



Intra- and inter-firm dynamics in combinatorial knowledge bases

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Abstract

Research on innovation has often concentrated on a narrow set of sectors and activities, and on the experiences of the most advanced regions in the world. However, innovation, when defined in a broad sense, incorporates a variety of processes and outputs that cut across organisational, sectoral, territorial and knowledge boundaries. This paper seeks to make a contribution to this literature by focusing on the experiences of less developed regions, and by examining how different knowledge bases contribute to technological upgrading and higher added value for firms. It argues that in regions where access to advanced knowledge and technology is restricted, or where firms do not have the absorptive capacity to access, absorb and exploit such knowledge, combining existing knowledge in innovative ways may be the best strategy for firms to become more innovative and competitive. It also argues that this combination can happen through vertical integration within the firm, or by the creation and maintenance of inter-firm mechanisms that stimulate knowledge dissemination. These themes are discussed by drawing on the evolution of the wine industry in three Portuguese regions. These regions have all experienced different trajectories, in terms of the renewal of their wine industry, and it is argued that this is in part the result of endogenous regional characteristics.

Keywords

Combinatorial knowledge bases, knowledge coordination, vertical integration, less developed regions, local value chains

Introduction

Innovation is an activity that is shaped by a variety of technological, organisational, managerial or symbolic contributions (OECD/Eurostat, 2005). However, due to a combination of methodological limitations and a bias in research towards the activities of leading firms in the most advanced regions of the world, the analysis of the technological dimensions of innovation often takes precedence over others (Bell, 2009; Manniche et al., 2017). This leads to a conceptual framework that is less relevant for the experiences of firms in less developed regions, not to mention those located in developing countries (Bell, 2009). The aim of this paper is to support the argument that a more comprehensive understanding of innovation is necessary, particularly in contexts where advanced technological

and scientific breakthroughs are not available to firms, or where firms do not have the absorptive capacity to turn them into innovation outputs.

This paper will approach this issue by drawing on the literature on combinatorial knowledge bases (CKBs), which has demonstrated empirically how innovations are driven and shaped by different knowledge bases at disparate points in their life-cycle (Manniche, 2012; Manniche et al., 2017). It will contribute to this literature by arguing that the

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combination of knowledge bases happens through intra-firm and inter-firm processes. Regarding the former, the literature on the vertical integration of firms will be discussed in order to understand the importance of knowledge diversity within the firm in generating ‘unstructured technical dialogue’ (Helfat, 2015). For inter-firm processes, this paper will draw on the literature on clusters and local value chains (Giuliani, 2007; Giuliani and Bell, 2005) in order to analyse the conditions that facilitate learning dynamics that involve several organisations.

Empirically, these concepts will be discussed through an analysis of three wine regions in Portugal, which, as will be shown, have experienced different trajectories in terms of their reconversion towards the production of high-quality wine. It will be argued here that this is primarily a result of the way in which regional value chains have been managed and the consequences for knowledge combination and innovation. To address these issues, this paper will be structured in the following way: the second section will introduce the main concepts through a discussion of the relevant literature. The third section outlines the methodological approach and the fourth section presents an introduction to the Portuguese wine making context and analysis of data from the three case studies. Finally, the fifth section will present some conclusions.

Combinatorial knowledge bases and the wine industry

According to Halkier et al. (2012), innovation dynamics are now more likely to cross geographical, organisational or sectoral boundaries. This is due to the geographical expansion and fragmentation of value chains, and the tendency for knowledge creation processes to become increasingly shaped by modularisation, standardisation and externalisation (Manniche et al., 2017). This phenomenon is a direct consequence of the current wave of globalisation and opens up important new avenues for research, which question previous assumptions about how innovation is framed by organisational or territorial boundaries (Halkier et al., 2012).

An equally relevant dynamic that has received less attention is the contribution that different knowledge bases make to innovation outputs (Manniche

et al., 2017). As recent research has shown, knowledge has become more complex over the past two centuries (Balland and Rigby, 2017), which results in the need for individuals to become ever more specialised. This creates coordination problems for firms who want to operate at the frontier of technological development, since they have to create mechanisms to combine highly differentiated knowledge (Neffke, 2017). It is, of course, necessary to acknowledge that typologies of knowledge, whether those that distinguish between tacit and codified, between science-based and engineering-based or between knowledge bases, can sometimes overstate the boundaries between different processes and activities. In reality, innovation activities always incorporate different knowledge bases, or different levels of tacitness, for instance (Dosi et al., 2008). Despite this, it is argued in this paper that this is an important topic of research because it contributes to an understanding of innovation as a process that involves multiple systemic interactions, both across extended value chains and across highly specialised domains.

The building block of the concept of CKBs is the typology developed by Asheim et al. (2011). The aim of this typology has been to capture how different types of knowledge are produced, disseminated and used, which in turn helps one to understand how innovation, in a broad sense, happens in different sectors (Martin and Moodysson, 2013). It does so by distinguishing between analytical, synthetic and symbolic knowledge. Analytical knowledge refers to codified, science-based knowledge, which is highly abstract and universal and can be shared across distances, provided that the scientific language is mutually understood. It is prevalent in sectors such as biotechnology or nanotechnology, its outputs are mostly product or process innovations and it is more likely to generate radical innovation than other types of knowledge. Synthetic knowledge refers to partially codified, engineering-based knowledge, with a significant tacit component and is more place-specific. It is dominant in advanced manufacturing industries, relies on high levels of practical skills and craftsmanship and usually leads to the modification of products and processes (Asheim et al., 2011).

Symbolic knowledge refers to creativity and culture and is highly sensitive to spatial, socio-economic or gender variations (Pina and Tether, 2016). It was originally studied primarily within arts-based environments, although it is relevant across all sectors of the economy. Its inclusion in this typology is one of the most valuable contributions of the knowledge bases concept, due to its relative neglect in innovation studies. Symbolic knowledge is at the core of value creation activities in the contemporary economy, as discussed in the seminal work of Lash and Urry (1994). These authors referred to the sign-value of brands, built through impressions and aesthetic symbols, and claimed that in successful organisations it is superior to the use-value of its physical or human resources. Symbolic knowledge is therefore concerned with the creation of meaning and aesthetic values through design, branding and the manipulation of images and symbols (Hatch, 2013; Pina and Tether, 2016). Because its value depends on customers being capable of recognising the images and symbols used, it is normally embedded in particular cultural environments and cannot be easily transferable.

Taking these three knowledge bases as the building block, the combinatorial approach seeks to understand how each affects innovation outputs. An example is provided by Manniche et al. (2017). Using the methodology of innovation biographies, the authors were capable of identifying 'decision events' in the life-cycle of innovations, where different knowledge bases took the lead in shaping the final output. These events were diverse in nature and included the identification of demand for a new product, the creation or dissolution of research teams, the technological breakthroughs, decisions made by researchers and the selection of a branding strategy. Although some of these elements are not often considered when studying innovation, they are in fact crucial aspects of business activities and all have an impact on the final product (Tödtling and Grillitsch, 2015).

Theoretically, the CKB approach relies on contributions from organisational studies and economic geography (Manniche, 2012; Manniche et al., 2017). In this paper, the former is deployed to understand the role of organisations as units that coordinate the use and exploitation of knowledge (Grant, 1996). In

turn, the economic geography literature contributes to our understanding of how the nature and governance of value chain networks can hinder or encourage knowledge coordination (Giuliani, 2007; Giuliani and Bell, 2005). This paper will now explain in greater detail how each framework contributes to the overall theoretical approach used in the empirical analysis.

Firms as a nexus of knowledge coordination

There are several contact points between the CKB approach and work undertaken in organisational studies. One of them is the knowledge-based theory of the firm, developed by Grant (1996, 2002), with some elements subsequently incorporated into the capabilities framework (Dosi and Nelson, 2013). The author proposed it as an alternative to the resource-based view, which defined the firm as a mechanism for value maximisation, by claiming that the firm exists as a nexus for the integration and coordination of different specialist knowledge. The reason why the legal status of the firm is necessary is due the unique characteristics of knowledge, including the difficulty of sharing tacit and/or idiosyncratic knowledge, which tend to aggregate in organisations and are not easily replicated.

Of particular importance to this paper is the tension noted by Grant (1996) between the need for individuals to specialise in areas of knowledge in order to create, acquire or store new knowledge, and the need to coordinate a variety of specialisms at the organisational level to produce goods and services. This means that firms working on the technological frontier must find strategies to coordinate the actions of highly specialised individuals with different technological or scientific backgrounds. As the author acknowledges, this perspective is very similar to that which argues that the firm's existence is justified because it reduces transaction costs for particularly complex activities (Williamson, 1995). The argument, though, is that by focusing on knowledge coordination the analysis extends beyond market transactions to include activities that operate according to different logics, such as learning or the emergence of organisational cultures conducive to innovation.

It is true that over the past two decades since Grant's contributions, economic geographers and others have shown that certain aspects of knowledge coordination can happen outside the boundaries of the firms (as shall be discussed in the next section), even for activities that would in theory have high transaction costs (Polenske, 2007). However, it would be incorrect to suggest that firms have become meaningless as a nexus of knowledge coordination. This is because, as a different strand of research within organisational studies has shown, processes of vertical integration and disintegration of firms are not linear nor unidirectional (Helfat, 2015). They are influenced, for instance, by factors such as industry or technology life-cycles, or by the quality of suppliers present in a region (Malerba et al., 2008).

When an organisation integrates vertically, it usually implies internal diversification through the creation of new areas of activity (or expansion of previous ones), which will require hiring experts with different knowledge bases. Therefore, although vertical integration is mostly shaped by the factors enunciated by Helfat (2015), it has the benefit of creating opportunities for 'unstructured technical dialogue'. This dialogue happens when informal and face-to-face encounters between experts specialised in distinct knowledge bases encourage in-house systemic innovation (Helfat, 2015). The challenge for CKB is as such to combine a view of the firm as capable of generating internal mechanisms to combine different knowledge bases, while acknowledging that they are not tightly bound entities and are instead part of multi-dimensional networks that can achieve similar purposes.

Knowledge combination in value chains

The role of extra-firm linkages in the coordination of knowledge has been extensively studied under a variety of concepts and approaches (Moulaert and Sekia, 2003). The cluster concept is particularly relevant here, due to its focus on local value chain integration through networks of upstream and downstream activities. While there are ongoing questions about its definition, empirical applications or policy relevance (Martin and Sunley, 2003), solving these issues is beyond the scope of this paper,

which is primarily interested in two aspects: the first is the fact that cluster networks are not, as is sometimes assumed, self-sustaining and self-organising, but are rather the product of deliberate action by economic agents (Giuliani, 2007; Giuliani and Bell, 2005). As a consequence, their degree of openness, their content or their persistence in time, and the ensuing externalities that these networks generate, depends on the strategic intent of those same actors and on the internal characteristics of their organisations (Rabellotti and Schmitz, 1999).

The second aspect is that clusters are shaped by the way in which local value chains are governed. Despite the usual focus on knowledge sharing between competitors, client-supplier relationships are fundamental to the functioning of clusters, and the way they are managed can have a significant effect on innovation outputs. For example, significant power asymmetries between actors can lead to fractious or low-trust relationships, which prevent the sharing of knowledge (Rabellotti and Schmitz, 1999). Also, they can have an aggregate effect by shaping institutions in a way that benefits large firms at the expense of smaller producers and thereby hinder the innovative capacity of the latter (Christopherson and Clark, 2007).

In summary, the combination of knowledge bases happens through a variety of mechanisms, which include intra-firm dynamics and the coordination of economic agents in value chains. Each type presents its own challenges. Intra-firm coordination may be hindered, for example, by the lack of appropriate management mechanisms or by an organisational culture that is conducive to departmental silos rather than knowledge combination (Hislop, 2013). On the other hand, networking in value chains may be negatively affected by governance modes that generate fragmentation or power asymmetries between clients and suppliers (Christopherson and Clark, 2007).

The wine industry provides a very interesting illustration of how the vertical integration of firms and the governance of value chains in a way that encourages cooperation can facilitate knowledge coordination and improve product quality. Globally, the rise in wine quality witnessed since the late 1980s has been facilitated by both processes, which have brought together the different stages of wine

Table 1. List of stakeholders and experts interviewed.

Entity	Location
CVRA (Regional certification authority for Alentejo)	Évora
Instituto da Vinha e do Vinho (national regulatory authority for the wine industry)	Lisbon
ATEVA (Association providing technical support to farmers in Alentejo)	Évora
ViniPortugal (Association dedicated to promoting Portuguese wine internationally)	Lisbon
IVDP (Regional certification authority for Douro)	Porto
Portuguese Association of Oenologists	Lisbon
CVRL (Regional certification authority for Lisbon)	Torres Vedras
Fenadegas (Association representing cooperatives in the wine industry)	Lisbon
Professor of business administration with research and management experience on the wine industry	Évora
Independent oenologist	Lisbon

making. This created opportunities for ‘unstructured technical dialogue’ along the different stages of the production life-cycle. This dialogue facilitates the sharing and coordination of expert knowledge regarding symbolic (e.g. taste, consumer preferences, branding), analytical (e.g. scientific advances in chemistry or biology) and synthetic (e.g. farming engineering, fermentation processes) knowledge, which helps firms to innovate and to improve the quality of their wine.

An example of the relevance of knowledge coordination within wine firms is provided in a recent paper by Pérez-Luño et al. (2017). Using data for wineries in Spain, the authors found that coordination of knowledge across several functional areas within firms improves firm performance. The same paper also concluded that when knowledge complexity is low, coordination across more than two functional areas is detrimental to product innovation, due to the high management costs involved. The need to maintain simple forms of coordination is therefore paramount. Regarding value chains, researchers have argued that in South Africa, for example, client–supplier relationships have become more asymmetrical, which is having negative consequences on this country’s wine quality (Cusmano et al., 2010; Giuliani et al., 2011). It will be argued in this paper that a better understanding of these processes is necessary to explain the technological and economic renewal of the Portuguese wine industry. It will also be argued that the different ways and speed at which this happened in the three

case study regions is essential to understand their different trajectories.

Methodology

This paper draws on empirical results from case studies in three Portuguese wine regions. The case studies were based on semi-structured interviews with firm owners or managers and with other stakeholders. In total, 57 interviews were conducted, as detailed in Tables 1 and 2, from a population of 400 firms in Douro, 100 in Lisbon and 243 in Alentejo. In order to reach the target population, all firms registered as winemakers in these regions were contacted by email. Their contacts were available on the websites of the regional certification authorities. Those that replied were interviewed, which means that their selection was not random and instead relied on self-selection. The interview script included two main sections: the first had questions about firm characteristics, with a particular emphasis on innovations adopted or introduced. The second section was about the sector as a whole in the region, where interviewees were asked to assess its recent evolution in terms of which factors (regional, national or international) have contributed/or hindered innovation and growth. Interviews were complemented with data from two other sources: firstly, from document analysis, with a particular emphasis on the history of wine making in Portugal and of the institutions regulating it; and, secondly, from secondary statistical data on grape and wine production.

Table 2. List of organisations interviewed.

Wine region	Type of firm	Number interviewed	Number of employees (range)	Employees (average)
Alentejo	Cooperative	2	16 to 24	20
Alentejo	Producer-bottler ^a	12	1 to 70 ^b	15.9
Alentejo	Bottler ^a	1	5	NA
Alentejo	Consultant oenologist/Bottler	1	1	NA
Alentejo	Hotel/producer-bottler/real estate	1	50	NA
Alentejo	Farm supplies/producer-bottler/laboratory analysis	1	14	NA
Lisbon	Producer-bottler	8	1 to 28	5.9
Lisbon	Cooperative	1	30	NA
Douro	Bottler	1	1	NA
Douro	Producer-bottler	16	1 to 300	29.7
Douro	Consultancy for wine promotion ^c	1	14	NA
Douro	Specialist wine shop	1	5	NA
Douro	Cooperative	2	8 (both)	8

^aProducer-bottler is the name given to a firm that produces grapes, transforms the wine, bottles it and sells it. A bottler is a firm that buys grapes or bulk wine to bottle it and sell it.

^bOne of the organisations interviewed is a multinational in the wine industry. It employs 23 people in Alentejo (which was the value used for this table) and 940 globally.

^cThis consultancy is based in Vienna, Austria, but they were interviewed regarding a project in Douro.

Figure 1 provides a map of wine regions in Portugal, with the case study regions highlighted on the left. Several details should be highlighted: in this paper quality wine is defined as that which received either a Protected Designation of Origin (DOP) or Indication of Geographic Protection (IGP) quality certificate (see also Figure 3). To get this certificate the wine must meet certain criteria not only in terms of the grape varieties used and the methods used for processing and transforming the wine, but also in terms of the territory where it was produced. The final product is also analysed technically and is tasted by experts to ensure that it meets the necessary standards. For this reason, quality wine certificates were used as an indicator of innovation, because achieving one generally means investments in knowledge and technology across the whole value chain.

The three wine regions identified as the target of this research project were chosen for two reasons: firstly, because they are the main wine producing regions in Portugal, measured in terms of quantity; and, secondly, because each has specialised in a different market segment (see Figures 2 and 3). Alentejo currently dominates the quality

wine market in Portugal with a 40% market share (see Figure 3). Douro, on the other hand, has traditionally been dominated by Port Wine, and only since the late 1990s did it start to see a significant shift towards the production of wine, with a strong emphasis on quality. Finally, Lisbon maintains a strong presence in low-end wine, with 30% of total production going to wine without quality certificates and less than 10% to that with DOP certificates.

The integration of value chains – the national context

Towards the end of the 1980s, the Portuguese wine industry entered a process of renewal. As indicated in Table 3, this has led to a steady increase in the unit value of wine exported, with Portugal occupying the third position worldwide for the period 2008–2011. This transition was shaped by endogenous dynamics that will be explored in the next section. However, it was also the result of wider changes in the regulatory regime for the sector, motivated by Portugal's accession to the European Union (EU) in 1986. Accession led to a new set of rules and institutions approved in

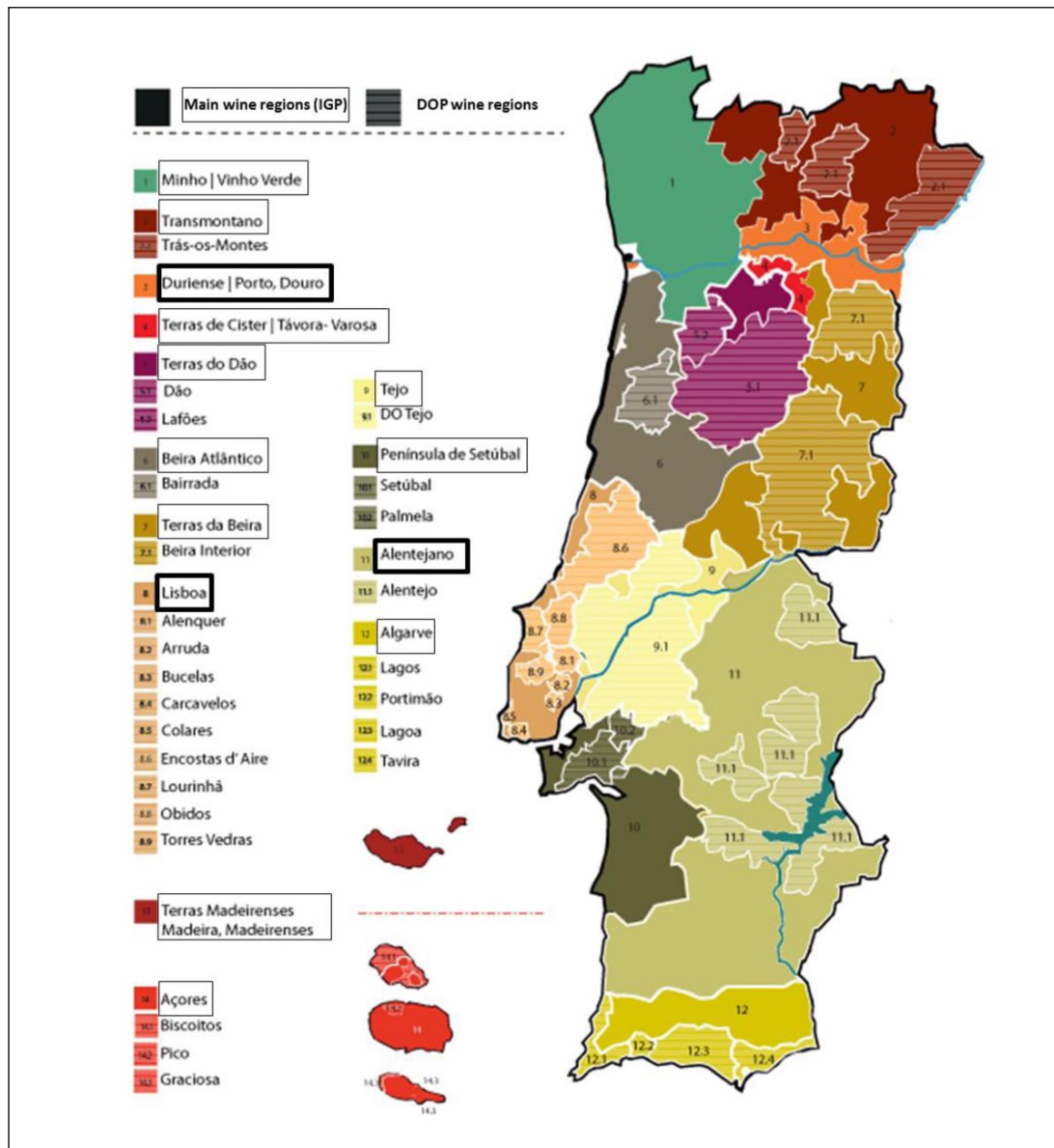


Figure 1. Main wine regions in Portugal. IGP: Indication of Geographic Protection; DOP: Protected Designation of Origin.

Source: IVV (2018).

1989, determining the criteria for certifying and enforcing quality in wine (and other agricultural products). These rules were in turn designed according to significant scientific advances in the wine sector, which allowed for the codification of knowledge

that until then remained mostly tacit and highly localised (Giuliani et al., 2011). Attached to the new regulatory regime were also a set of financial incentives that encouraged farmers to invest in local grape varieties and acquire new technology.

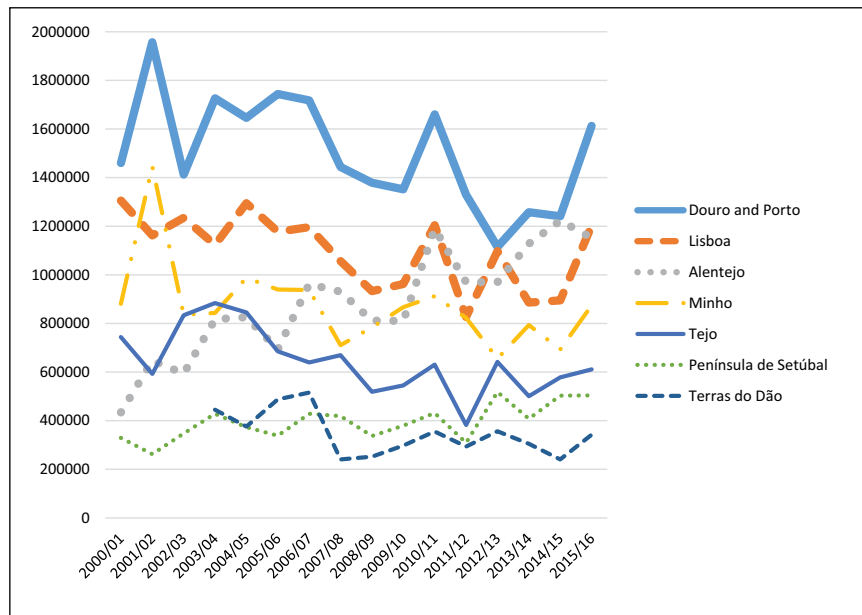


Figure 2. Total wine production in the seven Portuguese wine regions with the highest output (measured in hectolitres).

Source: author's research based on data from Instituto da Vinha e do Vinho (2018).

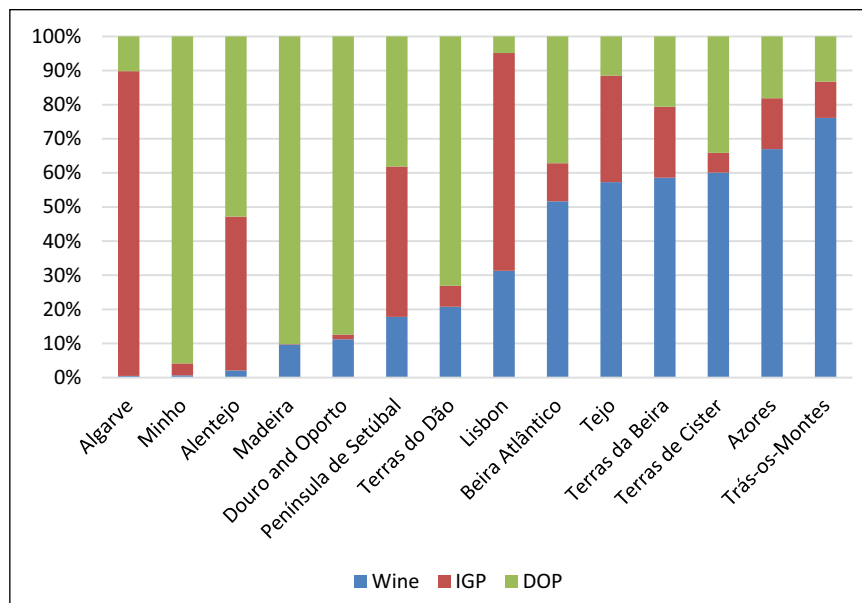


Figure 3. Proportion of wine produced in each region with Protected Designation of Origin (DOP) or Indication of Geographic Protection (IGP) certificates in 2015/2016 – (measured in hectolitres).

Source: author's research based on data from IVV (2018).

NOTE: 'Wine' refers to wine without a quality certificate; IGP and DOP are the two quality certificates, with the latter usually reserved for highest quality wines.

Table 3. Unit value for wine exports between 1975 and 2011 for a selection of countries (1000 USD/ton).

	1975–1979	1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	2005–2007	2008–2011
France	1.49	1.66	2.32	3.5	3.7	3.83	5.56	6.55
New Zealand	1.34	1.91	2.37	2.83	3.75	4.72	6.18	5.04
Portugal	0.94	1.38	1.87	2.32	2.58	2.33	2.44	3.14
Germany	1.49	1.51	1.49	1.65	1.91	1.76	2.58	3.07
Australia	1.22	1.7	1.86	2.07	3.3	2.87	2.98	2.66
Italy	0.42	0.48	0.73	1.13	1.44	1.88	2.41	2.62
USA	1.08	1.09	1.32	1.42	1.93	1.9	2.03	2.55
Chile	0.79	0.95	1.19	1.36	1.43	1.59	2.08	2.24
Argentina	0.35	0.54	0.49	0.76	0.91	1.29	1.33	2.23
South Africa	0.68	0.83	1.11	1.5	1.61	1.65	1.66	1.86
Spain	0.52	0.57	0.93	1.11	1.46	1.35	1.51	1.49

Source: FAOSTAT (2014).

Prior to this date, the production of wine in Portugal was characterised by the organisational and geographical separation between farmers and large commercial houses. The former were responsible for growing grapes and occasionally for transforming the wine; the latter would buy either bulk wine or grapes and bottle the final product to be sold in final markets. Mostly these large commercial houses were located in the metropolitan areas of Lisbon or Oporto. They were large, powerful entities, with a significant bargaining power, and focused on high-quantity and low-quality wine (Freire, 2011), with the exception of Port Wine producers. On the other hand, farmers were mostly poor and illiterate, lived in rural areas away from the urban centres and often worked only part-time. Their goal was to achieve high yields at the expense of quality (Freire, 2011).

In this restructuring process there were significant contributions from each knowledge base. Analytical knowledge was mostly embodied in the technologies acquired from abroad, in highly skilled human capital and, as stated previously, it was reflected in the EU rules regarding production and certification. The quality of research centres in Portugal in this area is generally quite low and, among those firms interviewed, only one reported formal links with universities. Portuguese firms therefore benefited from the efforts to codify knowledge that were driven primarily by agents in the USA (mostly California) and Australia (Giuliani et al., 2011). Synthetic knowledge was disseminated primarily through human capital. The importance of

agriculture in the Portuguese economy ensured the existence of farming engineers who could adapt to this new sector of activity. Even more relevant is the high number of individuals working for this sector with experience of studying or working abroad. A recent survey of Portuguese oenologists reported that 30% had had such experiences, primarily in the USA, Australia and France, with the number rising to 40% for those below the age of 40 (Marques, 2017b). Furthermore, the existence of foreign-owned firms in Portugal, especially in the Douro region, also facilitates the circulation of knowledge, both analytical and synthetic.

Although this is an overall representation of how this sector renewed itself in Portugal, there were significant differences in how this happened in each case study, as the paper will discuss next.

Alentejo: The newcomer

Alentejo was the first Portuguese region to take full advantage of the financial incentives offered by the EU to restructure its wine sector. As a result, it became the leader in the national quality wine market segment, with a 40% market share (Comissão Vitivinícola Regional Alentejana, 2016). Its success is all the more striking because the region had a negligible wine output before this period. This process was led by the six local cooperatives and a small number of large private producers, and it benefited from the region's previous specialisation in modern, intensive farming techniques. Although this could

have been a handicap in the previous paradigm of wine production led by tacit, localised knowledge, it was ideal for the new paradigm of codified and standardised knowledge, embedded in state-of-the-art technology and highly qualified human capital.

The groundwork for this transformation came from research by the University of Évora and the local economic agents, who identified autochthonous grape varieties and helped to delineate the rules that would determine the characteristics of certified wine. At this stage it was mostly about combining external (to the country) analytical knowledge with synthetic knowledge (both codified synthetic knowledge from abroad and knowledge embedded in local human capital) in order to allow for new productive processes and outputs. Despite its early work in this area, no interviewees referred to the University of Évora as a current partner or as a significant producer of scientific knowledge in this field, which seems to indicate a loss of local research capacity in this area. Symbolic knowledge also played a part, both in terms of producing wines that were appealing to new types of consumers, more focused on quality than on quantity, and in the investments made in branding and marketing. The two following quotes illustrate the process and impacts of these investments.

The main changes in Alentejo wine in the past two decades have been the restructuring of grapevine plantations in order to produce with higher quality, to increase the value of the raw material and of the investments made in new technologies and to adapt production to new rules and norms that were created for quality wine in the region. (...) There was also a lot of training of technicians in the cellars, which had been modernised. And investment in good teams of oenologists, Alentejo has always had excellent teams of oenologists.

(Interview with representative for ATEVA (Technical Association for Grapevine Growers in Alentejo), Évora, 8 October 2012)

The wine cooperatives in Alentejo are the oldest in the country and they had a more important role than in other regions, because they are managed as private firms. They have their own brands, they export, they have good quality wine.

(Interview with representative from Comissão Vitivinícola Regional Alentejana (CVRA), 25 September 2012, Évora)

Innovation in the Alentejo (and Portuguese) wine sector is closer to the doing, using, interacting mode, due to the lack of significant knowledge production, and is primarily the result of technological catch-up, of investments in human capital and organisational innovations. In a context where there are limited opportunities for differentiation on the basis of new technological outputs, the combination of different knowledge bases is fundamental to increase quality across the whole value chain and allow firms to increase the added value of their outputs (Figure 4).

One of the most interesting aspects of this region, however, is the fact that both external and internal agents criticised the region's inability to move in more recent times towards more unique (and higher value-added) wines. Although this fact is disputed by some agents in Alentejo, others admitted that the region produces quality but non-distinctive wines. This inability was, to a great extent, attributed to the strategies of cooperatives, who because of the coordinated nature of their business, struggle to adopt more radical production or branding strategies that would see them invest in riskier, but potentially more valuable, products. It indicates that the life-cycle of the region appears to have reached a stage of maturity around the production of 'standard' quality wines, relying on applying existing knowledge, with local actors (especially cooperatives) now struggling to leverage more complex forms of knowledge that would allow them to progress towards higher value-added products. A large Portuguese firm had recently invested in this region precisely to seek such a strategy, as illustrated in the following quote.

The Vidigueira [in Alentejo] is known as a region of white wines (...) and that is why we invested in that region. Plus our farm is undulated. That allowed us to identify 12 different types of soil, each with different levels of solar exposure. This year we are already making some noise with journalists because we will present wine with [the grape variety] Alicante Bouchet produced facing the North and Alicante Bouchet facing the South (...). The biggest challenge for Alentejo nowadays is showing that we don't only produce those easy wines that were responsible for the region's boom because the consumer and the business requires something else.

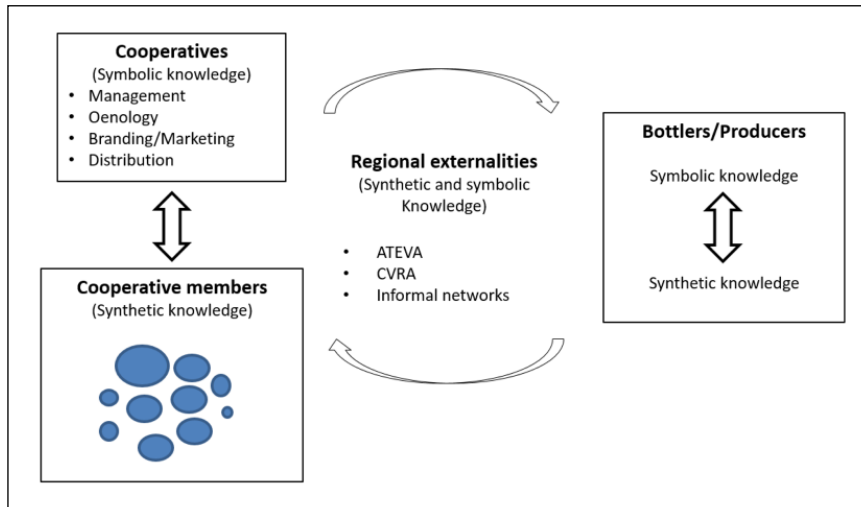


Figure 4. Knowledge bases, value chain integration and positive externalities in Alentejo. ATEVA: Technical Association for Grapevine Growers in Alentejo; CVRA: Comissão Vitivinícola Regional Alentejana. Source: author's research.

(Interview with Oenologist working for Sogrape, Avintes, 22 January 2013)

Despite the challenges that it currently faces, this is in many ways a case of successful sectoral transformation and renewal within a region. This transformation was facilitated by the verticalisation of value chains, which happened earlier than in the other two case study regions. Local cooperatives achieved this verticalisation by reversing their business strategy. Whereas before they operated as mediators between local farmers and large commercial houses, they now operated as private firms, with a professionalised management structure and quality control procedures. Alentejo's path was also helped by the decisions of a small number of large landowners, who decided to co-locate all stages for the production process in close physical proximity, rather than the previous strategy of managing farming outputs at a distance (usually from the capital city of Lisbon, but not exclusively).

Finally, this region's success was also helped by the creation of region-wide mechanisms for the diffusion of knowledge (Figure 4). One particularly important event was the creation of ATEVA in 1983, an association that employs farming engineers and provides technical advice to all farmers in Alentejo

who join as members. According to interviews, it remains a unique organisation in the Portuguese context, both in the quality of its services and the fact that it covers the entire wine region. Another organisation that benefited from this overall trend towards quality wine was the CVRA, the regional authority responsible for certifying wine. Even though it is a public authority with the right to legislate, its funding is entirely private and derives from the process of certification. As a consequence of the business approach taken by firms in this region, the CVRA has been from its inception a well-funded organisation, with the capacity not only to promote wines nationally and abroad but also to help create a sense of cohesion in the region. Finally, the cohesiveness of the system as a whole created an identity that survived the significant increase in the number of producers that came after 2001 as a result of changes in national legislation. This has allowed the region to maintain a steady output of quality wine.

Douro: Tradition and renewal

In Douro, the transition towards high-quality wine happened at a different pace and through different mechanisms. Due to the continuing importance of Port Wine in the region, both for commercial houses and

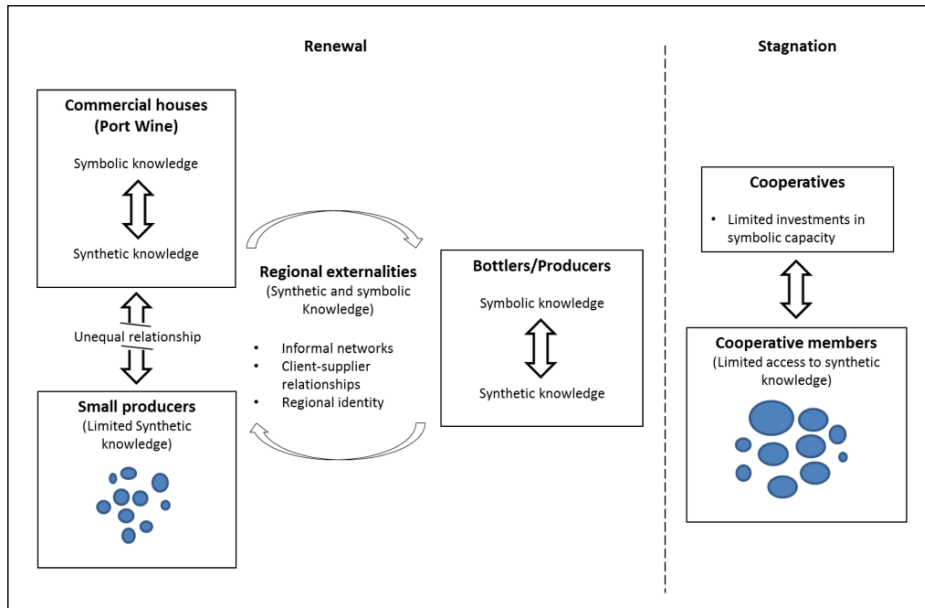


Figure 5. Knowledge bases, vertical integration and processes of renewal or stagnation in Douro.
Source: author's research.

farmers, there were fewer incentives to invest in the production of wine.¹ The region was therefore in a situation of lock-in until at least the end of the 1990s, where the success of one product created a disincentive to invest in diversification. In addition, Douro was hindered by negative path dependencies in the cooperative movement, which continued to produce high-quantity, low-quality wine, and exhibited a lack of investment in management and production structures. This issue was compounded by land fragmentation and the concomitant nature of farm work as mostly a part-time activity. The importance of these elements was expressed by the following interviewee:

I remember being in a meeting of a cooperative in Douro, and the management team was proposing an investment of half a million Euro to build a new cellar. But some of the members maybe make 1000 Euro per year from their small farm, so for them an investment like this makes little sense.

(Interview with firm owner, 14 January 2014, Olival)

The region continues, therefore, to witness divergent trends of renewal and stagnation, as summarised

in Figure 5. Regarding the renewal of this sector, the use of analytical and synthetic knowledge was somewhat different to the region of Alentejo, because this region already had access to high-quality technology and human resources used in the production of Port Wine. The main improvements happened at the level of organisational innovation and the governance of value chains. Another difference with Alentejo was in the nature of the actors involved, which allowed some agents to move very quickly to more value-added segments, by drawing on international expertise and the brand value of the region itself. In contrast, dissemination of knowledge has not been as effective in terms of the number of firms and cooperatives that have effectively combined new technologies and knowledge. This explains why, comparatively, some of its wine output is still of lower quality.

One early example of renewal happened when Symington, the second largest wine exporting company in Portugal, hired Bruno Prats at the end of the 1990s to create a high-quality Douro wine. Prats was a famous French oenologist previously based in Bordeaux who was at the time working as an external consultant to firms in Chile and South Africa.

The wine they produced is still today a reference in this region. A different example is the 'Douro Boys', a project involving five producers who inherited family businesses, together with Wine & Partners, a communications agency based in Vienna that specialises in the wine market. This project has been a reference in the Portuguese wine sector, mostly for its innovative approach to marketing and its international appeal. Both these projects would have been more difficult to implement in Alentejo, which relies more on domestic firms, which are less integrated in global wine value chains, in comparison to the multinationals operating in Douro.

Of particular importance for the renewal of the sector was the creation of an oenology bachelor's degree at the University of Trás-os-Montes e Alto Douro, located in Vila Real, on the edge of this wine region. It is the only degree of its kind in the country and it had a significant impact in training a new generation of qualified human resources. Together with the aforementioned tendency for Portuguese oenologists to gain work experience abroad, it has allowed even small producers to have access to high-quality human capital. This human capital modernised production in the region not only by adopting modern production technologies and recent advances in analytical and synthetic knowledge, but also by drawing on their symbolic knowledge about how to produce distinctive wines that can be valued by the market.

In what concerns the exploitation of symbolic knowledge for branding and marketing, both large and small firms have taken significant advantages from the potential of this region. All those interviewed for this project referred to the regional brand as one of their major assets and emphasised their capacity to produce unique wines that can distinguish themselves in international markets. This uniqueness results from Douro's association with Port Wine, from its unique morphological and climate conditions and from the preservation of a wide variety of grape varieties.

This shift in strategic direction was supported by more diversified forms of vertical integration in comparison to the example in Alentejo. Firstly, as the large Port Wine firms saw the potential in the Douro region for the production of quality wines and also as a tourist destination, they started to establish stronger links with the region. This has led them to acquire

significant amounts of land, in contrast to their previous business model based on buying bulk wine; and to create or improve their infrastructures, for instance by refurbishing old farm houses or warehouses, to have a more regular presence in the Douro. Their value chains are nonetheless not yet fully integrated. Commercial houses still rely on buying significant amounts of bulk wine from farmers, and according to vine growers this interaction is based on highly unequal arms-length relationships. Up to now, this distance has not caused major upheavals because the Port Wine market continues to generate significant profits, including for farmers. However, it is a situation that could undermine the notion of partnership that is supposed to link both sides of the production process. As illustrated in Figure 5, this creates barriers to the exchange of knowledge and maintains some of the perverse incentives that predominated in the past. This was also mentioned by an interviewee based in Austria who works with firms in Douro and other Portuguese regions.

The issue of small properties in Douro doesn't have to be a problem. (...) A producer with a small plot can make a great product, because they can take care of each plant and make wonderful grapes. (...) But for that they need to sell their grapes for a high price to a wine producer, who in turn will be happy to buy high quality grapes. But this is not very common in Douro. They are usually working against each other. (...) In Champagne, France, a farmer receives 30€ for a kilo of grapes, so they make a lot of money, which is normal. (...) Everyone has to make money with this, and not just [those who transform and sell the wine].

(Interview with firm representative, 16 January 2013, online video interview)

A second movement has been the rejuvenation of family-based firms. This has mostly happened as these firms have been taken over by a younger, more educated generation. Usually, this new generation has higher degrees in oenology, management or other relevant areas and in some cases work experience acquired elsewhere in Portugal or abroad (Marques, 2017b). They will usually establish themselves in physical proximity to the farm, and the largest of these firms will work closely with a network of small

producers. In the case of the latter, interviewees emphasised the importance of this relationship and defined it as a partnership in contrast to the relationships that large Port Wine firms establish.

Regional fragmentation is also reflected in the lack of formal organisations facilitating knowledge externalities. According to interviewees, the certification authority, Instituto dos Vinhos do Douro e Porto (IVDP), is still mostly concerned with Port Wine, including regulating its production and promoting it nationally and abroad. There is also a lack of privately owned organisations covering all the region (such as ATEVA in Alentejo) and, despite the strong association with a regional brand, a significant amount of distrust among economic agents. This is partly a result of acrimonious relationships with the large commercial houses and partly a reflection of the low levels of interpersonal trust that persist in Portugal.

Lisbon: Path dependency and stagnation

Finally, Lisbon is the region where the legacy of the previous organisational and geographical structure of the Portuguese wine sector has had the strongest negative impact. It shares similar negative characteristics with the Douro region (low-end business strategies among cooperatives), without the presence of large players that could use their financial resources to encourage a process of renewal, since most of the old commercial houses located in this area no longer exist. In addition, it is a region located close to the capital city of Lisbon, which has a pull effect on labour and other resources, leaving behind an ageing and impoverished rural population. Finally, it struggles with poor brand recognition, as acknowledged by a representative of the regional certification authority.

The non certified wine is in general produced by the cooperatives. (...) We have a high density of cooperatives. We have around 15 in our region (...) because of the high volume of production. (...) There are two giant cooperatives, and their presidents are our friends, but they don't certify one single litre. They don't have to. They flood the supermarkets with wine (...) that costs 1 Euro, and people buy it. Also because it's from Lisbon, people are not used to paying a lot, so the cooperatives say that there is no point in spending money with certification.

(Interview with representative from regional certification authority, 13 January 2014, Torres Vedras)

As summarised in Figure 6, it is a region with significant negative externalities, which mostly reinforce a path of sectoral stagnation. Nonetheless, based on the information collected in the case study it was possible to identify some elements that could lead to improvements. On the one hand, there are two large private firms in the region that replicate the business model of the old commercial houses, but with a stronger emphasis on quality wine. These firms are fully professionalised in terms of their management and marketing strategies. They also employ oenologists with experience of working in Portugal and abroad. They will tend to own land and then work with a network of suppliers, similar to what happens in the Douro region; however, their connection to the region of Lisbon is tenuous, partly because of its limited brand recognition. As a result they adopt a more pragmatic attitude, which places greater distance between themselves and farmers and creates fewer opportunities for knowledge combination and value chain integration. This was exemplified in the following quote, by a representative from the second largest private winemaker in Lisbon.

We control around 400 hectares, but we only own 200 in Lisbon. The rest we buy from people that [our oenologist] used to work with in the past (...) We buy wine from any region, depending on demand. Sometimes in Alentejo, sometimes in Douro. It depends on the year, depends on the awards. If the consumer wants Sauvignon Blanc we give them Sauvignon Blanc, we will not be using local grape varieties just for the sake of it.

(Interview with firm representative, 15 January 2014, Vila Chã de Ourique)

The second group of firms are smaller and also family-based businesses. In this group, the tendency towards professionalisation and the production of quality wine was weaker in comparison with the situation in Douro. Among the interviewees for this project, there were three small firms managed by individuals with training and dedicated exclusively to winemaking. Of these, two were working in small

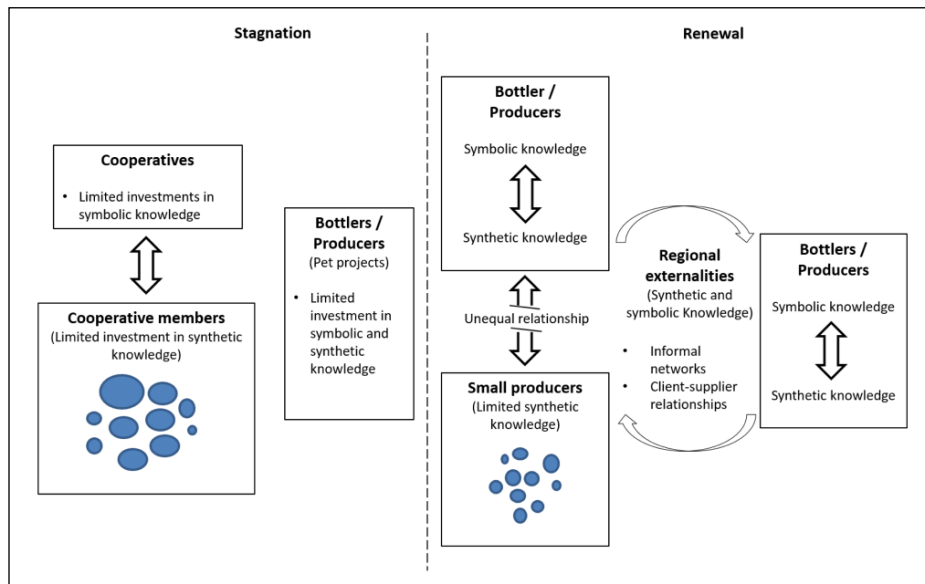


Figure 6. Knowledge bases, vertical integration and processes of stagnation or renewal in Lisbon.
Source: author's research.

niches: one on biological wine and the other on using a unique grape varietal to produce a high-end white wine. According to their own assessment, they were successful but saw themselves apart from most other agents operating in this region. A different group of firms was managed by retirees and who had taken up winemaking out of personal interest. They had a commercial approach to their firms, but lacked a clear strategic vision or business planning. Access to symbolic and synthetic knowledge was limited and based on the periodic use of consultant oenologists.

The fragmentation of value chains and the limited investments in knowledge sharing and enhancement prevents the emergence of strong regional externalities that could encourage firms to upgrade their wine quality. The regional certification authority, CVRL, remains underfunded in contrast to the one in Alentejo, and there is a lack of supporting organisations that could help diffuse knowledge. All these elements create a negative feedback loop, whereby firms continue to underinvest in knowledge, which in turn feeds the negative symbolic associations of consumers towards wine produced in the Lisbon region.

Three regions, three paths. As a summary, Table 4 highlights how the combination of knowledge bases and processes of organisational and value chain integration influenced the renewal of the wine industry in each region. It also helps to illustrate how, in each region, the wine industry is at a different stage of its life-cycle, partly as a result of when this renewal process started and partly due to the interaction between the different dimensions discussed in this paper. Alentejo is the region where both the combination and dissemination of knowledge has been more effective, which has allowed its industry to reach a degree of maturity and market dominance (within Portugal). This maturity has nonetheless generated a form of lock-in which stems investments in high-end, unique products.

In Douro firms have built on existing resources to implement more ambitious strategies in the production of higher value-added, niche wines. These strategies have implied organisational innovations, including the creation of physical and organisational proximity between the different stages of the production process. They have also involved using the symbolic value of a region previously associated with a fortified wine to recast it as a producer

Table 4. Main processes of knowledge combination and valorisation and their impact on renewal of the wine industry in each region.

Region	Process		
	Renewal	Value chains and knowledge combination/dissemination	Current strengths /challenges
Alentejo	Late 1980s: <ul style="list-style-type: none"> • Farm restructuring, technological catch-up and investments in human capital • Incorporation of analytical and synthetic knowledge produced abroad • Symbolic knowledge and organisational innovations aimed at national quality market segment 	<ul style="list-style-type: none"> • Physical and organisational verticalisation of value chains by cooperatives and large private producers • Mechanisms to combine and diffuse knowledge widely across the region • Cohesiveness to regional brand and identity 	<ul style="list-style-type: none"> • Dominance of national market in quality wine segment • Virtually all wine with quality certificates • Region associated with less distinctive/less value-added wines
Douro and Oporto	Late 1990s: <ul style="list-style-type: none"> • Existing resources (raw materials, technology, infrastructure) directed to new use • Analytical and synthetic knowledge already highly developed • Use of symbolic value of Douro brand to search for niche markets 	<ul style="list-style-type: none"> • Multinationals create greater organisational and physical proximity in value chain • Family firms' renewal • Asymmetrical relationships in value chains • Dissemination networks local rather than regional • Cooperatives producing high-quantity, low-quality wine • Fragmentation and low levels of knowledge dissemination • Regional brand not valued 	<ul style="list-style-type: none"> • Well integrated into wine global value chains • Process of renewal underway – including in cooperatives • Fragmentation slows process of renewal and hinders stronger regional externalities • Several emerging or established firms • Possible association with brand value of capital city • Major actors incapable or unwilling to restructure production
Lisbon	Early 2000s: <ul style="list-style-type: none"> • Path dependencies hinder regional renewal • Analytical and synthetic knowledge used to comply with basic regulatory requirements • Negative value of Lisbon brand • Limited production for quality wine segments 	<ul style="list-style-type: none"> • Cooperatives producing high-quantity, low-quality wine • Fragmentation and low levels of knowledge dissemination • Regional brand not valued 	<ul style="list-style-type: none"> • Several emerging or established firms • Possible association with brand value of capital city • Major actors incapable or unwilling to restructure production

of high-quality wines, using a series of branding and marketing strategies. Still, there is an ongoing process of renewal that is incomplete, due to power asymmetries within value chains and fragmented knowledge dissemination networks. In the region of Lisbon, investments in knowledge combination and dissemination have been less pronounced, and are primarily driven by a need to comply with basic regulatory requirements. Emergent firms in the region producing quality wine tend to draw on other forms of brand association (biodynamic wine, unique varieties) or on business strategies aimed at the mass market and detached from a specific association with the regional brand. There is

still the possibility that using the name of the capital city might generate positive symbolic association by consumers, but as it stands the strong path dependencies have prevented the initiation of a new life-cycle that would see a significant renewal of the industry.

Finally, the outcome of these three development paths is visible on the value of their product. Unfortunately, there is no harmonised data for wine prices per region, and the only data available is provided by regional authorities (for Lisbon it is not available). The data available indicates that average price per litre of wine with DOP certificates (usually indicating the highest quality) is slightly higher for the Douro

Table 5. Wine prices (2015) and exports (2014) for wines from Douro and Alentejo.

	Alentejo	Douro
Wine with DOP certificate (EUR/Litre)	3.7 ^a	3.88
With IGP (EUR/Litre)	NA	1.55
Port Wine (EUR/Litre)		5.16
% wine exported over total produced	15.7%	68.9%
% wine exported in Douro excluding Port Wine		34.2%

Sources: CVRA (2016) and IVDP (2018).

^aData from CVRA (2016) was in price per bottle. Since wine bottles are usually 0.75l, the price per litre was estimated on that basis for comparison with data from IVDP (2018).

DOP: Protected Designation of Origin; IGP: Indication of Geographic Protection.

region (Table 5). However, since production in Douro is more fragmented, with a high number of micro firms with limited resources, this value would probably be higher if only the largest producers were included. More importantly, these data show that Douro has been more successful in exporting its output, even when exports of Port Wine are excluded. Since exported wine tends to have a value slightly higher than that for the Portuguese market (Instituto dos Vinhos do Douro e Porto, 2018), these values indicate that the Douro region has indeed been able to achieve higher levels of added value per litre, despite starting this process of renewal at least a decade after Alentejo.

Conclusions

This paper has argued that, for firms in the winemaking sector, the combination of knowledge bases is essential to upgrade the quality of their goods and services and generate added value. It also argued that processes of organisational and value chain integration are important, due to the opportunities that they generate for learning across knowledge specialisations. These two dimensions were used to explain why three wine regions in Portugal experienced different trajectories of development over the past three decades and the mechanisms that stimulate renewal or reinforce stagnation. This analysis points towards three main conclusions.

The first is that it is necessary to restate that innovation is a complex process involving business, technical and symbolic dimensions, which all contribute to the final output (Manniche et al., 2017; OECD/Eurostat, 2005). Although some forms of knowledge are more difficult to measure, especially the tacit dimensions of each knowledge base or symbolic knowledge as a whole, the seminal work of Lash and Urry (1994) and more recent contributions (Hatch, 2013; Pina and Tether, 2016) demonstrate that they are central to firm competitiveness. This paper sought to contribute to this literature by demonstrating that renewal in the wine sector has happened through the coordination and dissemination of a varied set of specialist knowledge (beyond the significant scientific advances that propelled massive changes in the global wine industry, including its geographical dispersion (Giuliani et al., 2011).

The second conclusion regards the vertical integration of organisations. In particular, the literature on innovation should pay greater attention to the value of diversification within the firm, which can facilitate the emergence of boundary-spanning knowledge networks that cut across different specialisations (Helfat, 2015). Since the debates on post-fordism and flexible specialisation (Polenske, 2007), there has arguably been an implicit assumption in the literature that innovation primarily happens in specialised firms. However, this process is far from linear and, particularly in regions where the quality of suppliers or partners is low, vertical integration might be the most appropriate strategy (Malerba et al., 2008).

Finally, the third conclusion regards the dynamics of inter-firm relationships, which has been the main locus of economic geography research on innovation. There is a growing body of research discussing the heterogeneity and network fragmentation within territorial innovation systems (TIMs) (Giuliani, 2007; Marques, 2017a; Rabellotti and Schmitz, 1999). This heterogeneity is strongly shaped by strategic decisions by key agents, particularly lead firms, identified either by their size or their position at the frontier of technological development (Marques, 2017a). The manner in which these firms govern their value chain relationships, or the decisions

regarding how and in what way they engage with competitors or other organisations (such as knowledge producing organisations), shapes the nature and content of knowledge networks and has a self-reinforcing effect on regional development paths.

This last point has important theoretical implications. The emphasis given to systemic links in the TIM literature has often meant ignoring the characteristics and diversity of the nodes in those systems, that is, the firms and their supporting organisations. However, particularly in less developed regions (not to mention developing countries), the lack of absorptive capacity at the firm level, or the quality of supporting organisations, is a key factor in hindering or facilitating innovation activities (Bell, 2009). As such, before there can be an effective system, there have to be organisations that are capable of engaging in a manner that is conducive to generating positive knowledge externalities. Also, studies of system links and networking do not necessarily capture the power asymmetries that exist between economic agents (Christopherson and Clark, 2007), even in fairly homogeneous contexts (Marques, 2017a). These asymmetries shape the processes that sustain the TIM and its outcomes, thereby influencing innovation dynamic and outputs across space.

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Note

1. In the discussion of the Douro region, the word wine is used in contrast to Port Wine, a fortified wine that continues to be the region's main product.

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