Global distribution network design: exploration of facility location driven by tax considerations and related cross-country implications

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Abstract

Multinational corporations (MNCs) are moving not only their headquarters but also their logistics operations to low-tax jurisdictions to minimise the tax burden. However, the logistics and fiscal domains are guided by different principles. This study aims to explore the cross-country implications of locating facilities in low-tax jurisdictions to take advantage of tax arbitrage. A single case study is developed, considering a fashion MNC that moved its European warehouse from Italy to Switzerland.

The study offers theoretical insights about cross-country logistics network reconfiguration, formalising three possible scenarios and deepening the related implications. A quantitative evaluation of those scenarios is proposed, updating logistics cost items by including fiscal specifics and exploring the mutual interdependence between logistics and fiscal elements. To improve the study's managerial contribution, the influence of contextual parameters is also investigated, showing that facility location for tax purposes does not necessarily lead to maximise net income after taxes.

Keywords: Global distribution network design, facility location, after-tax profits, bonded warehouse, duties

Paper type: Application paper

Introduction

Global distribution network design, that is, designing how to manage global flows in downstream supply chains (Olhager *et al.*, 2015), is experiencing significant changes because multinational corporations (MNCs) are adopting an integrated approach where logistics and fiscal aspects are considered simultaneously (Norrman and Henkow, 2014). Fiscal specialists have been advising manufacturing and logistics on how to minimise the tax burden (Webber, 2011; Joseph *et al.*, 2017), but maximising profits on a global scale presents huge challenges (Cohen and Lee, 2020). An option is separating MNCs into pieces and concentrating high-value-added functions (bearing the most meaningful risks) into a specific organisation (Shunko *et al.*, 2017), often called a *Principal structure* (Bhutta *et al.*, 2003). Sometimes, MNCs later shift the Principal location to low-tax jurisdictions because of the achievable fiscal benefits (Adams *et al.*, 2008). Nevertheless, several governments have censured this behaviour and counteracted MNCs' actions to forbid them from establishing business units in low-tax jurisdictions for mere tax avoidance purposes (Shunko *et al.*, 2017). Therefore, to comply with international regulations (i.e. to justify their presence in low-tax jurisdictions), MNCs have started to shift distribution facilities to where principals are already located (Balaji and Viswanadham, 2008; Webber, 2011). This approach has introduced new challenges for MNCs because logistics and fiscal domains are driven by different principles, and frictions may arise (Henkow and Norrman, 2011; Dong and Kouvelis, 2020). There should be careful evaluation of cross-country implications related to managing flows crossing national borders by coping with different customs and tax authorities from both the logistics and fiscal viewpoints (Norrman and Henkow, 2014; Prataviera *et al.*, 2020). For instance, customs duties are taxes levied on the importation of certain goods into a customs jurisdiction (Cohen and Lee, 2020). Various solutions have been proposed to reduce or avoid customs duty burdens, such as bonded warehouse regimes that allow for storing goods under duty suspension (Sawhney and Sumukadas, 2005). However, these solutions may involve additional costs and nontrivial complexity due to special monitoring and auditing required by customs authorities (Hsu and Zhu, 2011).

Despite the rising debate in the practitioners' community (Henkow and Norrman, 2011; Cohen and Lee, 2020), studies on aligning logistics and fiscal issues are still under-represented in the academic literature. Moreover, current research seems to favour theoretical relevance rather than providing realistic solutions to practitioners for the existing problems, widening the gap with respect to practical applications (Stentoft and Rajkumar, 2018). In the discussed context, a relevant question for MNCs is how to design global distribution networks to maximise net income after taxes (NIAT) (Vidal and Goetschalckx, 2001) and simultaneously respect international taxation rules. This study aims to address this issue by exploring the location of logistics facilities alongside the Principals' facilities in low-tax jurisdictions, a problem barely studied in the academic literature that can also support practitioners' decision making. Indeed, previous literature mainly recommends

location according to production and logistics costs, neglecting the role of taxation (Shunko *et al.*, 2017), whereas MNCs seem to simply consider tax savings without addressing logistics drawbacks and potential complications from the cross-country setting (Adams *et al.*, 2008). At the same time, integrating global distribution network design with the huge variety of tax structures introduced by different jurisdictions poses great challenges for MNCs (Cohen and Lee, 2020). This opens up interesting research opportunities to inform the current debate about how companies should best design their distribution networks while coping with fiscal elements that are relevant to global distribution, such as duties, exchange rates and corporate income tax (CIT; Dong and Kouvelis, 2020).

For the present study, two research questions (RQs) were formulated as follows:

RQ1: How do MNCs approach facility location when considering fiscal issues, and which related criticalities and opportunities emerge?

RQ2: When does facility location for tax purposes lead to maximising MNCs' NIAT?

To address these research questions, a single case study was developed, considering a fashion MNC that recently moved its European warehouse from Italy to Switzerland. Two cross-country logistics scenarios (i.e. traditional central warehouse [CW] vs bonded warehouse [BW] in a low-tax jurisdiction) were formalised and compared with a base case scenario without cross-country flows, highlighting cross-country issues related to the close interdependence between logistics and fiscal elements. As tax savings may overshadow additional logistics costs related to cross-country flows, insights from case research were then consolidated. They were combined in an analytical model to carry out a scenario analysis that quantitatively investigated cross-country criticalities and opportunities, considering the two domains. Academia is increasingly asking for empirical and quantitative research in the field because available studies are often based on opinions or intent, but 'talk is cheap' (Cohen and Lee, 2020, p. 23). The developed model updated traditional logistics costs to include fiscal details and enabled the performance of a sensitivity analysis, computing the model's outcomes when changing contextual parameters and deepening their impact.

In the remainder of this paper, a review of the literature is provided before the methodology is described. The identified scenarios are then illustrated, followed by the model formulation and the main results. Finally, the results are discussed and conclusions are drawn together with directions for future research.

Literature review

In the last decades, globalisation of suppliers, manufacturers and distributors has led to an explosion of world trade (Meixell and Gargeya, 2005), and raw materials, components and finished products are flowing

into global supply chains and crossing country borders many times (Lee, 2010; Prataviera *et al.*, 2020). Global distribution network design aims at determining the number of echelons, and for each echelon, the type, size, number and location of facilities (Chopra, 2003; Mangiaracina *et al.*, 2015). Five main decisions are important—facility location, facility capacity assessment, facility opening/closing, inventory policy management (e.g. periodic review model vs fixed order quantity) and transportation design (Mangiaracina *et al.*, 2015; Olhager *et al.*, 2015). The location decision is considered the focal problem in network design (Melo *et al.*, 2009; Olhager *et al.*, 2015), representing a key aspect of strategic and logistics decision making (Vidal and Goetschalckx, 1997).

Integrating fiscal issues into global distribution network design

When designing global distribution networks, a mere logistics perspective may be reductive, given the relevant tax implications related to the geographical distribution of value-added activities (Frias *et al.*, 2014; Seppälä *et al.*, 2014). Tax permeates many aspects of a supply chain: direct taxes are levied on the income, customs duties and compliance rules are applied to movement of goods across borders and value-adding activities, and similar indirect taxes are applied to the transfer of goods (Hsu and Zhu, 2011; Dong and Kouvelis, 2020). Therefore, MNCs are increasingly considering fiscal elements to complement traditional logistics cost factors, such as handling, picking, transport and warehousing, used in network design (Henkow and Norrman, 2011; Cohen and Lee, 2020). However, logistics and fiscal domains are based on different principles (Norrman and Henkow, 2014).

On the one hand, stand-alone supply chain activities (e.g. network optimisation, strategic sourcing and lean manufacturing) can reduce operating expenses and working capital requirements and improve cash flow and asset utilisation (Balaji and Viswanadham, 2008). Nevertheless, these initiatives focus only on pre-tax cost reduction, and each dollar of operating savings may not necessarily transform into an actual reduction in cost after taxes (Fernandes *et al.*, 2015; Oláh *et al.*, 2018). Indeed, as changes in global logistics structures directly affect how and where a company is established and value-adding activities are performed, direct and indirect taxes are affected (Norrman and Henkow, 2014). On the other hand, tax planning performed independently from network design may lead to suboptimal strategies with respect to operating cost and profit (Balaji and Viswanadham, 2008), and an MNC designing its distribution network only according to tax purposes may underestimate the overall supply chain costs (Avittathur *et al.*, 2005). Hence, MNCs should integrate fiscal issues, determining where to locate business operations while aiming at maximising NIAT (Webber, 2011). Indeed, understanding and effectively managing tax liabilities can result in important savings (Fernandes *et al.*, 2015). While some studies identify the main principles underlying these decisions, so far, little research has been performed on locating part of the supply chain in tax advantageous jurisdictions, although it would

certainly allow huge profits to be generated for MNCs (Balaji and Viswanadham, 2008). Below, further details are given about the important subsystems to be considered, which are direct and indirect taxes and customs duties (Henkow and Norrman, 2011).

Direct and indirect taxes

Global distribution network design can have a substantial impact on income tax obligations (Henkow and Norrman, 2011; Webber, 2011). In domestic environments, cost minimisation can be suitable for companies' purposes, but profit maximisation should be preferred in a global environment because of different local tax rates (Miller and De Matta, 2008). Differences in tax legislation and tax rates applied by the different countries create several opportunities for MNCs (MacCarthy and Atthirawong, 2003; Frias *et al*., 2014); in particular, low tax rates become particularly attractive when products are profitable and the tax savings are not offset by supply chain costs (Webber, 2011). One way to reduce overall tax liabilities is the centralisation of high-value operations into a Principal structure, with the Principal located in a low-tax jurisdiction (Shunko *et al*., 2017). To the extent they are able, MNCs may have incentives to reallocate profits to reduce worldwide corporate tax liabilities, even when simultaneously required to locate physical operations in low-tax jurisdictions (e.g. Switzerland, Hong Kong, Ireland) to justify the profits they plan to report there (Hsu and Zhu, 2011; Joseph *et al*., 2017). Indeed, MNCs can take advantage of real and financial opportunities to reduce the tax burden. On the one hand, real responses include locating physical assets and economic activities in low-tax countries and pursuing 'substantive tax planning'. On the other hand, financial responses include efforts to merely shift income to more lightly taxed locations through 'formal tax planning' (Adams *et al*., 2008).

Many governments are attempting to assert the 'substance over form' principle to challenge those changes in business structure they perceive as merely tentative to reduce taxable income and shift profits to low-tax jurisdictions (Petriccione *et al*., 2007). Thus, tax authorities require that any restructuring of existing operations should produce substantial operational changes and introduce exit charges or other penalties when the 'substance over form' principle is not respected (Adams *et al*., 2008). Furthermore, important issues related to permanent establishment (PE) creation and indirect tax management could emerge (Miller and De Matta, 2008; Henkow and Norrman, 2011). Specifically, PE is a fixed place of business generally giving rise to income or value-added tax liability in a particular jurisdiction (Petriccione *et al*., 2007). Performing specific value-adding activities in different countries could have different PE implications, influencing where and how much tax should be paid (Joseph *et al*., 2017). Indeed, PE involves a 'fixed place of business' that requires a connection between the MNC's premises and some geographical positions, as well as a degree of permanence to that location. Moreover, PE mandates that the business is wholly or partly carried out through that fixed

place (Petriccione *et al.*, 2007). As PE is defined by the lax law of each jurisdiction, some operations may be deemed sufficient to create a PE in some jurisdictions while others are not (Henkow and Norrman, 2011). This is an important problem for MNCs because the maintenance of a fixed place of business solely for the purpose of purchasing goods or merchandise or of collecting information for the enterprise may be considered an ancillary activity that does not qualify MNCs for the creation of a PE (Adams *et al.*, 2008). Therefore, to claim to pursue substantive and not formal tax planning, MNCs have started to move their warehouses where their principals were already located (Balaji and Viswanadham, 2008; Webber, 2011). For instance, in the last two decades, some European MNCs within the fashion industry have been specifically moving their Principal to Switzerland (Deloitte, 2019). However, MNCs' attempts to reduce their taxes through global restructuring can be controversial, raising citizenship concerns. If the Principal is considered just a post box that is not aligned with the creation of a PE in the country, the 'substance over form' principle is not respected, causing alarms and public scrutiny. Therefore, to comply with international regulations (i.e. to justify PE in a low-tax jurisdiction), the MNCs under consideration later had to shift to Switzerland, along with their European central warehouses.

Customs duties

Other relevant issues to consider are customs duties and trade tariffs (Arntzen *et al.*, 1995; Dong and Kouvelis, 2020), as well as customs requirements and procedures (Sawhney and Sumukadas, 2005) or duty drawbacks (Häntsch and Huchzermeier, 2016). Generally, trade barriers are meant to protect national competitiveness from foreign competition, and they are usually classified into two types—tariff and non-tariff barriers (MacCarthy and Atthirawong, 2003; Adams *et al.*, 2008). Tariff barriers refer to paying taxes on imports and exports of goods. They are often computed as a percentage of the product value that crosses the border (i.e. customs value), but they may also be levied based on other parameters, such as weight or volume (EY, 2012). MNCs also face several non-tariff barriers, such as local content requirements, technical standards, quota restrictions and complexity in the required documentation (Lee, 2010). Trade agreements may also entail lower customs duties or special treatment for some products and trading partners if specific requirements are met. In fact, the level of customs duties depends not only on the customs value but also on the goods classification (i.e. the tariff code) and the origin of the goods being imported (Arntzen *et al.*, 1995; Cohen and Lee, 2020). In the last decades, many countries have signed free-trade agreements, calling for a preferential origin (which entails reduced or zero-rate tariff duties) for goods originating from a specific trade partner (Meixell and Gargeya, 2005; Frias *et al.*, 2014). For instance, a shoe manufacturer retained its manufacturing plant in Canada to satisfy demand in Israel, taking advantage of the zero duty rate agreed on between Canada and Israel (Cohen and Lee, 2020). Indeed, given the trade agreements and the customs duties in place, the

classification of goods and the customs duties that should be paid may change (Henkow and Norrman, 2011). As a consequence, homogeneous markets where trade could be conducted under specific rules (e.g. the EU or NAFTA) have been established (Adams *et al.*, 2008), but their existence implies higher customs duties and more restrictions created for other products and trading partners (Lee, 2010; Dong and Kouvelis, 2020).

An appropriate (re)design of a company's distribution network may reduce the company's customs duty burden, landed costs and lead times (Fleischmann *et al.*, 2006). For example, goods to be re-expedited could be stored under a customs duty suspension regime (i.e. in a bonded or customs warehouse) to avoid import duties in the country where the storage facility is located (Hsu and Zhu, 2011). However, this presents nontrivial trade-offs to be solved. On the one hand, a bonded warehouse may allow for simplifying and reducing the operational costs related to customs clearance procedures (Sawhney and Sumukadas, 2005). On the other hand, it may entail higher transaction costs and additional issues due to the complex procedures to be followed to secure authorisations from customs authorities (Lee, 2010).

Alternatively, import duties could be remitted on goods exported through duty drawbacks (Häntsch and Huchzermeier, 2016). Duty drawback systems allow for avoiding paying at import, or more commonly, to later recover duties on goods to be re-exported (Cohen and Lee, 2020). However, each jurisdiction offers its peculiarities about the opportunities to achieve duty drawbacks, which also relate to the type of warehouse (bonded or not; Hsu and Zhu, 2011). For example, in the case of traditional warehouses, duty drawbacks can be claimed for duties paid at import on components that are used for finished products to be exported but not to already finished products to be then re-expedited in other jurisdictions (Adams *et al.*, 2008). Consequently, if a product is imported in a bonded warehouse, it pays no duties; otherwise, for a traditional warehouse, duties will be levied, but the MNC may not always receive a full refund of such duties (Hsu and Zhu, 2011). Finally, it should be noted that 'static tariff values, and not the actual value added, are the basis for any correct calculation and crediting of duty drawbacks' (Häntsch and Huchzermeier, 2016, p. 113), and this can introduce further discrepancies between the duties paid and duty drawbacks (Adams *et al.*, 2008).

Former studies showed examples of MNCs starting to optimise their global supply chains by considering the minimisation of the overall customs duties liabilities in their corporate objectives; MNCs can do this because they can take advantage of regional/global trade agreements (Balaji and Viswanadham, 2008). While duties and direct taxes have been investigated from both qualitative and quantitative perspectives (Table 1), cross-country implications related to customs authorities were mainly emphasised in qualitative research (e.g. Henkow and Norrman, 2011; Webber, 2011).

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Methodology

This study aims to explore the interface between the logistics and fiscal domains, a topic currently lacking adequate attention in the academic literature. In more detail, it discusses MNCs' location of logistics facilities in low-tax jurisdictions for tax purposes. To accomplish this, single case study research is conducted to understand the problem and obtain real data, which are used to model different scenarios. Indeed, combining data obtained through exploratory case study research with empirically grounded analytical modelling can help yield a multi-perspective solution to existing problems (Choi *et al.*, 2016). As complete (and complex) models could hardly be used by supply chain professionals, the risk for academia is 'to talk to a smaller and narrower academic audience, using a language that an educated reader does not understand' (Stentoft and Rajkumar, 2018; p. 507). Conversely, to be manageable, a model must be simple yet rich enough to support decision-making capabilities (Bhutta *et al.*, 2003). To properly address the increasing complexity related to cross-country operations (Dong and Kouvelis, 2020), it was decided to limit the research scope to a 'single-tier, single-node' problem, with the location problem for a central warehouse as the unit of analysis.

First, two cross-country scenarios and a base case scenario without cross-country flows were formalised. Then, insights collected through case research were consolidated and formalised into an analytical model to carry out scenario analysis. Indeed, MNCs seem to focus their attention on tax savings, without placing great importance on additional logistics costs related to cross-country flows (Norrman and Henkow, 2014). Conversely, in this study, it was possible to quantitatively investigate cross-country criticalities and opportunities related to the identified cross-country logistics scenarios. Analytical modelling also enabled the performance of a sensitivity analysis, computing the model's outcomes when changing contextual parameters (Normann Asmussen *et al.*, 2018). Therefore, it was possible to gain a richer understanding of the situation, and at the same time, test the contextual effects on the developed model to generate knowledge without expensive real-life implementation (Mangan *et al.*, 2004). The research process is summarised in Figure 1.

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Case selection

Case studies in logistics can focus on holistic situations in real-life settings, but they require setting boundaries of interest (Ellram, 1996). Thus, case selection is a critical decision because it determines the extent to which the findings can be generalisable (Yin, 2009). A purposeful sampling approach was adopted, whereas sample selection was driven by the opportunity to gain accessibility to the phenomenon of interest and to study this phenomenon with the potential for new insights (Caniato *et al.*, 2018). Sampling was carried out in two steps. First, once the unit of analysis was defined, a list of MNCs that moved their warehousing operations to low-

tax jurisdictions was identified through trade press articles and discussions with practitioners. These MNCs were approached to determine the possibilities to make further inquiries, and from this larger sample, a single MNC was chosen. The considered MNC is an Italian luxury brand of fashion and leather goods, which had a principal structure in Italy and was used to distribute in the European market (homogeneous market) from a central warehouse located in Northern Italy (belonging to the same homogeneous market). First, it moved its Principal to Switzerland (i.e. a low-tax jurisdiction); then, it shifted the warehouse location to the same place, in a position close to the Italian border, to minimise logistics distortions. The MNC was deemed relevant to the research purposes because a bonded warehouse was established in Switzerland while a traditional warehouse had been considered as well. Although this convenience sample may have involved bias (Bryman and Bell, 2011), it was of fundamental importance to gain access to practitioners with a holistic understanding (e.g. legal and fiscal elements), as well as with a detailed operational understanding (e.g. cross-country operations criticalities, lead times, work processes), of the solution. Owing to the first sampling phase, this bias should have little impact on the final results.

Data collection

All the necessary data were primarily gathered through weekly visits over a period of four months, from August 2017 to December 2017. Weekly semi-structured interviews were conducted (Yin, 2009), involving managers from different departments (Supply Chain Planning, Logistics and Finance/Accounting), supported by the analysis of available archives, financial statements, internal plans and accounting documents, which were accessed through the company's informative system. To ensure a strategic vision about the considered problem, the key interviewees were two logistics managers and three fiscal experts. Several people in the MNC claimed that these key interviewees had the most extensive knowledge about the logistics and fiscal aspects to be considered in a cross-country distribution network design. Interviews were characterised by a focussed approach (Yin, 2009) to be able to explore the answers deemed most useful for a better understanding of the phenomenon. The interviews (approximately 120 min long, and when agreed to by the informant, recorded and transcribed) helped to limit the study's scope and increase focus, increasing the conceptual and instrumental relevance (Stentoft and Rajkumar, 2018). Given the broad variety of the required information, no strict interview guide was developed. Every interview was based on a list of open questions, which became increasingly detailed with the progression of the work. Moreover, every time a piece of information was collected, it was written off from that list and included in a calculation sheet and/or in a text document, where all details were reported. Data triangulation was also an integral part of the process: Industry reports, annual reports, news articles and other public documents were consulted, corroborating the findings and increasing the internal validity (Yin, 2009). Overall, interviews and secondary data were collected during the period from

August 2017 to March 2018. Due to the sensitive nature of the topic, confidentiality was guaranteed to interviewees, and therefore, neither the company nor individual identities will be revealed.

Data analysis

The first phase of the research was inductive in nature, aiming to formalise the system under study. Although this step is similar to inductive theory building (Yin, 2009), the end result of the phase was not a testable theory, but rather, a formal model from which to deduct further insights. Data collected during the interviews were processed and abstracted so that two cross-country logistics scenarios with different facility types (traditional warehouse versus bonded warehouse) were formalised and modelled to be compared with a base case without cross-country flows.

To concretely define those scenarios, several assumptions have been considered. Indeed, aligning global distribution network design with the intricacy of the relationships among supply chains, taxes and market structures is a critical problem for companies (Hsu and Zhu, 2011). Border crossing is tedious and difficult, and customs clearance operations can require long and uncertain times and entail unexpected costs (Sawhney and Sumukadas, 2005). Additional complexity is then related to PE creation, CIT, government incentives and trade agreements; these elements are often country-specific and change rapidly (Lee, 2010; Henkow and Norrman, 2011). Hence, the completeness, accuracy, reliability and replicability of both logistics scenarios and the model rely on the following:

- The considered low-tax jurisdiction does not belong to the homogeneous market; thus, cross-country issues, such as customs duties and customs clearance operations, were considered. All these elements depended on the origin of the goods.

- Triangulation transactions involving exclusively the Principal, and not the physical network, are not accepted by tax authorities because they do not bolster the creation of a PE in the low-tax jurisdiction. Hence, the MNC cannot sell its products in the homogeneous market from the low-tax jurisdiction, being taxed in the latter on related income while distribution is carried out from a central warehouse in the homogeneous market.

- Since network redesign only involves the warehouse and its inbound and outbound flow, it is assumed that the global network, both upstream (e.g. plants, subsidiaries, suppliers, consolidation hubs) and downstream (e.g. other regional warehouses, transit points, customers) is invariant.

The model was developed according to an analytical approach because of its flexibility (i.e. changes and variations can be applied to each single modelled activity with limited effort) and transparency (i.e. assumptions are clearly stated in advance), in line with Mangiaracina *et al.* (2016). This allowed for quantitatively comparing the three identified scenarios to identify the one offering the highest profits. Profits

were considered, rather than only costs, as taxes can have a significant impact on companies' overall performance (Miller and De Matta, 2008). Revenues, transfer prices, and CIT rates were considered (Fernandes *et al*., 2015) to determine the differential NIAT between the identified strategies. This modelling phase required the identification of three main elements—inputs (data and contextual parameters needed to run the model), model algorithms (mathematical formulas to assess the cost functions related to each individual activity) and outputs (tables and graphs to display the results). The model was then developed by considering nine cost functions related to both logistics and fiscal cost items. Those cost functions were developed by combining a literature review and expert interviews for each cost item and for each available logistics scenario, distinguishing between inbound and outbound flows. General functions were imported into Microsoft Excel, and calculation sheets were filled with the company's data.

Once the input data were entered in Microsoft Excel, the model returned the NIAT estimation for each scenario, allowing for separately considering any cost item. Since the data collection and the model construction phases were parallel, the model was first revised and populated with data and information (e.g. CIT rates) gained from the interviewees. They were later involved in validating the research by triangulating the model's results with the company's outcomes. Interviewees were also consulted when any doubt emerged through follow-up questions. In this way, the construct validity and reliability of the study were strengthened. Actually, this validation strategy may be argued as the mathematical rules are well validated (logical validity), whereas the parameters are less validated (data validity; Landry *et al*., 1983). However, this should not affect the reliability of the study because the research aims at exploring the phenomenon rather than providing normative guidelines to move logistics operations to Switzerland. Finally, to simulate outcomes related to the considered problem when changing key parameters, a sensitivity analysis was performed. Contextual parameters emerged from the literature and from the interviews (i.e. annual demand, product value, percentage of outflows and inflows with a preferential origin for a specific market region, operating expenses incidence over revenues, CIT rate and currency exchange rate) were considered. Those parameters were modified one by one, keeping the others invariant, to investigate their effect *ceteris paribus* (Creazza *et al*., 2010).

Cross-country logistics scenarios

The MNC in focus first created a Principal structure to improve supply chain performances and reduce costs by centralising value-added activities (including inventory management) in a central location bearing risks for the regional/global businesses. To minimise the tax burden, the MNC then moved its Principal to a low-tax jurisdiction, instituting a PE there to concentrate profits gathered worldwide. Indeed, PE implies an income or value-added tax liability in a given jurisdiction, and the MNC was willing to minimise its worldwide tax liabilities. In this way, business transactions can be performed as 'triangular transactions' (Henkow and

Norrman, 2011): Goods do not require any physical transformation in the low-tax jurisdiction, and from a logistics perspective, they will not require any transition from there. Therefore, the material/goods flow differs from the invoice and information flows: Three parties are involved in a commercial transaction with respect to the same goods, which are transported to a warehouse or directly dispatched from the first subject to the last one (drop-shipment). When the Principal is in a low-tax jurisdiction, this approach may involve huge fiscal benefits due to profit shifting.

In line with previous qualitative contributions (e.g. Norrman and Henkow, 2014), interviewees confirmed that integrating fiscal issues into logistics and supply chain decision making is far from a straightforward process. They highlighted how this process covers a wide range of behaviours aimed at minimising the tax burden and can be split into legal and illegal behaviours. However, their distinction is difficult to identify because the borderline varies from jurisdiction to jurisdiction. Taxpayers are allowed to arrange their businesses in a way that attracts minimum tax liability, but tax planning can often be interpreted as tax avoidance until it reaches tax evasion (i.e. avoiding the payment of tax without avoiding tax liability). While tax planning is legal, tax evasion is not, and managing operations through triangular transactions would make it difficult to justify the profits accounted for in the low-tax jurisdiction. Therefore, to address the 'substance over form' argument by tax authorities, the MNC had to locate not only the Principal but also the core of its distribution network (i.e. the central warehouse) in the low-tax jurisdiction. Specifically, interviewees highlighted that central warehouse location can be influenced by fiscal issues, while second-tier distribution warehouse location is more driven by other factors (e.g. customer needs and service level), accordingly with Adams *et al.* (2008).

Cross-country flows can entail a significant increase in complexity and costs, mainly related to coping with customs authorities (e.g. providing export/import authorisation or duties payment). Therefore, the MNC examined whether creating a traditional facility or establishing a bonded warehouse. Bonded warehouses can be used because they allow for duty suspension or avoidance, but these advantages must be traded off with higher costs and the need for specific authorisations. Traditional warehouses may be more cost-effective, but they do not help streamline customs procedures and might entail 'trapped duties' (e.g. related to duty drawbacks failure) or penalties arising from non-compliance with jurisdictions' regulations.

As explained by one of the interviewed logistics managers, 'we have not really been focussing on customs duties cost, which was not even recorded independently and rather included within an aggregated cost item. When discussing the available alternatives, we deepened into the potential risks in terms of trapped liabilities, penalties and delays costs, and we opted for a bonded warehouse'. Overall, the MNC achieved substantial long-term operational and tax cost savings, enhancing its competitiveness, by moving operations to the low-tax jurisdiction. It also experienced a significant increase in complexity, similar to the cases

described by Henkow and Norrman (2011). As claimed by the company's fiscal experts, 'MNCs locate Principals and central warehouses in low-tax jurisdictions, thanks to lower CIT rates offered by local authorities, but they often underestimate the overall supply chain implications; this is due to the high number of additional transactions taking place'. By establishing a bonded warehouse, the company could improve its profits and simultaneously minimise cross-country risks and operational criticalities related to coping with customs clearance procedures. These advantages, along with the tax savings, overshadowed the higher costs related to storing goods under duty suspension and to special auditing required by customs authorities.

Building on data collected through case research, three logistics scenarios were formalised and modelled (as shown in Figure 2)—a base case and two cross-country scenarios—mainly differing according to the type of facility located in the low-tax jurisdiction (traditional central warehouse [CW] vs bonded warehouse [BW]).

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The MNC's distribution network is subdivided into homogeneous markets (Adams *et al.*, 2008), indicating areas where regional barriers to trade are reduced or eliminated among the participating States by signing specific trade agreements (like in the EU), and a single currency is used. Given the trade agreements in place, the MNC devoted a central warehouse to each homogeneous market.

The base case accounts for a single central warehouse assigned to a specific homogeneous market, where its Principal had also been located. From this central warehouse, the MNC distributes its goods to countries belonging to the homogeneous market. In the two cross-country scenarios, it is assumed that the MNC moved its Principal, as well as the warehouse (either traditional or bonded), to a low-tax jurisdiction to minimise the tax burden. Indeed, interviewees stressed that moving logistics operations to where the Principal had been located represents a viable solution to cope with stricter international regulations and PE requirements.

Both scenarios offer pros and cons. A traditional warehouse enables MNCs to make changes to the goods, but customs duties paid on finished products that are then reintroduced in the homogeneous market are not refunded. As highlighted by the companies' fiscal experts, 'most tax authorities are fine with duty drawbacks on components that entail value-adding operations in their jurisdiction, but they do not accept those related to finished products because they relate only to storage operations'. Conversely, in a bonded warehouse goods are stored uncleared, without paying any import tax. Nevertheless, logistics costs (i.e. warehousing and handling activities) are higher and only changes needed to preserve goods are allowed; in addition, specific customs authorisations and certifications are needed. In both scenarios, the MNC can benefit from a lower CIT

rate in the low-tax jurisdiction, while sustaining additional cross-country flows and facing higher logistics and customs duties costs. Indeed, cross-country logistics scenarios entail that the perfect logistics solution is distorted, and additional cross-country flows are created, as shown in Figure 3.

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Model formulation

An analytical model based on the total cost approach was developed to quantitatively compare the cross-country scenarios with the base case. This one-period model (based on insights and data from the interviews) incorporates tax rates as exogenous parameters (Fernandes *et al*., 2015) to carry out a scenario analysis that identifies the scenario with the highest NIAT. It includes nine cost items, evaluated over a one-year time horizon and classified into two macro-categories—operating and logistics costs and financial and fiscal costs. The former category includes costs related to transport, material handling, inventory carrying and labour; the second category includes customs duties, customs brokerage fees, customs inspections, capital cost for payment in advance of duties and CIT. Costs can differ according to either warehouse location (i.e. homogeneous market versus low-tax jurisdiction) or warehouse type (i.e. traditional warehouse versus bonded warehouse).

To model the problem, the following main assumptions were considered:

1. It was assumed that MNC relies on third-party-logistics (3PL) facilities because 3PL providers have a relevant role in global distribution networks. Hence, initial investments were not introduced, and the service level provided by the 3PL was supposed to be constant over different countries.

2. A mono-product model was developed. Nevertheless, to deal with product variety, aggregate volumes were considered, and the concept of a 'composite product' was introduced (Arntzen *et al*., 1995). It represented an average among the whole product range weighted by product volumes (expressed in m^3/year).

3. Inventories were managed through a periodic review model, as proposed by the interviewees.

4. Return flows were disregarded: according to interviewees, they are managed by local warehouses, without involving the central warehouse.

5. Both components and finished products were considered although it was assumed that the central warehouse's outbound flows could involve only finished products.

6. Three different goods values were considered: purchasing value for components, purchasing value for finished products, and selling value for finished products. As a requirement for the justification of transfer prices to tax authorities, all transfer prices were properly defined (according to MNC

suggestions) to be the same for all destinations for a given origin and for a given component, in accordance with the arm's length principle (Miller and De Matta, 2008; Fernandes *et al*., 2015).

7. Since the low-tax jurisdiction does not belong to the homogeneous market, it was considered to have a different currency, and thus, the currency exchange rate was introduced.

8. In line with Miller and De Matta (2008), revenues were computed by fixing the selling value of finished products, and it was assumed that the currency exchange rate did not vary over the considered time horizon.

9. Preferential origin for goods was considered in favour of the homogenous area or the low-tax jurisdiction.

10. Customs duties on imported goods without a preferential origin had to be paid immediately. It was also assumed that there was an opportunity to claim for duty drawbacks; in this case, however, the capital cost for duties payment in advance was considered.

Additional information pertaining to cost function modelling is reported in Appendix A. As output, the model provides a final spreadsheet containing links to tables and graphs referring to both logistics and fiscal costs. In particular, the model allows a scenario analysis between the base case and the two cross-country alternatives that would be easily manageable by practitioners.

Model application: scenario analysis

In the model application, for which Table 2 reports the values assumed by input data, the two identified cross-country scenarios were compared with the base case.

-Place_Table_2_here-

As summarised in Table 3 and illustrated in Figure 4, the proposed scenarios were characterised by substantial differences in duties to be paid on goods without preferential origin towards the EU and Switzerland with respect to cost objects (components or products), goods destination (EU or Switzerland) and the considered tax authority (EU or Switzerland). The apex numbers in Table 3 correspond to the same entity in Figure 5 to illustrate where customs duties liabilities emerged in the supply chain.

-Place_Figure_4_here-
-Place_Table_3_here-

When both components and products move through the network, their value increases because of the additional performed activities, as well as the mark-up charged for each unit. Therefore, according to the moment when goods are processed by customs authorities, duties liabilities changed according to either the corresponding duty rate or the value to be considered (purchasing or selling value). Indeed, the cost difference in customs duties between the base case and cross-country scenarios was mainly related to the amount of duties due to the EU. For the base case, duties on components and products to be sold in the EU were assessed considering the purchasing value when entering the central warehouse (as the Principal and the central warehouse were both located in the EU). In addition, duties were raised on products to be sold in Switzerland, considering the selling value, as goods were exiting the central warehouse. By storing goods in Switzerland (CW and BW), the MNC had to pay customs duties for products without a preferential origin for the EU on the selling value (when exiting the central warehouse) and not on the purchasing value (which was lower), as in the base case. Furthermore, it had to pay duties (on the purchasing value) to Switzerland on those components aimed to be imported and then processed to become products for sale in Switzerland. It also should have had to pay duties to Switzerland on components to be processed before being sold in the EU. However, in the case of goods temporarily imported for processing, duty drawbacks (i.e. duties paid to tax authorities and then returned to the MNC) could be obtained through the application of the Inward Processing Relief procedure. In addition, significant differences characterised the CW and BW scenarios. First, for CW, duties on products to be sold in Switzerland were assessed on the purchasing value. Conversely, BW implied a bonded warehouse; thus, duties were paid once crossing Swiss borders (after storage in the central warehouse) and assessed upon the selling value. Second, customs duties to be paid to Switzerland on products to be sold in the EU were higher for CW compared with BW. Products to be re-exported had to be cleared when entering the traditional warehouse (without the possibility of obtaining duty drawbacks), while they were stored uncleared in the bonded warehouse.

For the numerical results, given the assumptions proposed in the previous section, revenues were invariant with the three alternative scenarios. Therefore, in addition to profit considerations, results referring to cost differences are shown to provide a better understanding of the underlying dynamics (Figure 5). To assure the required confidentiality, all data were properly adapted and transformed into relative measures (in percentages, using as basis profits and costs with respect to the base case); however, such assumptions will not disturb the results because the same proportions were maintained (Fernandes *et al.* 2015).

-Place_Figure_5_here-

The model application showed that both cross-country logistics scenarios significantly outperformed the base case; they exhibited a profit increase higher than 1% (Figure 5a) thanks to a cost reduction higher than 30% (Figure 5b). The high cost difference was mainly due to lower CIT: Taxes to be paid in the base case were almost four times higher (Figure 5c), with Italian and Swiss tax rates equal to 31% and 8%, respectively. Although these results were expected, contrasting evidence emerged when focussing on logistics costs (Figure 5d). Indeed, shifting logistics facilities to Switzerland would have rarely been justifiable because of the higher Swiss logistics costs and additional cross-country flows. Specifically, handling and labour costs were 40% and 71% higher in CW and BW, respectively, due to the higher Swiss fares. CW and BW were also affected by additional differential transport costs; moreover, for both cross-country scenarios, inventory carrying cost was 46% higher than the base case. Interestingly, although the storage cost per unit was higher (almost double) in Switzerland than in Italy, the goods value in the Swiss warehouse was slightly lower. This was because, when goods are being stored in Switzerland (either in a bonded or traditional warehouse), customs duties owed to the EU have not been paid yet (and thus, they were not included in the goods value in this study). This effect also strictly depended on the percentage of goods benefiting from a preferential origin for the EU. Indeed, for all three scenarios, customs duties represented more than 99% of the customs costs, with the incidence of customs brokerage fees and inspection costs lower than 1%. Conversely, if goods had satisfied origin requirements, the corresponding customs duties would have been null.

Overall, even if the MNC had to pay duties on goods without a preferential origin for the EU in the base case, in CW and BW, customs duties were three and two-and-a-half times higher, respectively, than they were in the base case. Nevertheless, thanks to the Swiss tax system and its trade agreements with the EU, for the two cross-country scenarios, CIT reduction largely surpassed the increased logistics costs and customs duties (Figure 5b). This result is in line with the considerations raised by the MNC in focus in the study, where BW (opening a bonded warehouse) represented the best solution because customs clearance procedures were streamlined and import duties were avoided on goods destined to be quickly re-exported.

Model application: sensitivity analysis

The results illustrated in the previous section were related to the specific model application. Therefore, a sensitivity analysis was performed to increase their generalisability. The following contextual parameters, being modified one by one while keeping the others invariant to investigate their impact *ceteris paribus*, were considered: annual demand, product value (selling value of finished products), percentage of flows with a preferential origin for a specific market region (i.e. EU as the homogeneous market), operating expenses incidence over revenues, currency exchange rate and CIT rates. While the currency exchange rate and CIT rates were considered exogenous parameters, the other parameters were related to the company's endogenous

decisions. Once these key elements were identified, variation ranges were ascertained. Since revenues were supposed to be invariant, the results refer to cost differences to better explain underlying determinants.

Annual demand

For annual demand, which varied between 50 000 and 750 000 units/year, BW was the best solution for any demand value. In addition, it emerged that BW cost-effectiveness increased with the demand compared with both the base case and CW. Indeed, on the one hand, logistics costs increased linearly with the demand for both cross-country logistics scenarios and customs costs. On the other hand, fiscal benefits increased more than proportionally because of the lower CIT rate applied to net income before taxes (NIBT). When referring to a single unit sold, given the same NIBT, the corresponding CIT was significantly lower for the two cross-country scenarios, implying a higher value for NIAT. By increasing the demand, this effect applied to a higher number of units, and an exponential trend for the three cost curves was then identified. Consequently, a higher demand did not emerge as a barrier to cross-country logistics scenarios, instead supporting their cost-effectiveness.

Product value

The analysis was specifically referred to the finished products' selling value variation between 50€/unit and 850€/unit. To avoid any unexpected distortion, the ratios between selling and purchasing values of components and products were kept constant. Product value directly affected CIT, customs duties and inventory carrying costs. Indeed, the higher the product value, the higher the customs value for duties paid in the EU, the higher the inventory value and the higher the NIBT; these elements all linearly increased with the product value. Different from the previous analysis, product value had an impact on the scenario choice. Indeed, below a selling value equal to 115€, the base case represented the best solution. Moreover, the cost increase related to cross-country scenarios would not be offset by the CIT benefits. By increasing the product value, both cross-country scenarios increased their cost-effectiveness thanks to the increase of NIBT and the lower tax rate to be applied, which further supported the steeper NIAT increase.

Percentage of flows with a preferential origin for the homogeneous market

As the central warehouse was assigned to supply the European market, the analysis focussed on the preferential origin towards the main destination market. In the model application, the percentage of flows with a preferential origin for the homogeneous market was assumed to be 90%, but this was later varied between 45% and 100%. This parameter had a relevant impact on the overall customs duties, and thus, on the scenario choice. Indeed, when it was lower than 75%, the base case emerged as the best solution because it directly affected

customs duties due to the EU and indirectly affected inventory carrying costs. On the one hand, its decrease increased the overall customs duties paid; in addition, for CW and BW, those duties were computed according to the selling value, which was higher than the purchasing one. On the other hand, it affected the goods inventory value, since duties costs in the EU are paid before goods are put away for storage in the base case, and after that activity in CW and BW.

Operating expenses incidence over revenues

Operating expenses directly affected the NIBT and CIT. By increasing its percentage incidence on revenues, the NIBT decreased. As a consequence, the CIT decreased as well. Regarding the NIAT, both cross-country scenarios performed better than the base case until X (i.e. operating expenses incidence over revenues) was equal to 56%; this was mainly due to the lower CIT. However, for X > 56%, the base case was preferable, since its effect, together with additional logistics and customs costs, reduced the NIBT in a way that overlooked the benefits of lower CIT.

Corporate income tax (CIT)

Particular attention was devoted to CIT rates, representing one of the most important elements affecting scenario selection. In the model application, the Swiss CIT rate was significantly lower than the Italian one (8% vs 31%). In the sensitivity analysis, it was varied from 8% to 30%. While the base case was obviously independent from variations in the Swiss CIT rate, the CIT increased for both CW and BW. The identified threshold value to make the base case preferable was 24%. Hence, given the Italian CIT rate (31%), the higher logistics and customs costs of cross-country scenarios were compensated only with a tax rate difference of at least 7%. Finally, to extend the results, a further analysis was computed by simultaneously changing both the Italian and Swiss CIT rates. CW was always outperformed by either the base case or BW. In the model application, where the Italian tax rate was equal to 31% and the Swiss tax rate was equal to 8%, BW represented the best solution.

Currency exchange rate

The model application was characterised by a currency exchange rate equal to 0.9€/CHF; it was then varied between 0.9€/CHF and 1.3€/CHF. In the sensitivity analysis, it was assumed that the MNC kept the selling value in euros constant; according to our interviewees, this is the usual approach adopted in the luxury fashion industry. The scenario choice was heavily affected by currency exchange rate fluctuations: While a euro appreciation made cross-country scenarios even more profitable, a euro depreciation of just 3% (i.e. currency exchange rate equal to 0.93€/CHF) would have made the base case the best scenario.

For each parameter described above, Table 4 summarises the variation ranges and the identified threshold values that support a switch from the base case to BW. BW always dominates CW. As previously reported, annual demand does not affect the choice, while BW is preferable with reference to the base case when the product value is higher than 115€/unit, operating expenses are lower than 56% of the revenues, the percentage of flows with a preferential origin for the homogeneous market is higher than 75%, the Swiss CIT rate is lower than 24% or the exchange rate is lower than 0.93€/CHF.

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Discussion and conclusions

In the last decades, MNCs have increasingly integrated fiscal issues when designing global distribution networks to maximise profits on a global scale (Webber, 2011). Nevertheless, logistics and fiscal domains are guided by different principles (Henkow and Norrman, 2011), and huge challenges have emerged (Miller and De Matta, 2008). The interface between the logistics and fiscal domains is still under-represented in the academic literature (Norrman and Henkow, 2014), and academia is increasingly looking for empirical research to understand how MNCs respond to the turbulent trade climate in place (Cohen and Lee, 2020). This study targets the practical problem of MNCs evaluating a move of logistics facilities to the low-tax jurisdiction where their Principal companies have already been settled (Adams *et al.*, 2008; Shunko *et al.*, 2017). Instituting a Principal in such jurisdictions can be motivated by the willingness to minimise tax liabilities, but specific requirements must be met to be compliant with international regulations about PE and justify this kind of supply chain structure. Therefore, to address the 'substance over form' argument by tax authorities, MNCs can be recommended to locate not only the Principal but also their CWs in low-tax jurisdictions.

This study explores how MNCs approach the facility location problem when considering fiscal issues and to what extent facility location for tax purposes truly leads to maximising NIAT. A single case study was conducted, considering a fashion MNC that recently moved its European central warehouse from Italy to Switzerland, where it created a bonded warehouse. Data obtained through exploratory case research were combined with empirically grounded analytical modelling; such an approach helps yield multi-perspective solutions to real problems (Choi *et al.*, 2016). Two cross-country logistics scenarios were identified and formalised; then, insights collected through case research were consolidated into a model that included both logistics and fiscal cost functions. This approach enabled a quantitative scenario analysis to identify the scenario offering the highest NIAT. Model development also enabled the performance of a sensitivity analysis, allowing for investigating the impact of different contextual parameters and generalising their implications.

The study investigated cross-country opportunities and criticalities, showing that including variables other than purely logistical ones paves the way for original logistics configurations. A bonded warehouse solution was formalised, considering such elements as goods' origin or different rules to manage duty drawbacks. In addition, fiscal cost items, such as customs brokerage fees or customs inspection costs, were first formalised and then introduced into a quantitative model. Furthermore, the study showed that the integration of fiscal issues into the decision process is not straightforward as there is mutual interdependence between logistics and fiscal cost items. For example, customs duties depend not only on the customs value but also on the goods classification and origin of goods. In turn, duties affect the value of goods at stock, thus influencing inventory carrying cost. Since fiscal and logistics issues are increasingly intertwined, when designing global networks, MNCs are recommended to go beyond the traditional considerations of manufacturing and distribution costs, aligning their international tax structures with supply chain decisions. However, the inclusion of duties, transfer pricing schemes, differential tax rates in different countries and exchange rates requires careful consideration because such factors are highly dynamic and change rapidly.

Thanks to the model development and related application, this study offers a quantitative evaluation of the identified cross-country logistics scenarios to be compared with a base case without cross-country flows. Building upon the model application, the paper confirmed that understanding and effectively managing tax liabilities related to global distribution can result in important savings due to the differences in tax legislation and tax rates applied by the different countries that create opportunities for MNCs (Norrman and Henkow, 2014). Nevertheless, the research also showed that logistics drawbacks and cross-country complications can be relevant. Adopting a mere logistics perspective, shifting logistics facilities to low-tax jurisdictions would have rarely been justifiable due to the additional cross-country flows and related costs. However, when considering fiscal issues, both cross-country logistics scenarios significantly outperformed the base case, as the CIT reduction largely exceeded the increased logistics costs and customs duties. Moreover, according to when goods are cleared by customs authorities, duties liabilities change according to the corresponding duty rate or the value to be considered (either the purchasing or the selling value). Indeed, goods' value increases along the distribution network because of the additional performed activities and the mark-up charged for each unit (in line with Miller and De Matta, 2008). The bonded warehouse emerged as the best solution, in harmony with the MNC's case history, as import duties were avoided on those goods destined to be quickly re-exported. Moreover, additional concerns can emerge in times of rising protectionism. Indeed, components usually have lower duty rates than finished products do (Cohen and Lee, 2020), and global executives are increasingly challenged to redesign global supply chains to determine what operations should take place in each country, as this could generate significant customs differences, and consequently, huge duties savings (Prataviera et al., 2020).

As the achieved results depend highly on the specific application, the influence of contextual parameters has been investigated through a sensitivity analysis. Despite the original motivation behind the warehouse location in Switzerland being tax-related, the results showed that it is not always true that tax savings are the only determinants to move operations. In contrast with former studies (e.g. Creazza *et al.*, 2010), it was found that annual demand did not affect the scenario's choice, making cross-country solutions feasible for companies with both high and small sales volumes. Moreover, this study revealed that cross-country scenarios represent a viable option when the product value is high, while for lower product value, extra cross-country costs would overwhelm the CIT savings. Therefore, cross-country scenarios can be more interesting for luxury fashion than fast fashion and apparel companies, and this is in line with what many MNCs have done in practice in the last decades. The analysis also highlighted the importance of duties, supported by the fact that, when a limited percentage of flows has a preferential origin for the destination market, adding cross-country operations is not cost-effective. Although this result depends on the goods' value, which is higher when goods exit the central warehouse, it also means that MNCs with global suppliers and production/sourcing facilities spread worldwide should avoid locating warehouses for tax purposes without carefully considering duties and other cross-country criticalities.

Finally, the analysis confirmed that exchange rate fluctuations may be extremely relevant (Fernandes *et al.*, 2015). Indeed, when the low-tax jurisdiction's currency appreciates, it may be less cost-effective to move operations there because potential tax savings may be cancelled after currency conversion. The same effect (i.e. tax savings erosion) can be achieved with a high incidence of operating expenses over revenues, which can reduce NIBT until overlooking the benefits of lower CIT.

Research implications and further developments

In light of the turbulent times we are currently experiencing, it is apparent that global distribution network design is much more complex than it was in previous decades. There are more 'land mines' that supply chain executives need to be aware of, and they should be helped in making their decision accordingly (Cohen and Lee, 2020). Such challenges proceed side by side with new opportunities related to fiscal issues, and MNCs can take advantage of smart supply chain design options.

This study is meant to offer both theoretical and practical contributions. First, it merges logistics and tax vocabularies, using a joint terminology (e.g. by clarifying what a Principal is and what PE implications might derive when discussing logistics choices) to better navigate cross-disciplinary issues. This can facilitate the interaction between the two domains, as cross-disciplinary knowledge is quite limited so far.

The study introduces the topic of warehouses located in low-tax jurisdiction for tax purposes into logistics research, specifically formalising cross-country costs and implications. While few studies have

broadly considered the interaction between the logistics and fiscal domains (e.g. Henkow and Norrman, 2011; Webber, 2011), this study specifically tackles the interaction between Principal and warehouse location, offering a contribution about substantive tax planning and a concrete example of facility location in a low-tax jurisdiction to take advantage of tax arbitrage. It also formalises a logistics solution with a bonded warehouse, as well as different options to assess customs value. Therefore, the study contributes to the supply chain literature by showing that duties and taxes are important factors, along with logistics costs, that directly and intricately influence supply chain decisions.

This also has implications for practitioners, as the answers to questions concerning the design of a tax-effective supply chain are not trivial. Indeed, they depend on several elements that are tackled in this study, such as CIT and duties on components or finished products, or the relative after-tax profits under different scenarios that might involve cross-country complexities.

Since existing models offer few practical applications due to their low manageability (Bhutta *et al.*, 2003), the paper's practical relevance was increased by 'seeking more realistic solutions for existing problems' (Stentoft and Rajkumar, 2018; p. 516). The study's conceptual relevance is supported by its contribution to decision-making processes by revealing original routes of action, while its instrumental relevance is enhanced by the schematisation of different cross-country logistics scenarios that can entail different ways forward. This can contribute to guiding companies when responding to the changes in the dynamic global environment, especially in light of the uncertainties in the trade regimes that might be forthcoming (e.g. Brexit). For example, although based on a specific set of tax and tariff policies in place between Europe and Switzerland, the present research highlights the relevance of a bonded warehouse as an instrument to manage international flows while minimising cross-country criticalities (e.g. those related to duty drawbacks opportunities or costs and risks related to non-compliance with customs procedures).

The sensitivity analysis indicates that, under reasonable business conditions, threshold values for deciding on cross-country scenarios exist for various parameters. Resulting insights can then be valuable for supply chain managers, as they might sometimes be counterintuitive. Moreover, managers can benefit from the development of a merged vocabulary in this study. In fact, logisticians and legal practitioners who have a good understanding of the other domain's principles will also more easily avoid friction with the other domain (Norrman and Henkow, 2014).

This research can inform the current debate among policymakers concerning the reaction of firms to changes in tariffs, duties, taxes and other elements that are relevant to global manufacturing and logistics. Nevertheless, some limitations do exist, and avenues for future research can be recommended. The paper's scope (a single distribution tier and a single warehouse) was limited to increase the study's manageability and to identify insights that practitioners may consider for understanding their business situation (Stentoft and

Rajkumar, 2018; Dong and Kouvelis, 2020). Indeed, supply chain models with a Principal may be truly challenging from a fiscal perspective, but moving logistics operations to where the Principal is located represents a fascinating solution to minimise fiscal expenses and respect the 'substance over form' principle. Therefore, for MNCs currently considering shifting their warehouses' location into low-tax jurisdictions, the study synthetises elements to consider when pursuing cross-country logistics reconfiguration.

We wish to remark that any research that analyses the interface between tax and supply chain decisions, like the present study does, cannot avoid the specifics of regulatory environments from given countries or jurisdictions. Therefore, the considered research scope can open up to future research to broaden the perspective and explore further problems (e.g. implications arising from indirect taxation).

First, the number of considered supply chain nodes (e.g. more than one warehouse or distribution centre or tackling second-tier distribution network nodes) could be enlarged. This study considered a single warehouse location to evaluate three scenarios according to the related after-tax profits. In addition, the logistics distortions could be increased (e.g. shifting the warehouse location from Italy to Luxembourg, instead of Switzerland, as a relevant low-tax jurisdiction in Europe). Moreover, in terms of sensitivity analysis, future research may jointly consider different contextual parameters to investigate mutual trade-offs (e.g. to explore the relationship between annual demand and CIT). Future research could also explore reverse logistics and online sales implications because storing goods to be re-expedited in bonded warehouses may create additional challenges. Finally, including the environmental impact in the quantitative modelling would be a key valuable direction to increase the current knowledge about tax-aligned global supply chains.

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Authors	Year	Qualitative				Quantitative			
		Logistics	Duties	Direct/indirect taxes	Cross-country implications	Logistics	Duties	Direct/indirect taxes	Cross-country implications
Arntzen *et al.*	1995	X	X	X		X	X	X	
Vidal and Goetschalckx	2001	X	X	X		X	X	X	
Bhutta *et al.*	2003		X	X		X	X	X	
Chopra	2003	X							
Truong and Azadivar	2005	X		X		X		X	
Avittathur *et al.*	2005	X		X	X	X		X	X
Sawhney and Sumukadas	2005		X		X				
Fleischmann *et al.*	2006					X	X		
Petriccione *et al.*	2007			X	X				
Adams *et al.*	2008	X	X	X	X				
Miller and De Matta	2008		X	X	X	X	X	X	
Balaji and Viswanadham	2008	X		X				X	
van Hoek *et al.*	2008	X		X					
Melo *et al.*	2009	X				X	X		
Henkow and Norrman	2011	X	X	X	X				
Hsu and Zhu	2011	X	X	X		X	X	X	
Webber	2011	X	X	X	X				
Seppälä *et al.*	2014			X		X		X	
Norrman and Henkow	2014	X	X	X	X				
Fernandes *et al.*	2015			X		X		X	
Häntsch and Huchzermeier	2016		X			X	X		
Shunko *et al.*	2017			X		X	X	X	
Cohen and Lee	2020	X	X	X	X				
Dong and Kouvelis	2020	X	X			X	X		

Table 1 – Main related literature contributions

Item cost category	Input data	Description	Unit of measure	Base case	Central warehouse (CW)	Bonded warehouse (BW)
General	Annual demand	Annual demand faced by the MNC for the considered homogeneous market (i.e. the EU)	Units/year	180 000	180 000	180 000
	Average product value (selling value of finished products)	Average selling value of the finished products sold in the EU	€/unit	680	680	680
	Incidence of operating expenses over revenues	Operating expenses include the selling, general and administrative expenses, amortisation and depreciation	%	50%	50%	50%
	Exchange rate	Ratio between the value of one unit of currency in the homogeneous market (i.e. €) and one unit of currency in the low-tax jurisdiction (i.e. CHF)	€/CHF	-	0.9	0.9
Transport cost	Replenishment frequency IN	Time between two inbound flows	Weeks	2	2	2
	Replenishment frequency OUT	Time between two outbound flows	Weeks	1	1	1
	Additional transport cost	Additional transport cost from the old warehouse location to the new one, in the low-tax jurisdiction	€/trip	-	440	440
Material handling cost	Inbound handling unit fare	Handling unit fare to process one product unit for inbound activities	€/unit	0.40	0.55	0.70
	Outbound handling unit fare	Handling unit fare to process one product unit for outbound activities	€/unit	0.50	0.65	0.80
Inventory carrying cost	Weighted Average Cost of Capital (WACC)	The rate that a company is expected to pay on average to all its security holders to finance its assets	%/y	7%	7%	7%
	Storage cost	Unitary cost for storing one product unit	€/unit*year	6.5	12.6	14.0
Labour cost	Percentage of annual demand entering the central warehouse as finished products	Percentage of the annual demand that does not require any value-added activity to be performed in the central warehouse	%	75%	75%	75%
	Labour wage	Hourly wage to perform value-added activities	€/h	18.0	25.2	25.2

(continues…)

| Item cost category	Input data	Description	Unit of measure	Base case	CW	BW
Customs duties cost	Percentage of outflows and inflows with a preferential origin for a specific market region (i.e. the EU)	Percentage of products that could be imported/exported without paying duties	%	90%	90%	90%
	Duties on components/products with preferential origin (EU)	Duties to be paid to import goods with preferential origin into the EU	% of customs value	0%	0%	0%
	Duties on components/products without preferential origin (EU)	Duties to be paid to import goods without preferential origin into the EU	% of customs value	12%	12%	12%
	Duties on components/products with preferential origin (Switzerland)	Duties to be paid to import goods of preferential origin into Switzerland	% of customs value	0	0	0
	Duties on components/products without preferential origin (Switzerland)	Duties to be paid to import goods without preferential origin into Switzerland	% of customs value	6%	6%	6%
Customs brokerage fees cost	Inbound brokerage fees	Brokerage fees to carry out inbound customs operations	€/operation	60	90	110
	Outbound brokerage fees	Brokerage fees to carry out outbound customs operations	€/operation	40	45	50
Customs inspection cost	Incidence of customs controls	Percentage incidence of customs controls	%	10%	10%	5%
	Commodity codes managed per customs clearance operations	Average number of different commodity codes to be managed by customs for each clearance operation	Commodity codes/customs clearance operation	20	10	10
	Lead time for customs inspections in Switzerland	Average time required to perform customs clearance operations at the Swiss border	Days	-	4	0
CIT	Corporate income tax (CIT) rate	CIT rate in the jurisdiction where the MNC collects profits	%	31%	8%	8%

Table 2 – Model application input data

Cost object	Goods destination	Considered tax authority	Customs duties liabilities		
			Base case	Central warehouse (CW)	Bonded warehouse (BW)
Components	EU	EU	Duties payment (purchasing value)[1]	-	-
Components	EU	Switzerland	-	Duty drawback (purchasing value)[1]	Duty drawback (purchasing value)[1]
Components	Switzerland	EU	-	-	-
Components	Switzerland	Switzerland	-	Duties payment (purchasing value)[2]	Duties payment (purchasing value)[2]
Finished products	EU	EU	Duties payment (purchasing value)[2]	Duties payment (selling value)[3]	Duties payment (selling value)[3]
Finished products	EU	Switzerland	-	Duties payment (purchasing value)[4]	**Duties exemption**
Finished products	Switzerland	EU	-	-	-
Finished products	Switzerland	Switzerland	Duties payment (selling value)[3]	Duties payment (purchasing value)[5]	Duties payment (selling value)[5]

Table 3 – Model application: differences among analysed scenarios about customs duties liabilities with respect to cost objects, goods destinations, and considered tax authorities. *(Note: For each scenario, the considered value to assess duties is included in brackets. The nearby apex numbers illustrate the place where customs duties liabilities emerge in the supply chain; see Figure 4.)*

Parameter	Minimum value	Maximum value	Case study value	Threshold value	Unit of measure
Annual demand	50 000	750 000	180 000	-	Units/year
Product value	50	850	680	> 115	€/unit
Percentage of outflows and inflows with a preferential origin for the EU	45%	100%	90%	> 75%	%
Operating expenses	40%	62%	50%	< 56%	%
Swiss corporate income tax (CIT) rate	8%	30%	8%	< 24%	%
Exchange rate	0.60	1.30	0.9	< 0.93	€/CHF

Table 4 – Identified threshold values for the considered contextual parameters to move the central warehouse to the low-tax jurisdiction
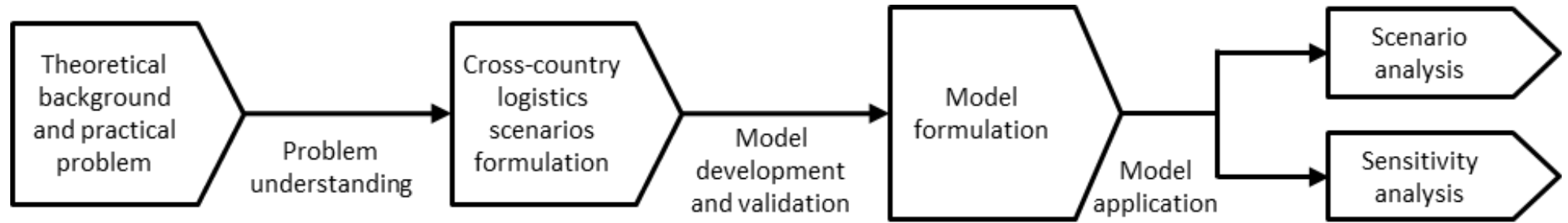
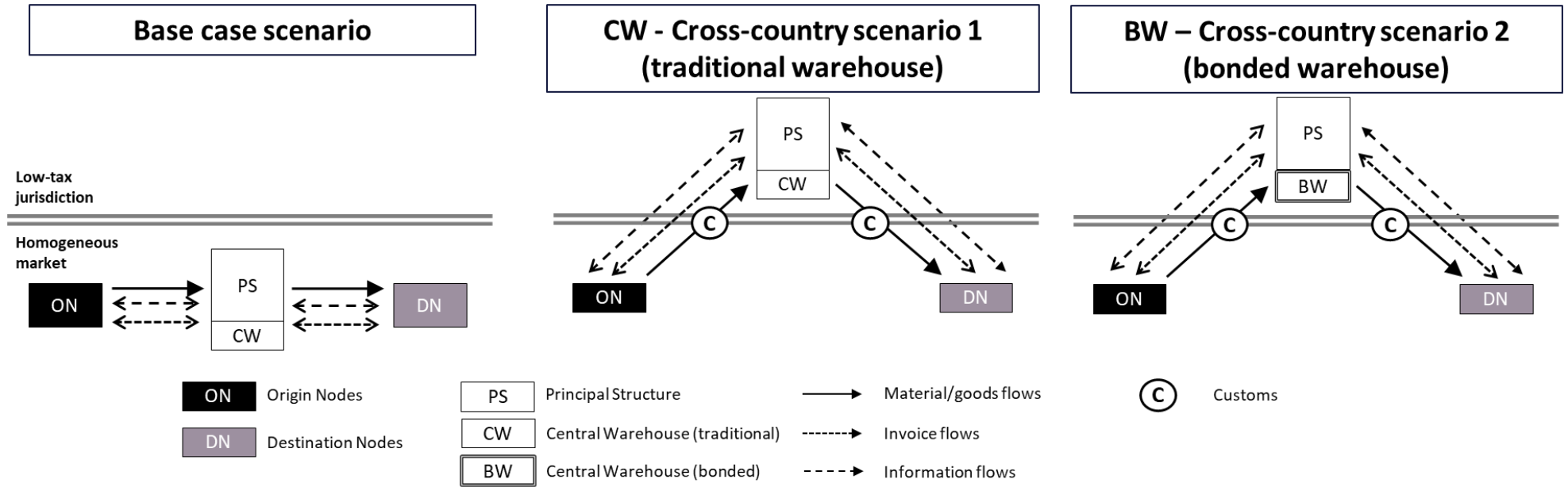**Figure 1** – Research process (adapted from Normann Asmussen *et al*., 2018).

Figure 2 – The proposed logistics scenarios, illustrating Principal structure implications.
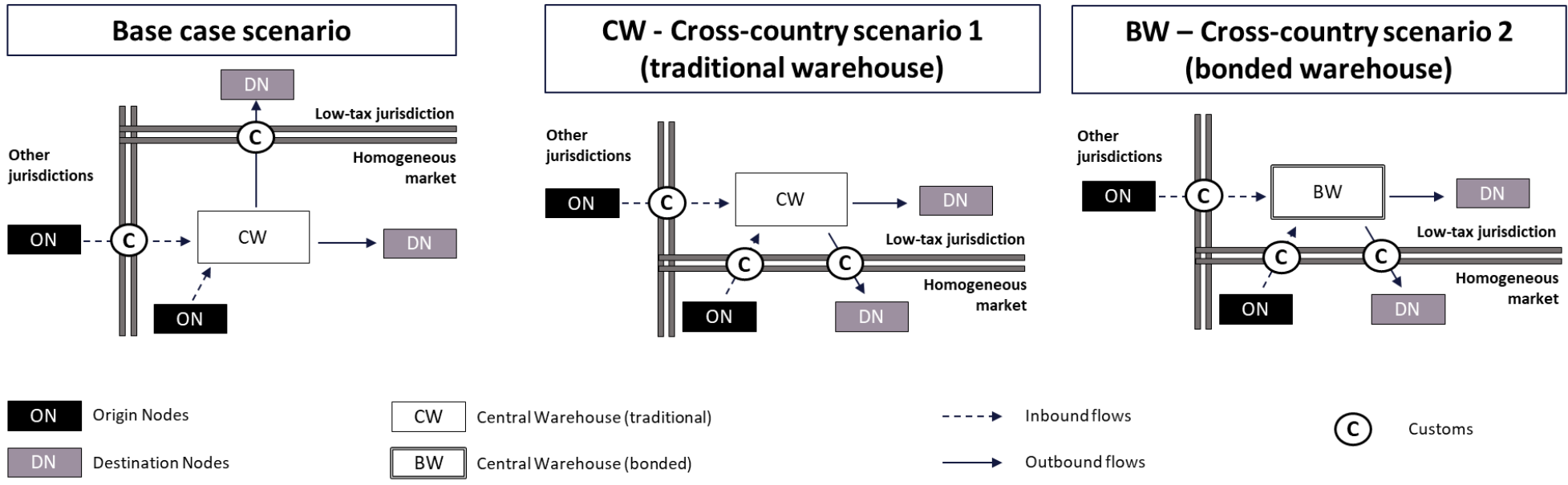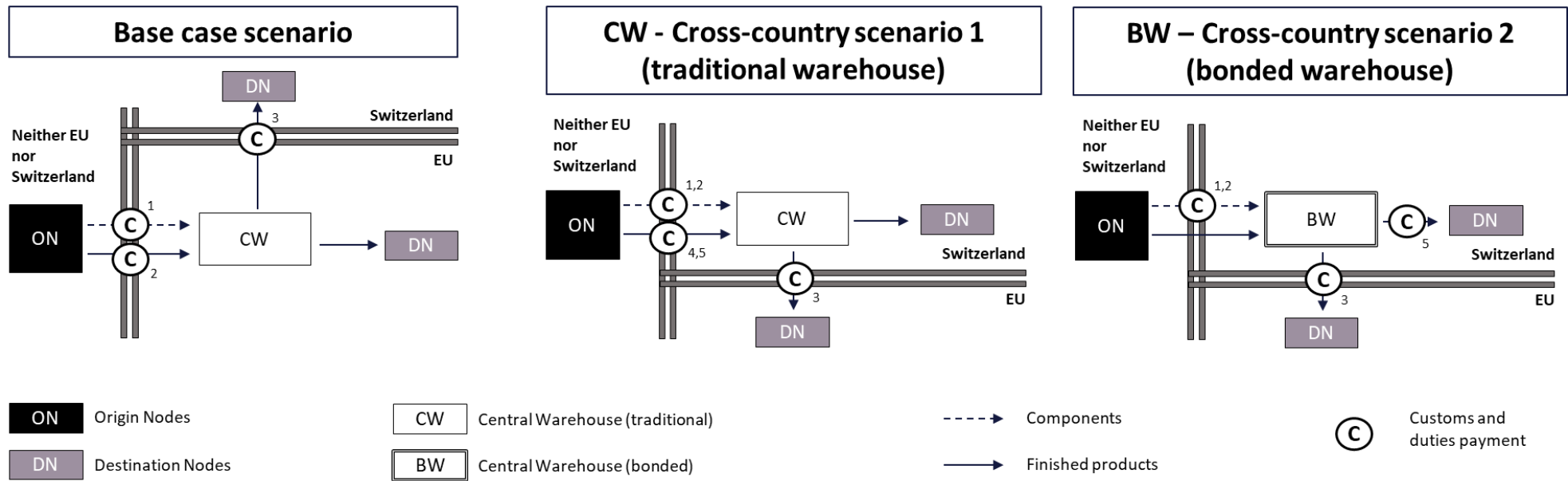
Figure 3 – The proposed logistics scenarios and related inbound/outbound flows.

Figure 4 – Model application: illustration of the differences among analysed scenarios about customs duties liabilities. (Note: The apex numbers illustrate the place where customs duties liabilities emerge in the supply chain, with refer to the cost objects, goods destination and tax authorities described in Table 3.)
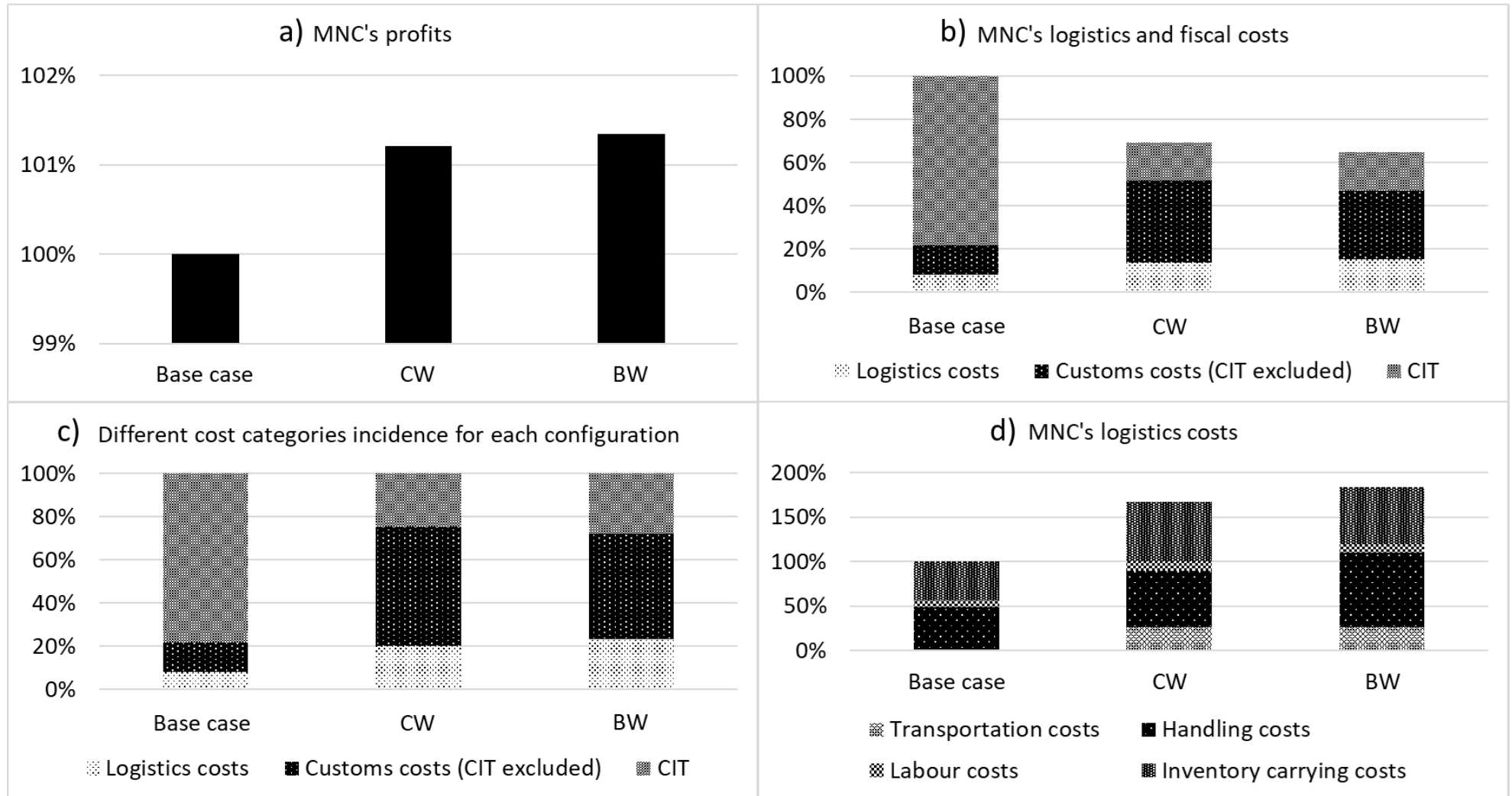
Figure 5 – Model application—scenario analysis: results.

Appendix A – Model cost items description

Cost items category	Cost items	Description
Operating and logistics cost	Transport cost [€/year]	Transport cost depends on the number of trips (full truckloads) per year, which is a function of the replenishments per year. Since a periodic review model to manage inventories is assumed, the replenishment time is predetermined (both inbound and outbound). Transport fare is expressed in terms of €/trip, independent of the distance.
	Material handling cost [€/year]	Handling cost was computed according to a €/unit fare, considering the material handling system, the labour produced by the handling operators, the energy consumption and the handling equipment maintenance. As anticipated when introducing cross-country logistics scenarios, handling fares are higher in the low-tax jurisdiction and even higher in the bonded warehouse.
	Inventory carrying cost [€/year]	Inventory carrying cost considered cycle, safety and in-transit stocks (Young *et al.*, 2009). To determine the goods value, all the activities required up to the considered node (i.e. the warehouse) were considered, including transportation costs, handling costs, customs inspection costs, customs brokerage fees and customs duties. As for average inventory level, cycle stocks were not differential in quantity among the different scenarios, while safety stocks and in-transit stocks were affected by an increase in LT related to cross-country scenarios. For the sake of the example, the additional time to carry out customs inspections was considered. However, for BW, this time was null since customs clearance operations and inspections could be performed directly within the bonded warehouse.
	Labour cost [€/year]	Labour cost was considered to account for the opportunity to perform potential value-added activities. A value-added activity increases the product value at a given stage in a production cycle or supply chain. Specifically, in the considered reference context, value-added activities transform components into finished products. Since they are activities that are performed within a warehouse, it is assumed that they are not substantial and they do not change the origin of the products (Adams *et al.*, 2008). Lastly, different labour wages were modelled for different countries.

(continues…)

Cost items category	Cost items	Description
Financial and fiscal cost	Customs duties cost [€/year]	Different duty tariffs were modelled for different goods (i.e. components and products) and different regions (i.e. the homogeneous market and the low-tax jurisdiction). The customs duties cost was given by the multiplication of duty tariff times the flow of goods on which duties have to be computed, times the unitary goods value when crossing borders. Customs duties collection is particularly relevant when goods do not have a preferential origin. In the model, it was assumed that goods with a preferential origin are characterised by null customs duties. It was also assumed that MNCs could benefit from duty drawbacks when suitable.
	Customs brokerage fees cost [€/year]	Customs brokerage fees cost was computed as the brokerage fee times the number of customs clearance operations per year. Brokerage fees usually have two parts—one fixed per each customs clearance operation, the other depending on how many commodity codes are managed in each operation. Since a 'composite' product was introduced (Arntzen *et al.*, 1995), which could result in lower brokerage fees due to the absence of the variable part—and therefore, an underestimation of this cost item—the average number of different commodity codes per each custom clearance operation was required as input data.
	Customs inspections cost [€/year]	Customs inspections cost was driven by the percentage of customs controls, which depended on the reliability of both the MNC and its third-party logistics service provider.
	Capital cost for payment in advance of duties [€/year]	Capital cost for payment in advance of duties in the homogeneous market was considered; it was evaluated according to MNC's weighted average cost of capital (WACC). According to the model assumptions, this cost item raised different considerations for duties. With reference to duties, duty drawback was modelled. The duties are claimed back when exported from the low-tax jurisdiction—hence, after the average number of days of inventory holding. In the case of a bonded warehouse, the capital anticipation for finished goods to be exported is null, as they are stocked uncleared.
	Corporate income tax (CIT) [€/year]	Vidal and Goetschalckx's (2001) cost structure was considered. CIT is driven by two main elements—net income before taxes (NIBT) and the CIT rate. NIBT was computed as revenues minus the cost of goods sold, the operating expenses (required as input data, in percentage), and the differential costs previously described. Once the NIBT is defined, the CIT rate affects it to determine the net income after taxes (NIAT).