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A Quest for Quality: Creativity and Innovation in the Wine Industry of Argentina¹

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Abstract

We study innovation and knowledge generation in the quality wine industry in Argentina. The approach followed provides a useful framework to understand innovation at the market and the individual innovator level. We show that the wine quality revolution in Argentina was driven by economic incentives. Wine producers seek for quality as a differentiation mechanism that allows them to appropriate, at least partially, of the return to innovation. We also show that the quality wine revolution of Argentina, involved a series of experimental and rapid conceptual innovations. All the former produced a radical change in the wine industry of Argentina.

Resumen

Estudiamos la innovación y la generación de conocimiento en la industria de vino de calidad en Argentina. El enfoque seguido provee un marco útil para entender la innovación tanto a nivel del mercado como del innovador individual. Mostramos que la revolución en calidad del vino argentino fue motivada por incentivos económicos. Los productores buscan diferenciarse por calidad como un mecanismo que les permita apropiarse, al menos parcialmente, del retorno a la innovación. Mostramos que la evolución hacia la calidad del vino en Argentina implicó una serie de innovaciones experimentales y conceptuales que produjeron un cambio radical en la industria.

Key words: Innovation, Wine industry, Argentina

JEL Codes: O31, Q13

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1. Introduction

The aim of this paper is to study innovation and knowledge generation in the Argentine quality wine industry. This has rapidly evolved from a bulk wine, domestic oriented industry, to a quality wine producer and exporter within the last three decades. The engine of this transformation was a succession of innovations aimed at improving the quality of wine made by entrepreneurs, winemakers and other actors in the sector. The evolution and changes in the industry are explained by the conception and development of these innovations, this makes the wine industry an excellent laboratory to understand the process of creativity and innovation.

The Californian 1970s wine revolution proved that great wines could be produced outside France. A New World of producers and exporters challenge the venerable Old World and started to compete on new grounds. The monopoly of origin denomination and the realm of terroir ceded room to varietals, cheaper than traditional European products and increasingly becoming good quality competitors. On the demand side, consumption increased in non-traditional geographies and social groups (Villanueva and Ferro, 2019).

In South America, the pioneers of wine innovation and exportation were the Chileans. The process started when a Spanish Winemaker, Miguel Torres, invested in Chilean vines and imported brand new technology to produce high quality wines (Kunc and Bas, 2009). The move was followed by all the industry and Chile became an international player with presence in the world market (Bustos et al., 2007). Approximately one decade later, Argentina began its process of incorporation to international markets as a quality producer and exporter (Stein, 2008). Both countries had important bulk wine industries but nil presence in international markets in the 1970s (De Francesco et al, 2013).

Romer (1990), shows that (endogenous) technological change can work as an engine of (persistent) economic growth. In Romer's endogenous growth model, incentives play an essential role for innovation. Technological change arises as a result of intentional investment made by profit maximizer firms, seeking differentiating their products. The ability of the innovator to profit from the investment is one of the key drivers of the innovation process. Discoveries can be made excludable (appropriated by whom made them) through technology or the legal system attributing patents, brands or other forms of intellectual property rights protection.

In this paper we mainly try to answer the following questions: How innovators in the Argentine wine industry have modernized the industry? Can their actions be stylized and yield lessons for public policy and managerial improvements?

The economic approach to innovation gives an analytical framework to try to respond these questions. The approach rests on case studies and pays special attention to the creative process at the individual level. The analysis distinguishes between two kinds of innovators: conceptual and experimental (Galenson, 2007). Quality wine development in Argentina combined both and gives interesting grounds to learn about the innovation process (Elias (2018) and Elias and Ferro (2018)).

Using the Galenson-Romer framework, we show that one of the most important determinants of the process of transformation of the wine sector were the entrepreneurs who took the risk of innovating in an industry that for many years had been doing the same. These innovations were across the board at all the stages in the value chain. They have in common their objective: all of them were oriented toward increasing the quality of wine and away from producing the traditional table wine. This drastic change was not fortuitous; it was driven by market incentives. Due to the possibility of partial exclusion that allows innovations associated with quality, the private return to innovation on quality wine was greater than on table wines.

We also show that the quality wine revolution of Argentina conceived in the 1980s and consolidated in the 1990s, involved a series of both experimental and rapid conceptual innovations. Conceptual innovations tend to be dramatic, consisting normally in something totally new, which break conventions of a discipline or activity. On the other hand, experimental innovation is gradual and progressive, following a trial and error process. Paradoxically, the experimental approach to innovation that placed Nicolas Catena, one of the most important innovators in the international wine industry, through a process of gradual (trial and error) and persistent innovation produced a radical change in Argentina's wine industry.

Winemakers have made innovations at many levels of the chain value, including vine, production, business, human capital capabilities and public and collective action. Important innovators are those whose work changes the practices of their successors. Whatever the nature of these innovations, its importance ultimately depends on the extent of its influence on other producers. In this paper, we pay special attention at the channels of influence to get an understanding of the diffusion of knowledge.

The quest of quality of the Argentine industry was influenced and shares some similarities with the Napa Valley's revolution led by Robert Mondavi. Mondavi experimental approach and his quest for quality through a long process of experimentation had an important influence in Catena and the Argentine quality wine revolution.

The process involved many innovators and innovations and continues today. In this paper we identify a subset of them and studied their cases, including Nicolás Catena⁵, Arnaldo Etchart, Michel Roland, Paul Hobbs, Susana Balbo, José Zuccardi, Silvio Alberto (Bodegas Bianchi) and Laura Catena (Catena Institute of Wine). Our focus is on private innovation aimed to increase product differentiation.

After this Introduction, Section 2 synthesizes and discusses our theoretical framework on innovation and creativity applied to productive processes. Section 3 analyzes the recent evolution of the wine industry in Argentina, concentrating in its international insertion in the last decades. Section 4 examines conceptually innovations and cases of successful winemakers and institutions who innovated in the industry, with the objective of stylizing lessons useful for public policy and management. Section 5 is for concluding remarks.

2. A Framework on Innovation and Creativity Applied to Productive Processes

In this section, we develop a conceptual framework for analyzing innovation in wine industry at the level of the innovator. The framework combines the Romer (1990) endogenous market-driven knowledge approach, with the Galenson (2006) microeconomic approach to creativity. Romer's approach, allow us to understand the economic incentives of innovators, while Galenson's approach points to the nature and the process of innovations.

2.1 Markets for Ideas and Incentives to Innovate

Romer (1990) emphasizes the role of investments in research and development, motivated in the profit seeking through the discovery and implementation of new products and/or processes. He introduces imperfect competition within an endogenous growth model,

which permits firms the private appropriation of the benefits arising from product differentiation to recover research and development expenses. Endogenous growth depends on incentives to invest in improving technology (to differentiate products, to collect mark ups, to recover costs, to spend in new research and development, to differentiate products, to collect mark ups, to recover costs, to spend..., ad infinitum). The growth process is thus no longer constraint by diminishing returns.

To understand the differences between endogenous and exogenous technical progress, Romer uses a classification of goods of ample utilization in public finance literature. According to this typology, goods can be characterized under two dimensions: rivalry and exclusion. The first is a technological feature; the second is a consequence of technology as well as of the legal system. A good which is rival and excludable (through collecting a price for its enjoyment), is a pure private good, whereas a good which is not rival and not excludable, is a collective, pure public good. As intermediate cases, an increasingly rival and not excludable good is a local or semi- public good (or subject to congestion), whereas a (in principle) non rival and excludable good is semi-private (or "club" good). Table 1 illustrates the concepts with some examples.

Table 1: Rivalry and Exclusion, Public, Public and Intermediate Goods

Degree of Exclusion	Rival Goods	Non Rival Goods
100%	A can of soda	Codified satellite TV broadcasting
↑		Secret recipe for a soda beverage
(%)	A television	Computer software
↓		GPS signal
0%	Fish in deep oceanic waters	Basic science
		Pythagorean Theorem

Source: ©Johan Jarnestad/The Royal Swedish Academy of Sciences

According to Romer (1990), new ideas are far different from most economic goods which are pure private, in particular from physical and human capital, because they are non-rival. The usage of an idea by one agent does not prevent other agent(s) from using it, without affecting its usefulness for both agents.

Due to start-up costs to develop new knowledge and the relatively low (or negligible) marginal costs for their replication, the production of knowledge show increasing returns to scale. Some form of exclusion provides incentives to develop some new ideas although not all ideas are excludable. Within some basic research (such as new theorems), it is difficult or impossible to exclude third parties from its use. In this case, private incentives at the level of the innovator are low, however, the benefits that are not internalized by a firm can be internalized by the industry, as in the case of organizations like Wines of Argentina, created by winemakers, and the Australian Wine Research Institute, created by winemakers and producers.

Bringing the classification of Table 1 to the knowledge world, there are ideas which are rival and others which are complementary to established knowledge (Table 2). On the other hand, rivalry is combined with excludability. Thus, the new ideas, rival of established knowledge and excludable for their adoption are private or exclusive knowledge. A patent, in one extreme, confers its owner full possibility of exclusion. Nevertheless, if such new ideas are not

excludable, their use depends solely on decision of the agents in adopting them. Besides, ideas complementing (non-rival) the existing knowledge if they are impossible to exclude, constitute public knowledge of free access, and instead, if they are excludable, become limited access knowledge, semi-private (or club goods), shared by members of a group who collect for the membership (and access).

Table 2: Public and Private Knowledge

Knowledge	Ideas rival of established knowledge	Ideas complementing (non-rival of) established knowledge
High possibility of exclusion (by a price)	Private or exclusive knowledge (a patent)	Limited access (semi-private or club) knowledge (franchised to members)
Low to nil possibility of exclusion (by a price)	Knowledge subject to adoption decisions (new practices developed by a state run research institute, as INTA)	Public knowledge freely accessible (old practices, affordable and proved)

Source: Own elaboration.

2.2 Differentiated Goods and Innovation: The Wine Industry

Experimental innovations associated to winemakers and brands yield generally private gains whereas some general or conceptual developments can be only partially appropriated. The distinction among both types of innovation for public policy design is important. Gains by differentiating are the market engine for innovate within the firm, and it explains why the wine industry is so dynamic. At the same time, the non-rivalry of some ideas can be considered as a positive spillover to the whole sector.

The quality wine market can be characterized as one of monopolistic competition, which diverges from perfect competition in product differentiation, while differs from monopoly because of the absence of entry barriers. Monopolistic competition differs from oligopoly in the degree of interdependency of the firms: in the latter is more pronounced since sellers are only a few, instead, in the former there are many. “Distinction”, an excludable attribute, is one of the features valued in the great wines. This differentiation allows protecting the innovation process and new ideas that can only be limitedly emulated by other producers.

2.3 Conceptual and Experimental Innovations

In order to have a more detailed characterization of the innovation process, in this section we introduce the innovator’s classification of Galenson. Based on the study of the careers of more than two hundred artists, Galenson (2007) established that in art there are two types of innovators: conceptual and experimental. The former plan their creative journey in advance, while the latter build on the road. A similar pattern can be identified in literature, music, business and other disciplines. Robert Mondavi once said: “wine is art”, thus a Galenson typology application to wine industry seems straightforward.

Conceptual innovations tend to be dramatic, consisting normally in something totally new, which break conventions of a discipline or activity. Conceptual innovators have precise objectives in advance, plan their work and afterward they execute following the plan. By its

nature, this pattern appears early in this type of innovator's careers. Any project is an opportunity to break with past and tradition.

On the other hand, experimental innovation is gradual and progressive, following a try and error process. These innovators proceed tentatively, learn gradually, and probably their most valuable contributions appear at the end of their careers. No project is considered ever finished; accumulation is the rule.

Conceptual innovations are easy to communicate between people working in the same field, sharing a common language. Instead, experimental innovations are difficult to share. Polanyi (1998) names them as tacit knowledge. They should be experimented, in order to internalize them properly. By its nature, experimental innovations are more prone to be privately appropriated, since they are in some sense encrypted while conceptual can be more easily "leaked" to other users, generating spillovers. A conceptual innovation is more simply replicated. It can disseminate through books, or by its embedment in capital goods, while experimental innovation can be shared by means of the mobility of human capital specific to the industry. Geographical proximity favors the externalization of experimental knowledge, as well as the access to a common market of labor and specialized inputs.

The Table 3 summarizes the objectives, methods and nature of the results of each type of innovator.

Table 3: The Typology of Innovators a là Galenson

Innovator Type	Objectives	Methods	Results
Experimental	Imprecise and evolutionary. Objective is an issue or problem.	Tentative and incremental. Try and error.	Slow development of abilities conveys to a body of work.
Conceptual	Specific and repentant (discontinuous). Objective is precise.	Goals are set in advance. Detailed planning.	A specific final product systematically developed.

Source: Elias and Ferro (2018), elaborating on Galenson (2007).

2.4 Romer-Galenson Framework: Private-Public, Experimental-Conceptual

In the generation of new ideas (innovation) the deliberate search of excludable ideas (responding to economic incentives) coexists with serendipity of casual and fortunate generation of non-rival ideas. There is also state action to generate new non-rival ideas, producing public knowledge of free access. To reconcile the above discussions on Public-Private, and Conceptual-Experimental Innovation, it is useful to mix Tables 2 and 3, which is presented in Table 4.

Table 4: Type of Innovation, Rivalry and Exclusion

Innovation	New ideas rival of established knowledge	New ideas complementing (non-rival of) established knowledge
High possibility of exclusion (by a price)	Search of excludable innovations to differentiate profitably products Experimental innovation, replicable if protocols are known (encrypted or	Limited access innovation (semi-private or club) to differentiate profitably members from outsiders Experimental innovation, replicable if protocols are known (subject to

1970	1.836	131	0.002	4	2890	8	0.31	1.33	76.50
1975	2.210	157	0.010	20	14281	40	0.28	1.38	84.40
1980	2.349	167	0.011	21	26604	75	0.45	2.48	83.34
1985	1.574	112	0.020	39	13018	37	0.17	0.64	51.12
1990	1.404	100	0.052	100	35387	100	0.11	0.68	41.30
1995	1.644	117	0.215	411	116247	329	0.09	0.54	41.01
2000	1.254	89	0.092	176	206677	584	0.47	2.24	31.49
2005	1.522	108	0.223	428	374430	1058	0.27	1.68	33.20
2010	1.609	115	0.281	538	812068	2295	0.44	2.89	33.06
2015*	1.498	107	0.270	517	834735	2359	0.48	3.09	28.68

Source: Own elaboration on FAOSTAT. *Last values of production, production index and per capita consumption correspond to 2014.

4. Innovations and Lessons of Successful Innovators

In this section we first characterized innovations and afterwards we concentrate in the innovators role related with each identified innovation. For the first objective (Subsection 4.1), we rest in a typology which analyzed the complete productive chain, and for the second one (subsections 4.2 to 4.4) we use results of interviews with key actors of the process plus secondary sources.

4.1 Characterizing Innovations in the Wine Industry

The quest for quality, motivated by market incentives, has been a main driver of innovation in the wine industry of Argentina. Farinelli (2013), analyzing Chilean and Argentine wine sector modernization, provides a systematic and very exhaustive typology of innovations, which she groups into “Product” (the vine), the “Process” (the winemaking), and the “Organization and marketing” (the trade). We add one point to the last one and two more sets of innovations, which can be called “Increased Capabilities” (the human capital) and “Collective and Public Action” (the institutions).

Among the first group, concerning the grape and soil, are: (1) the identification of the best terroirs and clones for each variety, (2) the introduction of new varieties additional to the more common, (3) the introduction of drip or furrow irrigation in replacement of old flood techniques, (4) vineyard’s trimming to limit high quality grape production, and (5) organic or biodynamic cultivation.

Within the second group, related with technology embedded in capital goods, are: (6) the replacement of old big casks for wine fermenting and ageing by new-brand little French and American oak-barrels, (7) adoption of stainless steel tanks for fermenting, (8) new refrigerating devices both for fermenting and ageing, (9) replacing of old vertical presses by new pneumatic ones, (10) use of gravity flow mechanisms.

Between the third group, of the commercial aspects, are: (11) new brands linked to geographical identification, (12) participation in international competitions, (13) marketing through social networks, (14) recreational and cultural activities related with wine, such as wine tourism, shows and gastronomy, (15) sophisticated winery architecture for promotion, (16) new containers (including canning).

The fourth group, of the human capital, include: (17) hiring international consultants, (18) joint ventures with world class international partners, and (19) a new generation of local oenologists.

The fifth category, of sector institutions, comprehends (20) partnerships between private and public sector, (21) purely public action, and (22) purely private collective action.

Table 6 resumes our economic framework to characterize the process of innovation and allow organizing the information. It combines the stages of the wine value chain with the innovations' classification of Galenson (experimental and conceptual) and Romer (degree of private appropriation of the innovation and spillovers). The innovations characterized as "Replicable or With Spillovers" are only transient privately appropriated, and they are mimic by competitors. Nevertheless, they provide advantages for the pioneers.

Table 6: Innovations in the wine chain value

Level of Innovation	Mostly Experimental	Mostly Conceptual	Private, Public, Club or Semi-Public
Vineyard			
	Study of Terroirs and Clonal Selection		Private
	New Varietals		Private
		Drip or Furrow Irrigation	Replicable or With Spillovers
		Trimming	Replicable or With Spillovers
		Organic or Bio-dynamic Cultivation	Replicable or With Spillovers
Winery			
		Oak-Barrels	Replicable or With Spillovers
		Steel Tanks	Replicable or With Spillovers
		Refrigeration for Fermenting and Ageing	Replicable or With Spillovers
		New Pneumatic Presses	Replicable or With Spillovers
		Gravity Flow Mechanisms	Replicable or With Spillovers
Trade			
		Brands Associated to Origin Denomination	Club Goods
	International Competitions		Private
	Marketing on Social Networks		Private
		Cultural and Recreational Activities	Replicable or With Spillovers
		Sophisticate Winery Architecture	Replicable or With Spillovers
		New Containers	Replicable or With Spillovers
Human Capital			
		Hiring of International Consultants	Replicable or With Spillovers
		Joint Ventures with World Class Partners	Replicable or With Spillovers
		New Generation of Local Oenologists	Replicable or With Spillovers
Institutions			
		Public-Private Collaboration	Semi-public
	Purely Public Action		Purely Public
		Private Sector Collective Action	Club Goods

Source: Farinelli (2013) and own elaboration.

At the product level, we identify one purely experimental innovation and one purely conceptual one: the terroirs and clone identification and the drip or furrow irrigation respectively. The first one is highly privately appropriating while the second is easily replicated.

The remaining three innovations at the product level are mixed: benefit the winery adopting them but they are also replicable, and it is expected that yield spillovers. The new irrigation techniques allow moving the production from the neighborhood of traditional soils (chosen in part because of the availability of water in lower areas where it came by gravity), to high areas, where water was very scarce and the weather more extreme. The new irrigation techniques were in principle expensive, but in part this higher cost was compensated by the incorporation of land initially marginal (and cheap) with respect to the activity.

At the process level, capital goods have embedded the innovations, and all the main wineries bought those machineries to replace old ones. The peculiar macroeconomics of the country influenced these innovations: from being a closed economy, the country opened its current account in the 1990s, in a context of overvalued local currency and these factors favor the massive import of new capital goods which reshaped the industry. The sector modernized in a few years. By their nature, these innovations are conceptual and easily replicated.

Concerning the trade or business levels, many tendencies converged: the declining local market, the possibilities abroad, the new communication technologies, the search of new business. In general, these innovations involve elements of concept but also of experimentation. The most appropriately innovation are those of participating (and winning) in international competitions and the social network activities for brand image creation. But there are elements of country and region reputation with externalities to the whole industry. Origin denomination creation is clearly a “club” good: the prestige of a region benefits all its members. Activities related to wine (tourism, culture, gastronomy) and winery architecture are similarly things which benefit individually and collectively the sector because of its spillovers, and they are replicable with certain investments. Recently, the industry is trying to innovate in containers. Since the beginning of the innovation wave in the local industry, by regulation, wines should be bottled in origin, which was seen at the moment as a way to increase vertical integration of the local production. Nevertheless, consumer demands and freight costs are influencing the experimentation on new containers, such as aluminum canning or other ways to transport and selling quality wine cheaply.

Increased capabilities refers to human capital development, and it follows a logical path: first, the hiring of international experts permits closing the gap with the frontier of best practices; second, the partnership with world class wineries implies access to “club” goods and signals prestige and recognition; third, the “import substitution” happens, with the accumulation of skills and experience in local human capital, learned in the new techniques and practices. The three components are in part appropriated and in part replicable: another firm can hire the same consultant; partnerships can exchange loyalties and local human capital is mobile among wineries.

In the institutional aspects, the first is conceptual, and it relates with the generation of a common strategy for the country and the industry. It implies the generation of public goods and externalities for the whole, combining the articulation of the public sector with the needs revealed by the private sector (activity of COVIAR, for example, see below). The second includes actions for scientific and technical development of public knowledge, specific experimental innovations in basic science and technology, which benefits the whole sector as well, through public goods in sanitary, genetics, climate and data collection for the sector (activity of INTA and INV, for example, see below). The third implies the generation of semi-private or club goods, for members of the agreement, with the potential of spillovers. It is mostly conceptual (activity of Wines of Argentina, for example). In the past, when the industry was bulk wine producer almost exclusively, the state focused in regulating the output surplus, sometimes with policies which yield more overproduction. Nowadays, the action seems more coherent, with the strategy of focusing in international markets of high-quality products. The

local consumption of bulk wine has continued to reducing, facing an increasing competition of beer and non-alcoholic beverages.

In what follow, to examine the innovations black box and get the details, we go deep into how these innovations were develop by analyzing specific innovators and successful winemakers. We will concentrate in three sets of innovations: those concerning the product, which are mostly private and experimental, and privately appropriated, those which modified the human capital of the industry, moderately appropriated by the public sector, but undeniable source of endogenous growth and to those related with the institutional development, which involve mostly public goods, externalities and club goods.

4.2 Innovation in Product

A Quest for Quality

As mentioned earlier, "Distinctiveness" is one of the attributes that is sought in the elaboration of great wines, an excludable attribute in Romer's classification. Since the differentiation in the sector occurs through quality, a large body of the innovations in the private sector is, not surprisingly, aimed at improving it. This differentiation through quality allows to protecting innovation in a partial way, what allows the generation of innovations and new ideas that can be emulated partially by other producers. These innovations, listed in the first column of Table 6, were across the board at all the stages in the value chain. They have in common their objective: all of them were oriented toward increasing the quality of wine and away from producing the traditional table wine.

Nicolás Catena, one of the most important innovators in the international wine industry, was the pioneer who produced the change in the way of producing wines in Argentina and with his success in export markets showed that it was possible to compete in the international quality wine market (Elias, 2018, Elias and Ferro, 2018). Catena's experimental approach was a key aspect for most of the innovations concerning the development of wine quality. Experimental innovators consider their work as a process of searching: as research. In his process of searching, without realizing, Catena developed an ambitious research agenda that currently is leaded by Laura Catena and the Catena Institute of Wine and involves many research institutions, including UC Davis, Universidad Nacional de Cuyo, IBAM and CONICET.

The oenologist and winemaker Susana Balbo highlighted the relevance of differentiation through the quality of the wine⁶, an idea that was difficult to implement considering the short run costs of replacing cheap common (high production) grapes with more expensive quality (low production) grapes. She experienced herself this difficulty in her first attempt to implement the idea at her family vineyards during her studies, after comparing costs and yields her brother didn't follow her advice.

Arnaldo Etchart, a winegrower from Cafayate, also believed that the path for development of the wine industry was to improve quality. His idea was that quality wines could be produced locally by combining the appropriate knowledge and human capital with the local resources, but he also realized that nobody in the local market knew how to do it. With this idea in mind, Etchart brought the French expert Michel Rolland to Argentina in 1988 to break the local practices of wine producing (Elías and Ferro, 2018).

⁶ Personal interview at Susana Balbo Wines, Mendoza, 4/29/2019.

Both Catena and Etchart realized that quality was the path for success for the local wine industry, but they reached the idea with different approaches. Catena did it in an experimental (inductive) way, by experiencing the Californian wine revolution, Etchart in a conceptual (deductive) way, when a container of his wine was returned from Europe because the color had faded from red to pink.

The quest for quality as a differentiation mechanism continues today and manifests itself in a different way. The winemaker Silvio Alberto points out that "*All the innovation, all the focus of the oenology is placed today in [terroir].... The terroir is not only the land where the vine is planted. The terroir is the set of factors that cause the plant to develop, from climatic factors, the ground floor, to the human factor.*"⁷

In the same line, for Laura Catena⁸ the deep identification of the Terroir in very small parcels is an extreme form of differentiation.

Influence of Robert Mondavi and the Napa Valley's Revolution

The transformation of the industry in Argentina was influenced and shares some similarities with the Napa Valley's revolution of the 1960s led by Robert Mondavi. Catena recalls, from his stay in California as a visiting professor at UC Berkeley in the early 1980s, the idea of trying to replicate the California experience in Argentina. At the time, the common knowledge was that only French can make quality wines.

Similar to Catena learning experience at the Napa Valley in the 1980s, Robert Mondavi also learned about a different way of producing wine by experienced it for himself. In 1962, he visited nearly fifty wineries of Europe. There he experienced for himself the beauty of pairing a fine meal with fine wines, and marveled at the subtlety and complexity of the wines he tasted. He noted the methods the French wineries employed, particularly the concept of small: producing wine in small batches—a far cry from bulk manufacture—and aging in small oak barrels. Mondavi returned to California with a transformed concept of the heights to which California wine could aspire (Briscoe, 2018).

This way of transmission of experimental knowledge was envisioned by Carlos Tizio Mayer, an agronomist, M.Sc. graduate from UC Davis and current (August 2019) President of the INV. In 1991, he led a tour to visit wineries in California organized by INTA and CREA. This visit to the Napa Valley represents a milestone for many of the winemakers and viticulturist who participated in the tour. They also took some master classes at UC Davis with top viticulture professors. During the visit, the American revealed the secrets of their sudden success (Mount, 2013).

Drip Irrigation

The introduction of Drip Irrigation was a key development in the wine industry. According to Carlos Tizio Mayer, it is the most important development in the Argentine wine industry because it allowed to developing vineyards in other good areas and in particular in high altitude areas.

⁷ Ibid footnote 8.

⁸ Ibid footnote 4.

Nicolas Catena was the first one to introduce it in the early 1980s as a result of his experimental approach. He brought the technology from Israel (Catena, 2016).

During the course of these investigations, Catena evaluated a fundamental factor: comparing the average rainfall in Mendoza with the averages of Europe and California, he realized that due to the scarce rainfall in Mendoza and the strict dependence on irrigation, the producers had a huge control over the amount of water that each vineyard needs to receive during the growing season. Then, he began an important study on the effects of irrigation control.

New Varieties: Malbec, High Altitude Malbec and Torrontés

The first wave of innovations in Argentina was oriented to improve the wine making process. That was a very significant change where the Malbec began to be known internationally. At the time, there were Malbec vines planted, but Argentines wanted to work other varieties (such as Cabernet Sauvignon and Chardonnay), and Malbec was used mainly to give color to local bulk market. The appearance of what was called the Argentine Malbec marked a milestone in the wine world. The discovery of the High Altitude Malbec is another phenomenon that was also very novel because it is a different type of Malbec. While both stages sequentially produced a significant improvement in the quality of wine, at the same time it highlighted the differences in flavors across regions and led to the exploitation of new (high altitude) areas.

This grape was used in blends for its color and it was recognized as a resistant variety for the extreme conditions of the local weather. Nevertheless, the first attempts to develop world class wines used Cabernet Sauvignon grapes among reds and Chardonnay among whites, trying to replicate the Californian path. Catena's daughter Laura convinced her father Malbec would be well received. Catena's father had been also confident with the possibilities of Malbec. The 1996 vintage was Malbec's watershed, encouraging him to plant at different altitudes and blend across microclimates. With the success of Malbec, Catena decided to end his attempts to produce similar wines to Bordeaux ones, based on Cabernet Sauvignon grapes, instead offering the consumers a new flavor and aroma which gained the international market attention.

At a certain point in his quest for high quality, Catena offered his wines to Jacques Lurton, a French reputed winemaker. This expert compared Catena's wines with those of Languedoc in France, a comparative hot place with lower quality on average than the best French wines. Thus, in his search for lower temperatures, Catena resolved to move all future plantings to southern and higher areas of Mendoza, to the Uco Valley at 1,440 meters over the sea level (Rose, 2009).

It was an experiment, these colder places face two major risks: one was the frost (early and late), and the other one was that the grapes could not ripen. He planted there seeking to learn: there was absolutely no guarantee of success (Personal Interview with Nicolás Catena, 2017). He made trials with Chardonnay, Cabernet Sauvignon, Malbec and Pinot Noir. . Later in the 1990s, the Malbec improved, they won the acceptance of international markets and local producers started to grow Malbec.

The Malbec behaved not just better with the cold, but produced something new, original. Catena was surprised by the response of Malbec to high altitude and cold weather. These experiments lead to the birth of the High-Altitude Malbec, Catena second's experimental

innovation. Trials with clones and experiments with altitude and lower temperatures led to the realization that sunlight intensity at higher altitude could substantially improve flavor and aroma. Low temperatures, high sunlight intensity and the poor soils near the Andes turned out to be an ideal blend, with quality controlled by strict irrigation (Elías and Ferro, 2018).

In the same line, Michel Rolland, who arrived in Argentina to work together with Arnaldo Etchart in his winery in Salta, developed premium wines in high altitude with mild climate in a zone under the Tropic of Capricorn, at 2,000 meters over the sea level.

Currently considered one of the top women winemakers in the world, Susana Balbo was the first graduate in oenology in Argentina in 1981, and the first to work as a winemaker in the country.

Her first job after graduation was in “Sucesión Michel Torino” in Salta, a northwest province, where she worked for 9 years. There she managed to transform the quality of the table wines of that area in particular, the Torrontés, a white grape with local character, and nowadays an iconic Argentine product –even not as famous and successful as Malbec. And she succeeded in selling it to the First Class of Pan American Airlines

During his second year in Salta, she organized the first Winegrowing Meetings of the Northwest of Argentina. She invited her professors and colleagues from Mendoza to give lectures seeking to disseminate scientific knowledge in the search for greater support and dialogue. Her Mendoza colleagues were impressed with the quality of white wines they were producing in Cafayate, because once Balbo did it, other wineries in the valley started to emulate her practices.

Years later she decided to bring the Torrontés variety to Mendoza, to the cold areas of Altamira, with different soils than those in Salta. And she managed to produce a totally different Torrontés. It is interesting to emphasize that the Torrontés from Etchart Winery was the first wine of Argentina entirely varietal in the 1970s, when the predominant concept was to produce blends (locally known as “cortes”).

José Alberto Zuccardi, leads the third bottled wine exporter in the country. Its winery, named after the family name, had experienced with non-traditional varietals, with international success with Tempranillo, and also experiencing with locally unknown grapes such as Aglianico, Arinarnoa, Ekigaina, Malvasia Nera, Nero Amaro and Nero D’Avola, etcetera.

Terroir

In France, the quality of the wine is attributed to the *terroir*⁹. There is the belief that the role of a winemaker and the techniques used in the elaboration is to bring out the expression and the character of a wine's *terroir*. This theory is the basis behind French wine differentiation strategy by region, vineyard, or AOC more prominently than the grape variety. However, the causal relationship between the climate phenomenon and soil composition, and the quality is not clear.

The effort to understand and explore these differences, led eventually to dig into the theory of the *terroir*. This entirely new phenomenon for Argentina is an extreme form of differentiation that provides strong incentives to invest in its development. Laura Catena has

⁹ This does not mean that processes do not matter. Since the 1980s, investment in vineyards and cellars in Bordeaux has been enormous, from high-tech wineries and A-list consulting enologists to the finest oak barrels and bottling lines (Balter, 2019).

the idea of digging into the theory of the *terroir* and applying it in Argentina when she was 28 years old with basically no work experience in the wine business.

Laura Catena founded and manages the “Catena Institute of Wine (CIW)”. To start the CIW was one of the first things she did when she started working at her family winery. The Institute was founded in 1995 with the aim of using scientific method to preserve nature and the wine culture. CIW started to study soil, climate and all other aspect of importance to produce a “grand vin”. It began to plant vines in high altitude and to explore micro-terroir, studying every part of the terrain, its characteristic and its ecosystem.

In her account of the story of the Adrianna Vineyard, Laura Catena (2015) explains that from the beginning they saw a big difference in flavor between Gualtallary Alto, where the Adrianna Vineyard is located, and areas further south which were at lower altitudes. They were getting extraordinary fruit quality in these other areas, but the flavors were different.

After observing that there was strong heterogeneity across vines in terms of their vigor and size within the Adrianna Vineyard, Laura Catena decided to devote resources to understand the soil variability and the different parcels within the Adrianna Vineyard. At that time, they didn't understand the geological origins of the site and how this diversity would enhance quality and an even extreme form of differentiation.

When they started their studying the soils, they were making 5 soil pits per hectare. After a decade of study, with 70 soil pits per hectare, they have a much deeper understanding of the vineyard. They vinify between 200 and 300 separate lots at Adrianna and usually keep them completely separate in barrel, so that they can each run their natural fermentations.

The CIW have collaborations with many research institutions, including the University of California, Davis, and the National University of Cuyo. Working in intermediate questions allows them to build a bridge with other institutions like INTA and CONICET.

4.3 Human Capital: Hiring International Consultants and Developing a New Generation of Oenologists

Whereas the transfer of conceptual knowledge can occur remotely, it usually consists of well-defined concepts that can be codified to some extent. An important part of the transfer of experimental knowledge is done through the movement of Human Capital specific to the Industry. Within the same region, the geographical proximity between producers facilitates the flow of experimental knowledge (knowledge spillovers) and provides access to a common labor market of specific human capital and specialized inputs.

As we discussed in section 2, the diffusion of conceptual innovations is easier than experimental innovations. Once a conceptual innovation comes to light, its replicability is relatively simple. After the irruption of high-quality Californian wines on the international stage in the 1970s, Michel Rolland introduced new techniques to improve wine quality by concentrating on vineyard performance, going against the well-established theory of the *terroir* as the main source of wine quality. It started in Bordeaux in the early 1980s, after an excellent harvest in 1982, Rolland was able to develop a group of well-defined techniques that applied in a systematic way and allows to produce a uniform quality of wines (fruity, rich and concentrated) in different wine regions. In fact, some wine experts consider Rolland's conceptual approach as a one-size-fits-all approach to winemaking and criticized it, arguing that allegedly it leads to the homogenization of wine (Coleman, 2008). They claim that the wine regions and the individual producers are losing their identity by producing similar wines.

The main conceptual innovation of Michele Rolland was to introduce techniques that improved the grapes and allow to obtaining good quality young wines. Shortening the horizon to produce good quality wines has a positive financial effect. His winemaking techniques allow him to produce good wines after only one to two years of aging, thus investors can recover their investment in a shorter period.

In contrast, experimental innovations should be experienced to understand and incorporate. The first innovation of Nicolás Catena, the use of what he calls the Californian-French technique to produce quality wines in Argentina begun to develop early in the 1980s where he experienced the new and revolutionary Californian concept to achieve wines that can compete with the French (Mount, 2013).

The use of the international market of human capital specific to the wine industry was an important initial development for the diffusion of the new practices. Nicolas Catena, Arnaldo Etchart, Bodegas Bianchi, among others winemakers, all hired international consultants. The concept that lower productivity per surface unit meant greater quality was a revolutionary conceptual innovation in Argentina introduced by Paul Hobbs and Michel Rolland, who faced a fierce resistance. The production of the new specific human capital over the revolution was another development that reinforced the process.

5. Concluding remarks

The purpose of this paper is to understand innovation and knowledge generation in the quality wine industry in Argentina.

We start by connecting two strands of the literature. Firstly, endogenous growth theory, which highlights the nexus between knowledge generation and its diffusion, with economic growth, distinguishing among free knowledge with pure spillover effect and a potential of endogenous growth from knowledge which is at least transiently privately appropriated, which generates incentives for further innovations. The latter because in a world of imperfect competition, differentiated goods means higher profits. When goods are rival and excludable, they are purely private, when they are non-rival and non-excludable, constitute purely public goods, and the intermediate cases help identify “club” or semi-private and semi-public goods. Secondly, the characterization of innovators as conceptual and experimental, identifies ways of creating and disseminating knowledge. Conceptual innovations are codified and can more easily be learned and spread, while experimental innovation is more private appropriated and difficult to communicate.

Putting all pieces together, the sector experienced a revolution by innovating swiftly, responding to macroeconomic circumstances plus microeconomic incentives, and combining the introduction of knowledge in several aspects of the activity. Some of the innovations were introduced through massive modernization of machinery, but we are especially interested in purely private and mostly experimental innovation at the product level (concerning varieties, clonal selection, irrigation and study of terroir) plus mostly conceptual innovation at human capital and institutional level, with more potential of spillover to the whole sector.

The innovations at the product level, yield transient advantages to the firms which spend money and invest time on them, and induce other producers to try to replicate the pioneers actions. At human capital level, the first wave of innovations implied “imports” of experts’ advice and joint ventures with successful international players, while the local capabilities become to develop in the form of a new generation of local oenologists. Institutions

responded accordingly and public action continues to produce public goods and externalities at technological normative and sanitary control levels, a fruitful collaboration started to develop within the private sector to market the brand “Argentina” and between public and private sector to promote internationalization of the industry as collective actions.

Romer’s point is about the intensity of public good nature of an idea and the incentives to produce it, while Galenson’s approach is about how ideas are conceived, how to acquire them and how they diffuse. Combining both yield some stylized facts:

- 1) Private efforts of R&D will focus in privately appropriating knowledge.
- 2) Experimental innovations are more likely to be privately appropriated by the way this knowledge is stored and communicated.
- 3) Some privately appropriated innovations will have that character only transiently and will become common knowledge in a period; other innovations would be patented and the possibility of privately appropriation will be last more time.
- 4) Some knowledge will be public or club good, by its conceptual nature which implies higher likelihood of diffusion, and replication at low marginal cost.
- 5) Club (semi-private) innovations would be produced by the private sector, if it can associate members for collective actions, and there is a space of collaboration between the public and private sector in some common strategies of the sector producing semi-public innovations.

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