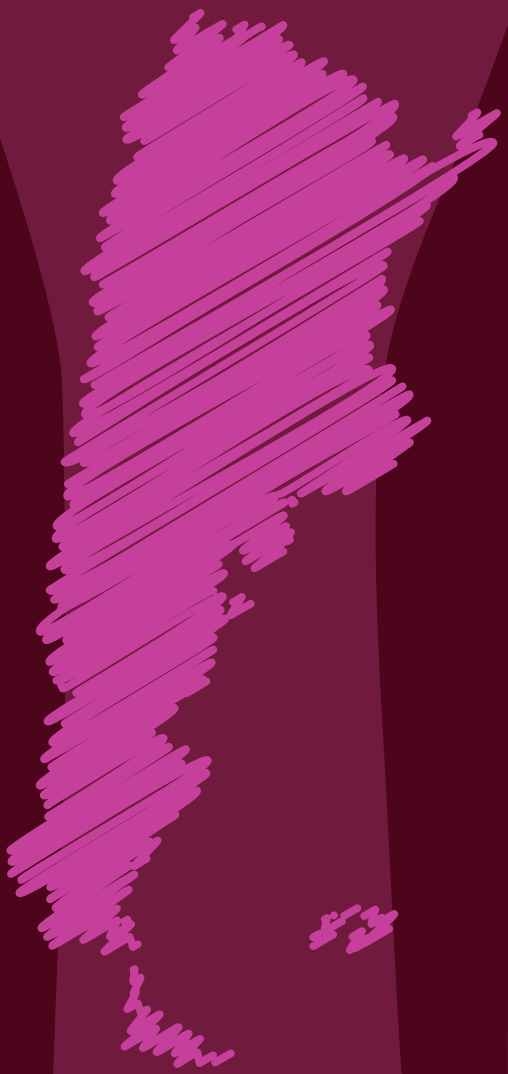
Knowledge and Innovation Analysis in the Wine Industry in Argentina

FOR THE ENVIRONMENT, RURAL DEVELOPMENT & DISASTER RISK MANAGENMENT DIVISION (CSD / RND)



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ABSTRACT

The Argentine wine industry has undergone a huge transformation during the last forty years. It went from being an industry that mainly produced common table wine to becoming one focused on international quality wines.

In this study we apply the economic approach to creativity to understand this process. The approach is based on the case study and begins with the idea that, in order to comprehend the innovation process, it is necessary to devote a lot of attention to understand how innovators produce their discoveries. In the study, we show that one of the most important determinants of the local wine industry transformation process was the human talent; namely, the entrepreneurs who took the risk of innovating in a relatively static industry in this regard. Changes were made along all stages of the value chain, and they were mainly oriented to the improvement of the wine quality, taking part of a dynamic process that combines conceptual and experimental innovations.

This sustained innovation process was not fortuitous; it was driven by market incentives. Wine producers seek quality as a differentiation mechanism that allows them, to appropriate the returns of innovation.

CONTENT

Introduction

"MAKING A WINE OF EXCELLENCE IS A COMBINATION OF AGRICULTURE AND TECHNOLOGY AND IS NOT FAR FROM WHAT CREATING THE IPHONE MIGHT BE, AS IT ALSO REQUIRES A VERY IMPORTANT KNOW-HOW."[1]

The Argentine wine industry has undergone a huge transformation during the last forty years. It went from being an industry that mainly produced common table wine to one focused on international quality wines. A succession of innovations aimed at improving quality, made by entrepreneurs, winemakers and other sector actors, were the engine of this transformation. The evolution and changes in the industry are explained by the conception and development of these innovations, which make the wine industry an excellent laboratory for understanding the creative and innovative process.

1. Laura Catena, La Nación, 30/12/2018.

Although the discovery of wine in ancient times presumably occurred by accident, the development of the art of viticulture and oenology was widely driven by incentives and market conditions. In this technical note we use the economic approach to creativity (predictive) to understand this process. This approach is based on the case study and begins with the idea that, to understand the innovation process it is necessary to devote a lot of attention to comprehend how innovators produce their discoveries: how artists create masterpieces, how engineers and entrepreneurs create new technologies and products. The main drivers in the analysis, are the innovators themselves.

The analysis starts from the characterization of Paul Romer (1990) on the internal process of ideas generation and distinguishes between two types of innovations and innovators: conceptual and experimental (Galenson, 2007). We use this framework of analysis to show that the quality wine industry is a case, in which there are incentives to innovate due to the ability to appropriate its benefits through product and brand differentiation. As differentiation occurs mainly through quality, plenty of the industry`s innovations are aimed at improving it.

In the early 1970s, the appearance of top-quality wines in California demonstrated that it was possible to produce them outside of France. The wineries of the "New World" began to compete with the "Old World Wine". The Controlled Denomination of Origin (DOC) and the "terroir monopoly" gave rise to varietal wines, with lower prices than the former ones, and increasingly better quality.

A decade later than Chile, Argentina began its incorporation into international markets as a producer in the New World. We will use the Galenson-Romer approach to innovation to show that **one of the most crucial determinants of the process of transformation of the local wine industry was human talent**; in other words, the entrepreneurs who took the risk to innovate in a relatively static industry in this regard. Changes were made along all stages of the value chain and they were aimed at the improvement of wine quality. This sustained process of innovation was not fortuitous; it was driven by market incentives.

Due to the possibility of exclusion permitted by the innovations associated with quality (the exclusivity given by a commercial brand, for instance), the private return of top-quality wines innovation was higher than the table wines.

We also show that Argentina's quality wine revolution, conceived in the 1980s and consolidated in the 1990s, was a dynamic process that combined both conceptual and experimental innovations (Elias, 2018, Elias and Ferro, 2018). Conceptual innovations tend to be dramatic and usually consist of the production of something entirely new, which breaks the conventions of a discipline or activity, On the other hand, experimental innovation is gradual and progressive, following a process of trial and error.

Paradoxically, Nicolás Catena's experimental approach to innovation, through a gradual (trial and error) and persistent innovation process, produced a radical change in the Argentine wine industry. *"Nicolás Catena is the great precursor of the change that took place in the Argentine wine industry: the opening of the industry abroad, starting to export, bringing people from outside to teach you, the chance that he gave you in his companies to go abroad to train you and the possibility to make elaborations in wineries in the United States, Europe, or anywhere he wants to send you, but always with the aim of obtaining the highest quality"* [2] says winemaker Silvio Alberto from Bodegas Bianchi.

Robert Mondavi and the Napa Valley Revolution had a great influence on the process of innovation and change in the sector, it involved several innovators and continues today. In this note we identify and analyze some of these innovators, both individuals and companies, including Nicolás Catena, Arnaldo Etchart, Michel Roland, Susana Balbo, José Zuccardi, Bodegas Bianchi, Laura Catena, Bodega Durigutti, Doña Paula and Silvio Alberto. Organizations associated with the sector, from the government, producers and research, such as the Catena Institute of Wine, Wines of Argentina (WofA), The National Wine Institute (INV) and the National Institute of Agricultural Technology (INTA) also participated in the process.

After this introduction, in Section 1 we carry out an analysis of the recent evolution of the wine industry in Argentina since the 1960s, which focuses on its international insertion in the last three decades and its importance for the Argentine economy; we refer to the appendix for a detailed statistical study of the world market (production, international trade, consumption and prices). In Section 2 we present the conceptual framework for the study of innovation and creativity processes applied to production processes. In Section 3 we analyze innovations, characterizing them, and showing highlighted leading innovators through case studies of successful winemakers in Argentina. The latter section concludes with the results of a survey conducted to wineries, which granted us the possibility to weigh the importance of the innovations found and its relevance for the industry. In Section 4, we refer to the knowledge generation and internalization of its benefits, for which we analyze the experiences of the United States and Australia. Finally, in Section 5 we present lessons learned.

2. Personal interview conducted at the Enzo Bianchi winery, Mendoza, April 30, 2019.

1.

Analysis of the recent evolution of the wine industry in Argentina and its insertion in the world market

According to the Argentine Wine Corporation (COVIAR, 2018), in 2017 the wine chain represented approximately **0.4% of Argentina's gross domestic product,** developed on an area of 218,000 hectares. In monetary terms, the added value of the wine chain in 2017 was USD 2,543 million*. The added value of wine represents 3% of the domestic manufacturing industry and 10% of the added value of the industrial sector of food and beverages. The estimate of direct jobs generated by the whole value chain is 106,000, to which 279,000 indirect jobs are added.

(*) AR $ 37,461 million at an average exchange rate of AR $ 13.55 = USD 1

In 2018 there were 218,000 hectares of vineyard, distributed in almost 24,000 farms, with an average area of 9.5 ha per vineyard[3] (INV, 2019). Around 350,000 hectares of vineyard in the late 1970s were substantially reduced after a historical maximum and then in 1990 it had reached 210,000 hectares, a figure which has remained stable. Meanwhile, the average vineyard area has grown as a result of the industry concentration: it went from 36,000 vineyards in 1990 to about 24,000 (INV, 2019).

In 2018, 2.573 million tons of grapes were harvested, 31% more than the previous year, along with the production of 14.5 million hectoliters of wine, 4.77 million hectoliters of must and 1.6 million hectoliters of grape juice[4] (INV, 2018 a). Wine exports, by volume, was 9% of the production. Meanwhile the production and export of must in the last thirty years has favored the channeling of production that was previously being used to make common wine.

Wine production has decreased from an average of approximately 25 million hectoliters (2.5 million tons) from the mid-1960s to the mid-1980s, to approximately 15 million hectoliters (1.5 million tons) since the 90s. With little fluctuations, production has remained around that value to date. Exports were virtually non-existent until the mid-1990s.

The wine exports in value in 2017 was USD 953 million FOB[5], of which USD 809 million were of wine and USD 88 million were of must. In the same year, USD 49 million raisins and USD 6.3 million fresh grapes were exported. The exported volume of wines was 2.23 million hectoliters, 87% of these being varietal.[6]

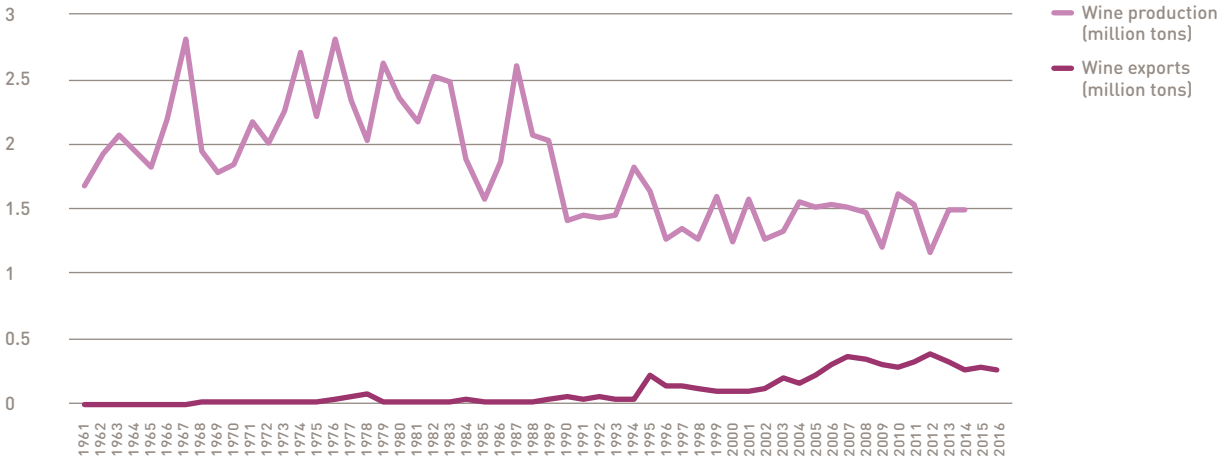
3. This surface was distributed in 18 Argentine provinces, but 70% corresponds to Mendoza and 21% to San Juan. 92% of these hectares were used in 2018 for grapes to make wines and musts, 6% for fresh consumption and 2% for raisins. In wine grapes, red ones (57%) predominate over white ones (19%) and pink ones (24%). Malbec is the predominant variety with 43 thousand hectares (INV, 2019). The "noble" varietals have gained relevance in the last thirty years over the previously predominant creole (Criolla) with which common wine was made.

4. From the grape harvest, 95% went to winemaking, 4% to fresh consumption and 1% to raisins. Almost a 40% of the grapes that entered in the establishment were own production.

5. That year, Argentina exported USD 57,879 million, so that the share of the wine complex in the total was 1.64%. In terms of the industry's added value (USD 2,543 million), exports participated in 32.5%.

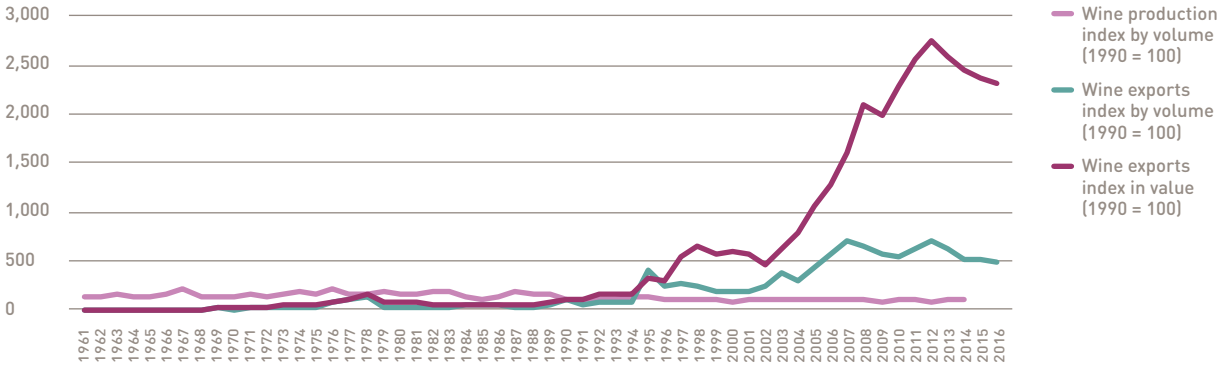
6. An 86% of the volume was sold in fractions and the rest in bulk. Malbec was the predominant strain of exported varietals (60% of the total).

FIGURE 1. ARGENTINE WINE PRODUCTION AND EXPORTS (MILLION TONS)



Source: Elaborated by the authors based on data from FAOSTAT.

FIGURE 2. EVOLUTION OF ARGENTINE PRODUCTION, EXPORTS IN VOLUME AND EXPORTS OF WINE IN VALUE



Source: Elaborated by the authors based on data from FAOSTAT.

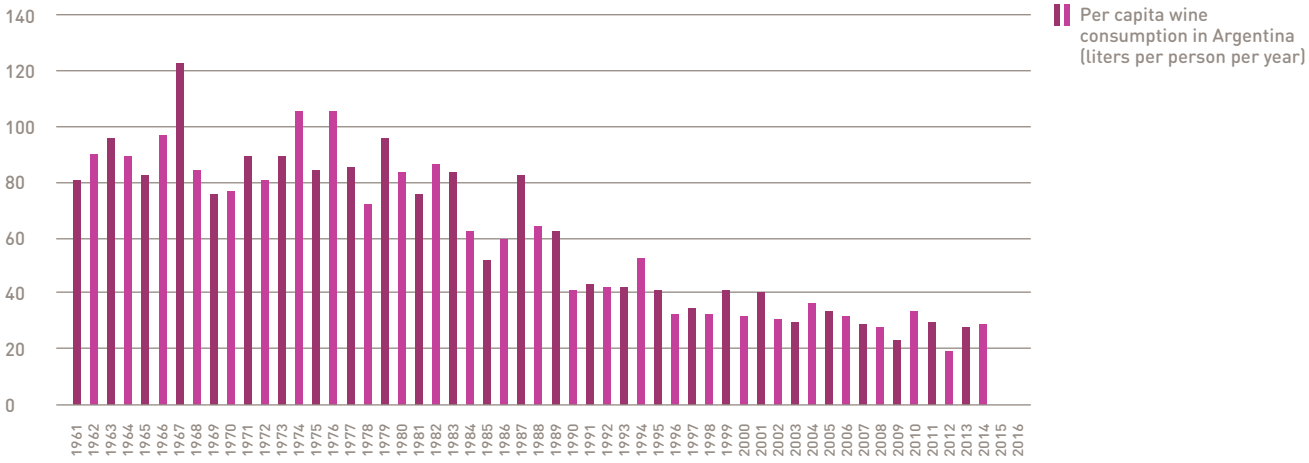
The main destinations for exports are the United States (one third of the total), the United Kingdom, Canada, Brazil, the Netherlands, China, Mexico and Paraguay (INV, 2018 b). From 1990 to 2015, while the exported volume grew by 417%, its value had grown by 2,259%.

The volume intended for the domestic market in 2017 was 8.9 million hectoliters, with a decrease of 5.2% compared to the previous year and averaging 20 liters of consumption per capita, per year, with a fall of 6.4% compared to 2016. Varietal wine (mainly Malbec, Cabernet Sauvignon and Torrontés Riojano) represented 21% of the domestic market, against 74% without varietal mention and 5% for sparkling wines and others (INV, 2018 c). Per capita consumption has been declining over time, from volumes close to 100 liters/person/year in the sixties, to one fifth of that figure in 2015.

In parallel, Argentine wine exports have improved in quality. Although the FAO data level of aggregation does not allow to discriminate between high or low quality wines, if the relative price of Argentine exports is taken against French wine, it is found that it went from 0.11 in 1990 to a value close to 0.50 in the middle of the current decade.

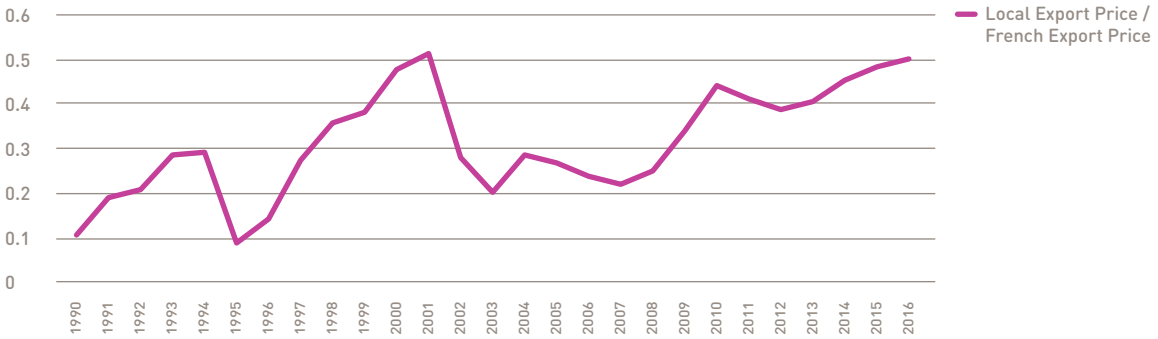
Generally, all New World producers have reduced this gap to some extent in the last three decades, but the Argentine case is remarkable. Table 1 compares the main features of the two producing countries. In the Appendix, the evolution of the world wine market is analyzed with detailed statistics gathered by “worlds of wine”. A conceptual and historical approach in this regard can be found in Villanueva and Ferro (2019).

FIGURE 3. PER CAPITA CONSUMPTION OF WINE IN ARGENTINA (LITERS/PERSON/YEAR)



Source: Elaborated by the authors based on data from FAOSTAT.

FIGURE 4. CONVERGENCE OF EXPORT PRICES OF ARGENTINE WINES TO THE FRENCH



Source: Elaborated by the authors based on data from FAOSTAT.

TABLE 1. ASPECTS THAT DIFFERENTIATE THE OLD FROM THE NEW WORLD OF QUALITY WINE

DIMENSION	OLD WORLD OF WINE	NEW WORLD OF WINE
Technology	Leontief	Neoclassical
Production	Craft	Industrial
Market	Local and international	Increasingly local and international
Consumption	Generalized	Elites and Generalized (except South America)
Habits	Historical	Recently Acquired (except South America)
Differentiation method	Protected designations of origin*	Varietals (horizontal differentiation)
Consumer flexibility	Traditional and hooked up	Modern and novelties seekers

Source: Elías and Ferro (2018).

(*) vertical and idiosyncratic differentiation.

2.

Conceptual framework of innovation and creativity processes applied to production processes

2.1. The market for ideas and incentives to innovate

The question that I first asked was, why was progress [...] speeding up over time? It arises because of this special characteristic of an idea, which is if [a million people try] to discover something, if any one person finds it, everybody can use the idea.[7]

Romer's approach (1990) to innovation emphasizes the role of investments motivated by the search of profit through the discovery of new products and processes aimed at differentiation.

To understand the properties of innovations and the determinants of the incentives to innovate, Romer uses a classification for goods of ample utilization in public finance literature. According to this, goods can be characterized under two dimensions: according to the degree of rivalry in its use and according to the degree of exclusion (possibility of charging for its use and enjoyment). Rivalry is a technological feature, while exclusion depends on technology and the legal system. Table 2 shows the different combinations of rivalry and exclusion and illustrates the concepts with some examples of what type of good is configured in each case by the combination of presence or absence of these attributes.

TABLE 2. **RIVALRY AND EXCLUSION, PUBLIC AND PRIVATE GOODS**

DEGREE OF EXCLUSION	RIVALITY IN CONSUMPTION	NO RIVALITY IN CONSUMPTION
Possibility of exclusion (for non-payment)	Rival and excludable (pure private good)	Non-rival and excludable (limited access, semi-private or club good)
Impossibility of exclusion (for non-payment)	Rival and not excludable (subject to congestion, local or semi-public public goods)	Non-rival and non-excludable (pure public good)

EXAMPLES

DEGREE OF EXCLUSION	RIVAL GOODS	NON RIVAL GOODS
100%	A can of soda	Codified satellite TV broadcasting
↑	↑	Secret recipe for a soda beverage
(degree of excludability %)	Open TV broadcasting	Computer software / GPS signal
↓	↓	Basic science
0%	Fish in deep oceanic waters	Pythagorean theorem

Source (upper table): Elaborated by authors based on Varian (2006).
Source (example table): © Johan Jarnestad / The Royal Swedish Academy of Sciences.

7. Paul Romer, 2018.

According to Romer, "ideas" are far different from most economic goods which are purely private, and in particular far different from physical capital and human capital, since they are not rival goods: the usage of an idea by a person does not prevent others from using it. A key aspect added by his analysis is the degree or the extent of the excludability of the ideas. Exclusion would seem to be critical for market developed ideas, even though not all ideas are excludable. For instance, within some basic research (such as new theorems), it is difficult or impossible to exclude third parties from its use, which would seem to reduce the incentives to innovate. However, profits that are not internalized by a firm may become internalized by the industry, as in the case of Wines of Argentina and the Australian Wine Research Institute, which we will analyze later.

Differentiated goods and incentives to innovate: the pursuit for "Distinctiveness" in great wines

In the case of the quality wines industry, there are incentives for innovation from a private perspective. Because they are differentiated goods, the winemakers can appropriate the return of innovation, usually in a partial way, through their brands. Since differentiation in the industry occurs through quality, most innovations in the private sector are aimed at improving it.

Differentiation in wine production is not new, it dates back to ancient times. Ancient winemakers on the Greek island of Rhodes, one of the largest wine producers and exporters in the Ancient Mediterranean, used stamped amphora handles to identify and brand their wines.[8]

The innovations associated with the winemakers and their brands are appropriable, whereas general or conceptual innovations can only be partially appropriable, which in turn allows the generation of innovations and new ideas that can at least be partially imitated by other producers. The distinction between both types of innovations is fundamental for public policy design. Gains generated by differentiating are the market engine for innovation within the firm, and it explains why the quality 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 oenologist and winemaker Susana Balbo highlighted the concept of differentiation through the quality of the wine: *"Prestige does not come from commodity products; it comes from luxury products. This is a concept that Catena is very clear about. Catena taught me that there is no lower-cost marketing than quality. Quality speaks by itself and promotes a category."*[9]

The quest for quality as a differentiation mechanism continues today. Winemaker Silvio Alberto points out that *"today we are working hard on the concept of the terroir. All the innovation, the whole approach to oenology today is aimed at determining where you are going to have the best Malbec, the best Cabernet Franc. The terroir is not just the land where the vine is planted. The terroir is the set of factors that make the plant develop, from climatic factors, the soil factor, to the human factor. That is the concept of terroir that we are investigating."*[10]

In the same line, Laura Catena argues *"within the Adrianna vineyard, in the Tupungato Alto area, we are working with the aim to make what the industry knows as Grand Vins, which are unique, unforgettable wines that have something particular and recognizable, that when you try them something happens to you and that's why you don't forget them no matter how much time passes."*[11]

8. "Doing Business in the Ancient World", exhibition displayed at the University of Chicago, Booth School of Business in collaboration with the Oriental Institute, curated by Jack Green and Brittany Hayden, 2015.

9. Personal interview conducted at Susana Balbo Wines, Mendoza, 4/29/19.
10. Ibid, footnote 2.
11. Ibid, footnote 1.

2.2. Conceptual and experimental innovations

"I don't seek, I find."
Pablo Picasso

"Great wine is born not in the vineyard, but in the brain."
Brian Walsh, Director of Winemaking, Yalumba (Australia)

"I seek in Painting".
Paul Cézanne

"We're making progress, but the best is yet to come."
Robert Mondavi, entrepreneur considered The Father of California Wine

Based on the study of the careers of more than two hundred artists, Galenson (2007) distinguishes two very different types of innovators in art: the conceptual, who plans in detail before making a work, and the experimental, who makes the more important decisions while they are working on it. In subsequent studies, Galenson identified a similar pattern in literature, music, business, and other disciplines. Robert Mondavi, one of the pioneers of quality wines in the New World said once: "Wine is art," thus the application of Galenson's analysis to the wine industry would seem to be direct with this metaphor.

Conceptual innovations tend to be dramatic. In most cases, they consist of something completely different, which breaks the general rules of a discipline or activity. In general, conceptual innovators have precise objectives in advance, allowing them to plan their work and execute it decisively. Their most radical new ideas, and consequently their greatest innovations, have the tendency to appear early in their careers.

On the other hand, experimental innovators proceed tentatively, through trial and error; building their skills gradually as they work and tend to make their biggest contributions late in their careers.

For an experimental innovator, there is not such a thing as a finished project. Their skills, and therefore their work, are improved over time, one job carried over to another. This is the reason why their careers are dominated by work on the same topic or problem, in search of a single objective. In contrast, for a conceptual innovator experience accumulation can be an issue. Experience and habits deteriorate their ability to innovate and break existing rules. Addressing new problems allows them to discover the benefits of extreme deviations. Table 3 summarizes the objectives, methods and the nature of the results of each type of innovator.

TABLE 3. GALENSON'S INNOVATION TYPOLOGY

INNOVATOR TYPE	OBJECTIVES	METHODS	RESULTS
Experimental	Imprecise and evolutionary. Objective is an issue or problem.	Tentative and incremental. Trial 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), based on Galenson (2007).

2.3. Dissemination of experimental knowledge in the wine industry: the influence of Robert Mondavi and the Napa Valley's revolution

Due to their nature, conceptual innovations are easier to disseminate than experimental ones. Once a conceptual innovation comes to light, its replicability is relatively simple. For instance, after the irruption of high-quality Californian wines on the international stage in the 1970s, Michel Rolland introduced new techniques to enhance wine quality, by concentrating on vineyard performance, going against the well-established theory of the terroir as the main source of grapes and wine quality. It all started in Bordeaux in the early 1980s. After an excellent harvest in 1982, he was able to develop a well-defined group of techniques that applied in a systematic way allowed him to produce an uniform wine quality (fruity, rich and concentrated) in different wine regions.

In contrast, experimental innovations are difficult to spread as they are difficult to communicate; Polanyi (1998) names them tacit knowledge. Experimental innovations must be personally experienced in order to understand them and incorporate them.

The transformation of the wine industry in Argentina shares similarities and it was influenced by the Napa Valley's revolution in the 1960s led by Robert Mondavi. Nicolás Catena's first innovation, the use of what he called the "French-Californian Technique" to produce quality wines in Argentina, began to develop early in the 1980s when he was a visiting professor of economics at the University of California in Berkeley. There, he experienced the new and revolutionary Californian concept to achieve wines that was able to compete with the French. Catena recalls it like this:

"One day we stopped by Robert Mondavi's winery. Back then, I still didn't know Mondavi, and we took the usual tour. Until then, I still hadn't understood what Californians were doing. But when I saw the investments and research that they were carrying out, and I could appreciate what they were achieving in terms of quality, I had a conviction: Why not try the same in Mendoza? I knew it would take time, but I also knew it could be done ... I always think about that visit as the key moment that changed my whole vision of the concept of quality regarding winemaking (Wines and Flavors)*".*

Similar to Catena's experimental learning experience in Napa Valley in the 1980s, Robert Mondavi also learned about a different way of producing wine by experiencing it for himself. In 1962 he visited around fifty wineries in Europe. There he experimented and learned the concept of producing wines in small batches, far from bulk manufacturing, and also learned about aging in small oak barrels. Mondavi explained: *"The contrast was stark: we were treating wine as a business; the great European châteaux were treating wine as high art."* Mondavi returned to California with a revolutionary concept about the scope that California wine could aspire *(Briscoe, 2018).*

Robert Mondavi acquired an obsession with quality very early in his career, when he convinced his father Cesare to buy the Charles Krug Winery, located in St. Helena, California, in 1943. Mondavi had an experimental approach and his quest for quality was through a long process of experimentation that started very early at the Charles Krug winery and continued at Robert Mondavi's winery, which he founded in 1966.

In Mondavi's wording, "There's no one in the world that does more research work for fine wines than we ourselves." Zelma Long, who started working for Mondavi in 1970, remembers the spirit of constant experimentation that occurred at the winery: *"Let's ask a lot of questions about the process, and let's try lots of things" (Pinney, 2012).*

Catena acknowledges the important influence of Mondavi's experimental approach: *"I discovered (at Mondavi) what investment, research and enthusiasm could achieve (Goldberg, 2012)".* As we show in this technical note, Catena's main developments were also accomplished through a trial and error process. Bodega Catena Zapata does more than 200 different experiments per year, where each of them is associated with a different hypothesis.

Since experimental innovators conceive of their work as an academic activity and work as trial and error, great experimental innovations are more difficult to detect, and in some cases the experimental innovator doesn't even realize they are really innovating, because of the slowness of the processes.

"In the late sixties everything was very clear, I had invented something [referring to a successful marketing campaign that boosted sales of common wine on the basis of differentiating it in the consumer mind, and which Catena considers one of its greatest professional achievements]. Well, later, let's say, back in the nineties, it was another phenomenon, slower, slower to realize that I had invented something" [12] says Catena.

Radical and disruptive changes are usually caused by conceptual innovations. According to the curator Joachim Pizarro, Pablo Picasso, the archetype of the conceptual innovator, produced an earthquake in the art world with "Les Demoiselles d'Avignon" [13]. Paradoxically, the experimental Nicolás Catena produced an earthquake in the wine industry in Argentina.

While the transfer of conceptual knowledge can be disseminated through well-defined concepts, an important part of experimental knowledge transference is carried out through the mobility of human capital related to the industry.

Susana Balbo illustrates this concept aptly when she points out: *"I think I have had two universities, the university of academic training and the university of travel. I think that the one that enriches you the most, without a doubt, is the latter (to work in other wine regions). Because knowing what happens in other wine-growing areas has a truly high impact on the professional's life."* [14]

This mechanism of transmission of experimental knowledge was noticed by Carlos Tizio Mayer, an agronomist, M.Sc. graduate of UC Davis and current president of the INV. In 1991, he led a tour organized by INTA and the Regional Consortiums for Agricultural Experimentation (CREA Groups) to visit wineries in California. This visit to Napa Valley represents a milestone for many of the winemakers and winegrowers who participated in the tour. They started the visit with a lunch organized by Robert Mondavi at his winery, and then visited Tally Vineyards, Inglenook Vineyards, Clos du Bois, Beringer Vineyards, Clos du Val, Sterling Vineyards, Simi Winery and other major wineries and grape producers. They also took some master classes at UC Davis with the best viticulture teachers. During this trip, Americans revealed the secrets of their sudden success (Mount, 2013, and personal interview with Carlos Tizio Mayer at the INV, 04/30/2019.).

12. Personal Interview, 2/2/2016.
13. https://www.youtube.com/watch?v=pngGDycLQuE
14. Ibid, footnote 9.

3.

Innovations in the Argentine wine sector

The quest for quality, motivated by market incentives, has been a main driver of **innovation in the wine industry of Argentina**. The process of enhancing the quality of wine was reinforced by the contraction in demand for the most expensive wines in the United States, due to the economic crisis of the 2000s, which displaced demand towards the relatively cheap Argentine wines.

3.1. Classification of the main innovations in the wine industry in Argentina[15]

There are three main stages in the process of developing quality wines in Argentina: (i) the usage of new techniques and capital goods to produce grapes and wines and new tools to market them, (ii) the development of High Altitude Malbec plus the introduction of new varietals; and (iii) the development of the terroir.

The process involved important changes throughout the value chain, including human and institutional capital. In a study made about the wine industry modernization, both in Chile and Argentina, Farinelli (2013) provides a taxonomy that is both systematic and exhaustive, which she gathers in three categories (i, ii and iii), to which we add two more (iv and v):

i) Product (the vineyard)

ii) Process (vinification)

iii) Commercial Aspects (the business)

iv) Increased Capabilities (human capital)

v) Public and collective action (the institutions)

In Table 4 (next page) we combine the classification of innovations in the industry above with our approach that combines the Galenson's innovators taxonomy (experimental and conceptual) and Romer's innovations (referring to the degree of private appropriation of innovations and "information leaks", spillovers or external effects).

15. This subsection is based on Elías et al. (2019).

TABLE 4. **MAIN INNOVATIONS IN THE WINE CHAIN VALUE CLASSIFIED ACCORDING TO GALENSON-ROMER**

INNOVATION LEVEL	MOSTLY EXPERIMENTAL INNOVATIONS	MOSTLY CONCEPTUAL INNOVATIONS	DEGREE OF PRIVATE APPROPRIATION OF THE INNOVATION
Product (Vineyard level)			
	Terroirs and Clones		Private goods
	New Varietals		Private goods
		Drip and furrow irrigation	Replicable or With Spillovers
		Trimming	Replicable or With Spillovers
		Organic or biodynamic cultivation	Replicable or With Spillovers
Process (Vinification Level)			
		Oak barrels	Replicable or With Spillovers
		Steel tanks	Replicable or With Spillovers
		New Refrigeration	Replicable or With Spillovers
		Pneumatic Presses	Replicable or With Spillovers
		Gravity Flow Mechanisms	Replicable or With Spillovers
Commercial aspects (Business level)			
		Brands Associated to Denomination of Origin	Club goods
	International competitions		Private goods
	Marketing in social media		Private goods
		Cultural and recreational activities	Replicable or With Spillovers
		Winery Architecture	Replicable or With Spillovers
		New Containers	Replicable or With Spillovers
Increased Capabilities (Human capital level)			
		Hiring of international consultants	Replicable or With Spillovers
		Joint ventures with world-class international partners	Replicable or With Spillovers
		New generation of local Oenologists	Replicable or With Spillovers
Public and collective action (Institutions level)			
		Public-private collaboration	Semi-public goods
	Pure public action		Purely public goods
		Private Sector Collective Action	Club goods

Source: Elías et al (2019), based on Farinelli (2013) and own elaboration.

At the vineyard level, we found purely experimental and purely conceptual innovations: (i) the identification of clones and terroirs; and (ii) drip and furrow irrigation, respectively. The first is highly privately appropriable and the second is easily replicable. The remaining three innovations at vineyard level (new varietals, trimming, organic/biodynamic cultivation), are mixed: they benefit the winery that initially adopts them, but they are also replicable and are expected to generate "spillovers". New irrigation technologies allow the production to be moved from traditional areas (initially chosen because of water availability in the lowlands where water is accessed by gravity), to higher areas, where water was very scarce and the weather more extreme. The new irrigation techniques were, in principle, very expensive, but these higher costs were partially offset by the incorporation of marginal (and relatively cheap) lands.

At the vinification level, all the main wineries bought new machinery (capital goods) with built-in innovations to replace the old ones. The country's peculiar macroeconomics influenced these innovations: Argentina went from being a very closed economy to opening its current account in the 1990s, in a context of overvaluation of the local currency. The combination of these factors favored the massive import of new capital goods that changed, in a few years, the industry equipment and modernized it. By nature, these innovations are conceptual and easily replicable.

Regarding the commercial aspects, several trends converged: the declining local market, the possibilities abroad, new communication technologies, and the search for new businesses. In general, this category of innovations has both conceptual and experimental elements. The most appropriable innovations are (i) to participate (and win) in international competitions; and (ii) the marketing through social media to create brand image. But these elements also "spill" by increasing the reputation of the country and the region. While the creation of Denominations of Origin belongs to the so-called "club" goods: the prestige of a region benefits all the wineries located in that area.

The social and cultural activities related to wine (tourism, shows, gastronomy) and the sophisticated architecture of the wineries are aspects that benefit the sector individually, but also collectively, due to "spillovers" and because they are replicable with a certain level of investment. Recently, the industry has tried to innovate in packaging. From the beginning of the innovation wave in the sector, by regulation, wines must be bottled at origin, which was seen at the moment as a way to increase vertical integration and local production. However, consumer demand and freight costs have influenced experimentation on new packaging, such as aluminum cans or other ways to transport and sell quality wine at lower costs.

The increased capabilities refers to the development of human capital and it follows a logical sequence: first, the hiring of international experts allowed to close the gap with the frontier of best practices; second, the partnership of local wineries in ventures with world-class players allowed the access to "club goods" and signals prestige and recognition; third, an "import substitution" occurred with the accumulation of knowledge and experience in local human capital, that learned the new techniques and practices. The three components are in part privately appropriable and in part replicable: another firm can hire the same consultant, partnerships can exchange loyalties, and local human capital is mobile between wineries. In this way, knowledge is disseminated.

In the institutional aspects, the first is conceptual one and it relates to the generation of a common strategy for the country and the industry. It implies the generation of public goods and externalities for the whole, by combining the articulation of the public sector with the needs revealed by the private sector. The second aspect includes actions for the scientific and technological development of public knowledge, specific experimental innovations in basic and applied science, in areas such as plant health, genetics, climate, soil and statistical data collection for the industry, as well as technical standards and sectoral regulations to safeguard product quality (activities carried out by official entities such as INTA and INV). The third aspect includes the generation of semi-private or "club" goods, for members of the agreement, with potential "spillovers". It is mainly conceptual (such as the activities developed by Wines of Argentina in order to promote the local product in the world).

In the past, when the industry was mainly common wine production, the government focused on regulating the output surplus, sometimes with policies that yielded more overproduction. Nowadays, the action seems more coherent, with the strategy of focusing on international markets for high-quality products. The local consumption of common wine continues declining and faces an increasing competition of beer and soft drinks.

3.2. Conceptual and experimental innovators in the Argentine wine sector

Many of the great innovations are produced in the business world. This is the case of the transport businessman Malcom McLean, who developed the modern intermodal transport container that revolutionized transport and international trade in the second half of the 20th century. As Edmund Phelps points out: *"The inventions made famous by the major innovations they led to were not prime causes- not thunderbolts from outside the economic system. They were born out of perceptions of business needs or an inspired sense of what businesses and consumers would like to have- all drawn from the innovators' experience and guesswork in the business world."*

The Argentine wine industry is no exception to the rule. Armed with his experimental approach, Nicolás Catena developed an entire new industry of quality wines in Argentina and resurrected the Malbec wine during the 1990s. Later, many producers emulated the new practices introduced by Catena and devised new innovations.

Susana Balbo

Currently considered one of the top winemakers in the world, Balbo was the first woman to graduate with a degree in enology from Argentina in 1981, and the first to work as a winemaker in the country.

"I don't work by trial and error. I believe in the application of concepts, of proven knowledge to enhance quality. This is why trips are important," says the conceptual Susana Balbo firmly and without hesitation.

She is considered one of the pioneers in Argentine wine exports, her success as an entrepreneur was already recognized in 1997, when she was elected Entrepreneur of the Year by the Argentine Organization of Businesswomen. Her conceptual approach to enology is not surprising: *"it was a coincidence that I studied enology... I wanted to study a hard science. My parents did not allow me to study at the Balseiro. I am the youngest daughter from a family with a hundred per cent Italian roots, and with a very traditional concept of the family."* [16]

Photo: www.botequimdovinho.com.br/dominio-del-plata-susana-balbo-wines/

16. Ibid, footnote 9.

Her first job was in Sucesión Michel Torino in Salta, where she worked for nine years. There she managed to transform the quality of the table wines of that area, in particularly the Torrontés. About her first conceptual innovation, Balbo points out: *"I was fundamentally inspired by an obsession with quality."* [17]

"When I arrived in Cafayate, the owner of the company gave me a challenge: to make international high-quality wines with what the vineyard got, which had 70% Torrontés grapes. So, I had to find a way to develop it. There, quality backed by knowledge came into play. The unusual thing I did at the time was to utilize enzymes for apples on grapes, something no one had ever done before. The sign [of] that it had been a success occurred when the wine was chosen for the first class of Pan American airlines: then I realized that I had achieved an international quality product since Salta wines were not being exported at that time." [18]

During her second year in Salta, she organized the first Viticulture Meeting of the Argentine Northwest. She invited her professors and colleagues from Mendoza to give lectures with the aim of disseminating scientific knowledge in the search for greater support and dialogue. Her colleagues from Mendoza 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 varietal to Mendoza, to the cold areas of Altamira *"in search of an area that had a very good sun exposure, height and enhancement for PH conditions, because Mendoza has more potassium in the soil than Salta has. The soil I chose is a calcareous soil, which generally delivers grapes with less PH. I was looking to replicate the chemical balance that the grapes have in Cafayate."* [19] And she managed to produce a totally different Torrontés.

After returning to Mendoza in the early 1990s, Balbo launched the Lovaglio-Balbo winery. After having serious financial problems, due to inflation and scams suffered, she decided to sell the winery in 1994. She then worked for a few years in American wineries.

In 1998, Susana was hired by Nicolás Catena to collaborate with the design and management of the new Bodega Catena Zapata in Agrelo, one of the most important and modern works of wine architecture in Argentina. The construction was completed in April 2001, and later Balbo became Export Manager of Catena Group.

In 1999 she launched her own venture: Susana Balbo Wines (formerly Dominio del Plata), her Agrelo winery, where she produces outstanding fine wines, within a select group of Argentine producers; wines conceived with a clear export focus and capable of competing with the best in the world.

The rapid growth of this project, the technology and infrastructure investment and the international recognition of its wines, have allowed the winery to position itself in many markets, making it one of the most prestigious in Argentina.

17/18/19. Ibid, footnote 9.

Nicolás Catena

Nicolás Catena is one of the most important innovators in the international wine industry, throughout this technical note we discuss many of his innovations and his approach to innovation. Armed with his experimental approach, during his fifties, Catena developed a completely new industry of quality wines in Argentina, and resurrected Malbec wine during the 1990s.

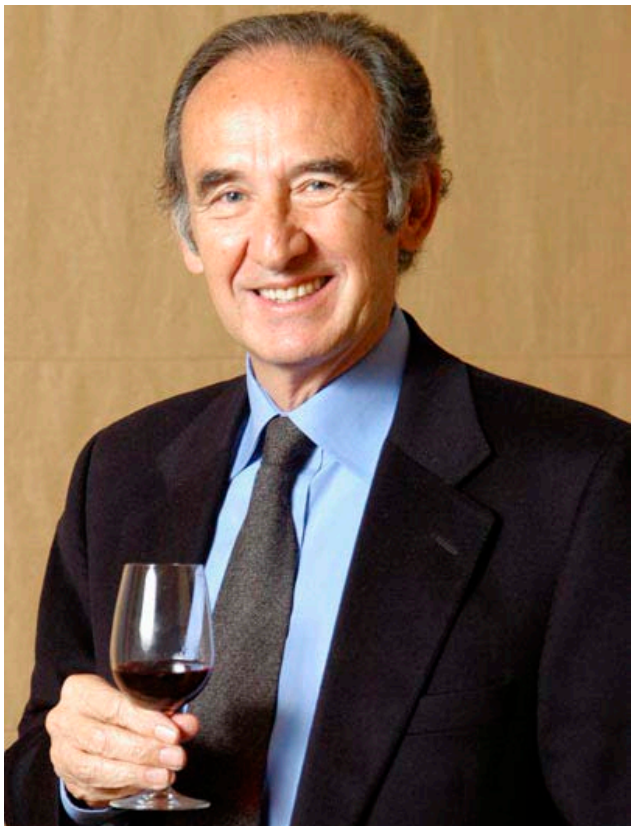


Photo: https://colognoisseur.com/tag/nicola-catena-zapata/

There are three main innovations (or revolutions) introduced by Catena: i) the use of the Californian-French vinification style to produce quality wines in Argentina; ii) the discovery and development of high-altitude Malbec wine; and iii) the discovery that soils in Mendoza are not homogeneous within very short distances, resulting in vineyard lots with unique characteristics. This latest discovery is still under development and has led the Catena family to explore deeper into the terroir theory.

Making the first Argentine wine that could compete internationally took Catena about 8 years. Discovering that altitude was relevant to Malbec took him another 7 or 8 years. All these developments were made through a process of trial and error.

Introduction of Drip Irrigation

Catena launched a research project, a rigorous study of microclimates and soil conditions, to assess which were the best growing areas in Mendoza, for planting Chardonnay, Cabernet Sauvignon and Malbec. At the same time, a careful selection of clones from Italy, France and California was made in order to determine which were the most appropriate ones for the Mendoza region.

During the course of these investigations, Catena evaluated a fundamental factor: when 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, producers had great control over the amount of water that each vineyard needs to receive during the growing season. Then, he began an extensive study on the effects of irrigation control. *"What we discovered is that strict irrigation care leads to a great leap in obtaining quality grapes,"* explains Catena.[20] 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 the development of vineyards in other good areas and, particularly, in high altitude areas. Nicolas Catena was the first to introduce it in the early 1980s as a result of his experimental approach.

High Altitude Malbec

At a certain point in his quest for high quality, Catena offered his wines to a reputed French winemaker. This expert compared Catena's wines to Languedoc wines in France, a relatively warm region and on average with lower quality than the best French wines. At that time, Catena thought the issue was the high temperature in which their vineyards were cultivated. After developing this hypothesis, in his search for lower temperatures, Catena decided to move all his future plantations to southern and higher areas.

The results were excellent. Catena tested with Chardonnay, Cabernet Sauvignon, Malbec and Pinot Noir. Of these varietals, Malbec not only performed better with the cold, but produced something new, original. Malbec was the big surprise. These experiments led to the birth of high-altitude Malbec, Catena's second experimental innovation.

20. http://www.vinosysabores.com/revista1-1.htm

Laura Catena and the Catena Institute of Wine

In France, the quality of the wine is attributed to the terroir[21]. There is a belief that the role of the winemaker and the techniques used in the elaboration is to reveal the expression and character of the wine's terroir. This theory is the basis behind the French wine differentiation by region, vineyard, or DOC more prominently than the varietal. However, the causal relationship between the climate phenomenon, soil composition, and quality, is not clear.

The first wave of innovations in Argentina was aimed at improving the quality of the winemaking process. This was a very significant change, in which Malbec began to be known internationally. The discovery of High-Altitude Malbec was another novel phenomenon because it is a different type of Malbec. Although the two stages sequentially produced a significant improvement in quality, at the same time they highlighted differences in flavors between regions and led to the exploitation of new (high altitude) areas. Efforts to understand and exploit these differences, eventually led to a deepening of the terroir theory. This phenomenon, completely new in Argentina, is an extreme form of differentiation that provides strong incentives to invest in its development.

Radical conceptual innovations are done swifter than the experimental ones and depend on the innovator's ability to perceive and appreciate the benefits of extreme deviations from existing practices, and this ability tends to decline with experience when thinking habits are firmly established (Galenson, 2007). Laura Catena, a Harvard biologist and Stanford physician, with basically no work experience in the wine business, had the idea to deepen the terroir theory and apply it in Argentina when she was 28 years old.

Laura Catena is founder and managing director of the Catena Institute of Wine (CIW), whose development was one of her first actions when she started working at the family winery. The Institute was founded in 1995 with the aim of using a scientific method to preserve nature and the wine culture. The CIW started studying soil, climate and all other important aspects to produce a "Grand Vin". It began to plant vines at high-altitude and to explore the micro-terroir, studying every part of the terrain, its characteristics and its ecosystem.

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

After observing that there was vast heterogeneity between vines regarding 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 vineyard. At that time, they did not comprehend how the site's diverse geological origins would enhance quality, also bringing about an extreme form of differentiation.

21. This does not imply that the processes do not matter. Since the 1980s, investments in vineyards and wineries in Bordeaux have been huge, from high-tech wineries and world-class enologists, to the finest oak barrels and modern bottling lines (Balter, 2019).

When they started the study of soils, they dug 5 soil pits per hectare. After a decade of study, now 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 in separate barrels, so that each of them can run their natural fermentations.

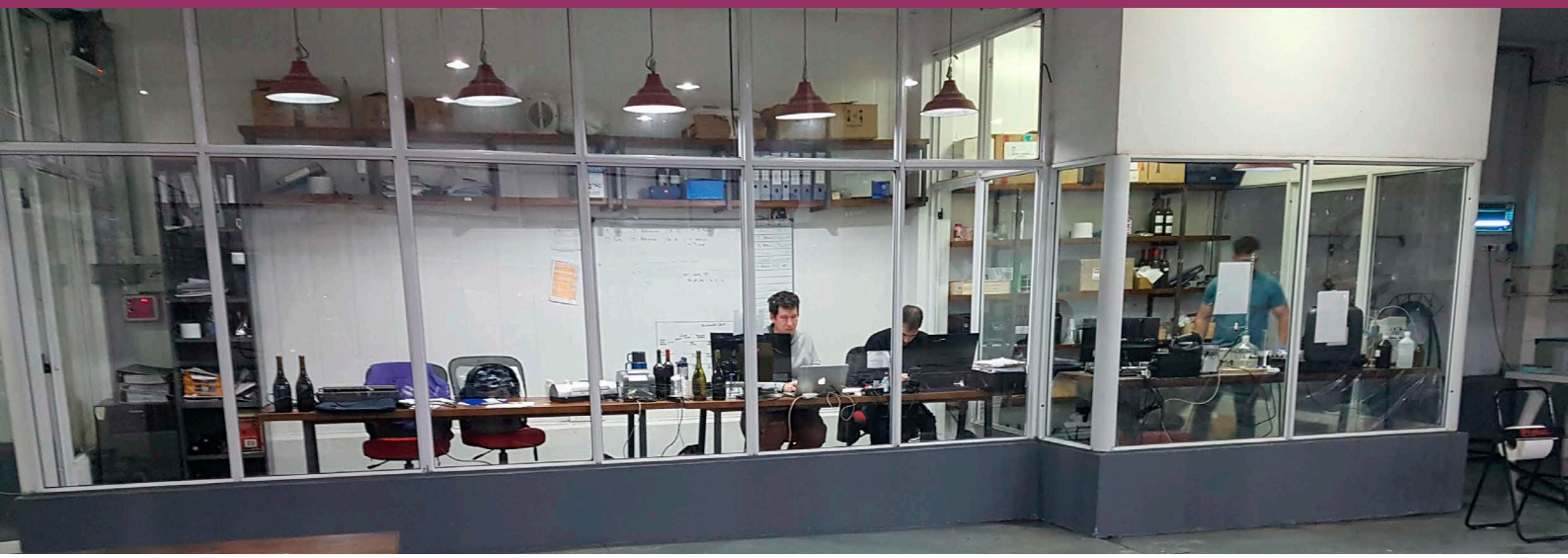
Although she knew that the prestige and quality of French wines stemmed from several decades and centuries of trial and error, her conceptual approach led her to take up the challenge of being able to figure out all this during the course of her life (Catena, 2015). The CIW conducts more than 1,000 microvinifications per year. Fernando Buscema, its current director, points out that the Institute was born to compete with the best and to comprehend the processes in a scientific manner. One of the main objectives of the CIW is to provide scientific basis to understand and explain the production of high-quality wines. For instance, by using experimental methods to separate the effect of sunlight from the effect of cool climate, it has been proven that the intensity of sunlight caused significant increases in skin tannins of the high-altitude Malbec (Alonso et al, 2016).

The CIW collaborates with many research institutions, including the University of California, Davis, and the National University of Cuyo. Working on basic intermediate questions allows them to build a bridge with other institutions such as INTA. For instance, Phylloxera, a worldwide commercial vine pest, was not widely known in Argentina. The CIW joined efforts with the National Council for Scientific and Technical Research (CONICET) to train an expert, by sending her to do a PhD in the United States. She returned to Argentina and continued in the academic world.

Phylloxera is a grape vine pest caused by an aphid that feeds on roots. In Argentina it is present since 1878. Why this pest that destroyed many vineyards in Europe has not caused damage to Argentina's vineyards? In collaboration with UC Davis (USA) and the Mendoza Institute of Agricultural Biology (IBAM, Argentina), the CIW carried out a genetic characterization of the phylloxera present in all the wine regions of Argentina. Strains related to Californian biotypes were found, but not with European biotypes. The CIW is currently assessing the aggressiveness of the strains in the most widely used rootstocks.

The Denomination of Origin law, approved in 1999, established the framework for the creation of Geographical Indications (IG in spanish), the system of quality distinction for Argentina. The Catena Zapata family believes that GIs are a key tool to help wine consumers understand the unique features of each of their regions. The CIW, the Catena wine team and the INV Technical Committee team have worked to create the IG Paraje Altamira. They are currently working to delimit the boundaries of the IG Gualtallary.

"Some of Adrianna's harvests have already reached that level [Grand Vins], I don't know whether all of them. But one of the problems we have today is that when you find the ideal place to plant a vineyard, as it happened to us with Adrianna, the next challenge is how to preserve the soil so that it does not get spoiled. Today, we are now studying how to take care of that ecosystem and the Catena Institute of Wine is working hard on this matter." (Catena, 2018)



Arnaldo Etchart and Michel Rolland

Arnaldo Etchart was the viticulturist who brought the french expert Michel Rolland to Argentina in 1988 to break with traditional local wine production practices.

He had the conceptual idea that it was possible to produce quality wine for the international market in Argentina if knowledge and appropriate human capital were merged with local resources, but he also realized that no one in the local market knew how to do it. When a container of his wine was returned from Europe because the color had faded, he decided to look abroad for someone with the required human capital to produce better wines.

Innovations and new knowledge can be generated by innovators working in collaboration. Teamwork can provide access to more knowledge and new ideas to increase productivity. However, Galenson and Pope (2013) point out that collaborations are not successful in many situations. A crucial condition for their success is the existence of a shared set of knowledge and techniques, which Michael Nielsen (2012) calls a “shared praxis”. Arnaldo Etchart and Michel Rolland shared methods, interests and a conceptual approach to innovation. The existence of a “shared praxis” between them, leaded to a successful and long-lasting collaboration, which continues today with Arnaldo Etchart's sons.

Rolland arrived in Argentina in 1988, when local wines were in average low-quality, to develop red wines of the Etchart winery (Malbec, Cabernet Sauvignon and Tannat) and Torrontés (Saieg, 2013). Once in Cafayate, Etchart strongly supported Rolland's radical new ideas and proposals, going against all his workers criteria, based on the traditions and knowledge they shared. This collaboration gave Rolland the opportunity to test his new conceptual ideas about growing, harvesting and producing wine in a wine region outside France. New techniques included deep pruning in winter, "green harvesting" to reduce the number of grapes, leaf trimming to keep the grapes exposed to sun and air, and late harvesting. According to Rolland, who is a wine consultant to wineries in thirteen different countries, wine production can be improved to a certain ceiling: the upper bound is given by the relationship between soil and climate. He conceives his knowledge as the ability to reach that ceiling (Cuculiansky, 2016).

The collaboration of these two conceptual innovators had immediate results. In 1990, Arnaldo Etchart and Michel Rolland launched onto the market one of the first premium wines of Argentina: Arnaldo B. Etchart Harvest 1989. In 1995, the first wines from San Pedro de Yacochuya were released for the domestic market. In 2001, the San Pedro de Yacochuya winery exported its first premium wine (vintage Yacochuya M. Rolland 1999), produced at 2000 meters above sea level, being one of the highest vineyards in the world. The winery is equipped with high technology. Furthermore, Etchart is responsible for the successful introduction of Torrontés in the international markets.

Silvio Alberto and *Bodegas Bianchi*

Graduate in Enology, Fruit and Horticulture Industry. Silvio Alberto has extensive experience in renowned wineries in Mendoza, where he performed as general manager, chief enologist and responsible for vines management.

"I started studying enology in the 80's, when this was an industry destined only for common wine, with a really poor wine quality, just for the domestic market. Wineries hired enologists to be in the lab. That was the enology that existed at that time, such was a more alchemistic enology than the sensory and intuitive enology that we have today in the production of premium wines. It was an enology that had nothing to do with today's." [22]

A few months before graduating with honors with a degree in Enology, Fruit and Horticulture Industry, Mariano Di Paola (his degree professor at that time) invited him to join the work team at Bodega Rutini in 1996. After a while, he had become the second winemaker of the firm (which he would leave in the year 2000) to later become the first enologist at Bodega Navarro Correas.

"I developed myself with an industry that was flourishing, with all the opportunities of training and professional growth that Nicolás Catena offered. My degree's cohort , one subsequent to ours and, conceivably, a previous one, are the hinge cohorts in this industry. Everything we learned [with the change in the industry] made us the most sought-after technicians by the wineries to start implementing these changes, which Nicolás Catena had already implemented in his wineries. The other wineries also wanted to modernize so we were highly sought after... we are the ones who saw what it [the industry] was and what it became, in terms of both:quality of the wines and exports of wine. In France, it has been 500 years of enology, and in Argentina after 30 years the scheme had completely changed." [23]

In 2003, Silvio Alberto carried out the Andeluna project. It grew up with him for eight years, until he decided to become (in 2011) the first enologist and general manager of Bodega Diamandes. During his professional life, he has received, among other recognitions, the Revelation Enologist Award, presented by an important institution and magazine specialized in enology. In 2013 his career led him to take the general direction of Achaval-Ferrer Winery. After serving as president, CEO and head of vineyards and enology at Achaval-Ferrer, he arrived at Bodegas Bianchi to put into use all his knowledge and experience as Chief Enologist.

With 90 years of experience in the world of wine, the Bianchi Family has been one of the pioneers in the development of the Argentine wine industry. Today, their family members are the fourth generation of winemakers. Originally located in San Rafael, province of Mendoza, Casa Bianchi has been visionary in incorporating advanced technology in the elaboration of its wines and sparkling wines.

Regarding his transfer to Bodegas Bianchi, he said: *"I wanted to return to the family winery business. I always remember with affection my outset at Rutini and at Andeluna winery, which was a personal project by Ward Lay. I was always interacting with the family and I had a relationship that was not the cold relationship of the multinationals (...) at the same time the project for the landing of Bianchi in the Uco Valley arises (...) Bianchi landed in the Uco Valley to add to its portfolio a new terroir, which is the new challenge for wineries. So as not to stay where you were born but to keep exploring new places and to be able to show the consumer, more than just varieties, rather new things. Today, enology means to look for new things so they can be offered to the consumer."* [24]

Regarding Bodegas Bianchi's transformation in the revolution of Argentine quality wines in the nineties, Silvio Alberto points out: *"Paul Hobbs corroborated what Don Enzo Bianchi already thought, and I am also currently corroborating what they all thought, San Rafael is [ideal for the production of] Cabernet Sauvignon. The arrival of Paul Hobbs brought that and likewise changes in vinification techniques, of elaboration in general."* [25]

22/23/24/25. Ibid, footnote 2.

José Alberto Zuccardi and *Bodegas Familia Zuccardi*

Being the director of Familia Zuccardi since 1992, José Alberto Zuccardi leads the third exporting winery of bottled wine 100% family owned. In a business where tradition seems to be the rule, Familia Zuccardi entered the wine industry from the cement industry. José Zuccardi considers this an advantage that gives them greater openness to innovate.

He personally considers that there are no restrictions or limits for innovating. Part of the innovation process consists of seeking financing and building partnerships in order to innovate. His company has participated in several programs and has developed joint research projects with universities and other institutions.

The two main innovations of José Zuccardi are: i) the introduction of non-traditional varietals to produce Argentine wines, leaving Malbec (a risky bet); and ii) the winery's enotouristic area development, from the architecture to the smallest details (such as a dining room for drivers that transport tourist contingents who visit the winery).

Innovation, being one of the fundamental values of the company, and one of his personal characteristics, has allowed Zuccardi's winery to generate new products, experiment with non-traditional varieties from Argentina and do researches on a permanent basis, which has meant a very valuable contribution to the Argentine wine industry.

The Zuccardi family is the only winery of its kind in Argentina that has an experimental area, in which 35 new varieties of wine are developed. In 1999, with the launch of Zuccardi Q Tempranillo, they were the first Argentine winery to produce a Premium wine from a non-traditional variety in Argentina. Zuccardi Q has its origin in the practice of marking with a "Q" (for quality) the oldest and most uniform lots of each vineyard. Currently, the grapes with which Zuccardi Q is made of, come from recognized micro-regions in the Uco Valley and selected ancient vineyards.

The winery's oenologists are now studying the quality potential of absolutely unknown varieties to the Argentine consumer, such as Agliánico, Arinarnoa, Ekigaina, Malvasia Nera, Nero Amaro and Nero D'Avola, among others.

In the late 2000s, Fuzion wine had a huge success in Canada. A Canadian wine critic wrote: *"Producers of $15 Australian shiraz and $20 California merlot should be afraid of Familia Zuccardi Fuzion Shiraz Malbec 2007... Very afraid."*

José Alberto has been awarded with multiple national and international recognitions, in which among them stands out the award given in 2016, for the first time to an Argentinean, by the IWC Lifetime Achievement Award (UK), that recognizes the international background of those leaders who have marked a before-and-after in the world of wine. He is also an active member of different business and social organizations: President of the *Argentine Vinicultural Union* (UVA after its acronym in Spanish), Board member of the Argentine Viticultural Corporation (COVIAR) and Board member of Wines of Argentina (WofA).

Bodega Doña Paula [26]

The focus, innovation and distinction of this winery revolve around environmental conservation. It is considered an Estate winery, since 100% of the grapes used for its wines come from their own vineyards.

Bodega Doña Paula was established in 1997 by Santa Rita Estates, part of the Chilean group Claro. Located in the Uco Valley, it practices sustainable agriculture with the aim of preserving natural resources. It does not use fungicides or pesticides, nor fertilizers.

The winery has recently achieved the Sustainability Protocol 3.0 of Bodegas de Argentina. Doña Paula is one of ten Argentine wineries to achieve the standard, originally developed by an association of 240 Argentine wineries and the CIW, it addresses specific environmental, social and economic challenges that are specific to wine in Argentine viticulture and certifies wineries of all sizes.

"This certification also represents a challenge that drives the entire Doña Paula team to improve their social and environmental performance throughout the winemaking process, minimizing the impact of our operations on the environment and generating shared value with our workers, their families and communities" [27] comments Ana Paula Minatel, Sustainability Coordinator of the winery.

Durigutti Family Winemakers [28]

The Durigutti brothers Héctor and Pablo, had the idea of merging tradition with new technologies and modern techniques.

Located in Luján de Cuyo in the district of Las Compuertas, where the first Malbecs in Argentina were born, the winery develops on precision viticulture. Precision viticulture studies allowed it to identify the soils characteristics on the 25 hectares of Finca Victoria, vineyards over 100 years old were rediscovered to produce high quality wines.

Aligned with the quest for differentiation, from the beginning The Durigutti brothers dedicated resources to study the soils in order to produce knowledge about the terroir, which allowed them to rediscover the potential of various microregions and in particular in their farms to identify each parcel potential.

Durigutti also works in the varietal innovation line combined with the knowledge of the terroir. They produce wines that come from the main producing areas of Mendoza: Altamira, Gualtallary, Vista Flores and La Consulta in Valle de Uco; Agrelo, Pedriel, Vistalba and Las Compuertas in Lujan de Cuyo, combined with distinctive varieties from different areas of the country, including Cafayate, Salta; Fiambalá, Catamarca; Famatina, La Rioja; Pedernal, San Juan; Alto Valle de Rio Negro and San Patricio del Chañar, Neuquén.

26. Information obtained from a visit to the winery, 04/29/2019, and http://donapaula.com/
27. https://www.thedrinksbusiness.com/2019/04/dona-paula-gains-sustainability-accreditation/
28. Information collected from a winery visit, 04/29/2019, and https://durigutti.com/

3.3. Survey to wineries on innovation regarding the Argentine wine industry

Through **Wines of Argentina**, we carried out a structured online survey of Argentine wineries, with a total of 27 responses (4% of all wineries). Of the total responses, 67% came from Mendoza, 18% from Salta, 4% from La Rioja and 11% from other Argentine provinces. Of the total respondents, 74% were male. Of these people, 81% had complete university studies or postgraduate studies, 4% incomplete university studies and 15% technical studies. In terms of ages, 33% were between 40 and 49 years old, 33% were between 30 and 39 years old, 30% over 50, and 4% under 29.

Considering the Argentine wine industry in the last 30 years, we asked which were the most important innovations (up to two per group) within the following categories: vineyard, winery, commercial, human capital, and public or collective action.

In the vineyard, 78% of the responses argued that the most important innovation was the **identification of the best terroirs for each variety and the strains cloning** and 70% believed that the other most important innovation was the introduction of drip irrigation systems.

Regarding innovations in the winery, 63% believed that the most important was **the introduction of new refrigeration devices for both fermentation and aging**, 44% considered the introduction of stainless-steel tanks for storage and fermentation being more important.

About innovation and commercial aspects, 53% of respondents considered **the introduction of recreational and cultural activities related to wine consumption** was the most important, while 44% considered participation in international competitions important; 19% believed that the denomination of origin was important and there was a significant 26% who highlighted “others” (without detailing).

The new generation of Argentine enologists was chosen by 59% as the most important innovation in the development of human capital capacities, while 30% considered it was the hiring of expert international consultants .

In terms of public and collective action, 89% of those surveyed attributed the most important innovations to purely private initiatives.

According to 81% of the respondents, today the greatest efforts in innovation are focused on enhancing quality and expanding. Meanwhile, the biggest obstacles to innovation were absence of credit (96% of the respondents) and taxes (85% of respondents).

The required future innovations are mainly identified in commercial aspects (48%), in primary grape production (26%) and in processing (19%). Respondents considered that the main mechanisms for knowledge transfer among wineries are informal (52%), that the knowledge exchange level among them is high (59%), and that staff mobility among wineries is medium (70%).

The survey provides a general idea about an industry that has a relatively homogeneous diagnosis of what happened, what is expected in the future, and the expected transmission channels of knowledge and innovation.

TABLE 5. WINERIES SURVEYS RESULTS REGARDING INNOVATION IN THE WINE ARGENTINE INDUSTRY

1. What do you consider were the MOST IMPORTANT INNOVATIONS regarding the vineyard in the Argentine wine industry in the last 30 years? Choose one or two of the following answers:	
The identification of the best terroirs for each variety and the strain cloning	78%
The introduction of drip irrigation	70%
Organic or biodynamic cultivation	15%
The development of new varietals	7%
Vine pruning systems to enhance production quality	7%
Other	4%
2. What do you consider to be THE MOST IMPORTANT INNOVATIONS in the wine making process stage in the Argentine wine industry in the last 30 years? Choose one or two of the following:	
New refrigeration devices for aging and fermentation	63%
The adoption of stainless steel tanks for fermentation	44%
The substitution of old vertical presses for pneumatic presses	30%
The substitution of old big sized fermentation barrels and wine aging barrels for small French and American oak barrels	22%
Other	22%
The usage of flow gravity systems	0%
3. What do you consider to be the MOST IMPORTANT DEVELOPMENTS in Argentine wine Commercialization stage in the last 30 years? Choose one or two of the following:	
Recreational and cultural activities related to wine (wine tourism, shows, gastronomy ...)	52%
Participating in international competitions	44%
Other	26%
The introduction of geographical identification (Controlled Denomination of Origin DOC) for some wines	19%
Marketing through social media	11%
The idea of associating the Malbec with Argentine tango as a promotion strategy	7%
The sophisticated architecture of winery for promotion purposes	4%
4. What do you consider was THE MOST IMPORTANT DEVELOPMENT (of the following) related to human capital in the Argentine wine industry in the last 30 years?	
The new generation of Argentine oenologists	59%
Hiring of international consultants	30%
Association with world-class international wineries	7%
Other	4%
5. What do you consider to be THE MOST IMPORTANT TYPE OF COLLECTIVE ACTION (of the following) for the enhancement of the Argentine wine industry in the last 30 years?	
Private-collective actions (e.g. Wines of Argentina, etc.)	89%
Public-private actions (e.g. COVIAR, etc.)	4%
Purely public actions (e.g. INTA, INV, etc.)	4%
Other	4%
6. Where are the wineries' greatest innovation efforts today?	
Acquiring or developing new technologies oriented to enhancing the quality or oriented to expanding	81%
Acquiring or developing technologies or/and implementing good practices oriented at avoiding losses	11%
Other	7%

Source: Wineries Survey on Innovation in the Argentine Wine Industry conducted online, July 2019.

TABLE 5. WINERIES SURVEYS RESULTS REGARDING INNOVATION IN THE WINE ARGENTINE INDUSTRY

7. What do you consider to be the biggest obstacles to innovation in the sector? Choose one or two of the following:	
Access to credit	96%
Taxes	85%
Access to basic infrastructure (e.g. electrification, rural roads, irrigation)	4%
Access to public research, extension and transference services (e.g. INTA)	4%
The availability of qualified human capital	4%
Other	4%
I consider that there are no obstacles for innovation	0%
8. In which stage of the wine production process are the most important innovations required in the next years?	
Commercialization	48%
Primary grape production	26%
Wine elaboration	19%
Wine tourism	4%
Nursery	0%
9. Which do you consider to be the main mechanism/channel of technology and new practices transfer in the sector?	
Informal between wineries	52%
Through preset mechanisms (such as repositories of good practices, formal meetings among wineries organized by institutions)	26%
Through the hiring of experienced specialized staff	22%
10. How much do you think knowledge is shared between wineries?	
Much	59%
Little bit	41%
Nothing	0%
11. What is the observed degree of mobility of highly qualified staff among wineries?	
Medium	70%
High	19%
Low	11%

Source: Wineries Survey on Innovation in the Argentine Wine Industry conducted online, July 2019.

4.

Generation of knowledge and internalization of its benefits: Experiences from the United States and Australia

A recurrent comment in interviews with wineries, being also manifested in the survey, is the need to improve **the articulation and the transfer of knowledge** between institutions dedicated to research and the companies.

Both the Australian and American quality wine industries based their development on major investments in research and development. The Australian wine industry has been characterized by its dynamism and its state-of-the-art wine research.

According to wine critic Karen MacNeill, High-Tech could be the middle name of the Australian wine industry. Australia is considered by many Argentine producers a role model when it comes to wine research and development. Susana Balbo and Silvio Alberto highlight the work and interaction between the Australian wine industry and the Australian Wine Research Institute (AWRI).

As we noted in section 2, it is difficult, or nearly impossible, to exclude third parties from the usage of some forms of basic research, which would seem to reduce incentives to innovate. However, the benefits not internalized by a winemaker or producer could become internalized by the industry, through the creation of institutions. The cases of the **Robert Mondavi Institute for Wine at UC Davis**, a public-private alliance, and the **AWRI**, which is supported by Australia's leading grape and wine producers are two examples of this. Both institutions emerged as a mechanism to internalize the benefits of research and development that are difficult for the individual producer to internalize. *Wines of Argentina* is a successful local example of benefit internalization at the industry level of the nation's brand care and development.

The Robert Mondavi Institute for Wine and Food Science was established in 2001 with a $ 25 million donation from Robert Mondavi to UC Davis, that allowed the Departments of Viticulture and Enology (VEN) and of Food Science and Technology (FST) to relocate into a state-of-the-art teaching and research complex. The Institute has a winery, a brewery, and food and dairy processing laboratory.

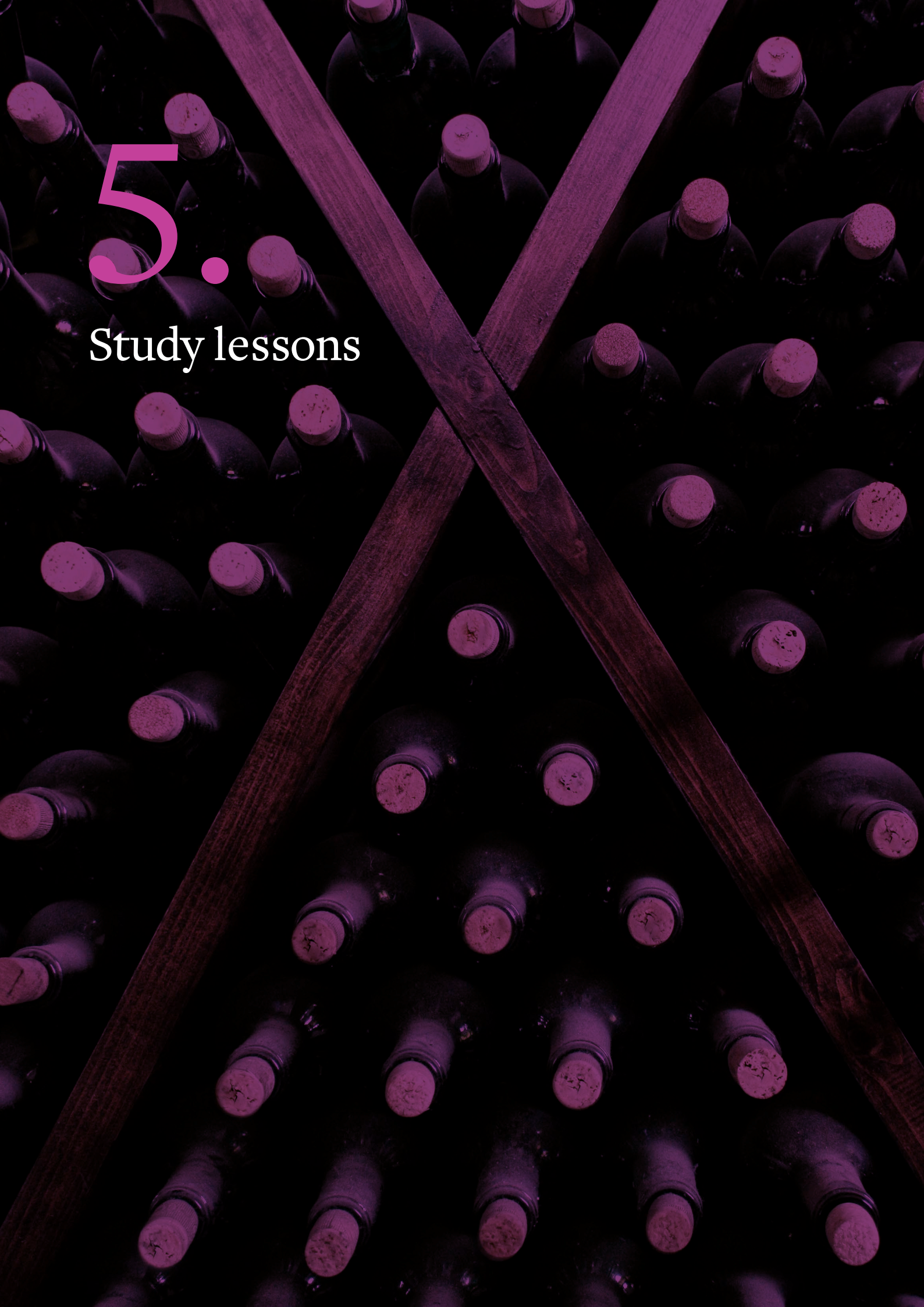
The Institute's role as an articulator between the different actors in the industry is key. The Institute serves as a gateway between UC Davis and a broad community of scientists, engineers, entrepreneurs, policymakers, industry professionals, and technicians dedicated to all the dimensions of the activities related to wine, brewing and food science.

The last decades were a period of great growth in the Australian wine industry. Over the past twenty-five years, the number of wineries has doubled, reaching 2,468 wineries in 2018. AWRI supports the industry through world-class research, practical solutions and knowledge transfer. Established in 1955, the AWRI is governed by an Industry-Led, Skills-Based Board and is a member of the Wine Innovation Cluster, located at the Waite Research Precinct in Adelaide. The AWRI's activities are guided by an industry-endorsed research, development and extension plan and an internal business plan. AWRI Commercial Services is the commercial arm of the organization and provides advanced analytical and consulting services on a fee-paying basis.[29]

AWRI supports producers and wineries by developing research focused on their priorities, it provides technical assistance services to answer queries from producers, and carries out extension and transfer activities. Their activities include hosting workshops and seminars in Australian wine regions, delivering technical information through its library, the AWRI website, and regular email newsletters. These publications include an Annual Report, an AWRI Technical Review and the Agrochemicals "Dog Book". They also conduct events, including the triennial Australian Wine Industry Technical Conference, the Advanced Wine Assessment Course and Research for Practice modules, provide analysis accredited by the National Association of Testing Authorities (NATA), and assistance with the wine export, they also supervise postgraduate students and provide lectures to undergraduate students.

The research work is carried out in an articulated manner with the industry, through meetings with producers and wineries. For example, for the period 2013-2017 the Research, Development and Extension Plan (RD&E) was developed during 36 meetings held in Australia with grape and wine producers and other stakeholders, and it was aligned with the Strategic Plan 2012-2017 of the Grape and Wine Research and Development Corporation (GWRDC) and other strategic directions from the industry and government. Their latest plan, for the period 2017-2025, includes five major topics: i) Clients, consumers and markets; ii) Extension, adoption and education; iii) Performance, products and processes; iv) Environment, sustainability and natural capital, and v) Fundamental data and support services.

29. https://www.awri.com.au/about_the_awri/about_the_awri/



5.

Study lessons

In the theoretical framework, Romer targets the intensity of rivalry (or appropriation) in contrast to an ideas public good nature and the incentives to produce it, while Galenson deals with how ideas are conceived, how to get them and how to disseminate them. If we combine the criteria of both authors, some stylized facts result:

1/

The incentives that the market provides for innovation and their interaction with the approach used by the innovator to develop new ideas, are essential in understanding the innovation process and the design of public policies.

Private research and development efforts focus on partially or fully appropriable knowledge, such as the identification and exploration of the micro-terroir developed by Laura Catena and the CIW.

2/

Experimental innovations are probably more appropriable privately because of the manner this knowledge is stored and communicated.

Some privately appropriable innovations have this nature temporarily and will later become common knowledge, like the use of the Californian-French vinification style to produce quality wines in Argentina, the discovery of the High Altitude Malbec, and the introduction of new varietals. During this period, they provide economic advantages to those who own them. Other innovations are likely to be protected longer by patents and trademarks, so private benefits can be expected to last longer. Knowledge can be a public or a club good, due to its conceptual nature, which implies a greater probability of dissemination and replication, like, for example, the introduction of drip irrigation.

3/

The benefits of public knowledge generation that are not internalized at individual level can be internalized by organizations that group them.

Semi-private (club) innovations can be produced by the private sector in case it manages to associate members with common interests for collective actions. The activity developed by Wines of Argentina to promote the brand and country image of Argentine wines around the world is a great example of this type of collective actions. There is also room for collaboration between the private and public sectors on some sectoral strategies to produce semi-public innovations, such as the creation of Geographical Indications (IG in Spanish).

4/

The quality leap that is perceived in the Argentine wine industry can be summarized in the following facts:

- Until 1995, exports were practically non-existent; today the Argentine wine industry exports one third of its added value.
- Exports in value, have increased (in percentage) much more than exports in volume.
- The country now has 5% of world wine production, 2% of world exports in volume and 3% of world exports in value.

5/

The identification of the innovations and their classification was ratified by personal interviews led by us with qualified informants and by the survey conducted by WofA to its associates.

Responses are highly concentrated in some proposed innovation categories. The sectoral cohesion is remarkable in the sense that it highlights the importance given to private collective action, to informally share knowledge among wineries, and the importance of local and imported human capital in innovation.

6/

The Galenson-Romer approach, developed in this technical note, provides an economic framework to analyze the market of innovation and knowledge in the wine sector.

The Galenson's method of classification, merged with Romer's idea that incentives matter for innovation, provides a guide for public policy design. The main policy lessons that emerge from the analysis are as follows:

- **To encourage the articulation and collaboration between research organizations and the private sector:** It is advisable to develop programs that require the joint participation of research organizations and the private sector, with the purpose that research is done focusing on the issues and challenges that wineries face. The Catena Institute of Wine and the Zuccardi Family, together with INTA, the National University of Cuyo and IBAM are local examples, in which some research lines have successfully worked in this way.

- **To favor (or not hinder) private collective action:** The State should not aim to replace the private sector where it has comparative advantages, but rather it should complement it where collective action may prove troublesome due to high transaction costs to achieve profitable deals.

  The experience of Robert Mondavi Institute for Wine and Food Science and AWRI, can be taken as a model for the successful development of this type of collective institutions dedicated to research and development, which manage to internalize external benefits to individual actors.

  A successful local example of this type of collective institutions is Wines of Argentina. The survey revealed a very high weight on the side of the wineries that responded to the private collective action activity through this institution. We consider pertinent to support this entity in the production of "club" goods related to the knowledge and reputation of argentine wines in the international market, and in the development and promotion of geographical indications of origin.

- **To develop trade opening agreements with other countries and improve existing agreements:** There is complementarity between innovation and international trade. Innovation has proven to be the way to international insertion, by differentiating the product through quality development. There is a conviction in the industry that the quality wine market is abroad, given that the domestic market continues to decrease in volume and has a ceiling at the prices it can pay.

- **To promote (or not discourage) the development of labor and research exchange programs with other countries:** Experimental knowledge travels with human capital. The exchange with other wine regions has been fundamental for local industry development. The successful experiences of Nicolás Catena, Susana Balbo, Laura Catena, Silvio Alberto, and the trip to the Napa Valley organized by Tizio Mayer in the early nineties, show the great importance of experimentation to learn and acquire experimental knowledge. The collaboration between the Catena Institute of Wine and UC Davis is an example of the importance and potential of international collaboration in research and development.

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