Do anchor infrastructures matter for regional Smart Specialisation Strategy? The case of Alentejo

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ABSTRACT

Do anchor infrastructures matter for regional Smart Specialisation Strategy (RIS3)? This paper investigates the potential of anchor infrastructures to leverage RIS3. An exploratory case study approach is employed. The data are derived from a huge infrastructure project in the Portuguese region of the Alentejo. The study reveals the effectiveness of investment in anchor infrastructure and its contribution to leveraging RIS3. The findings provide insights into the contribution of large public investments in RIS3, identifying key impacts along several important dimensions, shedding a light on one important dimension in Smart Specialisation studies hitherto ignored.

KEYWORDS

Smart Specialisation Strategy (RIS3); regional development; anchor infrastructures

INTRODUCTION

Based upon the principles of Regional Innovation Strat- egies (RIS), the concept of Smart Specialisation has been fast gaining importance, at both a policy level as well as in academia. Proponents of Smart Specialisation favour the concentration of efforts and resources along a limited number of priorities of specialization – areas where econ- omic agents, countries, regions and groups, have excellent explicit or latent capacities (Marinelli, Elena-Perez, & Alias, 2016). The goal of the strategy is to reveal the most promising areas of innovation in a given region (Foray, David, & Hall, 2009).

Smart Specialisation is a policy concept underpinned by the broader process of 'entrepreneurial discovery' (Arangu- ren, Magro, Navarro, & Wilson, 2019; Santini, Marinelli, Boden, Cavicchi, & Haegeman, 2016). This multi-stake- holder process implies developing a common strategic vision, identifying place-based domains of strategic poten- tial, developing multi-stakeholder governance mechanisms, setting priorities and using support policies to maximize the knowledge-based development of the region (Sotar- auta, 2018).

The idea of Smart Specialisation, initially developed along a policy-prioritization logic, is now promoted by the European Commission (EC) as a tool for regional development, and to enable the reduction of the economic gap between the regions under the Europe 2020 strategy (European Commission, 2014). Research and Innovation Strategies for Smart Specialisations (RIS3) focuses on directing these efforts in a few selected activities based on a region's specific strength and competitive advantage (Foray, 2014; Lopes, Farinha, Ferreira, & Silveira, 2018). An integral part of the European Commission's cohesion goal, Smart Specialisation, has become a prerequisite for accessing fresh funds for investing in much-needed inno- vation-driven productivity growth throughout the Euro- pean Union (EU) (Foray, David, & Hall, 2011; Paliokaite, Martinaitis, & Reimeris, 2015). Further, prom- ising results in the 2014–20 programming period will lead to higher allocations for Smart Specialisation in the next programming period 2021–28 (Ranga, 2018

Although the theoretical underpinnings of Smart Specialisation are well developed, there are still several challenges in the economic-impact analysis of these pol- icies. Particularly, there is a gap in empirical studies about the effectiveness of RIS3 (Lopes, Ferreira, & Far- inha, 2019; Varga, Sebestyén, Szabó, & Szerb, 2020).

The main contribution of this research, in an important aspect hitherto unexplored, is to discover the potential of anchor infrastructures to leverage the RIS3 in catalysing regional development. Anchor infrastructure projects have been seen as an important pillar in regional development, yet despite the rising scholarly interest in Smart Specialisation Strategy (S3) there remains a striking gap in our understand- ing of what role large infrastructure projects play in these strat- egies. This gap frames our research question, where we address the question of whether Smart Specialisation lever- aging huge investment in infrastructures really works.

The empirical context for studying the implications of an anchor infrastructure in regional Smart Specialisation is provided by the Alqueva Multipurpose Project (AMP), a large project located in Alentejo, the largest Portuguese region with a territorial area corresponding to approxi- mately one-third of the country. This region has also the lowest population density among the Portuguese regions, with a gross regional product (GRP) per inhabitant at 72.1% of the EU-28 average, and below the national aver- age (78.1%).

Like other regions of Europe, the Alentejo developed its smart strategy as a bottom-up approach, with regional stakeholders emerging as key protagonists in the regional development process. This regional strategy, RIS3Alen- tejo, has since its approval in 2014 been a key element of the regional development strategy. The sector of Food and Forestry is considered one of five specialization areas proposed in RIS3Alentejo, adding value to the territorial and climatic conditions of the region. The rational for specialization of this domain reflects a bet on the articula- tion of agriculture with agroindustry, leveraging natural advantages of the Alentejo, and betting on product innovation.

RIS3Alentejo attributes to the AMP a central role in the modernization of the Food and Forestry domain (CCDRA,

2014). The regional funding arm of regional, national and European monies, CCDRA, considers AMP as fundamental to promote a vibrant regional agri- cultural model, one of the most important specialization areas of the region.

As Europe jostles to keep its place among the top table of the world's most innovative regions, the ability of the AMP to leverage Alentejo's S3 and thereby pro- mote regional growth covers not only an unexplored research area but also holds important policy impli- cations. The extent to which Smart Specialisation plays out via large infrastructure projects could well determine if key regional development strategies have kept up their promise, and if the poorer parts of Europe can finally play catch up. If they do, then this promises a renewed policy thrust aimed at large infrastructure projects.

We focus the empirical analysis on the AMP and the Alentejo region. Through an exploratory case study, based on quantitative methods and using statistical and System of Analysis of Iberian Balance Sheets (SABI) data, differences on the performance dynamics of the region are explored before and after the completion of this anchor infrastructure.

The paper is organized as follows. Next, we present an overview of the literature on large infrastructures, regional development and Smart Specialisation. The third section then provides a brief overview of the study context. The data used and methodology are detailed in the fourth sec- tion. Results and some discussion are presented in the fifth section. The last section provides conclusions, limit- ations as well as directions for future research.

LARGE INFRASTRUCTURES, REGIONAL DEVELOPMENT AND SMART SPECIALISATION

The study is related to at least two different strands of the literature. First, it is framed by the role of large infrastruc- tures on regional development. Concurrently, our work is also related to RIS3 as catalysts of regional development. In what follows, we summarize these two strands of the lit- erature to demonstrate how these inform the research, and how the gap identified in this literature provides a motiv- ation for the same.

Large infrastructures and regional development

Infrastructure investments are essential to promoting econ- omic growth and development. Multilateral development bodies long recognized that infrastructure adequacy helps determine one country's success or failure (World Bank, 1994).

The relationship between infrastructure and economic growth has been empirically investigated by several authors (e.g., Aschauer, 1989; Banister & Berechman, 2001; Cal- derón & Servén, 2004). Extant empirical evidence shows that infrastructure investments are important for economic growth at both national and regional levels and can be used as a tool to stimulate growth and reduce regional inequal- ities. However, the response of economic growth to invest- ments and the availability of infrastructure varies between regions and countries, depending upon the initial situation – with the returns of infrastructure investments likely greater in relative terms for less developed regions.

Yet, as Stupak (2018) rightly observed, all investments in infrastructure are not the same, and the impact of these investments can vary according to the type of infrastructure created. Researchers have broadly distinguished two types of infrastructures: economic and social (Baren, 2009; Kara, Taş, & Ada, 2016). Economic infrastructure includes transport systems (highways, roads, tunnels, bridges, rail- ways, airports and ports), power distribution and telecom- munications networks, water and sewage facilities. On the other hand, social infrastructure encompasses entities such as schools, universities, hospitals and prisons. Economic infrastructure is more closely associated with the production of goods and services, while social infrastructure has the broader aim of providing community benefit. The impact of large infrastructure projects depends to a large extent on how effective investments are in increasing pro- ductivity, (i.e., how useful they are in producing goods and services).

With regards to economic infrastructure, dams have found an important presence in the literature as a policy tool for development (Biswas & Tortajada, 2001). Particu- larly large, multipurpose dams can arguably have economic impact as they are usually built to provide water for dom- estic and industrial use, irrigation for agriculture, to gener- ate hydropower and to help control floods. Additionally, albeit to a lesser extent, large dams have been used for tour- istic and recreational activities and aquaculture (World Commission of Dams (WCD), 2000).

The debate over 'large dams' has typically been highly polarized. Critics point to a wide range of environmental and related negative social impacts (Égré & Senécal, 2003; Tilt, Braun, & He, 2009). The literature on the effects of large dams on economic growth and regional development is much sparser (Biswas & Tortajada, 2001). The literature largely suggests that the economic impacts are reflected in changes in the opportunities of generation of employment and income; accessibility improvements or new tourism opportunities (Dimitriou, Mourmouris, & Sartzetaki, 2015).

Research and innovation strategies for Smart Specialisation

Since the implementation of RIS3 in the EU, this concept has been at the centre of increased research endeavour and has been developing at a fast pace allowing one to learn its distinct aspects. Lopes et al. (2019) developed a biblio- metric analysis of extant literature on RIS3 and encoun- tered four broad groups in the RIS3 research, which help contextualize the burgeoning literature. These can be sum- marized as follows:

- Business discovery (Komninos, Musyck, & Reid, 2014; Gheorghiu, Andreescu, & Curaj, 2016; Mieszkowski & Kardas, 2015).
- Smart Specialisation, innovation and specialization (Balland, Boschma, Crespo, & Rigby, 2019; Bečić & Švarc, 2015; Capello & Kroll, 2016; Cooke, 2016; Kroll, 2015; McCann & Ortega-Argilés, 2014; Mor- gan, 2016).

- Regional policies (Camagni & Capello, 2013; Capello & Lenzi, 2016; Valdaliso, Magro, Navarro, Aranguren, & Wilson, 2014).
- Regional development (Healy, 2016; Naldi, Nilsson, Westlund, & Wixe, 2015; Sörvik, Teräs, Dubois, & Pertoldi, 2019).

Attention here focuses on this last strand. While con- ceptually, Smart Specialisation is supposed to be appli- cable to any regional setting (Foray et al., 2011), until now most attention has been given to RIS3 applications in urban contexts, with little evidence about the

applicability in other territorial settings. Notable excep- tions are the studies of Pires, Pertoldi, Edwards, and Hegyi (2014); Naldi et al. (2015) and Sörvik et al. (2019). The former argued that the S3 policy framework can accommodate the specificities and foster the inno- vation potential of rural areas. There is a wide range of innovation activities in rural areas that can strongly benefit from and reinforce the relevance and impact of S3. Several examples are highlighted that make use of natural resources in an integrated way and combining historical legacy with new technologies to meet new and emerging societal demands (Pires et al., 2014).

A different perspective is however presented by Naldi et al. (2015) who explored smart growth of rural regions but provided a distinction between them. Rural areas are not uniform, intermediate rural areas are integrated with urban areas and often show a positive development, but more peripheral rural regions have some general character- istics that limit their potential to gain from smart growth policies. These include lack of scale in their population and industrial base, and limited access to markets compro- mising their potential for endogenous development. In addition, these authors present indicators of smart rural development, and analyses their relevance in future empiri- cal studies.

Sörvik et al. (2019) analysed five sparsely populated areas (SPA) in Europe. These regions have been able to create innovative environments and intend to use the pos- sibilities offered by the S3 approach. However, the specific characteristics of SPA cannot be neglected and several criti- cal issues should be considered: a shift towards a more sus- tainable and knowledge-based valorization of natural resources; the need to connect to extra-regional knowledge sources to attract skilled labour; the focus on endogenous human capital development; and more coordination and efficiency in multilevel governance, aligning different pro- grammes and strategies.

To the best of our knowledge, the NUTS-2 Alentejo – Portugal region, which provides the empirical setting, has not yet been analysed in prior RIS3 studies. Other Portu- guese regions (the Algarve, Central and Northern regions) were only studied by Cooke (2016) regarding RIS3. The author explored the transition of European Regional Development Fund (ERDF) policies to RIS3 and their respective strengths and weaknesses, detailing the ways in which three regions of Portugal received, understood and implemented RIS3.

Despite the growing and diverse literature, RIS3 studies have tended to be very focused on either the RIS3 design process or its implementation. Sörvik et al. (2019) empha- sized that to increase the knowledge base of S3 implemen- tation, more in-depth studies of their contextualization in different regional settings are needed. In addition, Lopes et al. (2019) mentioned the lack of studies comparing the performances of economies before and after the implemen- tation of RIS3.

It is worth noting that while there is a dearth of studies on the effects of large investments in S3, yet aspects of the literature on infrastructure investments suggest that they

can improve regional development. Large infrastructure projects can and should be considered as an important part of Smart Specialisation, given that it seeks to ensure that proposed actions are based upon sound evidence that properly reflects the comparative advantages of the physical and human assets of particular places in the global economy.

The research seeks to fill this gap in the RIS3 literature by providing empirical evidence on the role of an anchor infrastructure. We study the impact of the RIS3 of the AMP in the Alentejo region using as metrics the domains indicated in the RIS3 Alentejo.

STUDY CONTEXT

This section first presents a brief characterization of the Alentejo region, which provides the empirical framing, and it then describes the anchor infrastructure (AMP). Finally, it provides a link to Alentejo's RIS3 and the domain metrics for the study, where the Food and Forestry domain is central.

The Alentejo region

Alentejo is the largest of the seven Portuguese regions, with a territorial area equivalent to about 31,500 km^2, corre- sponding approximately to one-third of the country's terri- tory and roughly the size of Belgium. It shares its international borders with the Spanish regions of Extrema- dura and Andalusia. The region is home to 711,950 inhabitants (INE, 2018) with an average population den- sity of 23 people/km^2, the lowest among the Portuguese regions as well as among the lowest in Europe.

Alentejo is predominantly rich in mineral resources (marble, granite, pyrites and zinc, among others), along with agroindustries, where the production of cork, wine, olive oil and dairy products is also important for the local economy. The main traditional industries remain extractive (particularly the extraction of ornamental stone and copper pyrites), agro- food, metallurgy, machinery and chemistry. Taking into account the GRP per inhabitant in purchasing

power standards (PPS), the Alentejo region in 2016 (Euro- stat, 2018), had €21.200 (PPS)/inhabitant, below the national

average (€22,200) and much below, at over 36%, than the EU-28 average (€28,900).

According to the Regional Innovation Scoreboard 2017 (European Commission, 2017), Alentejo has been classi- fied as a 'moderate innovator' region. The regional inno- vation index (RII) in 2017 was 0.311 (normalized score), scaled at 84.0 relative to Portugal. For a more global per- spective, it is relevant to note that within the ranking of 220 European regions, Alentejo ranked 149th, with its innovation performance corresponding to 68.4% of the EU average. The region also witnesses very low rainfall resulting in a dry terrain, pointed out as one of the main limitations on the region's agricultural development. It is precisely due to this reason that policy-makers at different levels advanced with the AMP, anchored within the RIS3Alentejo, to serve as the catalyst for agricultural and hence regional development. Its set of infrastructures fuels the aim of lifting the economic and social conditions of one of the lagging regions in Europe.

The Alqueva Multipurpose Project (AMP)

The AMP is a structural project in the Alentejo region, considered a key investment in the region's development (Figure 1), within RIS3Alentejo. Preparation of the Irriga- tion Plan for Alentejo was conceived during the late 1950s so that the project could provide a strategic water reservoir for the Alentejo region. However, it was only in the 21st century (through the AMP) that this become a reality, and during 2011–16 the irrigation infrastructure became operational. The AMP is the greatest single investment ever made in Alentejo, as well as in the entire country, representing a total investment amount of €2.5 billion.

The AMP is centred on Alqueva Dam, the largest artificial strategic water reserve in Europe. Alqueva Reservoir extends for 83 km, occupying an area of 250 km^2. The reservoir's total storage capacity is 4.15 billion m^3, 3.15 bil- lion m^3 of which is its usable volume under normal oper- ation. It is from here that other dams interconnect to guarantee a sustained water supply, even in periods of extreme drought, to an area of around 10,000 km^2, to a total of 20 municipalities in NUT S-2 Alentejo. This makes the project a structural instrument giving rise to a diversified, sustained series of activities towards sustained integration.

The irrigation system of the AMP is an immense infra- structure network concluded in 2016 that serves an area of around 120,000 ha, and comprises of 69 small dams, reser- voirs and weirs, 380 km of primary network, 1620 km of pipes in the secondary network, 47 pumping stations, five mini-hydroelectric plants and one photovoltaic plant.

Figure 1. The Alentejo region of Portugal and the Alqueva Intervention Zone (AIZ).

The Alentejo research and innovation strategies for Smart Specialisation (RIS3)

Launched at the end of 2012, the Alentejo 2020 initiative, developed within the framework of the EU's Europe 2020 growth strategy, has set the key guiding principles vis-à-vis the new programming cycle 2014–20. Following the strategic plan envisioned in Alentejo 2020, a regional RIS3 had been designed for the region, the RIS3Alentejo. RIS3Alentejo established that one of the five strategic domains would be Food and Forestry. The territory, together with favourable eda- phoclimatic conditions and stimulated by the vastly enhanced availability of water from the AMP, creates a positive setting for the development of the Food and Forestry domain.

The rationale of specialization in the Food and Forestry domain in Alentejo RIS3 is a bet on the articulation of agri- culture with the agribusiness, valuing the potential scale of the Alentejo and therefore betting on product innovation.

The AMP is considered in RIS3Alentejo:

> as essential to promote the alteration of the regional agricul- tural model, starting with the introduction of new technol- ogies and the production of new products, based on agricultural and agro-food productions which are technologi- cally advanced, have high productivity, are environmentally sustainable and export-oriented.
>
> (CCDRA, 2014, p. 27)

Next, we explore the relevant domains of RIS3Alentejo to study the impacts of the AMP.

For RIS3Alentejo, the development of innovative pro- ducts that are adapted to new consumption patterns and have the potential to capture new segments and niche mar- kets assumes even particular importance. Research and development (R&D) activities may be basically considered as the main input in the innovation process. R&D invest- ment increases the possibility of achieving a higher standard of technology in firms and regions, which would allow them to introduce new and superior products and/ or processes (Bilbao-Osorio & Rodríguez-Pose, 2004; Bronzini & Piselli, 2016). Therefore, to answer the central question, it is worth analysing how the levels of R&D investment in the Alqueva Intervention Zone (AIZ) evolved (before and after the AMP was operational) and comparing this with the Portuguese average:

Did R&D expenditure among firms based in the Alentejo beneficiary region of the AMP, grow faster than the country average?

The Food and Forestry domain's specialization rationale pro- poses a focus on the articulation of agriculture and agroindus- try (enabling transformation for greater control over the value chain), enhancing the potential scale of the Alentejo region and focusing on product innovation. Therefore, to analyse this issue, it is worth investigating how the levels of the birth rate of agro-industries/agriculture in the AIZ region evolved (before and after the AMP was operational) and com- paring this with the Portuguese average.

According to the RIS3Alentejo, the AMP should create market opportunities for the emergence and growth of domestic companies. Therefore, it is important to ascertain whether this occurred after the AMP became operational.

Did business activities (agriculture and agro-industries sectors) in the Alentejo beneficiary region of the AMP grow at a faster rate than the country average?

RIS3Alentejo considers it essential that the Alentejo region should be able to attract investment to its territory which could provide the development and modernization of the region and hopes that the AMP can contribute to this design. The attraction of investment depends upon the combination of several factors (tax regime, natural potenti- alities of the territory, workers' qualifications, infrastructure and access to raw materials, communication and transport links). The vast network of infrastructures created in the AIZ by the AMP can be a relevant factor for attracting investment (foreign and domestic) to the region. Compar- ing data on business investment in the AIZ before and after the AMP became operational can provide valuable insight into how effective that contribution was.

Were firm investments in the Alentejo beneficiary region of the AMP, higher than the rest of the Alentejo region?

According to RIS3, it is expected that the AMP create market opportunities for more export-capable companies. The impact of the AMP on exports can be gauged by com- paring periods after and before the AMP is operational with the Portuguese average.

Did exports of firms based in the Alentejo beneficiary region of the AMP grow more than the country average?

The AMP effect on international trade should be noted in cross-border activities and can be measured by comparing periods after and before the AMP is operational and com- paring with the Portuguese average.

Did cross-border activities in the Alentejo beneficiary region of the AMP grow more than the country average?

Figure 2 summarizes the comprehensive framework devel- oped under the domains of RIS3 Alentejo to study the AMP's impacts.

DATA AND METHODOLOGY

This study adopts an exploratory case study approach, anchored on quantitative evidence. Case studies are appro- priate when the goal is to examine contemporary phenom- ena within a real-life context, to gain detailed knowledge of a complex issue, using data collected via multiple sources.

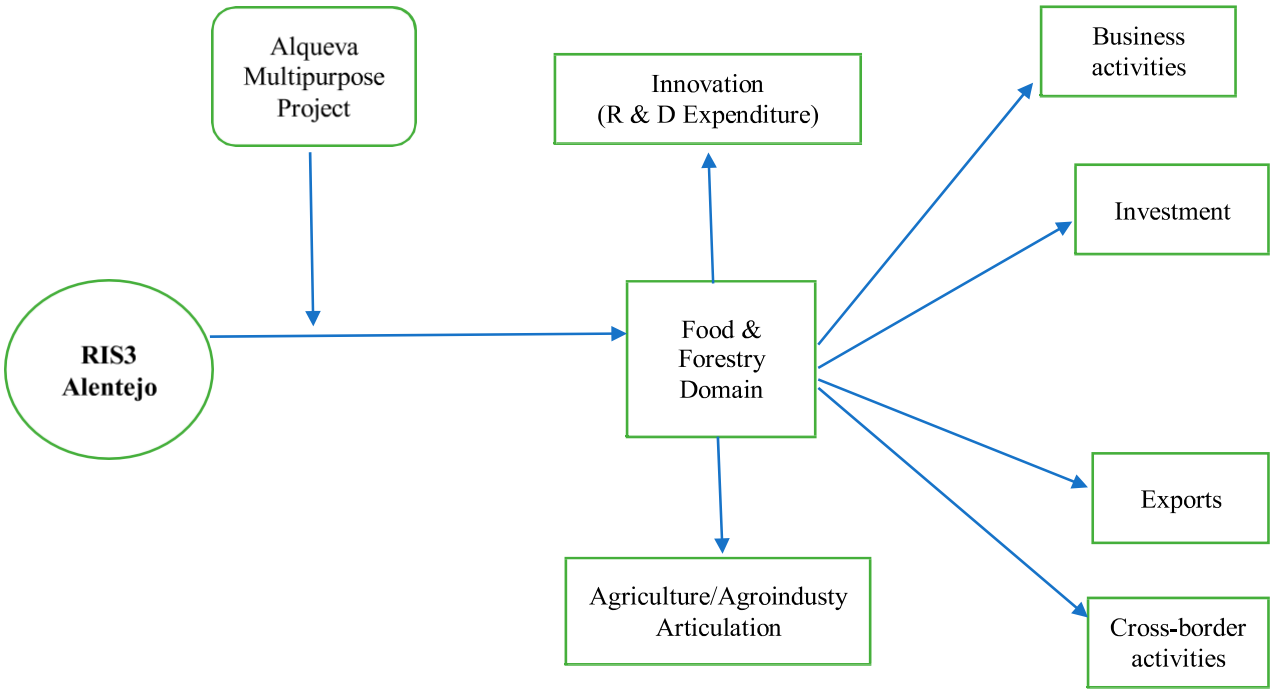

Figure 2. Comprehensive framework of the impact of anchor infrastructures on Smart Specialisation Strategies (RIS3).

The selection of cases is purposeful rather than random and is done with the aim of providing an in-depth understand- ing of the problem under investigation. Case studies may include and even be limited to quantitative evidence (Cooper & Schindler, 2014; Yin, 2014; Shareia, 2016). A quantitative case study research is appropriate because we focus on the particular project of the AMP and the Alentejo region, relying on quantitative methods to gather and analyse the data.

The goal is to compare the performance of the Alentejo and the AMP intervention zone with Portugal during the periods 2005−10 and 2011−16. This analysis is reinforced with comparisons with Alentejo−Alentejo and Portugal − Portugal, to verify the evolution on selected indicators. Where appropriate, we complement this analysis with rel- evant statistical tests, using the statistical software STATA 13, namely tests to compare the differences in the means between two groups, in order to find if these differences are statistically significant.

In order to understand to what extent there was an effective realization of the regional strategy of using AMP to leverage Alentejo's S3, it is first necessary to delimit the AMP intervention zone. Alentejo is one of the seven NUTS-2 regions of Portugal and is orga- nized into five intermunicipal communities (NUTS-3 regions): Alentejo Litoral; Central Alentejo; Alto Alentejo, Baixo Alentejo; Lezíria do Tejo. The AMP has a direct influence, both in the municipalities covered by the reservoir and in the municipalities that benefit from the installation of new irrigation perimeters. As more than 90% of this territory is located in the NUTS 3 regions of Alentejo Central and Baixo Alentejo, we have chosen to designate the AIZ as the sum of these two NUTS-3.

To perform a comparative analysis of the impact ofthe AMP on the AIZ, it was necessary to establish as base, a year before the Alentejo's S3 in which time the AMP infra- structures were not mostly operational. The chosen refer- ence year was 2011. In 2016, the infrastructure network was completed and so we chose this year for purposes of comparison (2017 was used whenever available). To enable the comparisons to be even more meaningful, we con- sidered it important to verify if the Alentejo region demon- strated superior (or inferior) performance dynamics before the infrastructure network was completed. Thus, we sup- plement the AIZ−Portugal comparisons in 2011−16 with the AIZ−AIZ, and Portugal−Portugal comparisons (2005−10 versus 2011−16).

The sectors of agriculture and agro-food industries that underpin the Food and Forestry domain have been ident- ified on the basis of the Portuguese Classification of Econ- omic Activities (CAE-Rev.3), which establishes the framework of economic activities, harmonized with the Statistical Classification of Economic Activities in the European Community (NACE Rev.2).

The variables were selected based on the comprehensive framework of Figure 2, derived from RIS3Alentejo:

- *Innovation* : R&D expenditures and R&D staff, used by international organizations (Organisation for Economic Co-operation and Development (OECD), 2015) or Naldi et al. (2015).
- *Agriculture/ agroindustry articulation*: owing to the close linkage and importance of the agriculture sector to agri-business, we constructed an indicator that high- lights the growth in the number of companies in the agribusiness sector relative to the agricultural sector: the birth rate of agroindustry/agriculture. The birth rate indicator in the economic regeneration of regions has antecedents in the literature (Johnson, 2005).
- *Business activities*: the AMP should create market opportunities for the emergence and growth of domestic companies. Following Eurostat or the World Bank, the number of firms, turnover and gross value added (GVA) were used.

- *Investment*: the indicator used was the volume of invest- ment that entrepreneurs applied to EU funds (Portugal 2020/Ministry of Economy of Portugal).
- *Exports and cross-border activities:* we use the most com- mon international trade statistics (value of exports and imports) to measure these impacts.

The data are derived from three different sources, which were analysed separately. The first data source is the Portuguese National Institute of Statistics (INE-Statistics Por- tugal 2006, 2011, 2012, 2017), and the other related information is taken from national scientific and techno- logical surveys. Third, in order to complement the first two data sources, we used detailed information extracted from a sample of small and medium-sized enterprises (SMEs). Following the general criterion based on the staff number to define an SME, we used companies with between 10 and 250 employees. The firms were selected from the SABI database and were operating in the specific sectors of agriculture and agro-industries. The SABI data- base contains comprehensive information (mostly financial data) of Iberian companies.

RESULTS AND DISCUSSION

This section discusses the results of the analysis pivoted on the research question of whether RIS3 levered in anchor infrastructure works. The analyses of the data were guided along the six dimensions previously mentioned: impact on (1) R&D expenditure; (2) the articulation between agricul- ture and agroindustry; (3) business activity; (4) firms' investments; (5) exports; and (6) cross-border activities. In what follows, we discuss each in turn.

R&D expenditure

The rapid globalization of markets, coupled with high rates of technological change, requires firms to adapt quickly to maintain their competitiveness in the macroeconomic con- text in which they operate. An effective response to market volatility is crucial for businesses survival, and increasingly obliges them to be innovative. Investment in R&D is, therefore, vital for firms and, consequently, for the compe- titiveness of the region, as catalysts for both efficiency and value creation.

Table A1 in Appendix A in the supplemental data online shows R&D expenditure in the AIZ and Portugal in 2011–16 and the Alentejo–Alentejo and Portugal–Por- tugal comparisons (2005–10 versus 2011–16). The data reveal a significant increase in R&D investment in the AIZ. The R&D expenditure grew by 17.8% between 2011 and 2016. This figure is even more significant because, in the same period, the growth rate of R&D expenditure overall in Portugal was negative at −4.92%. Firms in the agricultural sector with a smaller share of R&D expenditure at the beginning of the period increased fivefold over the five-year period. The agroindustry sector, representing 34% of the R&D outlays in the AIZ in 2016, grew by 3.1%, a low but significant figure given the fact that R&D expenditure in the country overall decreased over the period.

Investing in human resources with appropriate qualifi- cations is also vital for the development of all R&D systems. With respect to human capital for R&D activities, AIZ firms registered a very strong growth in human resources involved in R&D (46.2%), well above the Portu- gal average (19.3%). Although it was not possible to obtain sector-disaggregated data, given the representativeness of the agricultural (17%) and agroindustry (34%) sectors in the R&D expenditure for the AIZ, it is reasonable to assume that growth in R&D personnel in these sectors is in line with the growth in the AIZ's overall business.

A related relevant question as to whether the AIZ region also demonstrates superior performance dynamics before the infrastructure network was completed. The numbers from Table A1 in Appendix A in the supplemen- tal data online negate this, and on the contrary, the AIZ– AIZ and Portugal–Portugal comparisons (2005–10 versus 2011–16) reveal that R&D expenditure and R&D staff grew in Portugal and declined in the AIZ. These results show that the AMP project changed previous dynamics, and causality can be inferred.

Articulation between agriculture and the agroindustry

The rationale of specialization proposed within the context of RIS3Alentejo recommends a commitment in the articulation of agriculture with the agroindustry (transformation for greater control over the value chain), therefore leveraging the potential scale of the Alentejo in this sector, and fostering product innovation. To assess the evolution of this articulation during the period 2011–16 and in comparison with 2005–10, a ratio was calculated that correlates the birth rate in the agro-food industry with the birth rate in the agricultural sector (see Table A2 in Appendix A in the supplemental data online). The data reveal that in 2011 this ratio in the AIZ coverage was lower than the national ratio, and after six years the situ- ation reversed, with more firms born in the agro-food industry than in the agricultural sector. Similarly relevant is the finding that the AIZ ratio more than doubled in five years from 0.48 to 1.02. This conclusion is reinforced with the AIZ–AIZ and Portugal–Portugal comparisons (2005–10 versus 2011–16), which show that the 2011–16 figures for the AIZ exceeded those of 2005–10 and also were superior to the evolution verified in Portugal–Portugal.

Taken together, these results provide convincing evidence that the AMP project indeed resulted in growth in entrepreneurial activity in the agro-food industries, which strengthened the articulation between agriculture and agroindustry, as originally recommended and envisioned in RIS3Alentejo.

Business activities

According to the INE (see Table A3 in Appendix A in the supplemental data online), the impact on firms in the agricultural sector was significant with respect to the number of establishments, turnover and GVA. The number of establishments grew by 34.5% between 2011 and 2016. Also, the turnover of companies in the sector increased significantly in the period being considered (54.3%). However, it was at the level of the GVA that there was a larger increase (GVA almost doubled in the agricultural sector). The 2011–16 figures for the AIZ substantially exceed the 2005–10 period and this within-comparison provides convincing evidence that the AMP project has actually resulted in the development of business activities in the agricultural sector.

In the agroindustry sector, the number of companies grew slightly between these two periods, before and after the entry into operation of the AMP. Within the period 2011–16, the number of companies has stabilized, but the turnover increased by 16.6%, which leads to the con- clusion that there was an increase in the size of companies in the sector. It was not possible to measure the impact on GVA in agroindustry due to the unavailability of data for 2016.

The selected indicators reveal a considerable impact on business activity during the period of analysis. This impact is substantially greater in the agricultural as compared with the agro-food sector, leading to the conclusion that the contribution of the AMP to leverage RIS3Alentejo in this area had a bigger impact in the agricultural sector.

To explore further if business activity of AIZ firms had increased, we used a sample of SMEs operating in the AIZ in agriculture and agribusiness sectors (SABI data) com- paring the periods 2011–16 and 2005–10 (see Table A4 in Appendix A in the supplemental data online). The results corroborate the findings summarized in Table A3 online. AIZ demonstrated inferior performance dynamics before 2011–16, in both turnover and GVA indicators. Comparing 2011 with 2016, it is possible to see positive growth rates in all components. In global terms, the num- ber of employees grew 28.6%, turnover by 30.5% with the growth particularly significant in GVA (52.6%). Particu- larly, firms operating in the agricultural sector exhibit higher growth rates, revealed both a very strong dynamic and a positive evolution over the five-year period. Running statistical tests, comparing the base year of 2011 with 2016, all the mean differences were found to be statistically sig- nificant at any level > 0.01.

Additionally, we compared the GVA between SMEs located in the AIZ with similar SMEs operating in the rest of the country (see Table A5 in Appendix A in the sup- plemental data online). As noted above, for firms operating in the AIZ, comparing the base year (2011) with 2016, a GVA increase of 52.6% was verified for the agricultural and agro-food SMEs. Comparing these values with the averages for the rest of the country, for similar firms operating in the same sectors of activity, the growth rate was only 15.6% over the five-year period. This evidence, and the fact that 2011–16 figures exceed those for 2005– 10, support the claim that these firms operating in the AIZ had some benefits from the AMP.

To strengthen the analysis as well as to test for robust- ness, we performed a *t*-test to compare the means between groups (*t*-test for independent samples). The results obtained showed that the group means were significantly different in 2011, as the *p*-value (0.014) was < 0.05. How- ever, in 2016, the results reveal that there is no statistically significant difference between the means of the two groups (*p* 0.2476), confirming the convergence in GVA between the AIZ companies and the rest of the country, as a result of the strong growth rate exhibited by AIZ firms. In addition, the group means were statistically differ- ent in 2005 and for 2010 only if we consider significance levels > 10%.

Investments by firms

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RIS3Alentejo considers essential that the Alentejo region should be able to attract investment to its territory which could provide the development and modernization of tra- ditional sectors of the region (as the agricultural and agroindustry) and the emergence of strategic sectors for economic growth of the region.

For this dimension, we use data obtained from the Por- tuguese Ministry of Economy on the volume of investment that entrepreneurs applied for in EU funds, between 2014 and 2017 (Portugal 2020) in 46 municipalities of NUTS-2 Alentejo. Of these municipalities, 19 correspond to the AIZ and 27 do not belong to the area of influence of this infrastructure. An analysis of Table A6 in Appendix A in the supplemental data online shows that the average investment applied to EU Funds was €32.4 million for the 19 Alentejo AIZ municipalities. With a much smaller value, the remaining 27 municipalities (not belonging to the AIZ) applied an average of €17.4 million to EU funds. These averages are statistically relevant, as the group means are significantly different, confirmed by the results of the statistical test (*p*-value under Ha: diff ≠ 0, is < 0.05). Concerning foreign investment, unfortunately data in the sectors under study are not available by regions and sectors of activity, and a proxy had to be used for all the AIZ firms. Data on the proportion of personnel employed by foreign companies show, indirectly, a growth in foreign investment in the AIZ. The majority of foreign companies operating in the AIZ employed 7.76% of the workers in 2016, against 7.2% in 2011 (see Table A7 in Appendix A in the supplemental data online).

Exports

In recent years, exports have been a positive growth factor of the Portuguese economy. Having undergone a strict programme of financial assistance, Portuguese exports assumed greater importance, having registered the highest value ever in 2017. During the period 2011–17, exports of goods grew by 28.5% in Portugal. The beneficiary region of the AMP, with an increase of 28.7%, slightly exceeded the national value of exports of goods (see Table A8 in Appen- dix A in the supplemental data online). It is also note- worthy that this dynamic was only registered after the operation of the AMP, as in the previous period used for comparison (2005–

10), the AIZ region recorded a growth rate of exports lower than the average of Portugal (16.0% versus 19.7%, respectively).

We also verified whether this increase in exports also occurred at the level of smaller firms, which had tradition- ally been more oriented towards the domestic market. Table A9 in Appendix A in the supplemental data online shows that the volume exported by AIZ companies –small and medium-sized – increased significantly from 373,797 (€ thousands) in 2011 to 659,994 (€ thousands) in 2016, a jump of 77% over the period under analysis. The export profile had intensified for both the smaller firms (employees < 50) as well as medium-sized enterprises (≥ 50 employees). In the first segment, during the period 2011–16, export growth was 62.4%, while in the second group it was 93.0%.

The analysis was also carried out based on the sample of SMEs in the AIZ detailing the amount of sales by market (see Table A10 in Appendix A in the supplemental data online). In addition, we compared the results with the rest of the country (similar SMEs operating in the same sectors of activity). For SMEs operating in the AIZ, the overall sales growth over the period 2011–16, was 48.33%. This growth was mainly due to exports that grew nearly 40% during the five-year period, while the domestic market grew at half the rate of 21%. Compared with similar SMEs for the rest of the country, SMEs in the AIZ performed better. In the rest of the country, the overall sales growth was 7.9%. This growth was mainly due to export growth of 26.9%, while the domestic market grew by only 4.4%. Further comparisons were not possible due to unavailability of data for the period 2005–10.

Cross-border activities

Neighbouring Spain continues to remain Portugal's main trading partner. In 2017, Spain was the market of origin for about one-third of total imports (32%) and the destina- tion of one-quarter of Portugal's exports (25%). In the period 2011–17, imports stabilized at around 32%. Simi- larly, the weight of exports has remained stable at 25% over the last few years (see Table A11 in Appendix A in the supplemental data online).

Unlike the stabilization verified in the country overall, during the analysed period, the AIZ intensified inter- national trade with Spain. In 2011, exports represented a lower proportion than that of Portugal (17.5%); and by 2017, it reached 24.5%, close to the national value. The proportion of imports from Spain also increased in the AIZ from 51% to 57%.

Focusing on exports and comparing Portugal–Portugal (2005–10 versus 2011–16), a decrease is found on the representativeness of exports with Spain. The same com- parison Alentejo–Alentejo allows one to verify that the 2011–16 numbers for the Alentejo substantially exceeded those for 2005–10, providing convincing evidence that the AMP project actually resulted in an increase in cross- border activities.

Figure 3, based on the indicators used in the analysis of the six dimensions, reveals the important contribution of the infrastructure (AMP) to the rationale of specialization in the Food and Forestry domain in Alentejo RIS3. Over- all, the results reveal that this large infrastructure contribu- ted to the desirability of the articulation of agriculture with agribusiness, valuing the potential scale of the Alentejo and therefore betting on product innovation. Its impacts on the growth of business activities (agriculture and agroindustry), exports, investment and cross-border activities are also visible.

The findings are in line with empirical evidence of pre- vious studies on large infrastructure and regional develop- ment that show that infrastructure investments can make an important contribution to regional development and be used as a tool to reduce regional inequalities (Aschauer, 1989; Banister & Berechman, 2001; Calderón & Servén, 2004). Prior literature has emphasized positive impacts on job and income-generation opportunities, accessibility improvements or new tourism opportunities (Dimitriou et al., 2015). The study broadens this reading by specifically showing that these impacts are noted at the level of inno- vation, sectoral articulation, investment and foreign trade. Regarding research on large infrastructures and RIS3, the present study allows one to learn which infrastructures may be important to leverage RIS3 and adds knowledge within the RIS3 studies group related to regional develop- ment (Healy, 2016; Naldi et al., 2015; Sörvik et al., 2019) showing that large infrastructures can promote, within RIS3, the innovation potential of rural areas. The study also contributes to the knowledge about the impact of RIS3 in less favoured territorial contexts.

CONCLUSIONS

Does Smart Specialisation leveraging huge investment in infrastructures work? While there has been a huge growth in scholarly interest on RIS3, the literature so far has been silent on this question. Attention was focused on the empirical evidence provided by the AMP in the Alentejo region of Portugal, whose operationalization emerges as a key resource in the regional RIS3 focused on Food and Forestry.

Evaluation of the possible contribution of large public investments to domains defined in RIS3 is dependent on a rigorous *ex-post* evaluation exercise analysing the density of effects observed as a result of these investments. The dimensions of analyses included: exploring to what extent the main impacts of large infrastructures contribute to the expansion of RIS3 in terms of substantive areas such as R&D; business activity; international trade; attractiveness of foreign investment; and taking advantage of economic opportunities. We also assessed to what extent such an appraisal of major infrastructures contributes to productive assets and targets, and, by operating this reconfiguration, contributes to

the success of regional RIS3 for regions.

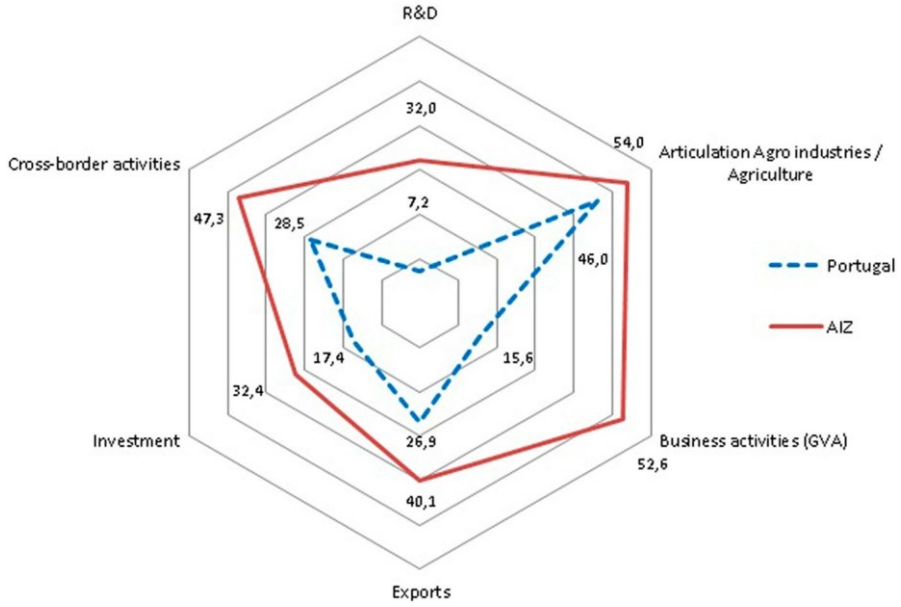

Figure 3. Comparison between the Alqueva Intervention Zone (AIZ) and Portugal, 2011–2016/17.

We believe that the present work provides a valuable contribution to this evaluation by studying a pioneering European infrastructure pivoting smart strategy case: that of the Alentejo region. In the context of the EU's Europe 2020 growth strategy, Alentejo defined a regional RIS3 for the region (RIS3 Alentejo) where it has established that one of the strategic domains would be Food and Forestry. The rationale of specialization on the Food and Forestry domain in Alentejo RIS3 proposes a bet in the articulation of agriculture with agribusiness (valuation of the potential scale of the Alentejo) and staking on product innovation. In this respect, the AMP is considered in RIS3 Alentejo to be essential to promote the change of the regional agri- cultural model, starting with the introduction of new tech- nologies and the production of new products, based on agricultural and agro-food which are technologically advanced, high productivity, environmentally sustainable and export oriented.

At least five conclusions can be drawn from the analysis of results of the research questions that helped to find an answer to the main question.

First, investment in R&D remains the vital element for companies and, consequently, for the competitiveness of the region, the catalysts for efficiency and value creation. The ana- lyses show a significant increase in R&D investment in agri- cultural sector in the AIZ after the AMP is operational.

Second, over the last years, there has been a significant growth in entrepreneurship that may strengthen the articulation of agriculture with agroindustry, as has been the goal of RIS3 Alentejo.

Third, business activities in the Alentejo region benefited from the AMP increasing in the period 2011–16 in terms of the number of establishments, turnover and gross value added. Fourth, the export profile of firms in Alentejo benefited from the AMP, and increased during the period 2011–16, and cross-border activities of AIZ companies were also energized.

Fifth, concerning the investment proposed from EU Funds, AIZ firms exhibited a more dynamic pattern when compared with their peers in the Alentejo region. In addition, RIS3 Alentejo considers essential that the Alentejo region should be able to attract foreign investment to its territory which will provide the development and modernization of traditional sectors of the region. Data on the proportion of personnel employed by foreign com- panies show indirectly growth in foreign investment in the AIZ. The majority of foreign companies operating in the AIZ employed more workers in 2016 than in 2011.

The AIZ–Portugal comparative analysis in 2011–16 with the comparisons of AIZ–AIZ and Portugal–Portugal (2005–10 versus 2011–16) allowed it to be verified that the 2011–16 figures for the AIZ region generally exceeded the period 2005–10 substantially, and this comparison pro- vided compelling evidence that the AMP project actually resulted in the region's economic development.

Summarizing, the analysis leads to the conclusion of the effectiveness of investment in anchor infrastructure in Alentejo and its contribution to leveraging RIS3Alentejo. The empirical study has both theoretical and practical significance. It contributes to the literature on RIS3 by pro- viding insight into the contribution of large public invest- ments to RIS3. It identifies key impacts along several important dimensions. Thus, we extend prior knowledge by confirming that anchor infrastructures influence the suc- cess of smart strategies for regions, a striking gap in the lit- erature on RIS3. The study also showed that large infrastructures can promote, within RIS3, the innovation potential of rural areas and contributes to the knowledge about the impact of RIS3 in less favoured territorial con- texts.

Finally, it contributes to the need for empirical analysis in RIS3, a gap noted by several authors.

We believe the results would contribute to policy- makers' analysis with regards to large infrastructures, and funding initiatives can be tied to performance indicators that strongly emerged from the analyses. The selected indi- cators reveal a considerable influence on the business activity in the period 2011−16 and demonstrate superior performance dynamics compared with the previous period. This impact is substantially higher in the agricultural sector compared with the agro-food sector, allowing it to be con- cluded that the contribution of the AMP to leverage RIS3 in Alentejo in this area is primarily affecting the agricultural sector. The domain of Food and Forestry defined in the RIS3 Alentejo should gain even further notoriety from the spillover effects of the AMP within a longer time frame. It is expected that a readjustment of uses, and new crops with new irrigation perimeters (fruit, vegetables) and associated agro-industry potentials, and the improve- ment of the management of water resources in the agricul- tural activity resulting from the new irrigation programmes (a more efficient use of irrigation water), will increase the quality and the added value of agro-food products.

The study also opens the way for new lines of enquiry. For instance, we believe that researchers should further analyse along different indicators, such as the irrigated sur- face area, crop alteration and mechanization of farms. Future studies could also consider the impact on a wider range of RIS3 domains examining a broader sample of firm coverage from all sectors of activity. Also, this study can be extended into comparisons with other cases in less developed regions.

This paper is not without limitations, one being the dif- ficulty in generalizing the results obtained. It may occur that the unit chosen for investigation (Alentejo region) is rather atypical in relation to many regions of the European Union. We maintain, however, that the analysis enhances one's understanding of the role of anchor infrastructures to leverage the strategy of Smart Specialisation.

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