,545	43,701	86.46%	280,545	100.00%	18.02%	15.58%	−2.44%
2015	50,000	44,474	88.95%	280,545	100.00%	17.82%	15.85%	−1.97%
2016	38,500	41,052	106.63%	280,545	100.00%	13.72%	14.63%	0.91%
2017	32,000	35,313	110.35%	280,545	100.00%	11.41%	12.59%	1.18%
2018	50,000	42,811	85.62%	280,545	100.00%	17.82%	15.26%	−2.56%
Total/Average	357,345	318,949	90.24%	2,573,936	99.06%	13.73%	12.29%	−1.44%

Budget: the amount fixed by EC and MS for this financial year as maximum to invest in the measure; execution measure of promotion: the amount implemented by the French beneficiaries in this year; execution ratio: the % of budget invested, based on original financial plan; execution all CMO measures: the amount invested by the French beneficiaries considering the entire CMO wine in the country; execution ratio all CMO measures: the % of budget invested in all CMO wine, based on the original financial plan; share of budget (A): the share that the promotion measure has of the budget (at the beginning of the financial year); share of costs (B): the share that the promotion measure has of the execution (by the end of the financial year). Source: Own elaboration based on DG AGRI reports.

Despite this important deviation in the execution of the measure of promotion, the exports of bottled wine to third countries have increased considerably. Figure 2 shows and compares the evolution of the exports of bottled wine both in Europe as well as third countries.

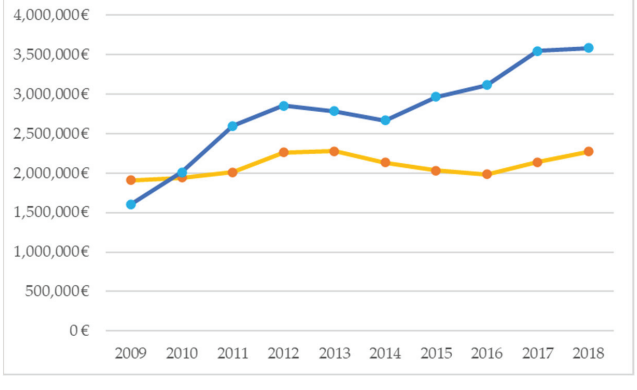

Figure 2. Evolution of the French exports of bottled wine in Europe and third countries (data in thousands of €). — export of bottled wine in third countries — export of bottled wine in Europe. Source: Own elaboration based on TRADEMAP.

Historically, the internal market has been the main destination for exports of bottled French wine. In Figure 2 and in Table 4, it is possible to appreciate how, since 2010 and during the first decade of implementation, the extra-community exports have increased in

value (+90.4%) compared to those of the internal market and have preserved a growing trend in spite of the decrease of the subsidies for the increase of promotion in these markets.

Table 4. Exports in value of French wines (data in thousands of Euros, HS code 21.04.21).

Year	Third Countries	Internal Market (EU)
2008	1,922,785	2,260,467
2009	1,606,300	1,907,845
2010	2,010,274	1,944,320
2011	2,596,020	2,009,087
2012	2,852,153	2,263,499
2013	2,786,076	2,276,741
2014	2,666,943	2,134,648
2015	2,968,051	2,033,384
2016	3,117,226	1,985,486
2017	3,547,056	2,138,564
2018	3,587,288	2,274,134
2019	3,660,159	2,372,956
Variation 2008/2019	90.4%	4.9%

Source: Own elaboration based on TRADEMAP.

These data, in addition to a lack of recent and specific literature regarding the topic, additionally encourage a scientific analysis to verify if the budget assignment is coherent with the need of the productive fabric and which factors may influence a better assignment and execution of the same.

3. Materials and Method

3.1. Sample and Data Collection

This research intends to study the influencing factor in an implementation of the measure of promotion with the final aim of reaching greater efficiency. Among the 15 MS that have activated this measure, France has been the country with the best execution ratio; even so, a large sum of money (€38 million) has been unused, and for the already explained reasons, we choose this country.

Due to the third NSP not having finished by the time of this study, and due to avoiding bias derived from the change of the subsidy percentage granted during the years of the COVID-19 pandemic, the study is focused on the decade 2009–2018, this being the complete period of two NSPs.

The data have been obtained from the official reports of the DG AGRI; specifically, for the export data, the Trademap database was consulted, considering the tariff entry HS 21.04.21. The measure allows the grant for activities destined for the promotion of finished products (bottled wines); because of this, this entry has been selected to verify the impact on the exports.

3.2. Definition of the Variables

For the development of this study, four conditions have been selected (Variables -V-) with the aim of explaining or justifying a large ratio of execution of the measure of promotion in France (Result -R-).

V1: *Budget available for the measure of promotion*.

This value expressed in euros indicates the monetary amount that France has available—and that the administration of the country has assigned—for the measure of promotion.

Justification: With the analysis of this variable, it intends to objectify whether the budget performance and distribution of the measure is appropriate.

V2: *Amount spend on all the CMO wine, as a sum of all the measures*

This amount, expressed in euros, is the sum of all the grants that France has executed for the beneficiaries of their own country throughout the financial year.

Justification: The study of this variable allows for the understanding of the volume and function of the wine CMO in its entirety to be able to contextualize the results obtained from the specific measure of promotion.

V3: *EBG: Execution Budget Gap of the measure of promotion*

This value, expressed as a percentage, is the difference between the budget quota assigned to the measure of promotion at the beginning of every financial year and the quota effectively spent from the total of the wine CMO for this member state.

Justification: These data help to understand the consideration of the country when it comes to assigning the budget to the measure. When the EB is closer to zero, the management and assignment of the resources shall be more coherent with an appropriate execution of its own productive fabric.

V4: *Value of the export in value of bottled wine in the year n − 1 regarding the implementation of the measure.*

This value, expressed in euros, indicates the value, registered in the year n − 1 (previous year) of the exports of bottled wine (22 April 2021) sold by French vineyards in third countries.

Justification: It is necessary to have a reference for the evolution of the sales of bottled wine and analyze them with the commercial activities and the promotion performed in the previous year. The study of the value in exports, different from the data in volume, is considered to be timelier when it comes to analyzing the causes of a promotion campaign.

R: *Execution ratio for the measure of promotion*

This value, expressed as a percentage, indicates which quota of the grant destined for this measure has been effectively implemented at the end of each financial year. It is the quotient between the amount paid to the beneficiaries and the budget available for the measure of promotion.

Justification: This value is of utmost importance for understanding the relationship between efficient execution and the rest of variables used. The analysis to perform intends to explain a heightened ratio of execution with the aim of improving the use of the resources.

The first three variables may be observed in Table 3, while we can observe the last variable, V4, and the R ratio in Table 4.

3.3. Data Analysis Method

The Fuzzy Set/Quality Comparative analysis (fs/QCA) model is a method of a theory of groups that considers the cases as configurations of causes and conditions, instead of trying each independent variable as analytically different and isolated from the rest. This empirical method examines the relationships between the result of interest (R) and all the possible combinations (high/low or absent) of their predictors or conditions (V1, V2, V3 and V4).

The interest in the methodology of fs/QCA is due, basically, to Ragin (1987, 2000, 2008). Its main purpose is to adjust the data of the theory going beyond the dependence of a single sample, which implies reaching predictive validity (McClelland 1998; Gigerenzer and Brighton 2009; Woodside 2013; Wu et al. 2014).

In order to understand the fuzzy-QCA, the theory of groups must be addressed. This allows for a detailed analysis of how the causal conditions contribute to a particular result. Instead of estimating the purposes of the individual variables, fs/QCA uses Boolean logic to examine the relationship between a result and all the possible preceding multiple combinations, allowing for the researchers to find different combinations of causal variables that suggest different theoretical paths to specific results (Longest and Vaisey 2008). According to Ragin (2008), instead of researching which factors are the most important, fs/QCA seeks to know which factors should be combined and in which combinations.

The measure of the consistency—similar to the correlation—is the proportion of the cases compatible with the result; that is to say, the number of cases that a specific configuration of attributes and the result divided by the number of cases that present the same configuration of attributes. The underlying idea is that there is a diffuse sub-group

relationship when the scores of belonging to a group (Xi) are consistently less or equal to the scores of membership in the other (Yi) (Xi $\leq$ Yi).

The measure of coverage—similar to the determination co-efficient—assesses the empirical relevance of a consistent sub-group. In other words, which proportion of the result is explained by the variables of the model, in this case, by the solution. The coverage is based on a causal combination, which guarantees that the cases which comply cover a large part of the result by being empirically important.

3.4. Calibration

A diffuse group may be seen as a continuous variable that has been calibrated in a useful manner to indicate the degree of belonging to a well-defined and specific group. This calibration is possible only through the use of theoretical knowledge and which is essential for the specification of the three cut-off or threshold qualitative points (complete member, incomplete member and maximum ambiguity). Table 5 shows the calibration step. In this research it indicates that the measure of promotion in the years 2009–2018 may be considered members of groups that vary in accordance with their specific attributes. As a result, each one of these quantitative variables has to be calibrated to grant degrees of membership or belonging to previously defined groups.

Table 5. Calibration variables and result according to the fs/QCA model.

Conditions (V) and Result (R)	No. of Samples Validated	Average	Standard Deviation	05 Percentile	Median	95 Percentile
V_1	10	35,734,50	12,088.53	16,300.00	35,250.00	50,545.00
V_2	10	257,393.60	42,563.95	155,744.00	280,545.00	284,267.00
V_3	10	−1.44	1.97	−4.44	−1.76	1.18
V_4	10	2,607,288.40	595,903.36	1,606,300.00	2,726,509.50	3,547,056.00
R	10	90.24	14.85	66.85	87.70	110.35

Source: Own elaboration from DG AGRI reports and TRADEMAP.

The values of the medians mark the degree of membership. These values, which coincide with the median, are considered to be ambiguous; low values are incomplete members (in other words "low value") and those which are high are considered to be complete members (in other words "high value").

3.5. Analysis of Sufficiency

Once the results and all the conditions are calibrated (the *fz* suffix indicates a calibrated variable), the true table is extracted (Table 6), which lists all the possible configurations. The value 1 in each configuration indicates a score of the calibrated variable greater than or equal than 0.5 (that is to say, closer to the category of complete member) and 0 indicates values of the calibrated variable less than 0.5 (closer to the category of no member).

Table 6. True table fs/QCA model.

V_1fz	V_2fz	V_3fz	V_4fz	Number	R*fz*	Raw Consist.
0	0	1	0	2 (25%)	0	0.873984
0	0	1	1	1 (37%)	1	1
0	1	1	1	1 (50%)	1	1
1	0	0	0	1 (62%)	0	0.860335
1	0	0	1	1 (75%)	0	0.892308
1	1	0	1	1 (87%)	0	0.769911
1	1	1	1	1 (100%)	1	1

Source: Own elaboration.

Those configurations without cases (reminders) are removed and, given the sample size, in spite of analyzing two whole financial cycles of the measure, there are few of them; they also remove those configurations with a single case.

The following step is the selection of a limit of consistency to distinguish causal combinations that are sub-groups of the result of those which are not. In general, values below 0.80 in this column indicate substantial inconsistency. As a consistency threshold, 0.95 is chosen, and we assign the value 1 to the variable result (R*fz*) when the consistency of this configuration passes the 0.95 threshold, establishing 0 otherwise.

In the true table, there are 2^K settings or ranks, where "k" is the number of conditions or variables. There is an empirical rule which states that $2^K <$ number of cases; as such, by having 10 cases (years), it was not possible to introduce a greater number of conditions. This empirical rule is a recommendation and is non-binding. By being a pioneering study with this model for the measure of promotion, only four conditions are selected, which is still an acceptable limit to ensure that the results obtained are reliable and robust. In order to apply the fuzzy QCA methodology in this research, the FS/QCA 3.0 (Fuzzy-Set/Qualitative-Comparative Analysis Version 3.0, sourced by COMPASS—Claude Rubinso: Irvine, California; Department of Sociology, University of California) software has been used.

4. Results

The final solution for the prediction and explanation of a high implementation ratio (above 87.70%) is as follows:

$$\sim V_1 fz * V_3 fz * V_4 fz + V_2 fz * V_3 fz * V_4 fz$$

Three common operations in different groups are the negation (~), the intersection ("logic and", which is represented by a multiplier operator $*$) and the Union ("logic or", which is represented by a sum operator +):

- Logic negation (~): (belonging to the group ~M) = 1.0 − (belonging to the M group)
- And logic ($*$) shall be performed taking the minimum score belonging to each case in the groups that are combined
- Or logic (+) is performed taking the maximum score of belonging to each case in the groups that are combined

The combination shown in Table 7 sufficiently increases the execution ratio of the measure (R) in 100% of the cases and covers 56.91% of the cases: a high V_4 together with a high V_3 and a low V_1 leads to sufficiently increasing the R level or even a high V_4 together with a high V_3 and a high V_2 leads to sufficiently increasing the R level.

Table 7. Model results.

Combinations	Raw Coverage	Unique Coverage	Consistency
$\sim V_1 fz * V_3 fz * V_4 fz$	0.3739	0.0534	1
$V_2 fz * V_3 fz * V_4 fz$	0.5157	0.1952	1
Solution coverage: 0.5691			
Solution consistency: 1			

Source: Own elaboration.

In order to represent the consistency and coverage of a solution, they may use scatter plot graphs that face the solution with the result: a combination -group- that systematically has all the scores (calibrated) less or equal to the scores of the result (upper triangle). It is said that this is a sub-group of the result and that the consistency is high. The years that are beneath the diagonal are inconsistent with the result and those that are above are consistent. However, within each group, there are degrees of relevance in relation to the score of the combination being less or more than 0.5 (upper right quadrant): it is more serious than an

inconsistency in the red triangle (Yi $\geq$ 0.5, Xi > Yi) and it is more relevant than a consistency in the green triangle (Xi $\geq$ 0.5, Xi $\leq$ Yi).

Figure 3 explains with a graph how the predictive combinations obtained using the fs/QCA model have been consistent throughout all the years studied, placing all of them above the diagonal. Additionally, three specific financial years (2013, 2016 and 2017) are very consistent, concluding that it is likely that there is a common pattern in these three years as the combination of factors obtained is particularly consistent.

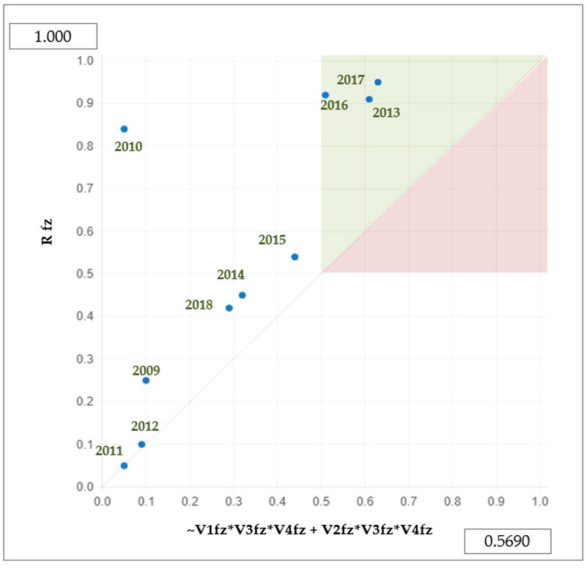

Figure 3. Graph of the fs/QCA consistency model. Source: Own elaboration.

5. Discussion and Conclusions

5.1. Theoretical Implicaciones and Managerial Implications

This study intends to enrich the debate regarding the CMO for the wine sector, focusing on the measure of promotion during the first decade of its implementation. The topic addressed is pioneering, given that the literature review undertaken has shown that until now, no similar studies had been considered in this context. As a result of this, it is not possible to establish a comparison between the results obtained in this study and other prior analysis. The results offer various combinations of factors which, based on the first decade of implementation in France, would explain how to maximize the implementation ratio of the measure of promotion®, for a more effective management of the same.

The correction and redistribution of the budget, expressed with the EBG (V_3) coefficient, should remain greater than the reference value (−1.76%). This would explain why in France the management of the public administration plays a particularly relevant role in the results of the measure of promotion. The planning of the resources among the different measures of the CMO is, as such, key for the country, evidenced by the co-responsibility of the functions between the private sector and the public sector in the management of international promotion by means of EU funds.

Similarly, a high value for bottled wine exported to third countries in the previous year (V_4) is present in both groups of combinations. This result may explain how the French productive fabric has a quite evident interconnection between the commercial results (exports) and the marketing functions of winemaking businesses (promotion campaigns). Greater income derived from the sales of bottled wines in third countries during the previous year shall be followed by a more effective management of the promotion campaigns with the European Union funds, according to the model analyzed.

A budget contribution for the low measure of promotion, according to the model, would also explain a better ratio of execution. This conclusion coincides with the trend that is registered by analyzing the five-year periods of implementation of the measure. France has managed to comply with 100% of the execution, and even surpassed this threshold by making the most of the flexibility that exists in the management of the CMO wine, solely in those financial years in which the budget has been considerably reduced in comparison to the previous year. For example, 104% of the execution was seen in 2013 (−59% of the budget in relation to the previous year), 106% in 2016 (−23%) and 110% in 2017 (−17%), as can be verified in Table 3.

Finally, the condition of an investment of high CMO wine (V_2) supports the conclusion that the different measures of CMO for the wine sector have a close connection between them. The possibility of making the most of different subsidies or grants for the productive process would generate economies for the organization that may benefit the rest of the functional processes, such as, for example, marketing and promotion activities.

The study shows predictive combination factors based on the situation of France in these ten years (2009–2018). These results intend to support the work of strategic planning made by the French national authorities, as well as serving as a reference for other MS and the EU technicians in their difficult task of assigning the budgets to the different CMO measures. A correct assignment of the resources needed for the measure of promotion could release other funds for other beneficiaries or other measures related to the production stage of the process, and not because of this, of less importance for creating value.

5.2. Limitations

Due to being a pioneering analysis on the topic, the study uncovers some limitations. First of all, despite considering two complete financial cycles, the size of the sample is a limit for reaching conclusions of a more generic nature regarding the sector and the CMO. Increasing the number of intervals in some of the variables has been considered, such as, for example, registering the exports per trimester and not annually. Notwithstanding, the execution data of the measure of promotion are published every 12 months, which limits the sample size in its consideration for years and, as indicated previously, the number of conditions to study according to the fs/QCA model. The method used is associated with the "learning by doing" technique, which for future studies, with a greater number of years, may provide more precise conclusions.

Second of all, the reports published by DG AGRI do not detail the market goals chosen by the group of French beneficiaries; because of this, it is impossible to offer an analysis that considers other factors beyond the measure mentioned, such as, for example, the market conditions, characteristics of the distribution channels, factors related to the harvest or the level of market penetration, among others.

Finally, the relationship between the measure of promotion and the commercial aspect (exports) is incomplete. In this study, because of the limitations of the fs/QCA model, only the results of the previous year's sales are considered (V_4) as proof of a greater or lesser investment in the promotion for the following year, when these commercial results may affect the strategic decisions of various coming years.

5.3. Future Lines of Research

The authors, with the aim of considering the results and conclusions obtained in this first approach to the measure of promotion, suggest future lines of research. Firstly, to explore additional, different scientific models other than fs/QCA, both qualitative and quantitative, which, with a greater number of cases (years of implementation), may offer more specific results and, perhaps, to other MS with similar characteristics. Secondly, on the basis of these results, it is recommended to analyze in detail the role of the public administration and its specific impact on the execution ratio, detecting potential structural improvements in the system that executes the grant.

Additionally, the authors detect a need to perform other studies at the beneficiary organization level, in order to measure the efficiency of each one of them and their link with the rest of the measures in the same financial year; similarly, a study focused on the behavior of wineries would help to understand whether the measure of promotion is truly an incentive for increasing campaigns or, on the other hand, is it considered a financial management tool for the structural cost saving that has already been considered.

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Appendix A

Table A1. Evolution of the European budget for the CMO wine during the first NSP (2009–2013). Data in thousands of Euros.

NSP 2009–2013	Budgeted by DG AGRI	% of the Budget Total
1. Support the single payment scheme	509,715	10%
2. Promotion	**623,747**	**12%**
3. Restructuring and conversion of vineyards	2,291,484	43%
4. Green harvesting	56,834	1%
5. Mutual funds	0	0%
6. Harvest insurance	129,116	2%
7. Investments	552,943	10%
8. Distillation of sub-products	451,699	8%
9. Distillation of alcohol for mouth use	538,509	7%
10. Crisis distillation	84,217	2%
11. Use of grape must	256,828	5%
Total	**5,315,092**	**100%**

Source: Own elaboration from DG AGRI reports and TRADEMAP.

Table A2. Evolution of the European budget for the CMO wine during the first NSP (2014–2018). Data in thousands of Euros.

NSP 2014–2018	Budgeted by DG AGRI	% of the Total Budget (0–9)
0. Support for the single payment scheme	735,295	12%
1. Promotion and information	**1,094,112**	**18%**
2. Restructuring and conversion of vineyards	2,655,987	43%
3. Green harvesting	23,930	0%
4. Mutual funds	0	0%
5. Harvest insurance	129,657	2%
6. Investments	1,200,467	19%
7. Innovation	1,010	0%
8. Distillation of sub-products	400,750	6%
9. Others	0	N.P.
Total (0–9)	**6,241,206**	**100%**
Total (1–9)	**5,505,911**	**N.P.**

Source: Own elaboration from DG AGRI reports and TRADEMAP.

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Article

The Development of *Indigofera* spp. as a Source of Natural Dyes to Increase Community Incomes on Timor Island, Indonesia

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Abstract: A strategy that has the potential to contribute to the achievement of the targets established under SDG 8 ("Decent Work and Economic Growth") involves the development of sustainable tourism to create productive job and livelihood opportunities and to promote local culture and products. In the province of East Nusa Tenggara (NTT), Indonesia, *ikat* weaving is an integral part of the cultural heritage of the region, with *ikat* characterized by unique design motives and the use of natural dyes. Unfortunately, in some areas, the use of natural dyes is diminishing as a result of competition with synthetic dyes and the limited availability of raw materials, particularly for the production of blue dye. The development of *Indigofera* spp. to produce natural, plant-based blue dye has significant potential to contribute to community incomes and employment. This study outlines a strategy for developing the use of *Indigofera* spp. as a natural dye and describes its potential for contributing to community incomes, especially on Timor Island, NTT. The study shows that weavers currently use indigo plants that grow naturally in gardens and yards. Although the community has a tradition of using these plants, informed by local wisdom, to develop the cultivation and processing of this plant through the application of the appropriate techniques, including innovative approaches to producing indigo paste, could enable the development of *Indigofera* spp. cultivation on a larger scale. The study shows that the availability of suitable land is high (±370 thousand ha), with 80% of the suitable land being categorized as critical. The study proposes a development based on the analysis of strengths, weaknesses, opportunities, and threats to assess the manner in which these opportunities could be leveraged with the support and participation of local communities and other stakeholders by leveraging the culture and wisdom of the community regarding the use of *Indigofera* spp.

Keywords: *Indigofera* spp. cultivation; indigo paste production; economic contribution; land suitability; development strategy

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1. Introduction

The province of East Nusa Tenggara (hereinafter referred to as NTT) has been in the top three poorest provinces in Indonesia (Beneditus Dalupe 2020; Wiryanta 2007). The livelihoods of the people of NTT still depend on natural resources, 48,7% obtained from agriculture, forestry, and fisheries, while 34% from the service sector. Likewise, on Timor Island, 40.35% of the people depend on natural resources for their livelihoods in agriculture, forestry, and fisheries (BPS Provinsi NTT 2021). However, NTT has creative economic potential through the culture-based tourism industry. With the increasing importance of

achieving the Sustainable Development Goals (SDGs) in various situations, tourism can play an important role in achieving goal number 8 of the 17 SDGs (UNWTO and UNDP 2017; Dahles et al. 2020; Scheyvens and Hughes 2019; Westoby et al. 2021).

Tourism, if implemented sustainably, seeks to balance the three pillars, namely economy, society, and the environment (Saarinen 2018; Sharpley 2020; Westoby et al. 2021). Although not always evenly distributed, tourism can increase income for many local people (Nugroho and Numata 2020). The expansion of cultural tourism towards intangible cultural heritage and contemporary culture has created more attention for the increased integration between tourism and the creative economy (Richards 2018).

The famous cultural product of the NTT community is *ikat* weaving (Amaral and Ikat 2019; Bessie et al. 2021; Dioh 2020; Luik et al. 2021; Wangge 2021), which is a hereditary culture from the ancestors of the NTT people with diverse geometric patterns (Windiyarti 2006; Hartono 2010; Tas'au 2016). The making of *ikat* is considered as a woman's activity; a tradition passed down from mothers to their daughters (Sulaiman and Anita 2020). *Ikat* is family property that has a high value as a symbol of social, religious, cultural, and economic status (Elvida 2015; Wangge 2021).

Ikat reflects the identity of the different ethnic groups in NTT, with each group having a different style (Susilawati 2010), such as representations of animals (Sumba Island), leaves (Rote Island), silk and embroidery weaving (Timor Island), and warp *ikat* weaving (Alor Islands) (Salma et al. 2018; Sulayman et al. 2017), also colors that differ widely from those found elsewhere in the archipelago (Dioh 2020) due to the use of natural dyes in its production (Ledoh et al. 2021; Murniati and Takandjandji 2015; Nomleni et al. 2019; Sabuna and Nomleni 2020).

Colored dyes are produced from colored plants (flowers, fruit, seeds, leaves, wood, bark, roots, and other parts), animals (insects that produce red and purple colors), and minerals (metals, metal salts, and oxides, red ocher) (Elsahida et al. 2019). *Indigofera tinctoria* L. is one of the plants used as a black and blue dye for yarn for making *ikat* by the community of NTT (Setiawan and Suwarningdyah 2014).

Indigofera species comprise mainly herbs, perennial or annual, shrubs or small-sized trees, distributed in forests, savannas, and disturbed areas (Marquiafável et al. 2009; Gerometta et al. 2020). The lifespan of *Indigofera tinctoria* L. as a dye producer is 2–3 years (Kurniawan 2020; Ariyanti and Asbur 2018), whereas if it only functions as a land cover it is 1.5–2 years (Kurniawan 2020).

The genus *Indigofera*, the third-largest in the family Fabaceae, consists of almost 800 species (Prabhu and Bhute 2015; Schrire 2013). However, tropical and subtropical zones are areas in the world where indigo natural plant dyes are widely found (Su et al. 2008; Prabhu and Bhute 2015). The distribution of this species is in Africa and Madagascar, the Sino-Himalayan region, Australia, and Central and South America (Schrire 2013), and a small portion can be found in temperate areas of East Asia (Ponmari et al. 2014).

Several species in the genus *Indigofera* are known to produce economically valuable indigo dye (Schrire 2013), such as *I. tinctoria* L. and *I. suffruticosa* (Marquiafável et al. 2009). This species is also an important prairie legume (Schrire 2013), with many benefits, such as an ornamental plant, soil cover, shade plant, green humus cover, and erosion control (Marquiafável et al. 2009). They are also used for their medicinal properties (Prakash et al. 2007; Renukadevi and Sultana 2011; Santos et al. 2015; Vieira et al. 2007).

Indigo has been used as a natural textile dye since before synthetic dyes were invented. Indigo extraction from *Indigofera* plants (*I. tinctoria* L.) started in India, Egypt, and China and then spread to other tropical countries, including Indonesia, while indigo in sThuringia (Europe) came from the woad plant (*Isatis tinctoria* L.). Indigo extracted from *I. tinctoria* L. has a better level of color quality than indigo extracted from *Isatis tinctoria* L., so the European textile industry began to import indigo from India and Indonesia (Głowacki et al. 2012). The development of natural dyes fluctuated with the fame of Indigofera in Indonesia, which was recorded in 1918–1925. The highest export value occurred in 1921, reaching 69,777 kg dry weight (Heyne 1987).

Natural indigo dye is slowly being replaced by synthetic indigo, and in 1913, the indigo dye used for textile purposes was derived from synthetic indigo (Séquin-Prey 1981; Głowacki et al. 2012). At present, an increasingly large proportion of weavers use synthetic blue dyes, as these dyes are relatively low cost, durable, and readily available, thus resulting in increased efficiency in the manufacturing process (Haji 2010; Indraningsih and Darsih 2013). The use of natural dyes is generally considered less practical, given that the quality of the product is uneven and that the dyes cannot be stored for long periods of time (Samadara 2018). Along with increasing public awareness of the dangers posed by using synthetic dyes, people are returning to using natural dyes that are more environmentally friendly (Angelini et al. 1997; Muzzazinah 2019).

In Indonesia, indigo paste production fluctuates from year to year. Thus far, domestic needs of indigo paste have not been optimally met because there is no industry specifically producing it. Furthermore, the production of indigo paste has only been supplied by household-scale producers in which the raw materials rely on wild or uncultivated plants (Kurniawan 2020).

While 18 species of *Indigofera* spp. are found throughout Indonesia, only six species can be used to produce natural dyes (Muzzazinah 2016). Several of these species, including *I. suffruticosa* Mill. and *I. tinctoria* L., are distributed across the Island of Timor in NTT (Agustarini et al. 2021). The morphology of Indigofera, which grows in the NTT region with its dry area, produces different colors than the same type that grows in Java and Madura (Muzzazinah et al. 2018).

The climate and land of NTT are dry, and most land is not very fertile. The grassland is mainly suitable for animal husbandry and dryland farming (Kwong and Ronnås 2011). This contributes to low economic growth and a limited role in adding gross value (Saragih 2007). The agricultural activities in NTT need to be more market-focused agribusiness. Based on the market potency of indigo as natural dyes, *I. tinctoria* L. and *I. suffruticosa* as agricultural commodities could be developed to support cultural tourism.

This paper shows the result of a series of activities conducted on Timor Island on (i) the evaluation of the use of natural dyes on Timor Island; (ii) the identification of best practice cultivation techniques for *Indigofera* spp.; (iii) socializing the leaf-processing technologies that enable the production of indigo paste for use as dyes; (iv) land suitability analysis for the cultivation of *Indigofera* spp.; and (v) economic analysis to determine the viability of the cultivation and utilization of *Indigofera* spp. as a raw material for the production of natural dye. It is hoped that this study will enable the identification of optimal strategies for the development of *Indigofera* spp. to produce natural dyes on a wide scale and thereby facilitate the achievement of targets established under SDG 8.

2. Methodology

2.1. Research Locations

The research was conducted in an area of Timor Island, Indonesia, that has a long community tradition of weaving, as shown in Figure 1. Timor is the largest island in NTT (>30% of NTT area), covering an area of ±2.9 million ha, with this divided into Indonesian territory (±50%) and the independent nation of Timor Leste (±50%). The research focused only on the part of the island that is Indonesian territory. Geographically, it is located at coordinates 8°19′17.9″ S–10°22′12.9″ S and 123°27′24.0″ E–127°18′06.2″ E. The research was conducted over the period from March 2019 to August 2021.

Timor Island lies at an altitude of 14–1480 m above sea level, with a land slope of about 16%. The soil predominantly consists of inceptisol, which is formed from limestone (sedimentary rock). The air temperature on Timor Island ranges from 24.4 to 33.0 °C, with air humidity levels ranging from 77% to 79% (BPS Provinsi NTT 2021). According to the Schmidt-Ferguson climate classification system, Timor Island can be categorized either as moderately dry or dry (E and F), with relatively long dry seasons (Andrianyta and Hermawan 2017). On average, 6 to 7 months of the year can be categorized as wet, while 5 to 6 months can

be categorized as dry. The number of rainy days ranges from 91 to 92, with the amount of annual rainfall ranging from 1211 to 1242 mm year^{-1} (BPS Provinsi NTT 2021).

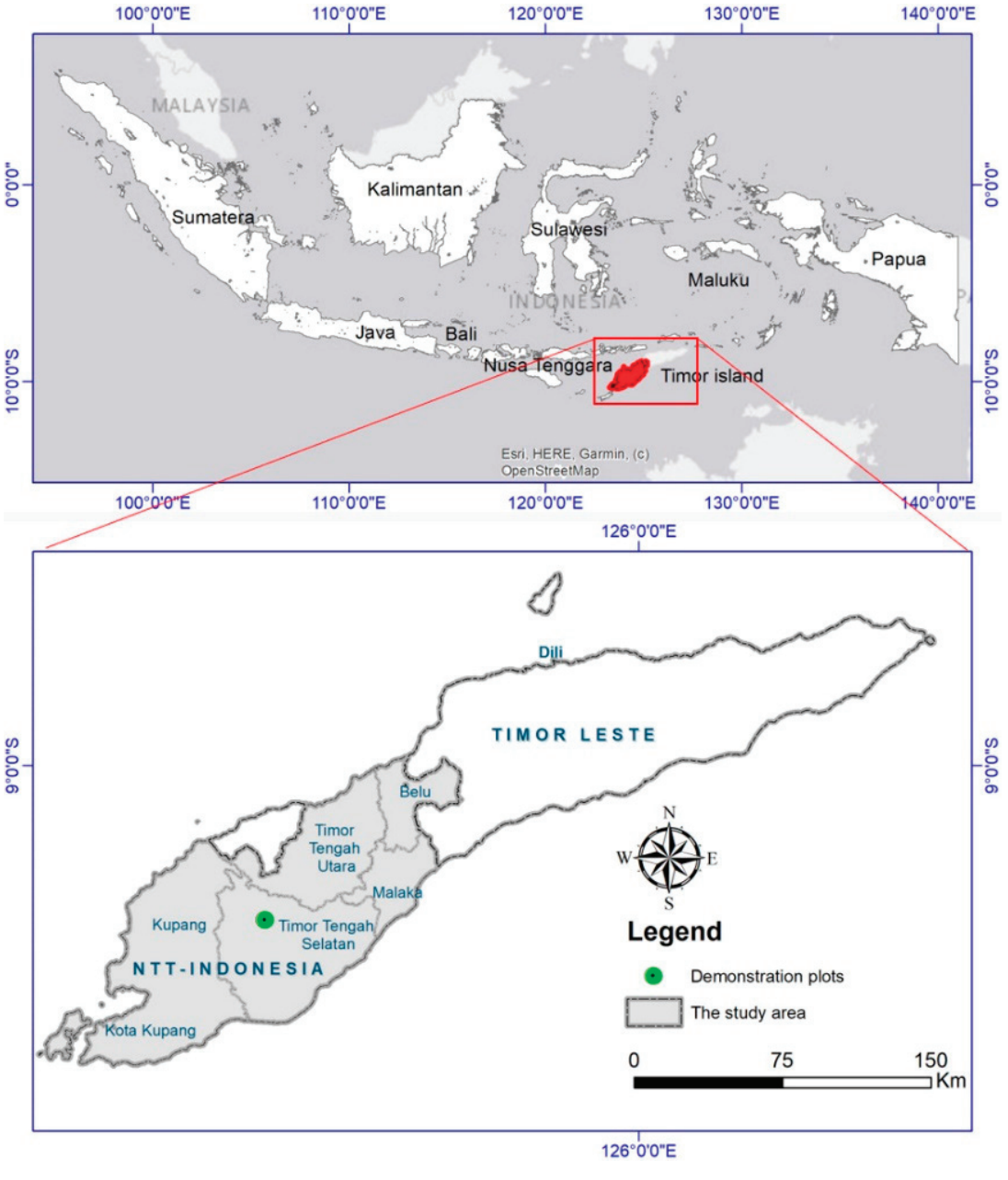

Figure 1. Research location.

2.2. Research Methods

2.2.1. Evaluation of Community Cultivation and Utilization of *Indigofera* spp.

An evaluation of community cultivation of *Indigofera* spp. was conducted first through a survey of the literature, followed by interviews with members of weaving communities and other stakeholders. Community data was collected in three villages in the district of Timor Tengah Selatan (TTS) on Timor Island, these being Fatumnasi, Bosen, and Oel Ekam. The informants were selected using purposive sampling techniques (Rai and Thapa 2015) according to the research objectives. In-depth interviews were conducted on 3 farmer groups, each consisting of 25 people. The purpose of gauging their knowledge regarding *Indigofera* spp. and other dyes used, their history of using *Indigofera* spp., the manner in which they produced and utilized natural dyes, the extent to which they had received training or other support from related institutions, and the degree to which they were interested in cultivating *Indigofera* spp. to make indigo paste. These interviews were conducted on July 2019.

2.2.2. Techniques for the Cultivation of *Indigofera* spp.

After the evaluation, the patterns of the community utilization of *Indigofera* spp. were compared with the techniques for its cultivation. The cultivation techniques were examined by observing demonstration plots established by farmer groups in the village of Bosen (North Mollo subdistrict, TTS). The plots were located on a relatively flat area, at an altitude of 600–900 m asl, with a slope of 3–8%. With regards to climatic conditions, the demonstration plots received an average annual rainfall of 1000–1500 mm, with an average temperature of ±21–24 °C, and a maximum temperature of ±27–30 °C. The experimental cultivation techniques conducted on these demonstration plots included three main stages, these being: (i) germination, (ii) seeding, and (iii) planting.

(i) Germination: The germination technique applied for the cultivation of *I. tinctoria* L. involved an experiment that utilized a Completely Randomized Design with two different types of treatment, involving seed scarification and planting media, respectively. The seed scarification treatments involved soaking the seeds in cold water for 24 h; soaking them in pure coconut water (100%) for 30 min; or without scarification treatment (control). In terms of planting media, three different treatments were applied, with the seeds sown in a planting medium consisting of: soil; sand; and a mixture of sandy soil (1:1). Thus, the experiment involved nine treatment combinations, with each treatment combination being repeated three times and with each replication consisting of 50 seeds, so the total number of seeds used for all the treatment combinations was 1350 seeds. The parameter observed was the percentage of seeds that germinated.

(ii) Seedling: The experiment was conducted in *I. tinctoria* L. nurseries using a Divided Plot Design, with shade level treatment as the main plot and nursery media as a subplot. Three different shade levels were investigated (0%, 50%, and 70%), with four different types of media, these being soil; soil mixed media + cocopeat (1:1); soil mixed media + rice husk charcoal (1:2); and mixed media soil + cocopeat + rice husk charcoal (1:2:2). At each shade level, the different media treatments were repeated six times, with 15 seedlings in each case, with the total number of units at 90 seedlings. The parameters measured were: seedling height and diameter; number of stalks; number of leaves; survival rate; dry weight; Top:Root (TR) ratio; and Seed Quality Index (SQI).

(iii) Planting: The *I. suffruticosa* Mill. were planted on an area with a slope gradient of about 15%. The field experiment was conducted using a split-plot design, with spacing as the main plot and with the application of manure as the subplot. The main plot consisted of three different spacings between plants, these being 50 × 50 cm; 75 × 75 cm; and 100 × 100 cm. In the subplot involving the application of manure, three different levels were applied: no fertilizer (control), 100, 150, and 200 g per tree. Each fertilization treatment was repeated three times, with 16 seedlings in each case.

The parameters that were observed included the survival rate, plant height, and the diameter and number of branches.

2.2.3. Techniques for Processing *Indigofera* Leaves to Produce Indigo Paste

The processing of *Indigofera* leaves to produce indigo paste begins with harvesting the leaves. Harvesting takes place 4–5 months after planting when the tree is producing mature brown fruits and bluish green leaves. The best time to conduct the harvesting process, which commences with pruning the leaves at the lower section of the plant (10–15 cm from the bottom), is in the morning or late afternoon. An evaluation was also conducted to compare the community's utilization of *Indigofera* with the application of leaf processing to produce indigo paste.

The processing of *Indigofera* leaves to produce natural dyes takes place in three stages, these being: the fermentation process; the oxidation or stirring process; and the indigo paste precipitation process. The fermentation process involves soaking the fresh leaves of the *Indigofera* plant in water, with the soaking time depending on the treatment. The oxidation process involves stirring and aerating the water in which the leaves of *Indigofera* were soaked, with the addition of some slaked lime ($Ca(OH)_2$), by gradually drawing the solution into the air to facilitate the oxidation process, at which point the color of the foam solution turns blue. The indigo paste precipitation process involves storing the indigo solution at room temperature for 24 h so that the indigo paste settles. Thus, the processing of *Indigofera* leaves involves the production of a paste by soaking the leaves and adding slaked lime.

2.2.4. Potential Cultivation Area of *Indigofera* spp. on the Island of Timor Island, Indonesia

An assessment of the suitability and availability of land for cultivation of *Indigofera* spp. was conducted through an analysis facilitated by the geographic information system (GIS), with the analysis utilizing an Analytical Hierarchy Process (AHP) facilitated by Open-source sofware QGIS Desktop version 3.14 and Superdecision version 2.10, free educational software by The Creative Decisions Foundation(Pittsburgh, PA, US). The weight of the criteria was determined on the basis of the AHP, with this weight then being applied to a weighted overlay in the GIS model. This multi-criteria method has been widely used to assess the suitability of land for the production of agricultural commodities (Kumar and Jhariya 2015; Mighty 2015; Widiatmaka 2016).

The land suitability criteria that were applied was consistent with the criteria developed by Indonesia's Ministry of Agriculture in 2011, according to the biophysical characteristics of the demonstration plots. Three different land suitability parameters were applied, these being parameters related to: soil (Texture, pH, CEC, C-org); topography (slope class and elevation class); and climate parameters (rainfall, average temperature, and maximum temperature). Data related to the soil parameter were based on the Digital Soil Map of The World (Food and Agriculture Organization of the United Nations 2003), with data related to elevation and slope processed on the basis of SRTM imagery with 90 m spatial resolution: http://srtm.csi.cgiar.org/ (accessed on 28 September 2021); data related to climate were based on world climate data: https://www.worldclim.org/ (accessed on 28 September 2021); and data related to administrative boundaries were based on Global administrative area: https://gadm.org/ (accessed on 28 September 2021). Data related to land cover, critical land, and land function status were based on the MoEF-Indonesia map product. Land function status related to the status of the land is in forest land/forest state or outside (Other Use Area (*Areal Penggunaan Lain*, APL)). The Indonesian Ministry of Environment and Forestry (MoEF) applies Consensus-Based Forest Land-Use Planning (*Tata Guna Hutan Kesepakatan*; TGHK) to establish the forest estate and designate its use. The TGHK mapping program classified forest land (*kawasan hutan*) by functions: (1) protection forest; (2) conservation forest; (3) limited production forest; (4) production forest for commercial logging; and (5) conversion forest for conversion of degraded production forest to agriculture or other uses. The area outside the forest land is then referred to as APL,

where this area is intended for cultivation activities, settlements, and other activities; they are public lands that are not designated as Forest Area (Brockhaus et al. 2012). Critical land referred to in this paper refers to a map of critical land created by MoEF, Indonesia. Critical land is the land inside and outside forest areas that have been degraded, resulting in the loss or reduction of ecological function to the specified or expected limit. Its determination is based on the criteria of land cover, slope, hazard level of erosion, productivity, and management (Ministry of Environment and Forestry 2013; Ministry of Environment and Forestry 2018). This is shown in Figure S1 (Steps for *Indigofera* Land Suitability—Land Availability Analysis).

2.2.5. Economic Analysis of *Indigofera* Development

Indigofera is cultivated through intercropping systems. To determine the added value derived from *Indigofera* in terms of contributions to community incomes, the analysis only takes into account the economic value of the *Indigofera*. The economic analysis included a feasibility analysis for the exploitation of indigo paste, a sensitivity analysis, and the calculation of the economic and social potential to be derived from the development of *Indigofera* spp.

Feasibility Analysis

The scope of the financial feasibility analysis for the commercial production of indigo paste covers all processes, from the cultivation of *Indigofera* leaves to the treatment of these leaves to produce indigo paste. In this analysis, the cost assessment covers only the operational costs, both fixed costs and variable costs, without any investment costs. Paste-making activities are carried out on a household scale so that it does not require infrastructure facilities that are categorized as investment costs, such as building houses or making soaking tubs.

The wages in the cost assessment is based on the local community wage standard, IDR 65,000 per labor day. This daily wages rate does not differ between woman and man, and type of work. The nature of *Indigofera* development on Timor Island is a home industry, and the labor was unpaid as they are family members. Wage value is used for analysis purposes only.

Income assessment is carried out by measuring the productivity of *Indigofera* per ha, then processed into a paste by calculating the yield based on research results of (Agustarini et al. 2021). The analysis of the price of the final product was based on an investigation of the selling price for indigo paste ins the marketplace (Shopee n.d.).

A number of different criteria are commonly used to assess business feasibility, including the following: Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit Cost Ratio (Net B/C Ratio), and Pay Back Period (PBP) (Nurmalina et al. 2018).

- Net Present Value (NPV)

$$\mathrm{NPV} = \sum_{t=0}^{n} \frac{Bt - Ct}{(1+i)^t} \quad (1)$$

Notes:

NPV = Net Present Value (IDR)
Bt and Ct are the benefits and cost, t is the year in a series ranging from 1 to n, and i is the discount rate.

- Internal Rate of Return (IRR)

$$\mathrm{IRR} = i_1 + \frac{\mathrm{NPV}_1}{\mathrm{NPV}_1 - \mathrm{NPV}_2} \times (i_1 - i_2) \quad (2)$$

Notes:

IRR = Internal Rate of Return

i_1 = interest rate that results in a positive NPV
i_2 = interest rate that results in a negative NPV
NPV_1 = positive NPV
NPV_2 = negative NPV

- Net Benefit Cost Ratio (Net B/C Ratio)

$$\text{Net}\frac{B}{C} = \frac{\sum_{t=1}^{n} \frac{Bt-Ct}{(1+i)^t}}{\sum_{t=1}^{n} \frac{Bt-Ct}{(1+i)^t}}, \quad \frac{Bt - Ct > 0}{Bt - Ct < 0s} \tag{3}$$

Notes:

Net B/C = Net Benefit Cost Ratio
Bt and Ct are the benefits and cost, t is the year in a series ranging from 1 to n, and i is the discount rate.

Pay Back Period refers to the period or time (years) that it takes for the investment to yield a positive return, indicated when the NPV value becomes positive. A business may be deemed financially feasible if NPV > 1, BCR > 1, and the IRR analytic interest rate and PBP are in the business cycle (Tiwa 2016).

Sensitivity Analysis

A risk model sensitivity analysis can be used to identify the most significant risk factors and to assist in developing priorities for risk mitigation (Frey and Patil 2002). According to (Kumar and Parikh 2001), climatic conditions greatly impact agricultural yields. Climatic anomalies, including those associated with La Nina and El Nino, can affect agricultural productivity. This is one of the factors that need to be considered in conducting a sensitivity analysis. Production costs and changes in the level of productivity of *Indigofera* spp. are parameters that are determined by prevailing conditions.

The Potential Economic and Social Value of the Development of *Indigofera*

Economic value is determined on the basis of the net profit value per hectare multiplied by the size of the area deemed to be most suitable (S1) for *Indigofera* cultivation, with three development target scenarios: 100% planted area (scenario 1); 50% planted area (scenario 2); and 25% planted area (scenario 3). Social value is determined on the basis of the rate of labor absorption associated with the development of *Indigofera* spp.

$$\text{potential income} = \text{net profit value} \times \text{land deemed suitable for the cultivation of } Indigofera \text{ spp.} \tag{4}$$

2.2.6. Development Strategy for the Sustainable Utilization of *Indigofera* to Produce Natural Dye

Analysis of the strategy for the development of *Indigofera* was conducted through the application of a SWOT-AHP analysis to the descriptive data. This method has previously been used to formulate agricultural and manufacturing product development strategies for a number of commodities (Ali et al. 2021; Santos et al. 2019; Görener et al. 2012; Kazemi et al. 2018).

The analysis is conducted through the systematic identification of both internal factors, including strengths and weaknesses, and external factors, including opportunities and threats. The SWOT analysis is conducted in a number of stages, including: compiling the Internal Strategic Factors Analysis Summary (IFAS) and External Strategic Factors Analysis Summary (EFAS); analyzing the Internal Factor Evaluation (IFE) Matrix and External Factor Evaluation (EFE) Matrix; and analyzing the Strategy Matrix. Factor weights were determined on the basis of pairwise comparisons between factors using the Analytical Hierarchy Process (AHP). AHP is a mathematical method for multi-criteria decision making developed by (Saaty 2008).

3. Results and Discussion

3.1. Evaluation of the Cultivation and Utilization of Indigofera spp.

Plant materials used for the production of colored dyes, especially *I. tinctoria* L. and *Morinda citrifolia* L., are collected from nature directly, either by the artisans themselves or by professional collectors (Setiawan and Suwarningdyah 2014). The collection of these plants is informed by different bodies of local wisdom. In Atambua, weavers believe that there is a strong spiritual dimension to the relationship between humans and nature so that they only collect enough plant materials to meet the needs of the producing household income (Siombo 2019). In general, weavers use naturally-growing *Indigofera* spp. grown in their gardens without any intensive cultivations to meet the production needs of the dye's raw materials (Seran and Hana 2018; Agustarini et al. 2021; Murniati and Takandjandji 2015).

Based on information from weavers in the research location, there are two species of *Indigofera* spp. in the region, these being *I. suffruticosa* Mill. and *I. tinctoria* L. (Agustarini et al. 2021). They explained that the species of *Indigofera* used produces a particular type of fruit (*I. suffruticosa* Mill.), as this type is more commonly found in gardens than *I. tinctoria* L. Users of *Indigofera* as a natural dye on Timor Island are weavers who are still on a household scale, so they only rely on plants that exist in nature. However, if in the future the industry becomes more developed to support cultural tourism, it is necessary to use cultivation.

The results of interviews with respondents indicate that the community is more familiar with *Indigofera* for use to produce black dye rather than blue, a finding supported by two other studies (Ledoh et al. 2021; Nomleni et al. 2019). The black color is obtained by mixing clay with *Indigofera* spp. and applying it to the thread. In this area, a synthetic dye is used for blue. Regarding the composition of the raw materials, they produce the dyes based on their needs and their available equipment. Usually, natural dyes are applied directly to the yarn after they are produced, without any attempts to store them.

The people of Timor Island, NTT, rely mainly on farming or animal husbandry for their livelihood. However, *ikat* weaving is another livelihood that is no less important. The activity of making *ikat* has been integrated with the daily activities of the community, especially the women (Buni et al. 2021). In the past, weaving was an activity for leisure time. Nowadays, along with the development of cultural tourism, *ikat* weaving has became a profitable source of income (Samadara 2018).

Women are more dominant in the activity of making *ikat*, which can be seen from the composition of weaver respondents, with a composition of 65% of women and 35% of men (Table 1). This is supported by the myth that developed in the community, especially in terms of processing *Indigofera* as a paste. There is a strict taboo forbidding men from being directly involved in producing dye from *Indigofera*, with a belief that those who violate that taboo will be cursed with infertility (personal communication with Marthen Tualaka, member of Farmer Group in Bosen Village, North Mollo, TTS District on 28 March 2019). Therefore, women dominate the process of manufacturing natural dyes from *Indigofera*, whereas men are more involved in the cultivation of *Indigofera*.

Table 1. Respondent information in three (3) research locations.

Farmers Group	Location	Gender Proportion of Group Members (%)	
		Woman	Man
Eno Saenman	Fatumnasi	68.4	31.6
Pahlawan	Bosen	47.1	52.9
Paloilmonit	Oel Ekam	75.0	25.0
Average		65.5	34.5

The main job of the head of the family is generally as a farmer whose sources of income are very small and also depend on the seasons. In general, the role of the women economically adds to the family's income. However, based on the study of (Buni et al. 2021)

in Sumba shows that the contribution of women's income to the weaving business and animal rearing is household income is very large, equal to 88%.

Training on the use of *Indigofera* as a natural blue dye is still rarely done. Thread of Life, a social enterprise that promotes the community-scale production of textiles using traditional materials and techniques as a means of achieving poverty alleviation, has made efforts to introduce the use of *Indigofera* in producing natural blue dye. In 2016, the organization conducted training programs and other forms of assistance to enable local communities to produce indigo paste from *Indigofera* with this training. It is expected that there will be an uptake in the use of *Indigofera* to produce good-quality and highly durable blue dye. Thread of Life could also play a role in facilitating access to markets for the indigo paste and the *ikat* that is produced by the community using natural dyes.

The community has responded to these initiatives positively, being open to receiving information and guidance and expressing enthusiasm for cultivating *Indigofera* spp. and the manufacturing of indigo paste. However, ongoing training and assistance will be needed to enable the community to produce indigo paste that meets market requirements. It is expected that these investments in community capacity building will produce positive impacts and benefits for all stakeholders involved in the cultivation and utilization of *Indigofera* spp. and for communities more generally.

3.2. Techniques for the Cultivation of Indigofera spp.

The system used to cultivate *Indigofera* spp. was similar to one applied in the Philippines (Mann and Garrity 1994). *Indigofera* spp. is never cultivated in monoculture systems but is always intercropped with other food-producing and/or commercial crops, including maize, green beans, and tobacco. It has been suggested that the cultivation of *Indigofera* spp. in multi-crop systems would reduce the need for chemical fertilizers (Garrity et al. 1994). Given that *Indigofera* spp. is a type of legume, intercropping with this plant could play a positive role in the nitrogen fixation process (Nezomba et al. 2008).

These techniques for the cultivation of *Indigofera* spp. could be adjusted to meet the needs of members of local communities on Timor Island on the basis of considerations related to the availability of land and applied where intercropping systems are in place for the cultivation of seasonal crops (maize), with the spacing between the plants adjusted in accordance with the conditions required for this system. In general, farmers on Timor Island plant maize with a distance between plants of 75 × 75 cm, although on dry land, the optimal spacing for maize is 100 × 50 cm (Arifin and Tafakresnanto 2019). For the cultivation of *Indigofera* spp., distances between plants of 100 × 100 cm are applied, intercropped with maize (with a spacing of 100 × 50 cm) (Figure 2).

The techniques applied by the community for the cultivation of *Indigofera* spp. cultivation technique involved a number of stages, from germination to seeding and planting in the field. At each of these stages, the results of the research were applied, with the following identified as the best practice techniques for cultivation:

- Germination. *Indigofera* seeds are characterized by external dormancy, as is the case with other types of legumes. Thus, they need to be subjected to a process of scarification to overcome this dormancy, with scarification achieved through immersion (Luna et al. 2009). The results of the research demonstrate that the combination of scarification and sowing media had no significant effect on the germination of *I. tinctoria* L. The treatment that had the greatest impact on germination was the sowing media. The three treatments that have the greatest impact on the germination of the *I. tinctoria* L. were without scarification (control), soaking in cold water for 24 h, and soaking in pure coconut water (100%) for 30 min. These treatments resulted in the highest germination rates in sand media, at 73.33%, 77.33%, and 88.00%, respectively (Table S1). By contrast, seeds sown on soil media and on a mixture of soil and sand produced a germination rate below 50%. This indicates that sand is a suitable medium for sowing *I. tinctoria* L. seeds. Even though the sand medium is poor in nutrients, according to (Wiryanta 2007), sand contains a number of minerals essential for the

plants' growth. In addition, the porosity of the sand media enables imbibition and adequate aeration, enabling the seeds to germinate rapidly.

- Seedling. Based on experience on Timor Island, planting *Indigofera* directly from seeds in the field without going through a nursery will cause delays in leaf harvesting. Planting using seedlings will harvest at the age of 4 months while using direct seedings when the plant is one year old. The successful growth of the plants is heavily dependent on the quality of the seeds, with the quality of the seeds being determined by the media used in the nursery. Therefore, mixed media with a sufficient level of nutrients and porosity results in the production of high–quality seeds. In addition, according to (Fredrick et al. 2020; Onyekwelu et al. 2012; Veloso et al. 2017), light intensity is another environmental factor that affects the survival and growth rates of seedlings with each plant species requiring a different light intensity for growth. Research shows that *I. tinctoria* L. seedlings planted in a mixed media consisting of soil, cocopeat, and rice husk charcoal (1:2:2) and placed in an unshaded location (0%) had the highest TR ratio and SQI, namely 5.53 and 0.0030, respectively (Table S2).

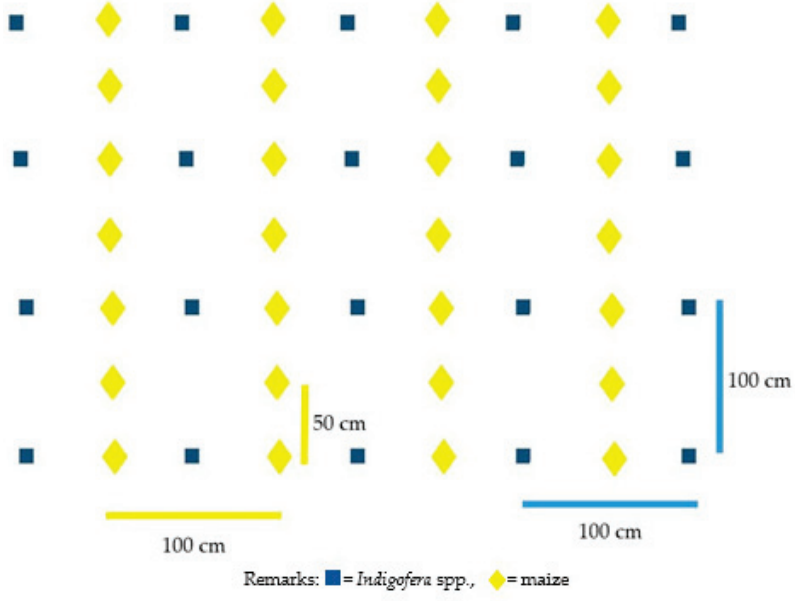

Figure 2. Cropping pattern of *Indigofera* spp. with maize on Timor Island.

The high TR ratio indicates that the media used is relatively fertile and that sufficient water is available (Orpa et al. 2019). According to (Rivai et al. 2015), rice husk charcoal has good aeration and drainage properties but low water holding capacity, while coco peat has both high porosity and water holding capacity. Mixing these two media with soil produces an ideal medium for the growth of *I. tinctoria* L. seedlings, particularly in an unshaded location (0% shade). By contrast, *I. tinctoria* L. seedlings planted in a mixture of soil and rice husk charcoal (1:2) and placed in 50% shade resulted in a seed quality index of 0.0030, but with a lower shoot to root ratio value (4.72). According to (Orpa et al. 2019), the low value of the root to shoot ratio indicates that the rate of the growth of shoots is lower than that for roots. This indicates that the level of nutrients contained in the mixed soil and rice husk charcoal media is lower than in the mixed soil, cocopeat, and rice husk charcoal media so that plants concentrate on forming roots to optimize nutrient absorption. Both types of media and shade treatment combinations also produced a relatively high biomass compared to other treatments, at 0.0768 and 0.0798 g, respectively. According to (Orpa et al.

2019), the increase in biomass indicates that photosynthesis is proceeding well, thereby resulting in increased plant growth. This is presumably due to an improvement to the growth media resulting from the addition of rice compost charcoal and/or cocopeat, with an increased soil nutrient content and improved aeration and drainage. However, both types of media require different light intensities to promote optimal seedling growth.

At three weeks of age, the *I. tinctoria* L. seedlings did not meet the criteria for transferring seedlings to the field, with the quality index value of the seeds failing to reach 0.09 (Bogidarwanti and Darwo 2016), with a minimum SQI value of 0.09 required to ensure a high survival rate. According to (Ariyanti and Asbur 2018), *I. tinctoria* L. seedlings are ready to be planted in the field at the age of 4–6 weeks, while *I. suffruticosa* Mill. seedlings are ready at around the age of 6–8 weeks or when the minimum seedling height is 30 cm. The use of ready-to-plant seeds may result in seedlings that are able to compete with those growing in a natural environment, where environmental factors cannot be fully controlled.

- Planting. The viability of *I. suffruticosa* Mill. plants up to the age of 4 months stood at 100% for all spacings, with the results of the research showing that the spacing treatment and the application of fertilizers did not significantly affect the growth of *Indigofera* spp. at 4 months of age. However, *I. suffruticosa* Mill. planted at a spacing of 100 × 100 cm showed better growth than the plants spaced at 75 × 75 cm and 50 × 50 cm. The average increase in height, diameter, and branch of *I. suffruticosa* Mill. planted at a spacing of 100 × 100 cm stood at 25.87 cm, 3.26 mm, and 6.44, respectively (Table S3). According to (Li et al. 2019), plant spacing has an effect on the final yield of a range of different types of plants. Likewise, (Azam-Ali and Squire 2002) reported that plant density depends on the soil, climate, and the type of plant grown. In extreme conditions, with poor soil and in semi-arid areas without irrigation, planting is best conducted at low density to avoid the growth of weak, weedy plants. Not only do these extreme conditions result in low yields; they also create ideal conditions for pests and diseases. With the different fertilizer treatments, the results of the analysis show that fertilizer dose sizes did not result in a significant difference in growth rates but that the application of fertilizer (100, 150, and 200 g per plant) resulted in better growth in diameter and number of branches than in the case of plants planted without fertilizer (0 g plant^{-1}). Similarly, the results of a study conducted by (Setiono and Azwarta 2020) show that the application of cow manure had a significant effect on plant height, stem diameter, number of leaves, and net weight of cobs per plant in maize, with the best results produced with 600 g of fertilizer per plant. This indicates that the soil at the study site required the addition of the appropriate amount of nutrients to facilitate growth, with the application of manure as a basic fertilizer at the beginning of the planting process adding macronutrients and some micronutrients required for plant growth, as well as improving soil structure, aggregating water holding capacity, and increasing soil permeability and the exchange of cations. Found in the study (Nyakpa et al. 2008) manure, as an organic fertilizer, plays an important role in the growth of plants due to its positive effects on the physical and chemical properties of the media. Manure can increase the media's capacity to absorb water and improve the living conditions of the microorganisms in the media, stimulating granulation and enabling available nutrient ions to trigger cell wall growth, resulting in increases to the size of the stem diameter.

The results of the research showed that the most significant factor in the cultivation of *Indigofera* in TTS is planting time, with the planting time having a strong effect on the leaf production of *Indigofera*. According to (Ariyanti and Asbur 2018), the optimal time to plant *Indigofera* is at the beginning of the rainy season. Therefore, the recommended time to plant *Indigofera* on Timor Island is in November, which receives high rainfall.

Planting at this time results in optimal growth and high leaf production. By the time of the arrival of the dry season, the plants have adapted to the environment, so there is no need for watering. However, in cases where the dry season occurs earlier than forecast,

watering may be required. Under normal conditions, *Indigofera* leaves can be harvested four months after planting.

Indigofera plants are productive for about 2–4 years, depending on the species and growing location. For example, the life cycle of *Indigofera tinctoria* L. on Java Island is 2–3 years (Kurniawan 2020; Ariyanti and Asbur 2018). The development cycle for the cultivation of *Indigofera* spp. described above throughout the four stages (germination, seedling, planting and harvesting) is very different from the cycle traditionally applied by the community (Figure 3A). The community only harvests *Indigofera* spp. plants found in nature, usually once a year, following the commencement of the rainy season (Figure 3B).

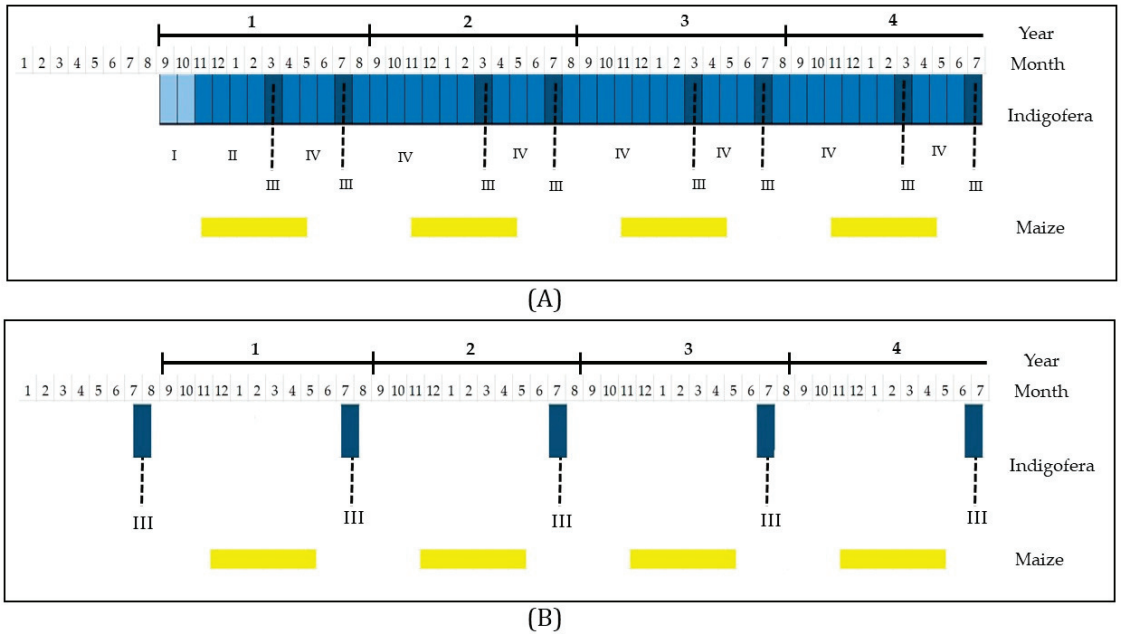

Figure 3. The production cycle for *Indigofera* spp. over 48 months: (**A**) application of cultivation techniques, (**B**) utilization of *Indigofera* spp. by the community. Notes: I = germination and seeding (1.5–2 months), II = planting (4 months), III = harvesting (4 months after planting, or when the plants are ready), IV = post-harvest maintenance/leaf pruning (4 months).

The initial planting of *Indigofera* is conducted at the beginning of the rainy season (around November) and preceded by germination and seedling (1.5–2 months before). The cultivation of *Indigofera tinctoria* L. on Java Island, harvesting is carried out when the plants are 4–5 months old. The next harvest is carried out 3–4 months after the first harvest or it can be harvested 3 times a year, with the life span of the plant as a dye producer being 2–3 years (Kurniawan 2020; Ariyanti and Asbur 2018). Furthermore, (Ariyanti and Asbur 2018) say that *Indigofera tinctoria* L. grows optimally in areas with rainfall below 1750 mm year^{-1} accompanied by a hot and humid climate. The dry condition of Timor Island (rainfall 1211–1242 mm year^{-1}) makes the frequency of harvesting not as often as in Java, a maximum of 2 times a year. Harvesting on Timor Island is conducted 4 months after planting when the plants are in full bloom, and the leaves are colored bluish green (community experience). Harvesting is conducted in the morning at 4–6 am (Ariyanti and Asbur 2018), with the process involving pruning at the bottom (1 m from the bottom) (Muzzazinah et al. 2021).

The initial harvesting takes place in March and a secondary harvest takes place in July. Likewise, maize, which is a staple crop, is planted in November and harvested in April, with the full cycle taking a year. Following the second harvest in July, the dry season arrives, during which period the plants will experience a decrease in growth. However, with the return of the rainy season, the growth of the *Indigofera* increases, enabling harvesting to take place in around March of the following year. Figure 3 depicts the annual production cycle.

3.3. Processing Indigofera Leaves to Produce Indigo Paste

After harvesting, the leaves of the *Indigofera* are immediately separated from the twigs, after which they are processed. This must be undertaken immediately to obtain a high yield of indigo dye. According to (Ariyanti and Asbur 2018), semi-dried or dry leaves will produce only a low yield because the β-glucosidae enzyme is more active in fresh leaves than in semi-dried or dry leaves. *Indigofera* leaves extract contains indican glucoside, which can be hydrolyzed to glucose and indoxyl. Indoxyl itself is a colorless indigo precursor that, in alkaline conditions, is easily oxidized, resulting in the production of blue indigo pigment.

The production of indigo paste from *Indigofera* leaves involves three processes these being fermentation to release the indigo precursors, removal of the leaves and oxidation of the liquor as a result of aerating under alkaline conditions caused by the addition of slaked lime ($Ca(OH)_2$), and the precipitation of the indigo dye with the slaked lime. Following these processes, the precipitate is used to produce a paste that is ready for use (Figure 4).

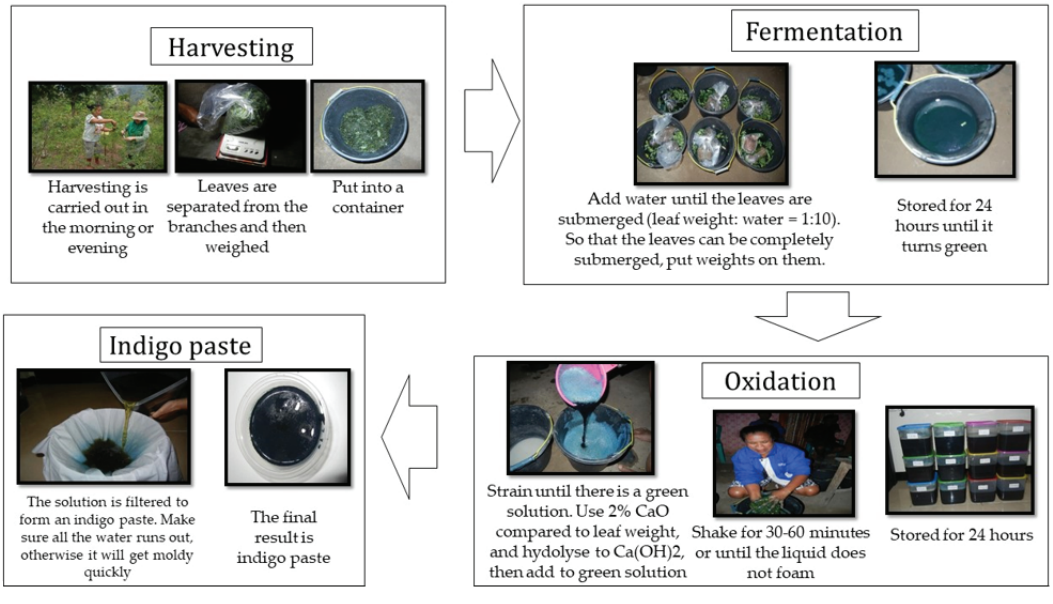

Figure 4. Process of producing paste from *Indigofera* leaves.

There are a number of differences between the indigo paste processing technique and the community utilization process. More details can be seen in Table 2.

Table 2. Differences between the indigo paste processing technique and the community utilization process.

Components	Community Utilization Process	The Indigo Paste Processing Technique
Raw materials	Indigo leaves	Indigo leaves
Additional materials	Clay + lime (CaO)	Lime (CaO)
Volume and composition	Depending on needs and available equipment usually 1:10	Lime (CaO) equivalent to 2% of raw materials
Process	- *Indigofera* spp. leaves are pounded + water, boiled, then filtered - thread soaked in black clay + lime (CaO) - removed and placed in a different container - *Indigofera* spp. solution is poured over the clay-covered thread - allowed to sit overnight - dried and then washed to remove clay - placed in the sun until fully dry - black thread is produced	- fermentation to release the indigo precursors - removal of the leaves and oxidation of the liquor as a result of aerating under alkaline conditions caused by the addition of slaked lime ($Ca(OH)_2$) and the precipitation of the indigo dye with the slaked lime - stirred or crushed for 30–60 min and then left for 24 h - the water is filtered until the indigo paste precipitate is obtained
Processing time	4–6 days	3 days
Final product	Solution	Paste
Viability period	Discarded immediately after being used to die the thread (±48 h)	Can be stored for a year or more
Color produced	Black	Blue Indigo

3.4. Potential Cultivation Area of Indigofera spp. on Timor Island, Indonesia

Indigofera spp. plants have a high level of adaptability, often growing in the wild in all types of soil, with high levels of tolerance to drought, flooding, and high salinity (Campos et al. 2018). Many are found growing in coastal regions in soil with clay-sand soil characteristics and with a pH ranging from 6 to 7. It grows well in locations with an average temperature of 22–28 °C and with a maximum temperature of 32 °C (Bobojonov et al. 2012). For the cultivation of plants, altitude is the first criterion that must be considered out of a number of topographical parameters. Altitude parameters are closely related to temperature parameters, with a relationship between altitude, temperature, and rainfall (Sagredo et al. 2014). *I. suffruticosa* Mill. can be found at altitudes of 1–1800 m asl, while I. tinctoria at 0–800 m asl. Both species grow in areas where the air temperature ranges between 21 and 34 °C. Generally, it is recommended that agricultural activities take place in flat areas to minimize soil erosion, in areas with soil of good quality (Kumar and Jhariya 2015). Due to impacts on environmental sustainability, cultivation on steep slopes is not recommended (Malley et al. 2006). Based on these considerations, the areas with the highest suitability scores are those with slopes of 0–3%. Climatic parameters are a critically important factor for plant growth, affecting a wide range of physiological processes (Gruda 2005). Both rainfall and temperature affect plant growth in high-land areas, as shown by a number of studies (Motsa et al. 2015; Naughton et al. 2015). Air temperatures have an impact on chemical reactions and the physical properties of plants, with effects both at the cellular level and at the plant level (Gruda 2005). On Timor Island, temperatures range from between 12.2 and 27.6 °C, with a maximum temperature of 33.5 °C.

The weight of the criteria generated from the AHP is presented in Table 3. The results showed that the consistency ratio (Cr) stood at 0.03. This value is still below the maximum threshold (Cr) of 0.1. This shows that the results are valid, in accordance with the threshold recommended by (Saaty 2008).

The results show that topographic and climatic conditions have a higher weight than soil quality. These results indicate that soil quality is not a limiting factor for the successful cultivation of *Indigofera* spp. Soil on Timor Island has specific characteristics, as follows: dominated by medium soil texture (±85% of the area); ±47% of the area has soil conditions with pH 7.1, CEC 10.4, and Corg 0.97. A study by (Suriadi et al. 2021) found that soil pH on Timor Island is neutral to alkaline. Although the soil is alluvium, the surrounding parent

material is made entirely of limestone. Soil derived from limestone parent material has a shallow solum of <50 cm, with most of it lithic. The soil also has very low organic carbon content. In terms of topographic conditions, the largest proportion of the land has a slope of <8% (±53% of the area), at an altitude of <600 m above sea level (±77% of the area). In terms of climatic conditions, the largest proportion of the land has an annual rainfall of 1000–1500 mm (±84% of the area), with an average temperature of 24 °C (±69%) and a maximum temperature of 30 °C (±48%). Timor Island is characterized by a dry climate (Suriadi et al. 2021).

Table 3. Weight of criteria resulting from pairwise comparison.

Criteria	Text.	Ph	CEC	Corg	Alt	Slope	RF	Temp.	MaxTemp	Weight
Text.	1	2	5	4	1/5	3	1/4	1/3	1/2	0.069304429
Ph	1/2	1	4	3	1/5	2	1/5	1/4	1/3	0.049803415
CEC	1/5	1/4	1	1/2	1/9	1/3	1/8	1/7	1/6	0.017784182
Corg	1/4	1/3	2	1	1/8	1/2	1/7	1/6	1/5	0.024925978
Alt	5	6	9	8	1	7	2	3	4	0.306953228
Slope	1/3	1/2	3	2	1/7	1	1/6	1/5	1/4	0.034439834
RF	4	5	8	7	1/2	6	1	2	3	0.22058476
Temp.	3	4	7	6	1/3	5	1/2	1	2	0.15394614
MaxTemp	2	3	6	5	1/4	4	1/3	1/2	1	0.122258035

Notes: Text: texture, CEC = cation exchange capacity, Corg = C organic, Alt = altitude, RF = rainfall, Temp. = temperature, MaxTemp = maximum temperature.

The results of the land suitability analysis for *Indigofera* spp. on Timor Island are presented in Figure 5. Land that is not suitable for the cultivation of *Indigofera* spp. plants covers an area of less than ±1% of the total area of the island. The unsuitable land is mainly located around mountain peaks, characterized by a combination of physical properties that do not permit crop cultivation, including steeper slopes and very low temperatures. This land is generally not cultivated, with the land cover consisting of forests. Thus, almost 99 percent of the land on Timor Island is suitable for the cultivation of indigo plants. The degree of suitability varies, however, from *very suitable* (S1) to *marginally suitable* (S3), with the greatest proportion of the land falling into the very suitable (S1) category, with land in this category covering a total area of ±1.3 million ha.

To determine the suitability of land for the cultivation of *Indigofera* spp., a land availability analysis was conducted, based on considerations related to land cover and land-use conditions. Of the Indonesian territory on the Island of Timor that consists of agricultural land, 453,931 ha has suitable land conditions for indigo cultivation. However, the development of land for this purpose is directed at land not covered by forest and/or that has been used for plantations or other agricultural uses. Thus, 369,836 ha of the Indonesian territories of Timor Island are available for the cultivation of Indigo, with most of this land consisting of abandoned land, mostly either open land or covered with shrubs and grasslands (Figure 6).

In Indonesia, measures to develop the cultivation of *Indigofera* spp. could also play a role in accelerating land rehabilitation, considering that a large proportion of the suitable areas consist of critical land (±80%), with more than 60% of this area located outside forest areas (Other Use Area (*Areal Penggunaan Lain*, APL)). Measures to accelerate land rehabilitation initiatives are important, particularly in the context of the threat of deforestation in the tropical mountain forests of Timor (Pujiono et al. 2019). The most suitable land in critical APL areas could be prioritized for the development of *Indigofera* spp. (±163 thousand ha). The distribution of the area based on the level of criticality of the land and land function status is presented in Table 4.

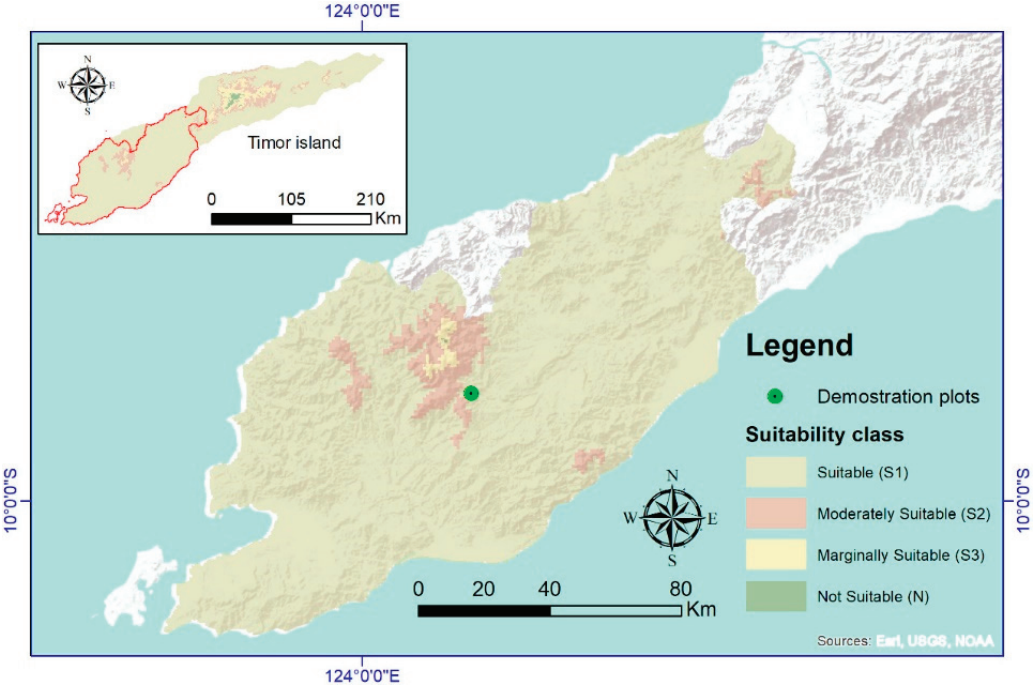

Figure 5. Land suitability map Indigo on Timor Island.

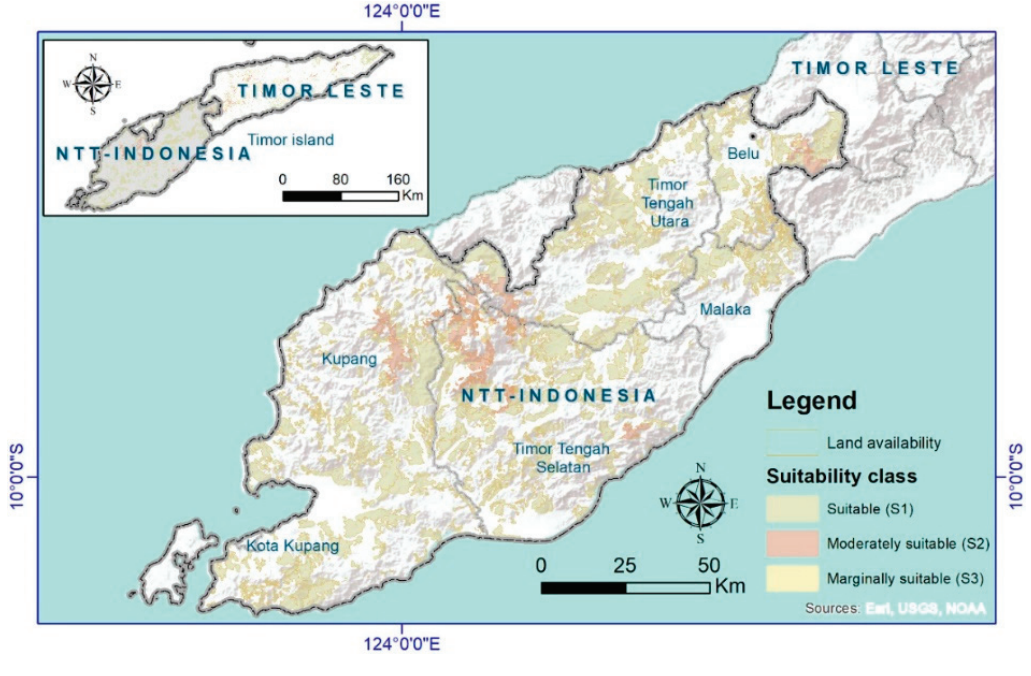

Figure 6. Land availability map for the cultivation of Indigo on Timor Island.

Table 4. Area available for the cultivation of indigo cultivation based on land function status and land criticality for the prioritization of rehabilitation efforts.

Category		Land Use Function (ha)			
Suitability	**Criticality**	**Protection**	**Production**	**Conservation**	**APL**
S1	Moderately Critical	34,599	41,749	201	140,556
S1	Critical	14,363	8038	179	22,297
S1	Very Critical	667	40	—	171
S2	Moderately Critical	10,143	720	805	12,969
S2	Critical	3342	34	177	2304
S2	Very Critical	161	—	—	117
S3	Moderately Critical	281	—	490	16
S3	Critical	43	—	33	—
Total		63,599	50,581	1885	178,429

Remark: S1 = suitable, S2 = moderately suitable, S3= marginally suitable.

3.5. Economic Analysis of the Cultivation of Indigofera spp.

3.5.1. Feasibility Analysis

A business feasibility assessment was conducted to determine the feasibility of the development of *Indigofera* spp., including cultivation activities and the production of indigo paste. *Indigofera* spp. cultivation activities includes nursery, nursery maintenance, planting preparation, planting, and plant maintenance. The production of indigo paste activities includes harvesting and processing the paste.

Cost

The cost of activities associated with the cultivation of *Indigofera* spp. and the processing of leaves to produce indigo paste were assessed. The following Table 5 contains a list of the type of expenditures involved and their magnitude:

Table 5. Types of expenditure involved in the cultivation of *Indigofera* spp. and the production of indigo paste in 2021.

Type of Expenditure	Units Required	Units	Total Expenditure (IDR)
a. Fixed operating costs			
Purchase of paranets	7	m	210,000
Purchase of tarpaulins	175	m	1,050,000
Purchase of dippers	56	fruit	560,000
Purchase of filtering cloth	56	m	1,120,000
b. Variable Operating Costs			-
Purchase of polybags	40	Kg	1,800,000
Purchase of manure for the nursery	100	Kg	2,500,000
Purchase of manure for planting	200	Kg	5,000,000
Purchase of water for production of paste	28,000	Liter	14,000,000
Purchase of quicklime	56	Kg	2,800,000
Wages for filling polybags and sowing	50	labor day	3,250,000
Nursery maintenance fees	5	labor day	325,000
Wages for digging holes	50	labor day	3,250,000
Wages for planting	20	labor day	1,300,000
Wages for maintenance work	730	labor day	47,450,000
Wages for harvesting and processing leaves	56	labor day	3,640,000
Wages for paste production	112	labor day	7,280,000
Total			95,535,000

Income

Income calculation begins with *Indigofera* productivity, with total production calculated based on *Indigofera* leaf productivity per unit area. In 1 ha with a spacing of 100 × 100 cm, there will be 10,000 plants. Each individual plant produces an average of 35 g of *Indigofera* leaves per harvest. Harvesting on Timor Island can be done twice a year. Therefore, in

1 year, the production of *Indigofera* leaves is 700 kg ha^{-1}. Based on the productive age of the plant, the Indigofera cultivation cycle is 4 years. Thus, the productivity and total production of *Indigofera* leaves in one business cycle for 4 years is 2800 kg ha^{-1}.

The next step in the income calculation process is to calculate the yield of paste. Based on the results of the study, it was found that when 300 g of *Indigofera* leaves were added to 6 g of lime (2%) and 3 l of water, this yielded 177 g of paste (Agustarini et al. 2021). The calculation of paste yields based on the research activities is presented in Table 6.

Table 6. Indigo paste production from 1 hectare of *Indigofera* plant.

Indigo Paste Yield in 1 Year	Value	Units
Paste yield per kg (1000 g) of *Indigofera* leaves	390	g
Productivity of *Indigofera* leaves per ha per harvest	350	kg
Paste yielded in a single harvest per hectare	136.50	kg
Paste yielded per year per hectare	273	kg

The productivity of paste yields per hectare per year is 273 kg (Table 6). The price of indigo paste is relatively inelastic due to both the supply and demand for indigo paste being relatively stable. Thus far, there has been no substitution of natural blue dye apart from *Indigofera*, and production competition is still limited. There is no large industry that produces an indigo paste that will potentially monopolize the market price. The price used for income analysis was the price of indigo paste in 2021, based on the selling price of indigo paste in the market place (IDR 110,000 kg^{-1}, or USD 7.75). Therefore, the income derived from producing indigo paste is IDR 30,030,000 $ha^{-1}year^{-1}$ (or USD 2117) and income during the cultivation cycle is IDR 120,120,000 ha^{-1} (or USD 8469).

Results of the Financial Analysis

In conducting a financial feasibility analysis, it is necessary to consider changes in the value of currency over time. The cash flow on which the calculation of the investment eligibility criteria is based runs over a fairly long period of time (4 years). A calculation of the changes in the value of money over this period is calculated by including discounts in the analysis. Discounts are needed to convert the expected future flow of resources into an estimated present value (Riyanto 2018). The results of the financial analysis for the production of indigo paste are presented in Table 7, based on an assumption of a discount factor of 8%, based on the Bank Rakyat Indonesia credit interest rate in 2021. This follows (Nurmalina et al. 2018), who state that one of the factors for determining the discount rate is loan interest rates.

Table 7. The results of the financial analysis into the production of indigo paste with a factor discount of 8% over a 4-year business cycle.

Investment Parameters	Value
NPV	IDR 18,526,006 or USD 1306.145
BCR	1.23
IRR	126%
BEP	Second year

The results of the analysis demonstrate the feasibility of indigo paste production. This is shown by the values of the investment parameters, with the NPV showing a positive value, with the BCR above 1, with the IRR above the discount rate, and the BEP within the period of the business cycle. The analysis shows that the production of indigo paste has the potential to yield profits of IDR 4631,501.50 ha^{-1} $year^{-1}$, or USD 326,536 (exchange rate: USD 1 = IDR 14,183.73).

El Nino events impacted Timor Island in 2006–2007 (Kieft and Soekarjo 2007), with further impacts from La Nina in 2009 (Kota and Adiningtyas 2010), with these climatic

anomalies having a severe impact on Timor's agricultural sector and on community welfare. The results of research related to the cultivation of *Indigofera* spp. show that climatic conditions are one of the most important factors for the cultivation of this plant, with significant implications for productivity. Thus, it can be concluded that the climatic anomalies associated with El Nino and La Nina would impact the productivity of agricultural crops.

With El Nino conditions resulting in extreme dry seasons, when these conditions occur, it is essential to water plants so that they do not die. To determine the impact of this on the cultivation of *Indigofera* spp., a sensitivity analysis was conducted, taking into account factors including decreased productivity and the increased production costs resulting from the need for watering.

The analysis involved two scenarios for decreased productivity, with the first assuming a 10% decrease (a reduction in income of IDR 3,003,000 year^{-1} or USD 211.72 year^{-1}) and with the second assuming a 20% decrease (a reduction in income of IDR 6,006,000 year^{-1} or USD 423.44 year^{-1}). The two scenarios involving increased production costs are respectively based on the need for watering activities with an intensity of 1 month in 1 year (resulting in an additional cost of IDR 3,741,497 year^{-1} or USD 263.79 year^{-1}) and on an intensity of 2 months in 1 year (resulting in an additional cost of IDR 7,482,993 year^{-1} or USD 527.58 year^{-1}), as shown in Table 8.

Table 8. Results of sensitivity analysis for the decreased leaf production of *Indigofera* spp.

Investment Parameters	Productivity from *Indigofera* spp.	
	Decline of 10%	Decline of 20%
NPV	IDR 8,581,689 or USD 605.0375	IDR −1,364,628 or USD −96.21
BCR	1.11	0.98
IRR	51%	0.02
BEP	Third year	Not achieved

The results of the sensitivity analysis for the decreased leaf production of *Indigofera* show that the production of *Indigofera* paste would remain feasible if the production of *Indigofera* leaves decreased by a figure not exceeding 10%. However, if the decrease is greater than 10%, then the production of indigo paste is not feasible. Sensitivity analysis is conducted if there is an increase in costs due to watering activities. It is carried out in 2 scenarios, namely 1 and 2 months of watering in a 1 year planting period (Table 9).

Table 9. Results of sensitivity analysis to the increase in costs due to watering activities.

Investment Parameters	Period for Which Watering Is Required in One Year	
	1 Month	2 Months
NPV	IDR 6,135,695 or USD 432.5868	IDR −6,256,616 or USD −441.1122
BCR	1.07	0.94
IRR	38%	−19%
BEP	Third year	Not achieved

The results of this sensitivity analysis indicate that indigo paste production activities remain feasible if watering is required for a maximum of 1 month in 1 year. However, when watering is required for longer periods than this, indigo production becomes unfeasible.

3.5.2. Potential Economic and Social Value to Be Derived from the Development of *Indigofera* spp.

The potential economic value of *Indigofera* development is from the indigo paste selling activities in which its raw material is harvested from *Indigofera* potential cultivation areas. Based on the results of the various analyses, a number of findings related to the

development of *Indigofera* on Timor Island were obtained, including the following: the potential area to be prioritized for development covers ± 163 thousand ha; *I. suffruticosa* Mill. can generate production yields of 700 kg ha^{-1}; resulting in yields of indigo paste of 273 kg ha^{-1}, with the potential to generate profits of IDR 4,631,501.50 ha^{-1} $year^{-1}$ or USD 326.54 (exchange rate: 14,183.73). The potential economic value to be derived from the development of *Indigofera* on Timor Island is distinguished based on three plantings scenarios: 100% targeted area development with intercropping (scenario 1); 50% targeted area development with intercropping (scenario 2); and 25% targeted area development with intercropping (scenario 3). A comprehensive outline of the potential economic and social value to be derived from the development of *Indigofera* can be seen in Table 10.

Table 10. Potential economic and social value to be derived from the development of *Indigofera*.

Parameter	Scenario 1 (100% Target Area)	Scenario 2 (50% Target Area)	Scenario 3 (25% Target Area)
Area (Ha)	163,000	81,500	40,750
Potential supply of raw leaves (tons $year^{-1}$)	114,100	57,050	28,525
Potential supply of indigo paste for dye (tons $year^{-1}$)	44.5	22.25	11.12
Economic potential	IDR 754,934,744,500 or USD 53,225.40	IDR 377,467,372,250 or USD 26,612.70	IDR 188,733,686,125 or USD 13,306.35
Potential social impact in terms of employment (labor day)—per year	42,054,000	21,027,000	10,513,500

The potential social impact to be derived from the development of *Indigofera* takes the form of employment, given that the processes involved are labor-intensive. This potential is demonstrated in Figure 7, which shows that wages account for the largest proportion of the operational costs associated with the development of *Indigofera* (70%). The wage component for 4 years of *Indigofera* production cycle absorbs 1023 labor day (years 1: 348 labor day, years 2–4: 225 labor day) consists of the cultivation of *Indigofera* and the producing of indigo paste. In the first year, we need more labor for the cultivation activities. In the second to fourth year we only have maintenance and indigo paste production. In the cultivation of *Indigofera*, the wage component reaches 84% of the total cost of wages, while the proportion of the manufacture of indigo paste reaches 16%. Thus, this sector is suitable to be developed as it is able to absorb many workers in the rural sector.

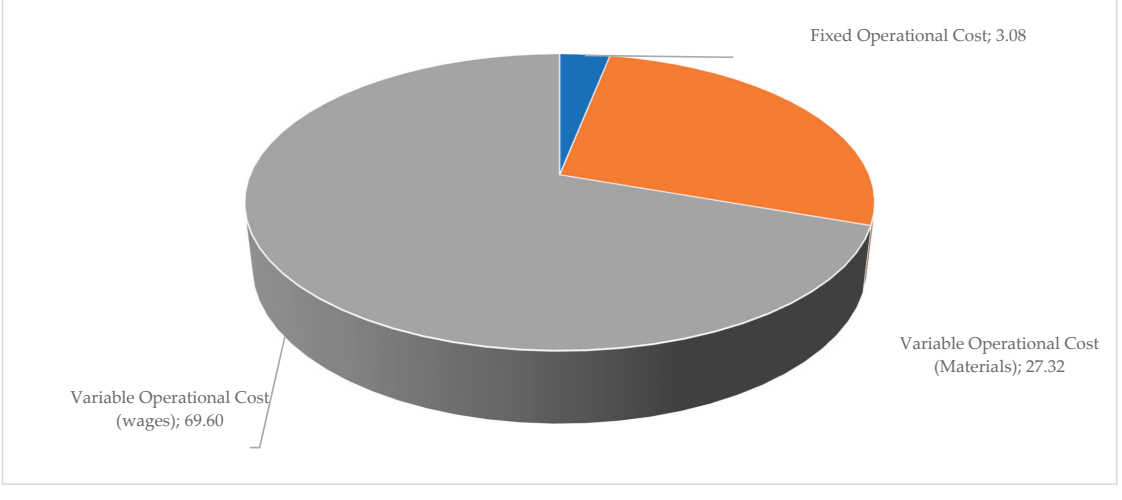

Figure 7. Composition of costs related to the development of *Indigofera*.

Ikat weaving also has economic potential as a tourist attraction. Weaving from this region has significant aesthetic value and plays a major role in establishing cultural identity (Susanti 2021). Thus, it has the potential to act as a form of cultural tourist attraction that could create value for NTT as a market for tourists.

As shown by a study conducted by (Muda and Suwito 2019), *ikat* weaving could drive increased tourist visits to the region, with significant potential economic benefits for the community. The development of weaving crafts has the potential to generate significant employment and to reduce the unemployment rate. Thus, this innovation has the potential to generate strong positive social value (Salma et al. 2018). There is good potential to develop the *ikat* weaving business, given that most craft people work individually, with very few working together in groups (Muda and Suwito 2019). Weaving has strong market potential due to its recognition as an environmentally friendly art product by upper-middle consumers. According to (Samadara 2018), both national and international tourists prefer to buy *ikat* from Sumba with natural dye compared to synthetic dyes.

Together with increasing public awareness of the negative effects of synthetic colors on health and the environment, the market for natural dyes has good prospects (Salma et al. 2018). Therefore, *ikat* weaving can be regarded as a form of cultural heritage that could be developed through a community empowerment approach to generate significant positive economic and social benefits for members of communities in rural areas.

3.6. Development Strategy the Sustainable Use of Indigofera Leaves to Produce Natural Dyes

A development strategy for the sustainable use of *Indigofera* leaves to produce natural dye was formulated through a quantitative SWOT analysis. A quantitative SWOT analysis may be used to conduct an evaluation according to specific desired parameters and to develop management strategies (White et al. 2015). The main advantage of the SWOT approach is to show current and possible future constraints related to implementing a proposed initiative (Johnson et al. 1989). The SWOT analysis approach is an effective technique to formulate strategies (Hill and Westbrook 1997) because it categorizes factors related to the proposed initiative as either *internal* (strengths, weaknesses) or *external* (opportunities, threats) (Shrestha et al. 2004). Therefore, the approach can provide insights into how to transform threats into opportunities and offset weaknesses into strengths (Wang 2010; Liu 2013).

The SWOT diagram for the development of the use of *Indigofera* leaves as a natural dye in a sustainable manner on Timor Island, Indonesia, was constructed according to interviews with experts. Strengths and weaknesses are categorized as internal factors, and opportunities and threats are categorized as external factors (Table 11).

The determination of weights in the SWOT-AHP model is based on the results of comparisons between SWOT components using pairwise comparisons. The results of the analysis show that the value of the consistency ratio (Cr) is 0.03 for external factors and 0.04 for internal factors. This value is still below the maximum allowable Cr of 0.1, following the recommendations of (Saaty 2008). The results of the SWOT-AHP analysis show that the coordinate value for the internal factors stands at 2.10, while the external factor stands at 2.32 (Tables S5 and S6). Based on the position and action evaluation matrix strategy, there are four quadrant strategies: aggressive, competitive, defensive, and conservative (David et al. 2019).

These results indicate that the strategy for the production of *Indigofera* spp. on Timor Island lies in quadrant I, indicating that the strategy should be implemented aggressively. An aggressive strategy's leverage is the existing strengths and opportunities, rather than using defensive options to minimize weaknesses and threats (Rauch 2007).

Local wisdom relates not only to providing livelihoods and sustaining the lives of local communities but as also as a means to strengthen ecological sustainability and to leverage the community's unique resources to stimulate the sustainability of local wisdom itself (Lake et al. 2018). The strategy for the development of *Indigofera* spp. on Timor Island involves leveraging the community's culture and wisdom related to the use of this plant

acquired over generations, as a result of which it has developed the appropriate cultivation techniques, which consist of knowledge of the right time for planting, following good cultivation practices, and using appropriate planting materials. This provides a strong basis for leveraging the development of indigo paste in suitable areas to capture significant economic and social opportunities.

Table 11. Diagram of the SWOT analysis for the sustainable development of *Indigofera* to produce natural dyes.

	Strength	**Weakness**
Internal factor	Communities in the region are accustomed to agricultural cultivation activities	Community members do not yet cultivate *Indigofera*, but gather it from the wild
	Indigofera grows naturally on Timor Island	Communities are not yet familiar with techniques for cultivating *Indigofera*
	High potential *Indigofera* that grows naturally and can be collected by members of the community	The process of producing natural dye from *Indigofera* is more complicated than the process of producing other types of natural dyes
	Strong willingness of community members to participate in cultivating *Indigofera*, which is usually conducted through collective cooperation	Communities are not yet familiar with the processes for producing indigo paste of sufficient quality to compete with other products
	Wide availability of land suitable for the cultivation of *Indigofera*	Low general levels of education may constrain the transfer of knowledge related to the cultivation and processing techniques
	Communities have a strong cultural tradition of weaving using natural dyes	
	The use of *Indigofera* is a natural dye is widely accepted as part of local cultural traditions, preceding the use of synthetic dyes	
	Opportunity	**Threat**
External factor	Increased farmer incomes from the production of indigo paste from *Indigofera* leaves	Unpredictable climatic conditions due to global climate change
	Increased weaver incomes from the sale of cloth using natural dyes	The presence of synthetic dyes that makes weaving more efficient
	Indigofera can be intercropped with food crops without negative impact on the growth of any of the crops involved	Paste production is inefficient and manufacturing costs are high due to increased paste production not balanced by the availability of raw materials
	Indigofera has good potential for use to rehabilitate critical land	
	There are good prospective markets for indigo paste	
	The technology required for the production of indigo paste is available	
	Trend back to nature	
	Increased awareness of the need for environmental and occupational safety	
	Limited availability of plants that produce natural blue dye	

Based on the SWOT-AHP analysis, it would be possible for the regional government of NTT to formulate a number of strategies for the development of *Indigofera* spp. on Timor Island, including the introduction of *Indigofera* spp. as an agro-industry commodity and its use for the rehabilitation of critical lands. These strategies could be implemented by developing partnerships with the private sector to increase the potential sale of indigo paste,

to expand markets, and to increase community capacity is to cultivate and process the plant. A number of stakeholders and actors could be involved in this initiative, including women's farmer groups, *Dewan Kerajinan Nasional Daerah/Dekranasda* (the Regional National Crafts Council), the Industry and Trade Office, the Women's Empowerment Service, the Agriculture and Plantation Service extension agencies, and private companies. Support for women's capacity building in terms of education is needed for the regeneration or further development needs. This is reinforced by (Chisamya et al. 2012), which states that by being educated, girls experienced a transformation of the inequitable gender relations they faced in society. Related to agriculture, although in Indonesia it is dominated by men, women appear to have equal access to productive resources, such as land and inputs, and greater control over household income than men (Akter et al. 2017). Funding and financing for these strategies could be sourced from related agencies, grant funds, business service agency (*Badan Layanan Umum*, BLU), and mutual cooperation funds managed by farmer groups.

Thus far, neither the NTT provincial government nor district governments have promulgated regulations related to the preservation of *ikat* or the use of natural dyes. Regional regulations could play a significant role in supporting strategies to develop the commodity, to create predictability and legal certainty, and to demonstrate a clear commitment to the development of cultural industries in NTT (Setiawan and Suwarningdyah 2014). In addition, local regulations related to weaving and tourism could play a strong role in facilitating the achievement of SDG 8 targets.

4. Conclusions

The people of Timor Island are familiar with a range of plants that can be used to produce natural dyes, one of which is *Indigofera* spp. (*I. tinctoria* L. and *I. suffruticosa* Mill.), which is generally used to produce a black dye for *ikat* fabrics made by the community.

The cultivation of *Indigofera* is conducted in three stages: germination, seeding, and planting. Sowing media plays an important role in increasing the germination rate, with the best sowing media for the germination of *I. tinctoria* L. being sand media. At the seedling stage of *I. tinctoria* L, a mixed media consisting of soil, cocopeat, and rice husk charcoal (1:2:2) and placed in an unshaded area (0%) and mixed media consisting of soil and rice husk charcoal (1:2) and placed in 50% shade resulted in the highest biomass and the best quality index. At the planting stage of *I. suffruticosa* Mill., a spacing of 100 × 100 cm resulted in the best increases in height, diameter, and number of branches, while the use of fertilizer (100, 150, and 200 g plantings) resulted in better growth than without the use of fertilizer. Providing 100 g of fertilizer per plant results in the best results in terms of height, diameter, and number of branches.

Indigo paste is produced by adding quicklime CaO equivalent to 2% of the weight of the leaves and water equivalent to 10 times the weight of the leaves. This technique is more time-efficient and results in the production of a higher quality paste with a longer shelf life than through the techniques currently applied by the community.

The potential area suitable for the development of *Indigofera* spp. on Timor Island covers ±163,000 ha. The results of the financial feasibility analysis showed that the processing of *Indigofera* spp. to produce indigo paste is feasible. The results of the sensitivity analysis show that the tolerable decrease in production levels is only 10%, with a maximum of one month of watering in a year for the production of indigo paste to remain feasible. The total potential supply of raw materials to produce indigo paste from Timor Island stands at 11–44 tons/year, with the economic potential standing at USD 13–53 million/year. The cultivation and processing activities are labor-intensive, requiring a workforce of 1032 person/ha during the *Indigofera* spp. production cycle (4 years).

Strategies to develop the cultivation and processing of *Indigofera* spp. on Timor Island could be conducted aggressively by leveraging the identified strengths related to the cultivation of *Indigofera* spp. In particular, this would involve deleveraging local wisdom and cultural traditions related to the use of *Indigofera* spp. over generations by applying the appropriate cultivation techniques, together with innovations in the indigo

paste production process and the development of suitable areas to capture economic opportunities.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/economies10020049/s1, Figure S1: Steps for Indigofera Land Suitability—Land Availability Analysis; Table S1. Effect of scarification and media on the percentage of germination of *Indigofera* spp. seeds; Table S2. The effect of media on germination percentage; Table S3. Effect of shade and media on growth parameters of height, diameter, number of branches, leaf production, and percent survival of *Indigofera* spp. seedlings; Table S4. The effect of spacing and manure application on increasing growth in height, diameter, and number of branches of *Indigofera* spp. four (4) months after planting; Table S5. Internal strategic factors based on weights, ratings, and scores; Table S6. Internal strategic factors based on weights, ratings, and scores.

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