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Research Articles

Investigation of Innovation in Wine Industry via Meta-Analysis

Ali Dogru[1], Joseph Peyrefitte[1]

[1] School of Management, University of Southern Mississippi

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This study provides a systematic review of 76 relevant wine business studies published in the last 30 years. Our meta-analysis investigates six commonly used variables to explain wine innovation: absorptive capacity, technology adoption, sustainable practices, export orientation, firm size, and firm age. We also investigate the association between innovation and financial performance, using the reported effect sizes in the literature. Our meta-analysis reveals that absorptive capacity, technology adoption, sustainable practices, export orientation, and firm size positively correlate with innovation efforts, and innovation is positively associated with financial performance. However, we find no correlation between firm age and innovation. In addition to the meta-analysis, we apply basic text analytics and narrative review methodologies to identify a taxonomy of wine industry innovation according to four types of innovation. Based on our systematic literature review results, we make a series of managerial and policy recommendations for wine firms. Finally, we identify gaps in the literature and suggest future research directions.

MANAGERIAL SUMMARY

Measuring innovation in the wine industry is hard not only due to broad, abstract, and ambiguous connotations of the term "innovation" but also owing to peculiar characteristics of the wine industry, which complicate data collection, model building, and analysis. Moreover, innovation activities are often seen as business secrets, which considerably limits the exchange of information among fairms and with researchers, slowing down the diffusion of innovation within the wine industry. Despite these challenges, innovation may provide significant value to the industry; however, wine researchers need to convince practitioners that innovation may lead to competitive advantage and bring financial success. We believe that as both the quantity and quality of innovation-related wine research improves, the role that innovation plays in the wine industry would be clearer.

In this study, we provide a systematic review of the relevant wine business literature that consists of 76 studies published since 1991. While providing a narrative review of qualitative studies to identify common wine innovation types and forms, we perform a meta-analysis on the quantitative studies that report usable/convertible effect sizes for pairwise relationships between six commonly used variables (i.e., absorptive capacity, technology adoption, sustainable practices, export orientation, firm size, and firm age) and innovation, as well as the association between innovation and financial performance. Our analysis reveals that absorptive capacity, technology adoption, sustainable practices, export orientation, and firm size are positively correlated with innovation efforts, and innovation is positively associated with financial performance. Furthermore, we find that firm size moderates the relationship between absorptive capacity and innovation. We discuss several managerial and policy implications of our analysis and make a series of recommendations for future research avenues.

Our managerial recommendations include 1) engaging in innovative practices and collaborating with researchers, particularly in quantitative research projects, 2) prioritizing eco-innovation activities, 3) adopting emerging industry 4.0 technologies, 4) investing in absorptive capacity, and 5) increasing export-orientation and international visibility.

We suggest future quantitative studies to explore the impacts of 1) links to research institutions, 2) patent ownership, 3) and other variables, such as proximity, corporate social responsibility, national and international regulations, R&D subsidies by governments, competitive pressures from stakeholders, and the managerial perceptions regarding innovation and financial performance. We also recommend researchers consider conducting MASEM, which currently does not exist in the literature. We recommend future qualitative research efforts to focus on clearly defining and classifying innovation in the wine sector and comparing the performances of wine supply chains before, during, and after the pandemic to exemplify how innovation has helped wine firms recover from disruptions caused by the pandemic. Finally, to mitigate the negative impacts of the recent pandemic on wine supply chains, we suggest that wine business research should benefit from interdisciplinary studies more, particularly with operations management and supply chain management fields.

INTRODUCTION

Innovation is a broad and abstract term with multiple connotations. Innovation may simply mean a new idea, method, process, product, or technology. However, a key component of a general definition of innovation is that it must be implemented so that either a new product is made available to potential users or a new process is put into use in organizational operations (Gault, 2018). Organizational adoption of innovations is intended to increase organizational effectiveness or performance either in response to or as a preemptive action to changes in its internal or external environment (Damanpour, 1991). The pandemic drastically affected the global supply chain that serves wine and wine-related businesses in 2020. Yet, most wine businesses avoided major disruptions and learned that better planning is necessary during environmental uncertainty (Penn, 2021). Hence, introducing innovative methods, products, and services remains essential for wine business survival and success.

From a business perspective, innovation is a novel solution to a practical problem that generates financial and/or social value (Kavadias & Ulrich, 2020). This definition emphasizes three essential features of business innovations:

- Innovations stem from practical needs.
- Innovations offer practical solutions.
- If successful, innovations provide some form of value to its stakeholders.

However, innovation is somewhat difficult to measure. Aside from its ambiguous connotations, innovation is also hard to assess due to its spill-over and synergistic amplification effects (i.e., the combined impact of distinct innovative practices in a firm might be larger than the sum of the individual effects of these innovative practices).

Management science literature usually breaks this broad concept into smaller parts to decrease abstraction and mitigate this measurement problem. Studies either treat innovation as a function-specific variable (i.e., production, logistics, marketing, and service innovation, etc.) (Faccin et al., 2017) or distinguish between process vs. product innovation (Murovec & Prodan, 2008; Presenza et al., 2017; Utterback & Abernathy, 1975), incremental vs. radical innovation (Ettlie et al., 1984), conventional vs. eco-innovation (Frigon et al., 2020), or internal vs. external innovation (Kavadias & Ulrich, 2020).

Measuring innovation in the wine industry is more problematic than other industries due to peculiar characteristics of the wine industry, such as relatively high concentration of small and medium-sized enterprises (SME) (Lorenzo et al., 2018), widespread family ownership (Gilinsky et al., 2016), terroir-dependency of wine production (Van Leeuwen & Seguin, 2006; Vaudour, 2002), orientation toward tradition (Vrontis et al., 2016), fragmented business and knowledge networks (Tyler et al., 2020), and reliance on tacit information (Woodfield & Husted, 2017). These industry-specific characteristics complicate data collection, model building, and analysis. Furthermore, innovation activities are often seen as business secrets, which considerably limits the exchange of information among firms and with researchers, slowing down the diffusion of innovation within the industry.

This study provides a comprehensive review of research since 1991 that addresses wine business innovation, its forms, and its outcomes. In addition to basic text analytics and narrative review techniques, we conduct a meta-analysis of quantitative studies investigating the role of innovation in the wine industry. To the best of our knowledge, there is no meta-analysis on wine innovation. Therefore, our study aims to fill this gap in the literature. We believe that wine researchers and practitioners would greatly benefit from our systematic literature review, discussion on managerial and policy implications, and suggestions for future research.

The research questions that motivate our study are as follows: *How strong is the link between innovation and financial performance in the context of the wine industry? What are the factors associated with and common forms of wine industry innovation? What research gaps and future research avenues exist in the wine innovation literature?*

Our meta-analysis reveals a positive correlation between innovation and financial performance. Furthermore, we find positive associations between specific determinants (i.e., sustainable practices, technology adoption, absorptive capacity, firm size, and export orientation) and innovation. However, we find no correlation between firm age and innovation.

We organize the rest of the paper as follows. The following section (Section 2) discusses prominent theories that guide wine business research. The methods section (Section 3) summarizes our systematic study search procedure, provides descriptive statistics about the study pool, and introduces our meta-analytic approach. Section 4 provides the results of our meta-analysis and moderator analysis. Section 5 discusses managerial and policy implications, identifies gaps in the literature, and makes recommendations on potential future research efforts. Section 6 concludes the paper summarizing our findings and discusses limitations.

THEORETICAL DISCUSSION

This section discusses prominent theories that guide wine innovation: Resource- & knowledge-based views and sustainability & eco-innovation theories.

Resource and Knowledge-Based Views

The resource-based view (RBV), the leading theory used to explain wine innovation, argues that competitiveness and financial success are primarily determined by firms' internal resources (Barney, 1991). These internal resources include quality of HR (i.e., formal education, skills, and training), technological capabilities, financial assets, and R&D activities (Cohen & Levinthal, 1990; Galbreath, 2005). Firms gain a competitive advantage by managing and strategically investing in these endogenous capabilities. For instance, firms may include sustainable practices that lead to operational efficiencies to improve their performance (Barney, 1999). Furthermore, Atkin & Johnson (2010) show that forming alliances for marketing purposes could be an effective strategy to gain a competitive advantage. A fundamental assumption in RBV is that as the firm size increases,

innovation capacity increases. Therefore, large firms are considered more advantageous than small and medium sized enterprises (SMEs) due to their extensive pool of high-quality HR, substantial financial assets, and sizable technological infrastructure.

Some studies challenge the classical RBV by providing a different perspective. For instance, Humphreys & Carpenter (2018) point out that some large and established market-driving wine firms achieve competitive advantage by playing a status game rather than strategically investing in their endogenous resources and innovative practices. Contrary to market-driven firms that rely on consumer information as a key input to develop innovative strategies and techniques, status-driven (market driving) firms seek to shape consumer preferences by creating a vision, employing celebrity winemakers, influencing critics and media, and affecting retail sales by promoting scores by critics and form alliances to maintain and enhance their status (Humphreys & Carpenter, 2018). One may argue that playing a status game itself may require significant resources, so the argument does not refute RBV but intends to clearly distinguish how resources are utilized to gain competitive advantage by status- and market-driven firms. This debate is still an open question.

Knowledge-based view (KBV), a derivation of RBV, considers knowledge as the most crucial asset of a firm that pursues a competitive advantage via innovation (Grant, 2015; Woodfield & Husted, 2017). This theory argues that knowledge base (KB) is a function of technical expertise, education level, HR training, technological capabilities, and R&D efforts. The central assumption is that the larger the KB, the more likely the innovation is. Recent knowledge-based studies find that innovation does not diffuse evenly on a par with proximity; instead, it spreads in a highly selective manner in proportion to the size of knowledge bases (KB) of heterogeneous firms. Firms with distinct KBs make up knowledge networks (KN). KN differs from a business network (BN) because the former is established selectively considering the relative capacities of firms, whereas the latter represents a pervasive structure that brings nearby firms that operate in the same sector together where hierarchy is less important. Giuliani (2007) finds that the structure of KNs significantly differs from that of BNs such that diffusion of innovation is more uneven in the former, and firms with stronger KBs are more likely to be central in the KN.

Some studies examine the impact of the inter-generational exchange of tacit information on innovative capacity. For instance, Woodfield & Husted (2017) find that bi-directional exchange of information between generations in family firms is critical for innovation. They state that transferring the incumbent's experience-based tacit knowledge to the successor is necessary but not sufficient for maintaining and improving innovative capacity. The successor should also share up-to-date information gained via education with the incumbent. Finally, within this stream of research, the roles that academic institutions play in wine-related innovation via firm-university linkages has attracted some attention, but results are quite country-dependent. For example, Giuliani & Arza (2009) find that in Chile, the stronger the firms' KB and higher the university's scientific quality, the more likely a university-industry linkage is. However, in Italy, the results are almost reversed. In both Chile and Italy, the stronger the KBs of firms with connections to universities, the higher the diffusion of innovation (Giuliani & Arza, 2009).

Sustainability and Eco-Innovation Theories

In broadest terms, sustainability is the ability of a firm to use its resources without harming the ecological system in meeting the wants and needs of customers. Sustainability theory (ST), which has emerged in reaction to the classical myopic profit-maximizing firm behavior, argues that firms should be farsighted in distributing resources more equitably between generations to enable sustainable development. Harsh economic competition leads to the accelerated use of non-renewable energy sources, which changes the climate, negatively affecting agricultural practices, including wine production.

Rooted mainly in ST, eco-innovation theory (EIT) asserts that firms should care about the long-lasting impacts of innovations on our biosphere and future generations. Due to its close relationship with the terroir, the wine industry is one of the sectors that eco-innovation has a significant value potential. As defined by Kemp & Pearson (2007), eco-innovation is "the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resource use (including energy use) compared to relevant alternatives." As scientific studies in environmental sciences, earth and planetary sciences, agriculture, biology, chemistry, and material sciences point out, the earth system and its constituent subsystems are governed by complex and dynamic interactions between biological systems, materials, and energy. The prolonged coexistence of our biosphere and civilizations requires social, environmental, and economic sustainability. Various endogenous and exogenous factors affect the ecological behavior of a firm.

The roles that integrated environmental management systems (EMS) play in improving firm outcomes, sustainable practices, and eco-innovations have attracted some attention in the EIT literature. For instance, Sroufe (2009) demonstrates that the EMS positively impacts specific operational performance metrics, such as quality, reduced cost, and international sales. Atkin et al. (2012) find that wine firms with a clear EMS exhibit significantly different cost leadership and differentiation strategies. They state that wineries with a clear EMS are more likely to increase their sustainability commitments, enter new markets, and operate more efficiently than those without a clear EMS. Melnyk et al. (2003) point out that firm age, size, and ownership type are related to investments in EMS. Gilinsky et al. (2008) indicate a propensity to invest in EMS innovations by young entrepreneurial agricultural businesses.

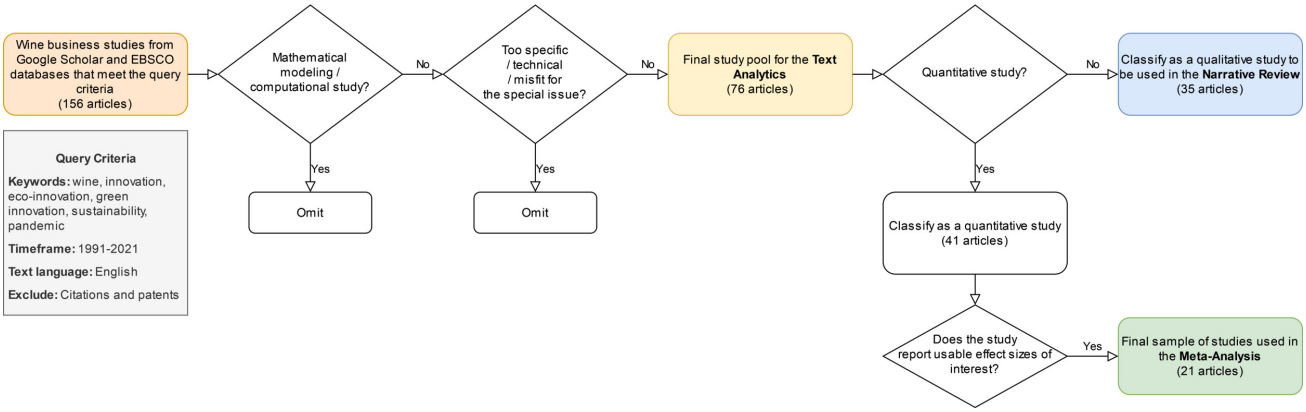

Figure 1. Systematic Review Procedure

METHODS

Search Procedure, Inclusion Criteria, and Final Sample of Studies

Figure 1 illustrates our systematic review procedure. We first conduct a search for studies published in English since 1991 that contain combinations of "wine," "innovation," "eco-innovation," "green innovation," "sustainability," and "pandemic" in the title, abstract, and the article text on Google Scholar and EBSCO databases, excluding citations and patents. This initial search yields 156 candidate studies. Although the wine business literature is quite vast, studies that focus on innovation is quite limited because of the peculiar characteristics of the wine industry, as discussed in the Introduction section. We perform an initial screening to exclude 1) computational studies that use mathematical modeling techniques, such as optimal scheduling of wine bottling operations, and 2) studies that are too specific or technical, such as studies that measure the impact of a specific microbiological ingredient on wine quality. While screening the candidate studies, we also check if a study fits well to the scope of the special issue. After this meticulous examination process, we identify the most relevant 76 wine business studies as our study pool.

We first perform preliminary text analytics on all 76 articles to provide insight into the last 30 years' research efforts on wine innovation. We then classify this study pool based on five criteria: theory, methodology, independent variable(s), dependent variable(s), and major contribution. This classification helps us categorize studies as either quantitative or qualitative and identify research gaps. We classify 35 articles as qualitative and 41 studies as quantitative. We use qualitative studies to perform a narrative review to identify common wine innovation types and forms addressed in the literature. Quantitative studies that report usable/convertible effect sizes of interest are used in the meta-analysis. Out of 41 quantitative studies, only 21 studies report usable/convertible effect sizes.

Overview of the Study Pool

We provide the detailed classification of the quantitative and qualitative articles in the study pool in Tables A2 and A3 in the Appendix, respectively. To save space, we use some abbreviations, the list of which is also presented in the Appendix (see Table A1). To give the reader a flavor of our study pool, we provide descriptive statistics using the bar and pie charts in Figure 2.

Figure 3. Word Cloud of the Study Pool

The bar charts illustrate the frequency of studies by country and by period. As can be seen, Italy, the USA, Spain, Canada, Australia, and France are relatively better represented than other countries, and the number of relevant wine studies increases over time (i.e., the majority of wine studies published between 2013-2020). There are more quantitative studies in the study pool than qualitative studies (53.9% opposed to 46.1%). The prominent theories that provide bases to these studies are resource-based view (RBV), knowledge-based view (KBV), sustainability theory (ST), eco-innovation theory (EIT), and geographical proximity theory (GPT). The most frequently applied quantitative methodologies are exploratory data analysis (EDA), followed by principal component analysis (PCA), ordinary least squares (OLS) regression, cluster analysis, logistic regression. Widely adopted qualitative research methodologies are surveys, interviews, reviews, and case studies.

Text Analytics

Figure 3 depicts a word cloud of the study pool. The word cloud attaches higher importance to high-frequency words in the text, representing them bigger and bolder than less important ones.

Figure 4 summarizes basic text analytics conducted on the titles, abstracts, keywords, and main bodies of all study

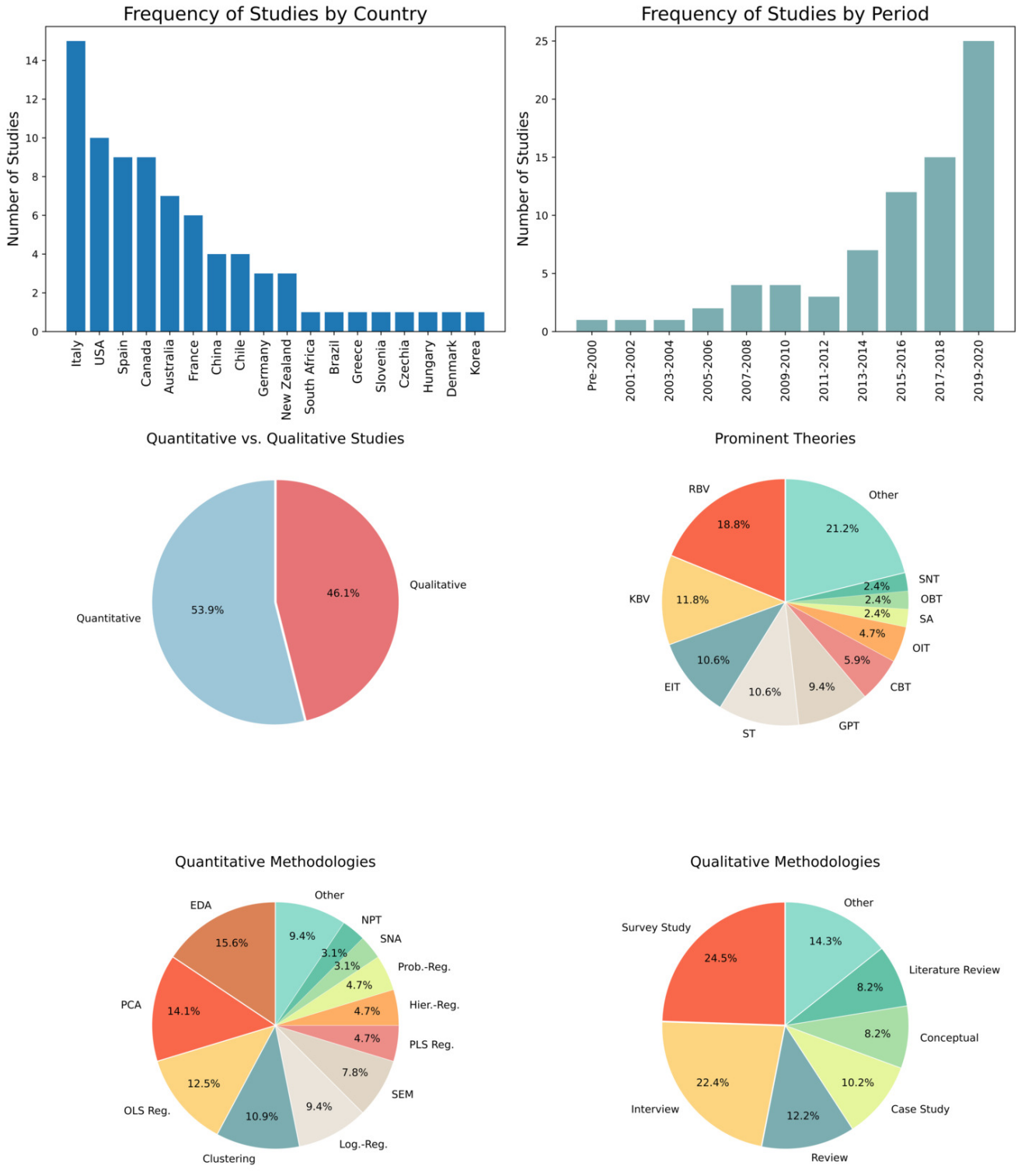

Figure 2. Descriptive Statistics about the Study Pool

pool articles. The left figure (Figure 4a) illustrates the frequencies of innovation types categorized by quantitative and qualitative articles. As can be seen, the most frequently discussed innovation type is green or eco-innovation, followed by product, marketing, process, conventional, and logistics/delivery innovations. Another interesting finding is that quantitative studies more frequently mention innovation than qualitative studies in all categories. The right figure (Figure 4b) depicts the frequencies of most repeated keywords by study type. The keyword "wine" has the highest frequency (as expected), followed by "sustainability," "innovation," "information," and "performance." Some of these keywords, such as "wine," "family," "COVID-19", "terroir," and "tacit," are used more often in qualitative studies than quantitative studies. These findings are consistent with a recent bibliometric review of 213 *Web of Science* wine

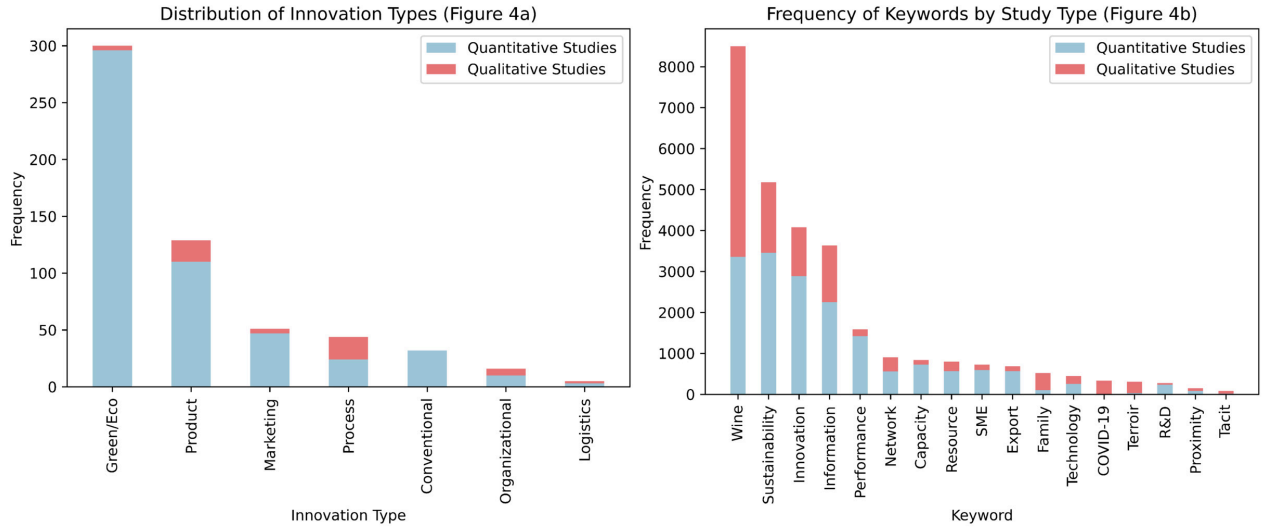

Figure 4. Summary of Basic Text Analysis

innovation articles by Porto-Gómez et al. (2020). The researchers' review assessed the topics discussed and discovered that non-technological innovation is the most researched topic, while product innovation is focused primarily on consumer demand for wine; sustainability and sustainable innovation are both gaining relevance.

Narrative Review

Using NVivo software, we classify common forms of innovation in the qualitative studies according to the four types of innovation described by Gault (2018, p. 619): product innovation, production or delivery innovation, organizational innovation, and marketing/communication innovation. The narrative review approach is designed for topics that hinder a full systematic review (Snyder, 2019) and may provide valuable insights (Baumeister & Leary, 1997). We summarize the results in Table 1.

We limit our coding of the forms to only those papers that had used wine business data in their analyses. Production or delivery innovation is the most common type of innovation (mentioned 76% of the articles), followed by product innovation (70%), marketing/communication innovation (40%), and organizational innovation (26%).

Meta-Analysis

After this broad summary, we turn to our meta-analysis, which uses a subset of quantitative studies (21 out of 41 articles) that report usable/convertible effects sizes (60 effect sizes in total). Developed by Hunter et al. (1981), the meta-analytic approach is a high level, systematic, and replicable methodology that synthesizes many quantitative empirical studies in a scientific field to draw broad statistical conclusions about the magnitude and direction of relationships between variables of interest (Hunter & Schmidt, 1990, 2000, 2004). This study uses two R packages (metafor and robumeta) to conduct the meta-analysis illustrated in Figure 5.

Following the meta-analysis methodology, we investigate a single relationship at a time. Since the wine studies are drawn from different populations with substantial heterogeneity, we use random-effects models, which assign less weight to larger studies with smaller variance (Quintana, 2015). Heterogeneity refers to the between-study variation (high heterogeneity requires a random effect model). We report I^2 statistic as the measure of heterogeneity. I^2 is a performance statistic that indicates the percentage of variance attributable to study heterogeneity rather than chance. Unlike the Q-statistic, I^2 is not sensitive to the number of studies included in the analysis (Quintana, 2015). We select Pearson correlation coefficient (r) as the primary effect size since it is a standard metric reported in most studies in our study pool and is relatively easier to interpret than other metrics. If a study does not report r but reports another convertible effect size (i.e., F-statistic, t-statistic, odds ratio, partial eta squared, and Kendall's tau), we transform them into Pearson correlation coefficients (Hu & Yang, 2021; Lipsey & Wilson, 2001; Peterson & Brown, 2005; Walker, 2003) using the formula provided in the Appendix (Table A4 and Figure A2). Finally, we perform a moderator analysis using firm size (average number of employees), firm age (average firm age in years), geography (whether a sample belongs to an old world or new world country), and publication quality (whether a study is published in a 1st Tier or 2nd Tier outlet) as the moderator variables.

Variable Definitions and Measurement

In this subsection, we define the variables in Figure 5 and exemplify how they are measured. It is important to note that there are variables that we could not include in our analysis due to insufficient number of studies, such as proximity, corporate social responsibility, government subsidies and tax cuts, national and international regulations, competitive pressures, and perceptions of managers. Although some of these measures are well studied in other industries,

Table 1. Wine Business Innovation Types and Forms

Product Innovation	Production or Delivery Innovation	Organizational Innovation
New or significantly improved product or service	New or improved raw materials, production techniques, equipment, technology, grape growing and transformation techniques, and logistics	New or significantly improved methods in business practices, workplace organization, or external relations
Product and brand differentiation	Patent new technologies	New business or management strategy
Change in components	Use of organic, chemical, and innovative substances	New human resources policies
Change in product design	Reduction of material, water, and energy use	New manufacturing management system
Sales of hotter climate varieties	Use materials with less greenhouse gas-intensive	Quality control
New wine container closures	Recycle waste, water, materials	Simplification of the decision-making process
Types of wine produced, new varietals	Alternative energy use, packaging, and waste disposal	New forms of human resources training
New wines responsive to consumer trends	Reduction of refrigeration loads	New organizational philosophies, culture, or organizational structure
Organic products/ farming	Energy-efficient technology	New competitor connections
New product development through OI, product development speed	Grow grapes suitable for hot temperatures, establish vineyards in areas less subject to climate risk	Next-generation organizational policies, practices, mechanisms, and structures
New tasting room	Canopy management techniques	**Marketing/Communication Innovation**
Entry-level trendy wines	New distribution through open innovation	New marketing tools (QR code, website, newsletter, wine club, training course)
Educate young consumers' palates through events	Warehousing and breeding innovation	Strengthen brand
Increased quality	Organic certification	New or significantly improved marketing methods
Design new products with new technologies	Wildlife protection	New promotion/sales through open innovation
Enhance existing products with new technology	Improved value chain activities (i.e., changing buying practices, sale of wine by-products, and technical advice/support from peers)	Enter new markets, new market segment
New packaging/labels	Monitoring wine quality with biosensors	Raise wine status
New bundles of products and services	Heated and refrigerated maceration	Market carbon policy
New box containers for high-end wines	Photovoltaic roofing	Wine selling innovation
A large range of wines offered	Biotechnologies applied to yeasts	Family promotes wines
Niche products based on typical or organic products	Submerged cover fermentation	Use of social media to promote wine products

their impacts on wine innovation and financial performance have attracted relatively less attention.

Innovation. As mentioned earlier, studies either use "innovation" as a generic term or use different innovation classifications (i.e., product vs. process innovation and conventional vs. eco-innovation). To ensure consistency and prevent over-representation of a single study in the meta-analysis, we use only one effect size per study for each relationship pair. For instance, if a study reports multiple effect sizes coming from the same sample, each corresponding to a specific class of innovation (i.e., product vs. process innovation or green vs. conventional innovation), we use the effect sizes that correspond to "product innovation" and "green/eco-innovation", respectively, since green/eco- and product innovations are the most frequently mentioned innovation categories in the study pool (Figure 4). The only exception is a study by Giuliani & Arza (2009), who report two sets of effect sizes coming from two distinct wine clusters, Italy and Chile, respectively.

Financial performance. Financial performance is a continuous measure that indicates how successfully and efficiently a firm utilizes its resources to maximize its revenue.

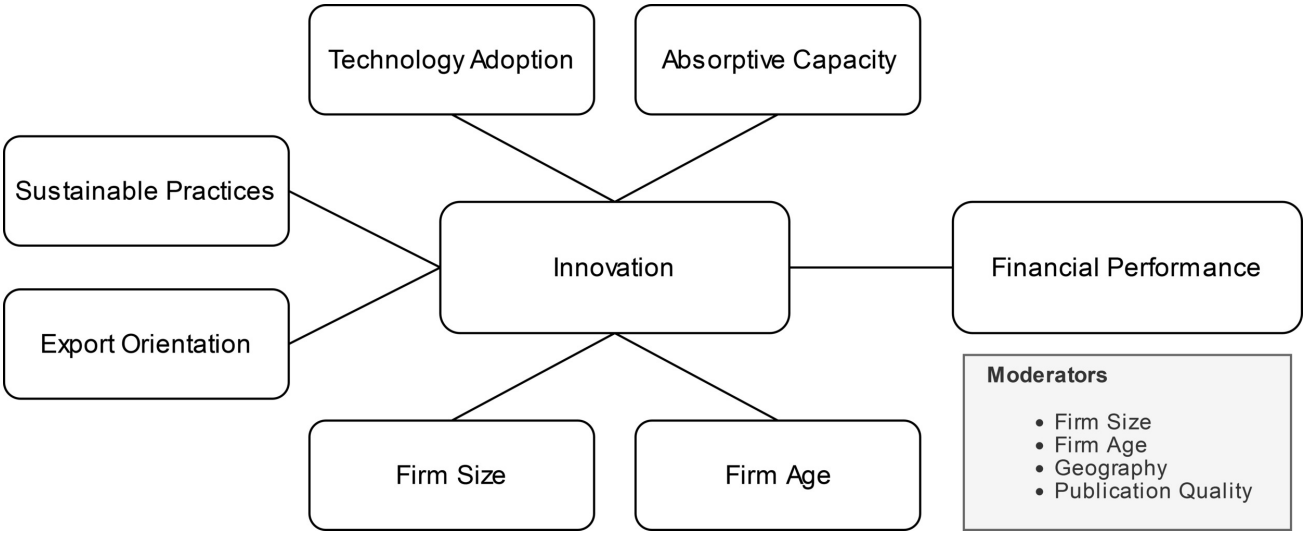

Figure 5. Meta-Analysis Framework

Common metrics to measure financial performance include the volume of wine sales (Galbreath et al., 2016), profit (Lorenzo et al., 2018), market share (Guerrero-Villegas et al., 2018), return on assets (Pradana et al., 2020), subjective evaluation of last 5-year's financial performance in comparison to similar firms (Knight et al., 2019), and cost-reduction as a result of employing an innovation (Annunziata et al., 2018).

Absorptive capacity. Absorptive capacity is the ability of a firm to embrace, assimilate, and apply new knowledge for commercial ends (Cohen & Levinthal, 1990). R&D efforts and/or expenditures (Stasi et al., 2016), quality of HR (Giuliani & Arza, 2009; Giuliani & Bell, 2005), patent ownership (Ahn et al., 2013), knowledge acquisition and assimilation efforts (Pradana et al., 2020), and relationships with external knowledge sources, such as universities (Presenza et al., 2017) are often used to measure absorptive capacity. For instance, Giuliani & Arza (2009) measure absorptive capacity (knowledge base) as a function (weighted average) of three distinct variables: formal training of HR (a continuous variable calculated using a weighted average formula), HR national and international experience in months (a continuous variable calculated using another weighted average formula), and experimentation effort (a categorical variable measured from 0 to 4).

Technology adoption. Adopting technologies, such as wine machinery, biotechnologies, biosensors, and other wine-making techniques, are considered good predictors of innovation (Stasi et al., 2016). Though falling behind other sectors, automation in the wine industry has gained traction in the last decade with advancements in AI, robotics, sensor, and other Industry 4.0 technologies. Technology adoption is often measured via survey questions on whether a firm adopts a particular technology or not, so it is often treated as a binary or a categorical variable (Annunziata et al., 2018).

Sustainable practices. Common sustainable practices are organizational policies (i.e., environmental policy statement, environmental purchasing policy, etc.), procedures (i.e., collecting data related to ecological issues, supplier selection based on environmental criteria, engaging in environmental audits, etc.), strategies (i.e., eco-labeling, promoting eco-certification, strategic goals for reducing waste and carbon emissions, etc.), and other environmental applications, such as environmental management system, restoring contaminated soil, using recycled material (Guerrero-Villegas et al., 2018), monitoring emissions (Galbreath et al., 2016), use of frugal irrigation systems (Fiore et al., 2017), environmental disclosure (Knight et al., 2019), and using renewable sources of energy (Annunziata et al., 2018). Sustainable practices are typically measured via surveys and are often treated as a categorical variable.

Export orientation. Export orientation is a continuous measure to identify a firm's primary growth strategy, usually reflected as a ratio of exports to total sales (exports + domestic sales) (Maurel, 2009). The larger the sales are to other countries, the higher the export orientation is (Annunziata et al., 2018).

Firm size. Firm size is typically measured either by the log number of employees (Annunziata et al., 2018), the amount of wine production (Galbreath et al., 2016), total sales, or total assets (Guerrero-Villegas et al., 2018).

Firm age. Firm age measures the cumulative time in years since the firm was founded. Most studies use the log firm age to mitigate considerable variation in firm ages.

Moderator Variables. We examine four moderator variables: firm size, firm age, geography, and publication quality. To measure *firm size*, we use the average number of employees reported by these studies. To account for inherent variation in firm sizes and ages, we take the log of these measures (if not already taken). *Geography* and *publication quality* are categorical variables. To investigate the impact of geography, we classify studies as either "New World" or "Old World" studies. We also group each study as either 1st or 2nd Tier. We primarily use the ABDC Journal Quality List for this classification. If an academic journal is not listed in the ABDC Journal Quality List, we turn to other lists and global metrics, such as Harzing – ABS 2021, JCR 2021, and h5-index. Journals that are rated A^{-} and above

Table 2. Summary of Meta-Analysis Results

Relationship	$\bar{r}$	95% CI	k	N	I^2	p-val.
Sustainable Practices <-> Innovation	0.54	[0.13, 0.80]	8	2,000	99%	0.013
Technology Adoption <-> Innovation	0.34	[0.15, 0.51]	4	1,181	92%	0.001
Absorptive Capacity <-> Innovation	0.29	[0.19, 0.39]	14	2,450	86%	0.000
Absorptive Capacity (Adj.) <-> Innovation	0.28	[0.12, 0.44]	14	2,450	84%	0.001
Firm Size <-> Innovation	0.14	[0.05, 0.23]	8	1,273	57%	0.002
Export Orientation <-> Innovation	0.11	[0.02, 0.20]	7	1,544	93%	0.023
Firm Age <-> Innovation	0.02	[-0.08, 0.11]	6	1,839	67%	0.685
Firm Age (Adj.) <-> Innovation	0.06	[-0.10, 0.22]	6	1,839	70%	0.467
Relationship with Financial Performance	$\bar{r}$	95% CI	k	N	I^2	p-val.
Innovation <-> Financial Performance	0.27	[0.16, 0.38]	9	2,778	88%	0.0001

$\bar{r}$: Estimated average effect size, **k**: Number of studies, **N**: Total sample size, **Adj.**: Adjusted

$(i.e.,\ A^-, A, A^+)$ are classified as 1st Tier, whereas journals rated below A^- $(i.e.,\ B, C, D)$ are classified as 2nd Tier.

RESULTS

Table 2 summarizes meta-analysis results (please see Figure A1 in the Appendix for the individual forest plots). We use funnel plots, Egger's regression, and rank tests to assess potential publication bias (please see Table A5 and Figure A3 in the Appendix). Results indicate small publication biases related to group of studies corresponding to 1) absorptive capacity and innovation, and 2) firm age and innovation. After adjusting for publication bias using the Vevea and Hedges weight-function model, our initial estimate for the relationship between absorptive capacity and innovation $(\bar{r} = 0.29,\ p < 0.0001)$ decreases to $(\bar{r} = 0.28,\ p < 0.0010)$, whereas the initial estimate for the correlation between firm age and innovation $(\bar{r} = 0.02, p < 0.6845)$ increases to $(\bar{r} = 0.06,\ p < 0.4670)$. However, even after the adjustment, the correlation between firm age and innovation remains insignificant.

All I^2 values indicate substantial heterogeneity. When we compare estimated average effect sizes $(\bar{r})$, sustainable practices $(\bar{r} = 0.54,\ \ p < 0.0133)$, technology adoption $(\bar{r} = 0.34,\ \ p < 0.0005)$, absorptive capacity $(\bar{r} = 0.28,\ p < 0.0010)$, firm size $(\bar{r} = 0.14, p < 0.0016)$, and export orientation $(\bar{r} = 0.11,\ p < 0.0225)$, appear to have relatively the largest and statistically significant effects on innovation.

The relatively large correlation between sustainable practices and innovation is meaningful as most studies in our study pool focus on green innovation (Figure 4). Some of these studies find significant associations between the two variables (see the corresponding forest plot). Furthermore, in practice, green/eco-innovations constitute a relatively large segment of innovations implemented by wine firms due to the close ties of winemaking to terroir. The large positive association between technology adoption and innovation is intuitive since implementing innovative practices often requires new technologies, and technology adoption typically speeds up the existing innovations. The medium positive correlation between absorptive capacity and innovation emphasizes the importance of yet another duality: on the one hand, increased absorptive capacity may create a more conducive atmosphere for innovations to take place; on the other, innovative practices may lead to increased absorptive capacity by attracting highly skilled labor, granting new patents, and expanding existing R&D activity. The medium positive association between firm size and innovation is intuitive due to the inherent correlation between firm size and absorptive capacity (please see the moderator analysis). Finally, the small positive association between export orientation and innovation highlights the link between external openness and innovative practices.

The analysis also reveals a significant positive association between innovation and financial performance $(\bar{r} = 0.27,\ p < 0.0001)$. This finding is important since it justifies that the individual positive associations previously identified by each of the nine studies in the analysis collectively point out a significant positive correlation between innovation and financial performance. This result has two implications. First, wine firms that achieve higher financial performance may be more likely to engage in innovative practices. Second, successful innovative practices may translate into financial success. We find no correlation between firm age and innovation. One explanation could be that established wine firms usually have larger resources to innovate; however, they may be more tradition-oriented, whereas younger firms may be more innovation-driven despite lacking the necessary resources to innovate.

Finally, we also investigate the relationship between links to research institutions and innovation. Conventional wisdom suggests that the stronger the links to research institutions, the more likely the innovation is. However, when we conduct a meta-analysis on this relationship using the existing studies, we find a small correlation $(\bar{r} = 0.05,\ p < 0.27)$, which is not statistically significant. Furthermore, the corresponding I^2 value is 0%, indicating no heterogeneity. This is because of the small number of studies with effect sizes located close to zero (please see the corresponding forest plot). Therefore, we exclude this measure from the analysis.

Table 3. Summary of Moderator Analysis Results

Innovation & Financial Performance		Estimate	SE	z-value	p-value	95% CI
Geography	*New vs. Old World*	0.03	0.13	0.21	0.84	[-0.23, 0.29]
Publication Quality	*1st Tier vs. 2nd Tier*	-0.12	0.12	-1.04	0.30	[-0.36, 0.11]
Absorptive Capacity & Innovation						
Firm Size	*Sample mean*	0.20*	0.08	2.52	0.01	[0.045, 0.36]
Firm Age	*Sample mean*	0.08	0.12	0.66	0.51	[-0.15, 0.31]
Geography	*New vs. Old World*	-0.10	0.12	-0.80	0.43	[-0.34, 0.14]
Publication Quality	*1st Tier vs. 2nd Tier*	-0.18	0.12	-1.58	0.11	[-0.41, 0.04]
Technology Adoption & Innovation						
Geography	*New vs. Old World*	-0.01	0.29	-0.03	0.98	[-0.58, 0.56]
Publication Quality	*1st Tier vs. 2nd Tier*	-0.11	0.24	-0.45	0.65	[-0.58, 0.36]
Sustainable Practices & Innovation						
Firm Size	*Sample mean*	0.27	0.17	1.59	0.11	[-0.06, 0.60]
Firm Age	*Sample mean*	0.25	0.28	0.90	0.37	[-0.29, 0.79]
Geography	*New vs. Old World*	0.30	0.53	0.55	0.58	[-0.75, 1.34]
Publication Quality	*1st Tier vs. 2nd Tier*	0.50	0.51	1.00	0.32	[-0.49, 1.50]
Export Orientation & Innovation						
Firm Size	*Sample mean*	0.01*	0.00	2.06	0.04	[0.00, 0.02]
Firm Age	*Sample mean*	0.00	0.68	-0.01	0.99	[-0.35, 0.33]
Geography	*New vs. Old World*	0.10	0.14	0.76	0.45	[-0.16, 0.37]
Publication Quality	*1st Tier vs. 2nd Tier*	0.01	0.10	0.11	0.91	[-0.19, 0.21]
Firm Size & Innovation						
Geography	*New vs. Old World*	-0.03	0.10	-0.33	0.74	[-0.23, 0.16]
Publication Quality	*1st Tier vs. 2nd Tier*	-0.12	0.09	-1.26	0.21	[-0.30, 0.07]
Firm Age & Innovation						
Geography	*New vs. Old World*	0.02	0.11	0.17	0.86	[-0.19, 0.23]
Publication Quality	*1st Tier vs. 2nd Tier*	0.11	0.12	0.95	0.34	[-0.12, 0.35]

* $p < 0.05$; SE = Standard Error; 95% CI = Confidence Interval for Coefficient

Moderator Analysis

Table 3 provides a summary of moderator analysis results. We find only two statistically significant moderating effects. First, firm size moderates the relationship between absorptive capacity and innovation ($\bar{r} = 0.2022, p < 0.0116$) as expected, indicating a relatively strong interaction. Second, firm size moderates the relationship between export orientation and innovation ($\bar{r} = 0.0091, p < 0.0392$); however, the estimated effect size is quite small as compared to the moderating effect of firm size on the relationship between absorptive capacity and innovation. Moderating effects of firm age, geography, and publication quality on all other pairwise relationships are not statistically significant; however, we attribute these results to small sample sizes that constrain the moderator analysis.

DISCUSSION

Managerial and Policy Implications

Our meta-analysis has several managerial and policy implications. First, our interpretation of the large positive correlation between innovation and financial performance is twofold. On the one hand, wine firms with higher financial performance may be more likely to allocate their resources to innovation activities than those with lower financial performance. On the other, innovation activities may lead to higher financial performance either directly by granting a competitive advantage to the adopting firm or indirectly via its synergistic spillover and amplification effects. Either way, we believe that this preliminary result looks promising for both wine firms and researchers. Therefore, we encourage wine firms to consider engaging in innovative practices and collaborate with researchers, particularly in quantitative research projects.

Second, we find that wine firms that implement sustainable practices may also be more likely to engage in eco-innovation activities that support these sustainable practices. Eco-innovation, which already constitutes a significant portion of innovation activities in the wine industry, is expected to grow in the near future due to various internal and external factors. Therefore, we suggest that wine firms should invest their resources primarily in eco-innovation activities.

Third, we recommend that wine firms consider adopting emerging industry 4.0 technologies to enhance their existing innovation activities. Besides increasing efficiency of operations, these technologies may accelerate innovations

by enabling real-time data collection and monitoring (i.e., RFID tags, sensors).

Fourth, our meta-analysis reveals that innovation usually takes place in firms with higher absorptive capacities and successful implementations of innovative practices have the potential to enhance the absorptive capabilities of wine firms. Therefore, we recommend wine firms that would like to compete on innovation invest in their absorptive capacities by training their existing HR, employing highly skilled employees, increasing R&D activities, establishing links with colleges and research institutions, and patenting innovative ideas.

Fifth, larger firms may be more advantageous in innovation than smaller ones due to their potentially higher absorptive capacities; however, this result should not discourage small firms from engaging in innovative practices. On the contrary, it should encourage them because competing on innovation may be a critical strategy that leverages small firms against large wine firms in the harsh competition, which gets more challenging as new firms join. From this perspective, small wine firms should see innovation as a matter of survival rather than a choice.

Sixth, export-oriented wine firms may be more open to innovation since they typically employ a more diversified and highly skilled workforce with considerable exposure to international standards. External openness may increase their situational awareness, responsiveness to external competitive factors and innovative trends, and willingness to cooperate with research institutions. Therefore, we suggest that wine firms that consider competing on innovation diversify their customer base by entering new markets, employ experts with international experience, and increase their visibility by participating in international competitions and academic conferences.

Finally, our meta-analysis points out a scarcity of quantitative articles focusing on innovations by U.S. wine firms. Most U.S. wine business studies are qualitative papers (i.e., literature review, review, commentary, or descriptive studies). As discussed in the Introduction section, researching innovation in the wine industry is already challenging due to the peculiar characteristics of the wine industry. SMEs dominate the U.S. wine industry with a high concentration of family ownership that prioritizes tradition over innovation. Despite the existing business and knowledge networks, the U.S. wine industry is fragmented, and innovation activities are perceived as business secrets due to high competition. All these factors limit the exchange of information (primarily tacit). In these types of business structures, trust plays a vital role. Quantitative research requires data. Wine firms do have the data. Research collaborations' role in promoting innovation is well established in other sectors (although the link between research institutions and wine firms remains an open question in the wine industry, we believe there is value in research partnerships). Since establishing trust is critical to enable such collaboration, researchers need to convince wine firms that the proposed research will benefit the firm and its outcomes. Some of our findings (i.e., positive association between innovation and financial performance) might be used to justify that. On the other hand, wine firms should accept some risks to realize the potential value of research collaborations. In time, mutual understanding and trust would lead to a virtuous cycle in which wine firms and researchers prosper.

Suggestions for Future Research

Aside from presenting the big picture of academic studies in a particular field, systematic literature reviews contribute to the research efforts by identifying major gaps and strategically directing future research questions. In addition to variants and extensions of already existing studies, we identify eight research gaps. We discuss how future quantitative, qualitative, and interdisciplinary studies may contribute to the innovation-related wine business literature.

Quantitative Studies

Impact of collaboration between wine firms and research institutions on innovation. Our systematic literature review reveals a shortage of quantitative studies exploring the link between innovation and collaboration with research institutions. We could find only three studies in this area, one of which (Giuliani & Arza, 2009) provides country-dependent mixed results, as discussed earlier. As the number of studies that report effect sizes from different populations increase, the relationship will be clearer.

Investigation of the link between patent ownership and innovation. We also find a shortage of academic studies that examine the relationship between patent ownership and innovation. The only two studies considering patent ownership in our study pool are Presenza et al. (2017) and Choi & Gu (2020). Although wine patents are abundant, the actual impacts of these patents on both wine innovation efforts and financial performance remain unclear. Accessing patent data has never been easier, thanks to the U.S. and EU patent offices. However, researching the impacts of patents on innovation and wine firm performance is challenging for two reasons. First, patents are typically kept as business secrets by wine firms. Second, this type of research requires the identification of specific links between individual patents and their short-, medium-, and long-term impacts on innovation and firm performances, which is somewhat problematic. We recommend future quantitative studies to take on this challenge.

Examination of impacts of other variables on innovation. Finally, we suggest future quantitative studies to focus on the impacts of other potential variables on innovation, such as proximity, corporate social responsibility, national and international regulations, R&D subsidies or tax cuts by governments, competitive pressures from stakeholders, and managers' perceptions regarding innovation. Another research direction is to investigate how climate change stimulates/facilitates innovation efforts with significant implications on financial success. Although there are articles in the literature investigating the impacts of these variables, the number of studies is not sufficient for a meta-analysis.

Using meta-analytic structural equation modeling (MASEM). A possible extension of our meta-analysis is to perform MASEM, to investigate the relationships between different constructs that we use/mention in this study, innovation, and financial performance. MASEM combines the powers of the classical meta-analytic approach and SEM,

enabling testing hypotheses by fitting structural equation models on a sample of effect sizes. To the best of our knowledge, there is no MASEM study on wine innovation yet.

Qualitative Studies

Providing a clear definition and classification of innovation in the wine industry. The qualitative research studies reviewed here have provided some unique perspectives of wine innovation from producers worldwide. Still, the research to date has provided little innovation knowledge that may be applied in existing wine businesses, so much more specificity is needed. The studies have highlighted wine producers' key concerns and interests in organic methods (Karagiannis & Metaxas, 2020; Signori et al., 2017), organic certifications (Ouvrard et al., 2020), and the need for combining traditional methods with new technologies (Vrontis et al., 2016) as ways to innovate in the area of wine production. Going forward, future studies might provide more detail about these innovations that may be useful to winemakers for application. One notable exception is the work of Soceanu et al. (2020), whose experimental study described how wine industry by-products may be sold to various industries to reduce waste and enhance financial performance at the same time.

Organic and sustainability interests were also exhibited in quite a few studies that addressed product innovation, but most likely due to competitive concerns, there was very little specificity about product innovation; topics included new varietals and entry-level wines (Ouvrard et al., 2020), new packaging (Signori et al., 2017), and greater product variety to include organic products (Vrontis et al., 2011). Last, only a few qualitative studies have supplied marketing/communication and organizational innovation findings. (Humphreys & Carpenter, 2018) suggest a focus on competing by gaining market influence rather than satisfying consumers, while (Vrontis et al., 2016) addressed in a one-firm case study how a family used only family members' promotions rather than traditional mass communication channels. Similarly, little is known about organizational innovations other than potential changes to cultures and structures that may increase competitiveness by allowing for connections with competitors (Signori et al., 2017) and knowledge sharing and integration between family generations (Woodfield & Husted, 2017).

Comparative investigation of wine innovation before, during, and post-COVID-19. COVID-19 has placed considerable tension on wine supply chains. Many wine firms have faced challenges, such as finding seasonal workers to harvest grapes, decreased cellar-door visits due to restriction on mobility, shifts in consumer behavior (i.e., online shopping), change in sales channels (shift from on-premise to off-premise), and reduction in logistic capacities.Cardebat et al. (2020), for instance, discuss some of these challenges and provide preliminary analysis on the impact of the pandemic on fine wine markets. Similarly, Vergamini et al. (2020) distinguish short- and long-term implications of the pandemic on the wine industry and argue that in the short-term, wineries that rely on tourism are likely to be negatively affected most. In the long run, large firms will be affected less due to their market power. We suggest that future qualitative studies conduct similar comparative analyses to identify lessons learned and draw practical insights. As more data becomes available, comparative studies would provide more value to research and practice.

Interdisciplinary Sudies

Innovation is an interdisciplinary process. One way that wine researchers may contribute to the literature is to collaborate with researchers from other disciplines. Although there are countless interdisciplinary collaboration opportunities, we point out two of them here, operations management (OM) and supply chain management (SCM). We believe that both disciplines may provide significant value to innovation-related wine research.

Application of operations management (OM) methodologies. The pandemic has significantly changed consumer preferences. As online sales and home delivery have gained traction, the need for novel operational solutions (i.e., transportation, inventory management, and home delivery scheduling) have increased. In this regard, we argue that wine business literature should take better advantage of OM techniques, such as process simulation and online appointment scheduling. Data-driven and prescriptive OM methods may help wine researchers make informed policy recommendations to practitioners. For instance, wine researchers may collaborate with OM researchers to develop process simulation models to test the potential impacts of candidate innovations on firm performance by running various what-if scenarios. Similarly, OM and wine researchers may collaborate to investigate possible benefits of online appointment scheduling methodologies to schedule home deliveries, as well as on-site and online wine tasting sessions, which have become popular during the pandemic. Another interdisciplinary research avenue is to investigate the impact of machine learning-based recommender engines that make real-time customized online wine recommendations to online wine customers. Recommender engines may serve as critical tools for wine firms that seek to increase their online visibility by promoting their wine to targeted wine drinkers based on their preferences. In this regard, we believe that collaboration with OM researchers would accelerate research on wine innovation and provide practical value to the industry.

Exploration of the role that innovation plays in improving supply chain resilience. Supply chain resilience has gained traction during the pandemic, after many tightly optimized beverage chains had failed to respond to shifts in consumer preferences, such as the increase in off-premise (particularly online) and decrease in on-premise sales (Vergamini et al., 2020). One way to improve wine chain resilience is innovation. For instance, blockchain technology can be used to monitor the whole lifecycle of wine from the winery to the table, ensuring real-time traceability and prevent counterfeiting (Danese et al., 2021), and smart vending machines with age verification features may increase wine availability during lockdowns. Automation may decrease reliance on seasonal labor to harvest grapes, and electronic tongues and noses may be used to inspect wine quality (Rodríguez-Méndez et al., 2016). We invite supply chain researchers to collaborate with wine researchers,

studying what roles innovation may play in improving wine chain resilience.

CONCLUSION

Measuring innovation in the wine industry is hard not only due to broad, abstract, and ambiguous connotations of the term "innovation" but also owing to peculiar characteristics of the wine industry, which complicate data collection, model building, and analysis. Moreover, innovation activities are often seen as business secrets, which considerably limits the exchange of information among firms and with researchers, slowing down the diffusion of innovation within the wine industry. Despite these challenges, innovation may provide significant value to the industry; however, wine researchers need to convince practitioners that innovation may lead to competitive advantage and bring financial success. We believe that as both the quantity and quality of innovation-related wine research improves, the role that innovation plays in the wine industry would be clearer.

In this study, we provide a systematic review of the relevant wine business literature that consists of 76 studies published since 1991. While providing a narrative review of qualitative studies to identify common wine innovation types and forms, we perform a meta-analysis on the quantitative studies that report usable/convertible effect sizes for pairwise relationships between six commonly used variables (i.e., absorptive capacity, technology adoption, sustainable practices, export orientation, firm size, and firm age) and innovation, as well as the association between innovation and financial performance. Our analysis reveals that absorptive capacity, technology adoption, sustainable practices, export orientation, and firm size are positively correlated with innovation efforts, and innovation is positively associated with financial performance. Furthermore, we find that firm size moderates the relationship between absorptive capacity and innovation. We discuss several managerial and policy implications of our analysis and make a series of recommendations for future research avenues.

Our managerial recommendations include 1) engaging in innovative practices and collaborating with researchers, particularly in quantitative research projects, 2) prioritizing eco-innovation activities, 3) adopting emerging industry 4.0 technologies, 4) investing in absorptive capacity, 5) increasing export-orientation and international visibility.

We suggest future quantitative studies to explore the impacts of 1) links to research institutions, 2) patent ownership, 3) and other variables, such as proximity, corporate social responsibility, national and international regulations, R&D subsidies by governments, competitive pressures from stakeholders, and the managerial perceptions regarding innovation and financial performance. We also recommend researchers consider conducting MASEM, which currently does not exist in the literature. We recommend future qualitative research efforts to focus on clearly defining and classifying innovation in the wine sector and comparing the performances of wine supply chains before, during, and after the pandemic to exemplify how innovation has helped wine firms recover from disruptions caused by the pandemic. Finally, to mitigate the negative impacts of the recent pandemic on wine supply chains, we suggest that wine business research should benefit from interdisciplinary studies more, particularly with operations management and supply chain management fields.

This study has two main limitations. First, our meta-analysis relies on a relatively small number of effect sizes. As the number of studies in wine innovation increases, we expect a meta-analytic approach to provide a better picture of investigated relationships. Second, we convert certain effect sizes into Pearson correlation coefficients using some approximations, which increase prediction error. We suggest future quantitative studies to report correlation matrices. This would eliminate the need for effect size conversions and reduce errors in meta-analysis.

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Table A1. List of Abbreviations

Theories			
BAM	Behavioral Agency Model (Theory)	**PDT**	Psychological Distance Theory
CBT	Consumer Behavior Theory	**QT**	Quality Theory
CLT	Construal Level Theory	**RBV**	Resource Based View
CSRT	Corporate Social Responsibility Theory	**RIT**	Resistant Innovation Theory
CT	Competitive Theory	**RT**	Resilience Theory
CU	Catch-up Theory	**SP**	Systems Perspective
EIT	Eco-Innovation Theory	**SEPR**	Socio Economic Perspective on Resilience
GPT	Geographical Proximity Theory	**SIT**	Social Influence Theory
GT	Grounded Theory	**SMT**	Social Media Theory
IT	Institutional Theory	**SNT**	Social Network Theory
KBV	Knowledge Based View	**ST**	Sustainability Theory
OBT	Organizational Behavior Theory	**UET**	Upper Echelons Theory
OIT	Open Innovation Theory	**WCF**	Walsh's Conceptual Framework
OLT	Organizational Learning Theory	**WO**	Windows of Opportunity Theory
Methodologies			
ABM	Agent-Based Modeling	**OLS**	Ordinary Least Squares
CATI	Computer Assisted Telephone Interview	**PCA**	Principal Component Analysis
EDA	Exploratory Data Analysis	**PLS**	Partial Least Squares
EHA	Event History Analysis	**QA**	Qualitative Analysis
FAM	Factor Analytic Method	**Reg.**	Regression
GNA	Geospatial Network Analysis	**SEM**	Structural Equation Modeling
Hier.	Hierarchical	**SMA**	Social Media Analysis
IPA	Importance Performance Analysis	**SNA**	Social Network Analysis
MMPR	Mixed-Method Participatory Research	**SSFA**	Spatial Stochastic Frontier Analysis
NPT	Non-parametric Test	**Log.**	Logistic
Other			
BN	Business Network	**KB**	Knowledge Base
DTC	Direct to Customer	**PEP**	Proactive environmental practices
IMO	International market orientation	**R&D**	Research and Development
KN	Knowledge Network		

Table A5. Tests of Publication Bias

	Egger's Test		Rank Test	
	z	**p-value**	**Kendall's τ**	**p-value**
Innovation & Financial Performance	-0.0609	0.9514	-0.0556	0.9195
Absorptive Capacity & Innovation	2.0849*	0.0380	0.2458	0.2690
Technology Adoption & Innovation	0.0185	0.9852	0.0000	1.0000
Sustainable Practices & Innovation	-0.7518	0.4522	0.0364	0.9008
Export Orientation & Innovation	0.5719	0.5674	0.0000	1.0000
Firm Size & Innovation	0.1097	0.9127	0.0364	0.9008
Firm Age & Innovation	3.5554*	0.0004	0.6000	0.1361

APPENDIX

Table A2. List of Quantitative Studies Used in the Meta-Analysis

Paper	Theory	Methodology	Independent Variable(s)	Dependent Variable(s)	Contribution
Calle et al. (2020)	EIT, ST	T-test, PCA, ANOVA, Clustering	Legal form (cooperatives vs. non-cooperatives)	Environmental behavior	No significant difference between cooperative and non-cooperative wine firms regarding their environmental behavior (i.e., proactive, preventive, and activist behavior).
Doloreux et al. (2020)	RBV	Log.-Reg.	DUI, STI, R&D, Firm Size	Types of Innovation	Wine firms may enhance innovation via Scientific and Technologically based Innovation (STI) and Doing, Using, and Interacting (DUI) activities.
Frigon et al. (2020)	EIT, RBV	Log.-Reg.	Internal and external innovation activities	Conventional and eco-innovations	Both conventional and eco-innovation are associated with internal factors, but eco-innovation is more closely related to external factors.
Pradana et al. (2020)	RBV	PLS-Reg.	Absorptive capacity, human capital	Innovation, financial performance	Absorptive capacity and human capital are positively associated with innovation and financial performance.
Tyler et al. (2020)	UET, CT	OLS-Reg.	Environmental practices, perception of competitive pressure	Environmental practices, financial performance	Weaker competitive pressure is positively associated with the adoption of eco-practices. Stronger competitive pressure positively moderates the relationship between the adoption of eco-practices and financial performance.
Doloreux & Frigon (2019)	OIT, GPT, RBV	PCA Clustering	Innovation strategy, expenditure, knowledge sourcing	Clustering based on the 4 innovation modes	Innovation modes are associated with different innovation outputs, some innovation modes better reflect certain firms in three wine regions in Canada.
Knight et al. (2019)	RBV	PLS SEM	Brand, service, financial, and innovation performances	Environmental behavior, environmental disclosure	Brand, service, and innovation performances are positively associated with environmental behavior, innovation performance is positively associated with environmental disclosure.
Menna & Walsh (2019)	WCF	K-means Clustering	Wine prod. (% of GDP), % growth in prod./acre, # of programs in vineology	Number of clusters	Using data from 2011-2014 classifies 22 OECD countries into one of four clusters (i.e., Innovation Wasteland, Innovation Nirvana, Innovation Push, Innovation Pull).
Williams & Spielmann (2019)	IT	OLS.-Reg.	National laws, international laws, distributors, end consumers	International market orientation (IMO)	The greater the pressure from national laws, the lower the IMO. The greater the pressure from international laws, the greater the IMO. The pressures from distributors and consumers positively and negatively affect the IMO.

Paper	Theory	Methodology	Independent Variable(s)	Dependent Variable(s)	Contribution
Lorenzo et al. (2018)	RBV	PCA, Hier.-Reg.	Technological capability, management, business strategy	Financial performance	Individual firms achieve superior financial performance via a cost leadership strategy. The technological capabilities of mercantile firms and cooperatives are positively associated with their financial performance.
Faccin et al. (2017)	SNT	OLS-Reg.	Social capital, competitiveness	Innovation	Competitiveness and innovation are positively correlated. There are also positive relationships between social capital and competitiveness, and social capital and innovation.
Fiore et al. (2017)	EIT	Correlation Analysis	Orientation to sustainability	Marketing innovation choices	Wineries with marketing innovation tools are more oriented towards sustainable practices.
Galati et al. (2017)	RBV, SMT	Two-stage Cluster Analysis	Intensity, richness, and responsiveness	Number of clusters	Small firms are more engaged in social media activity than large firms. Firms managed by CEOs with high education levels are more engaged in social media activity.
Presenza et al. (2017)	RBV, OIT	PCA Log.-Reg.	External knowledge sources, technological capabilities, competitive pressures	Process or product innovation	Firms that use external knowledge sources are more innovative and their absorptive capacity impacts the use of external sources.
Guerrero-Villegas et al. (2018)	CSRT	PLS	Corporate social responsibility (CSR), Innovation	Objective and subjective Performance	CSR positively affects performance via mediating effect of innovation.
Zheng & Wang (2017)	GPT	OLS-Reg.	Revenue, productivity, geography, whether a Top10 firm	Mark-up value	Chinese wine firms located in famous wine-producing areas have considerable market power and the sector is an oligopoly (firms with high market power determine their prices).
Annunziata et al. (2018)	RBV, EIT	SEM	SC collaboration, innovation capacity, technology adoption, proactive environmental practices (PEP)	Financial performance	SC Collaboration and innovation capacity positively correlate with PEP. PEP positively correlates with financial performance and positively mediates the relationships between SC collaboration and financial performance, and 2) product innovation and financial performance.

Paper	Theory	Methodology	Independent Variable(s)	Dependent Variable(s)	Contribution
Galbreath et al. (2016)	RBV, GPT, OLT	SEM	Absorptive capacity, eco-innovations, knowledge exchange	Firm outcomes	Absorptive capacity is positively associated with eco-innovation and knowledge exchanges (KE). KE is positively related to eco-innovations. KE partially mediates the effect of absorptive capacity on eco-innovations. Eco-innovations are positively related to firm outcomes.
Giacomarra et al. (2016)	QT	T-test	Voluntary certification	Labor productivity, wine exhibition participation	Certified wine firms exhibit better economic performance measured in terms of labor productivity and wine exhibition participation.
Stasi et al. (2016)	RBV, EIT	Log.-Reg.	Regulations, demand, technology push factors	Innovative technologies	Voluntary environmental certification and networking positively correlate with innovation.
Vidoli et al. (2016)	GPT	SSFA	Labor, machinery, water, energy, fuel, land, whether a family firm, gender, subsidies, diversification	Production output	Based on analysis of FADN survey results in Italy, smaller firms tend to share more tacit knowledge, locating themselves at the center of KNs. Large firms choose to stay at the periphery, share less knowledge within the local KN in a highly selective manner.
Hojman (2015)	KBV	Ordered Probit	Firm age, export orientation, networking, ownership, consulting, employing expert winemaker, award winner	Whether a firm is an LC Innovator, the year a firm listed as LC innovator for the first time	Foreign influence, the long-term presence of a senior expert winemaker, and participation in international competitions are positively related to innovation activities.
Ahn et al. (2013)	KBV, OIT	SEM	Inventive, absorptive, transformative, connective, innovative, desorptive capacity	Sales, profit	OI capacities are significantly associated with financial performance. Note: Although not directly related to wine, the classification of capacities based on OI is useful for wine studies.
Muscio et al. (2015)	EIT	Log.-Reg.	Regulatory aspects, demand factors, firm & technology factors, geo-economic factors	Adopting cleaner production (CP) and end-of-pipe technologies (EOP)	Regulation and access to knowledge positively correlate with eco-innovation efforts.
Dries et al. (2014)	RBV, OIT	Multivariate Probit	Dynamic (absorptive and adaptive) capabilities	Open innovation	Both regional and company-specific factors affect open innovation.

Paper	Theory	Methodology	Independent Variable(s)	Dependent Variable(s)	Contribution
Doloreux & Lord-Tarte (2013)	OIT	EDA, NPT	Open innovation strategy	Innovation capacity	Adopting open innovation strategy through collaborations has a higher impact on innovation development and R&D activities.
Doloreux et al. (2013)	OIT, GPT, RBV	PCA Clustering NPT	Types of innovation, innovation activities, sources of knowledge	Clustering wineries into four categories	Wineries draw on a variety of knowledge sources (i.e., market, government, and educational establishments) to conduct product, process, and organizational innovation.
Leenders & Chandra (2013)	EIT	Hier.-Reg.	Internal & external drivers	Green innovation & business performance	Internal drivers are more important. Green innovation improves business performance and DTC sales capability moderates the relationship between green innovation and performance.
Muscio et al. (2013)	EIT	Log.-Reg.	Structural characteristics, Innovation activity, outward orientation, marketing strategies	Adoption of eco-innovations	Business characteristics, firms' scientific search processes, and innovative behavior are key drivers of innovation.
Atkin et al. (2012)	ST	Survey, EDA, ANOVA	The business case for environmental management system (EMS)	Cost advantage, differentiation advantage, superior operating performance	Respondents who have completed EMS cases exhibited significantly higher cost leadership and differentiation advantages over those who have not completed the case.
Chrisman & Patel (2012)	BAM, MLA	Two-stage OLS-Reg.	Family firm measures, performance aspiration gaps, interactions	R&D investment, R&D variability	Family firms invest less in R&D than non-family firms, due to myopic aversion. However, when performance is below aspiration levels, family firms spend more money on R&D than non-family firms, and variability in their R&D decreases due to their long-term investment orientation. Note: Although not a wine study, findings can be generalized for family firms, including wine firms.
Moreno et al. (2011)	KBV	OLS-Reg.	Technological posture, firm size, firm age, product & process innovation, internal &external sources, innovative effort	Business performance	Technological posture, firm size, firm age, product & process innovation, internal sources, and innovative efforts are positively correlated with business performance.

Paper	Theory	Methodology	Independent Variable(s)	Dependent Variable(s)	Contribution
Giuliani & Arza (2009)	KBV	Two-stage Probit OLS	KB of firms, university scientific quality	University-Industry link, diffusion of innovation	In Chile, the stronger the KBs and higher the university's scientific quality, the more likely a firm-university linkage. The results are reversed for Italy. In both countries, the stronger the KBs with linkages to universities, the higher the diffusion of innovation.
Maurel (2009)	RBV	EDA, OLS-Reg.	Internal, external, and strategy related determinants	Export performance	Business partnerships, innovation, greater firm size, and effective export commitment are linked to higher export performance.
Murovec & Prodan (2008)	KBV	PCA, SEM	Absorptive capacity	Product or process innovation	Absorptive capacity is positively related to both product and process innovation.
Bruwer & Li (2007)	CBT	CATI, Clustering, PCA	Consumer characteristics (connoisseur, information use, occasion, loyalty, etc.)	Consumer Segments	Identifies 5 wine-related lifestyle segments: Conservative knowledgeable drinkers, enjoyment-oriented social drinkers, basic drinkers, mature time-rich drinkers, 5) young professional drinkers.
Garcia & Atkin (2007)	RIT	ABM, Conjoint Simulation	Co-opetition strategy	Consumer adoption and firm adoption of screw caps (Stelvins)	The size of the alliance significantly affects the rate of innovation diffusion. As the size of the alliance grows, profit decreases.
Giuliani (2007)	GPT, KBV	PCA SNA	KB of firms	Normalized degree centrality	Firms with stronger KBs are likely to be more central in the cluster KN. The structure of the KN differs significantly from that of BN. The diffusion of innovation in KNs is more uneven than that of a BN.
Johnson & Bruwer (2007)	CBT	Survey, EDA	Regional Branding	Perceived wine quality	Regional branding is a multi-faceted entity and positively related to perceived wine quality.
Giuliani & Bell (2005)	KBV, GPT	PCA Clustering SNA	Absorptive capacity	External openness, intra-cluster knowledge linkages	Knowledge in the network is not diffused evenly but flows among firms with larger absorptive capacities.
Delacroix & Swaminathan (1991)	OBT	EHA	Organizational & environmental conditions	Organizational change & disbanding	Large and older wineries are more conservative and less likely to disband, prior change is a good predictor of future change.

Table A3. List of Qualitative Studies

Paper	Theory	Methodology	Contribution
Carlsen (2004)		Conceptual	Proposes a framework that places wine production and tourism on opposite ends of the industrial spectrum. The former is a supply-driven, product-oriented sector focused on capital growth, whereas the latter is a demand-driven profit-maximizing service sector.
Cardebat et al. (2020)		Review, Commentary	Points out that COVID-19 leads to uncertainty in the wine sector in inventory management and distribution. Drawing attention to changes in consumption patterns, authors predict that companies that serve large domestic markets, produce quality-driven terroir wines, and have solid direct sales capabilities would perform better.
Choi & Gu (2020)	GPT, KBV	GNA	Provides evolution of wine-related knowledge creation in China between 2007 and 2016 using patent data and GNA. The success industry was assigned to joint ventures with the US, Italy, Germany, France, and Canada, government-led development plans, and government policies that promote industry-university collaboration.
Colbert et al. (2020)		Commentary	Draws attention to a recent increase in online alcohol sales and home delivery in Australia. States that online retailers are subject to less regulation, which leads to problems such as leaving alcohol unattended without age verification, an increase in family violence, and self-harm.
Karagiannis & Metaxas (2020)	ST	Survey, EDA	Surveying managers of 41 SMEs in Greece, makes recommendations on sustainable wine tourism development. Only 22% of wineries offer online sales and %50 of wineries accept credit card payments. The sector largely relies on on-site sales (83%).
Z. Li et al. (2020)	PDT, CLT	Conceptual	Discusses the impact of COVID-19 on tourist behavior (indirect effect on on-premise sales in countries that rely on tourism).
Laguna et al. (2020)	SNT	Survey, SMA	Investigates the impact of COVID-19 on consumer food & beverage preferences by using SMA and an online questionnaire. Finds a reduction in shopping frequency. No changes in shopping location. 27.7% of consumers report an increase in their wine & beer spending, and 30% reported a decrease.
Neufeld et al. (2020)		Commentary	Discusses risks associated with the increasing availability of alcohol via online sales and home delivery, loosening of regulation, and diversion of alcoholic beverages for other purposes (i.e., disinfectants) during the pandemic.
Ouvrard et al. (2020)		Interview	Based on 11 interviewees from France and Italy, the authors identify four elements, namely performance, resources, innovation, and value creation, as essential factors that make up a sustainable business model.
Soceanu et al. (2020)	EIT, ST	Lab Experiment, Case Study	Proposes a method to recover waste from winemaking for better economic, social and environmental performance.
Šťastná et al. (2020)		Survey, IPA	Based on 271 survey responses from Czechia, authors classify various aspects of wine tourism into four major performance categories (Concentrate here, keep up the good work, low priority, and possible overkill) via IPA analysis.
Ugaglia & Ouvrard (2020)	QT, ST	Case Study, Interview	Discussing a product differentiation strategy of a French wine company that seeks to improve quality via innovation and sustainability while respecting tradition.
Vergamini et al. (2020)	RT	Review, MMPR	Analyzes the impact of the pandemic on the wine sector in Italy, Spain, Portugal, France, Australia, and the US, distinguishing between short- and long-term implications. Makes recommendations on improving resiliency. Notes that in the short term, wineries that rely on tourism are likely to be affected the most.
Porto-Gómez et al. (2020)		Literature Review	Using a bibliometric review approach identifies sustainable innovation as the emerging distinct type of innovation in the wine industry.
Cradock-Henry & Fountain (2019)	SEPR	Case Study, Conceptual	Investigates the socio-economic impact of a recent earthquake on New Zealand's wine sector and makes recommendations on improving the resilience of wine supply chains.

Paper	Theory	Methodology	Contribution
Pabst et al. (2019)	CBT	Survey, Interview	Wine producers in Germany believe that the EU's mandatory nutrition labeling policy will create consumer confusion and uncertainty, increase production costs, and create opportunities for wineries that focus on clean labeling to completely avoid additives that require labeling.
Gault (2018)	SP	EDA	Proposes a general definition of innovation. "Innovation is the implementation of a new or significantly changed product or process. A product is a good or service. The process includes production or delivery, organization, and marketing processes."
Humphreys & Carpenter (2018)	SP, RBV, SIT	Interview	Points out that winemaking is more of an art than a science and customer preferences can easily be influenced due to unique market conditions (i.e., high ambiguity and complexity, noisy consumer learning, and limited consumer expertise). Unlike market-driven firms that use consumer data to develop innovative products and strategies, market driving firms do not focus on consumers and innovation at all, they just play a "status game" to shape consumer preferences by developing a vision, employing celebrity winemakers, influencing critics, and media, affecting retail sales by promoting scores by critics, and form alliances to enhance their status.
H. Li et al. (2018)		Historical Analysis	Proposes that China should be classified as an "Ancient" wine producer, presenting some historical evidence and information about Chinese wine culture and history. States that China is currently classified in neither New World nor Old World.
Scaringella & Radziwon (2018)		Literature review	Classifies 104 studies and links four main ecosystems (i.e., business, innovation, entrepreneurial, and knowledge systems) and territorial approaches under an evolutionary system theory and proposes a theoretical framework.
Y. Li & Bardají (2017)		SWOT, EDA	Provides a detailed SWOT analysis of the Chinese wine industry and makes a series of recommendations on improving the performance of the industry focusing on domestic sales.
Morrison & Rabellotti (2017)	CU, WO	Comparative Study, EDA	Analyzes the evolution of the wine industry from 1960 to 2010, comparing old and new world countries' performances based on production volume, consumption, export volume, export value, and unite export value, to explain why catch-up is slower than other industries.
Signori et al. (2017)	GT	Interview	Identifies four major barriers to sustainable innovation: competing motivations, innovation focus and styles, lack of sustainability orientation, and lack of resources and capabilities.
Woodfield & Husted (2017)	KBV	Case study, Interview	In family firms, successors not only receive experience-based knowledge from incumbents but are also the sources of new knowledge gained via education. Firms that facilitate bi-directional tacit information sharing between the two generations may achieve greater benefits in terms of innovation.
Gilinsky et al. (2016)	ST	Case Study, Interview	Family firms in the wine sector are long-term performance-oriented: the number one priority for incumbent managers is "leaving the land in better shape for next generations."
Sacchelli et al. (2016)		Content Analysis, Text Mining	Wine research focuses mostly on the socio-economic impacts of climate change. Ecological aspects are often ignored. Adaptation and defensive strategies are in their initial stages. Temperature control and water deficit strategies are proposed. Future research should focus on uncertainty analysis. Australia, the US, and the EU attach greater importance to sustainability than China and South Africa. Terroir and quality issues are primarily discussed in French and Italian studies.
Schimmenti et al. (2016)		EDA	Investigates adoption of sustainable entrepreneurship practices by the three wine producers in Sicily that participate in SOStain program.
Rodríguez-Méndez et al. (2016)		Literature Review	E-tongues and e-noses are widely used in the wine industry to assess the quality of grapes and crushing, to monitor the fermentation and aging, to analyze nano-oxygenation due to corks in bottling, to classify grape varieties and their geographic origin, to detect spoilage, off-odors, frauds, and adulterations, and to assess various chemical parameters. Despite recent developments, e-tongues and e-noses still perform worse than a panel of human wine experts.
Vrontis et al. (2016)	CBT	Case Study, Interview	Innovation and tradition are not mutually exclusive. Blending the two may lead to a competitive advantage.

Paper	Theory	Methodology	Contribution
Dressler (2013)	RBV	Survey	Wine companies in Germany mostly adopt innovation strategies related to pricing. They spend more money on renovating old buildings and facilities (i.e., creating fancy tasting rooms). They neglect innovations regarding strategic sourcing, innovative services, and social media.
Vrontis et al. (2011)		EDA, Concep- tual	Investigates the role that branding plays in Italian wine firms' local and international competitiveness and consumer behavior (response) to wine branding, and develops a conceptual framework named as Preliminary Prescriptive Strategic Branding Framework.
Schultz & Jones (2010)	ST	Review	Examines the potential negative impacts of global warming on future wine production. Authors predict that climate change is likely to change grape varieties, grape compositions, the timing of growing, harvesting, and production, as well as wine styles.
Van Leeuwen & Seguin (2006)	ST	Review	Explains the impact of terroir on producing high-quality wines. Making a distinction between terroir wines and branded wines, authors state that contrary to branded wines, the volume of terroir wines cannot be easily increased.
Alant & Bruwer (2004)	CBT	Survey, FAM, QA	Based on analysis of survey results, proposes a conceptual motivational framework that explains wine tourist behavior. The framework has three dimensions (visitor, wine region, visit dynamic) and three sub-dimensions.
Vaudour (2002)		Literature Review	Proposes a more scientific definition of terroir, which excludes conscience connotations. States that spatial modeling and GIS data can update the concept of terroir.

From Cohen's d to r	From log(OR) to Cohen's d	From t-statistic to r	From F-statistic to r
$r = \frac{d}{\sqrt{d^2+4}}$	$d = \frac{\sqrt{3}\,log(OR)}{\pi}$	$r = \sqrt{\frac{t^2}{t^2+df}}$	$r = \sqrt{\frac{F}{F+df}}$
From partial η^2 to d	**From Kendall's τ to r**	**From log(OR) to OR**	**From probit (β) to log(OR)**
$d = \sqrt{\frac{(n-1)\eta^2}{n(1-\eta^2)}}$	$r = sin\left(\frac{\pi\tau}{2}\right)$	$OR = e^{log(OR)}$	$log(OR) = 1.7\beta$

Figure A2. Formulae used to convert between effect sizes

Table A4. Effect Sizes Before and After Conversion

Innovation & Financial Performance					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Pradana et al.	2020	138	0.255	r	0.255
Knight et al.	2019	220	0.489	r	0.489
Annunziata et al.	2018	357	0.533	r	0.533
Lorenzo et al.	2018	339	0.226	r	0.226
Guerrero-Villegas et al. (2018)	2018	121	1.950	t statistic	0.178
Galbreath	2016	203	0.180	r	0.180
Stasi et al.	2016	334	0.843	Log odds ratio	0.226
Chrisman & Patell	2012	964	0.090	r	0.090
Moreno et al.	2011	102	0.142	t statistic	0.143
Absorptive Capacity & Innovation					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Frigon et al.	2020	151	1.120	Log odds ratio	0.295
Pradana et al.	2020	138	0.232	r	0.232
Doloreux et al.	2020	151	0.305	Log odds ratio	0.084
Annunziata et al.	2018	357	0.327	r	0.327
Lorenzo et al.	2018	339	0.133	r	0.133
Faccin et al.	2017	104	0.720	F statistic	0.083
Presenza et al.	2017	191	0.023	r	0.023
Galbreath et al.	2016	203	0.410	r	0.410
Stasi et al.	2016	334	2.041	Log odds ratio	0.490
Hojman	2015	43	0.250	r	0.250
Muscio et al.	2015	334	0.585	Log odds ratio	0.159
Giuliani & Arza	2009	32	0.540	r	0.540
Giuliani & Arza	2009	41	0.460	r	0.460
Giuliani & Bell	2005	32	0.523	Kendall's tau	0.732
Technology Adoption & Innovation					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Frigon et al.	2020	151	1.350	Log odds ratio	0.349
Annunziata et al.	2018	357	0.427	r	0.427
Lorenzo et al.	2018	339	0.074	r	0.074
Stasi et al.	2016	334	2.041	Log odds ratio	0.490
Sustainable Practices & Innovation					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Frigon et al.	2020	151	0.890	Log odds ratio	0.238
Knight et al.	2019	220	0.452	r	0.452
Annunziata et al.	2018	357	0.276	r	0.276
Guerrero-Villegas et al.	2018	121	4.430	t statistic	0.375
Fiore et al.	2017	280	0.493	r	0.493
Stasi et al.	2016	334	17.470	Log odds ratio	0.979
Galbreath et al.	2016	203	0.490	r	0.490
Muscio et al.	2015	334	0.339	Log odds ratio	0.093
Export Orientation & Innovation					

Innovation & Financial Performance					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Annunziata et al.	2018	357	0.264	r	0.264
Presenza et al.	2017	191	-0.027	Log odds ratio	-0.008
Galbreath et al.	2016	203	0.020	r	0.020
Stasi et al.	2016	334	0.455	Log odds ratio	0.124
Hojman	2015	43	0.210	r	0.210
Muscio et al.	2015	334	-0.008	Log odds ratio	-0.002
Maurel	2009	82	0.164	Partial eta squared	0.216
Firm Size & Innovation					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Frigon et al.	2020	151	0.680	Log odds ratio	0.184
Pradana et al.	2020	138	0.011	r	0.011
Doloreux et al.	2020	151	0.557	Log odds ratio	0.152
Annunziata et al.	2018	357	0.068	r	0.068
Guerrero-Villegas et al.	2018	121	1.230	t-statistic	0.112
Galbreath et al.	2016	203	0.150	r	0.150
Muscio et al.	2013	47	-0.030	Log odds ratio	-0.008
Giuliani	2007	105	0.429	r	0.429
Firm Age & Innovation					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Frigon et al.	2020	151	0.230	Log odds ratio	0.063
Annunziata et al.	2018	357	-0.049	r	-0.049
Guerrero-Villegas et al.	2018	121	0.850	t statistic	0.077
Galbreath et al.	2016	203	0.140	r	0.140
Hojman	2015	43	0.170	r	0.170
Chrisman & Patel	2012	964	-0.110	r	-0.110
Links to Research Institutions & Innovation					
Author	**Year**	**Sample Size (n)**	**Reported Effect Size**	**Type of Effect Size**	**Effect Size After Conversion**
Presenza et al.	2017	191	-0.059	Log odds ratio	-0.016
Stasi et al.	2016	334	0.216	Log odds ratio	0.059
Giuliani & Arza	2009	41	0.489	Probit coefficient	0.223
Giuliani & Arza	2009	32	0.114	Probit coefficient	0.053

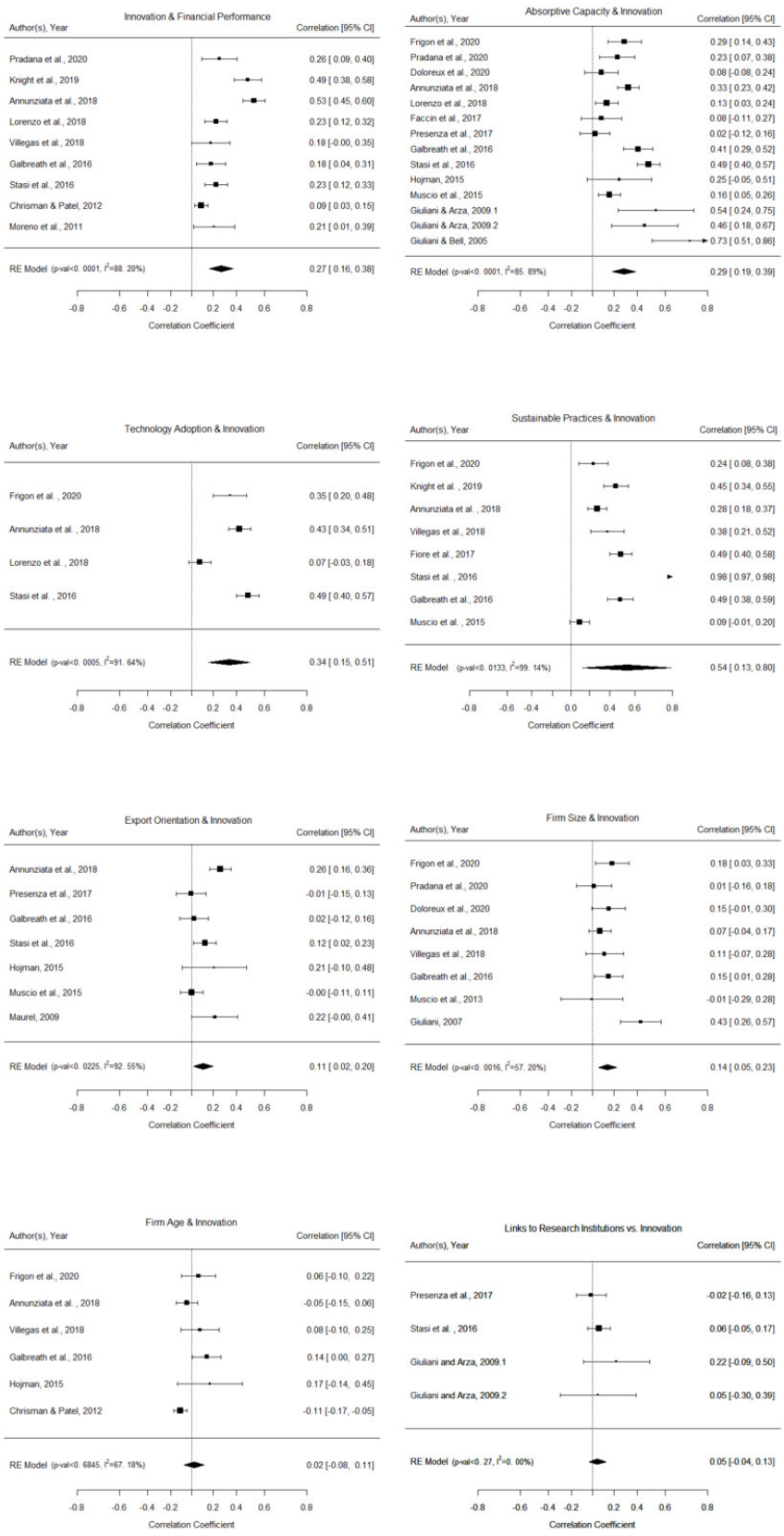

Figure A1. Forest Plots

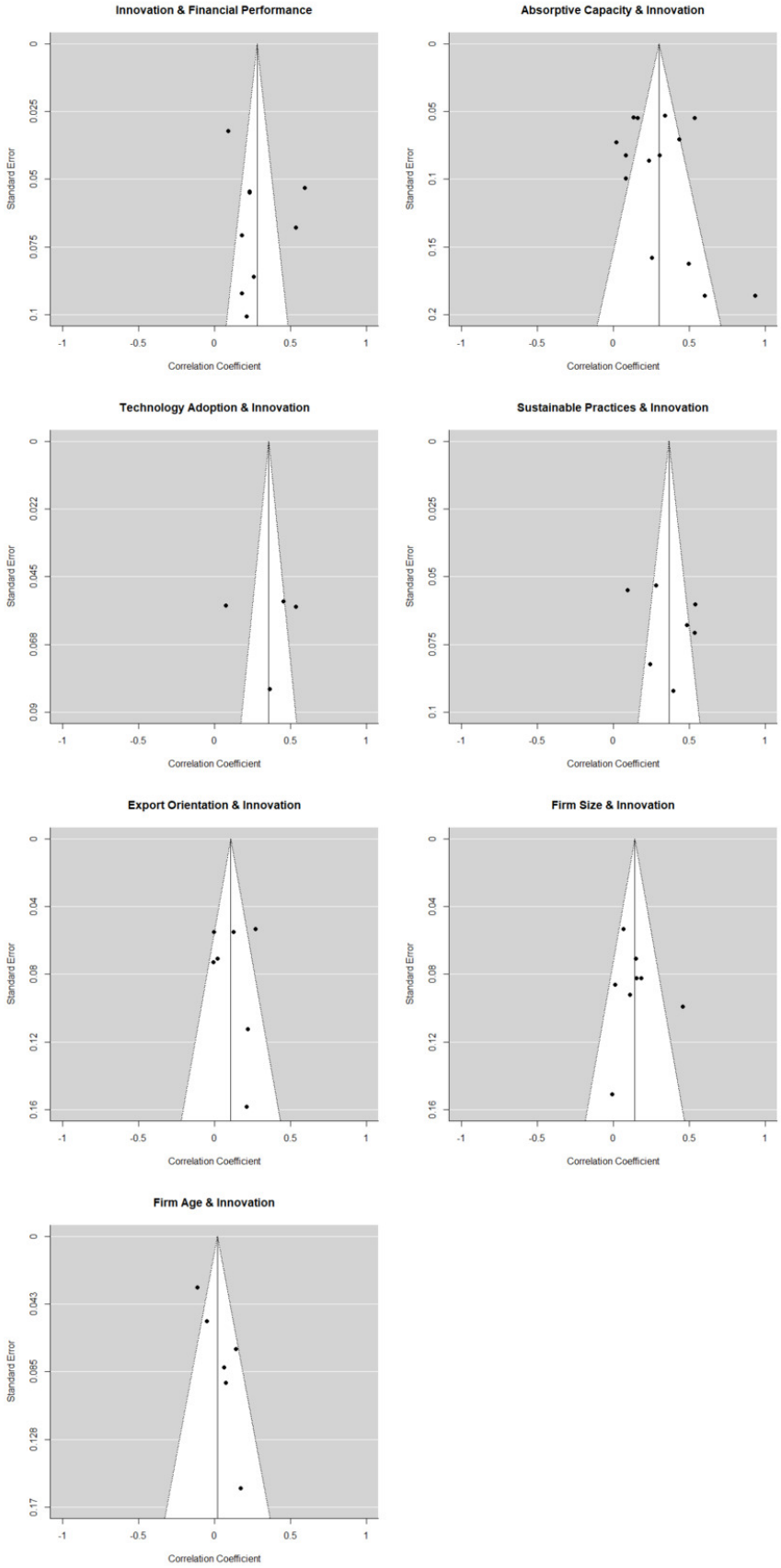

Figure A3. Funnel Plots

Supplementary Materials

Managerial Summary

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