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THÈSE PRÉSENTÉE

POUR OBTENIR LE GRADE DE

DOCTEUR DE L'UNIVERSITÉ DE BORDEAUX

ÉCOLE DOCTORALE ENTREPRISES, ÉCONOMIE ET SOCIÉTÉ
SPÉCIALITÉ SCIENCES ÉCONOMIQUES

Par **Linda JIAO**

Déterminants macroéconomiques du prix du vin

Sous la direction de **Monsieur Jean-Marie Cardebat**, Professeur

Soutenue le 31 Mai 2018

Membres du jury :

Monsieur Stephen BAZEN,
Professeur, Université Aix-Marseille, ***rapporteur***

Monsieur Benoit FAYE,
Professeur, INSEEC Bordeaux

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Professeur, Université de Bordeaux, ***président***

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Abstract

This thesis fills the gap in the research on the discovery of the macroeconomic and financial determinants of fine-wine prices. As a first step, a literature review presents main academic contributions on wine pricing. Complementary to the hedonic pricing approach, it is necessary to study the impact of macroeconomic and financial factors on the evolution of wine prices. Thereby, we have empirically identified the macroeconomic determinants of fine-wine prices. Throughout the past 20 years, the price of fine wines have been moving in accordance with the economic cycles, and there was a significant breakpoint at 2004 when fine wines started to be increasingly financialized. Finally, we have witnessed the existence of long-term relationships between fine-wine price indices and stock-market indices and confirmed the transmission of price fluctuation from financial markets to fine-wine markets in a short-medium term.

Keywords: wine, price, macroeconomics, finance, econometrics

Résumé

Cette thèse porte sur les déterminants macroéconomiques et financiers des prix du vin. Dans un premier temps, une revue de la littérature présente les principales contributions académiques portant sur les prix du vin. En complément de l'approche du prix hédonique, il est nécessaire d'étudier les liens entre l'évolution du prix du vin et les facteurs macroéconomiques et financiers. Ainsi, nous avons identifié de manière empirique les déterminants macroéconomiques du prix du vin. Au cours des 20 dernières années, le prix du vin a évolué en fonction des cycles économiques. Nous avons observé un point de rupture significatif en 2004, lorsque les vins prestigieux ont commencé à être de plus en plus financiarisés. Enfin, nous avons témoigné de l'existence de relations à long terme entre les indices des prix du vin et les indices boursiers et confirmé la transmission des fluctuations des prix des marchés financiers vers les marchés du vin à court et moyen terme.

Mots clés : vin, prix, macroéconomie, finance, économétrie

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Synthèse en Français

Chaque bouteille de vin procure une expérience et des sensations uniques. Les caractéristiques relatives à la couleur, à l'odorat et au goût peuvent renvoyer vers des spécificités tant sur les environnements géographiques, climatiques que sur les choix de cépages et de technologies de vinification. Tous ces facteurs fondamentaux définissent le style, garantissent la qualité du vin et déterminent également le prix. Dans la littérature sur l'économie du vin, les études sur la détermination des prix du vin ont commencé par la modélisation du prix du vin par ses caractéristiques intrinsèques et extrinsèques, ses facteurs objectifs et subjectifs ainsi que l'interaction entre l'offre et la demande. Ces cadres de prix hédoniques ont été bien clarifiés par la détermination du prix d'un vin et les différences de prix entre différents vins. Cependant, l'explication de l'évolution des prix à travers le temps reste un mythe, en particulier pour les vins dédiés à l'investissement qui connaissent des fluctuations de prix élevées sur le marché secondaire. Ceci conduit à l'objectif de la thèse - expliquer l'évolution des prix au cours du temps et découvrir les déterminants macroéconomiques et financiers.

Les échanges du vin remontent à l'âge du bronze lorsque nos ancêtres ont commencé à échanger sur de longues distances. Avant les années 1990, les producteurs de vin étaient concentrés autour de la région méditerranéenne. Le marché était plutôt fragmenté et les producteurs n'avaient pas beaucoup d'interactions entre eux. La majeure partie de la production était consommée par les consommateurs locaux ou importée vers les pays voisins (Houssain et al., 2008, Anderson et al., 2016). Ce n'est que depuis la mondialisation des deux dernières décennies que l'industrie mondiale du vin a connu des changements structurels considérables (Anderson et al., 2003, 2016). De par la baisse des coûts de logistique et de communication ainsi que la diminution des barrières tarifaires et non tarifaires dans le commerce international, les producteurs de vin ont eu la possibilité d'élargir leurs activités commerciales à l'étranger. Le commerce international du vin s'est développé à grande vitesse, accompagné d'une diffusion rapide des savoir-faire, des technologies de la viticulture et de la vinification. L'émergence de nouveaux pays producteurs met en compétition l'Ancien Monde avec leurs avantages dans les stratégies de prix et de marketing. Les grands acteurs établissent des alliances stratégiques ou investissent directement à l'étranger afin de renforcer leur position concurrentielle à l'échelle mondiale. Du côté de la demande, la croissance de la richesse et le développement de nouveaux médias ont facilité la diffusion de la culture du vin et encouragé la demande dans les économies émergentes.

De nos jours, sur ce marché mondial, le vin est devenu un produit mondialisé qui est exposé à toutes sortes de facteurs qui peuvent avoir un impact sur lui et cela, de tous

les coins du monde. Il n'est pas surprenant que le prix d'une bouteille française puisse être affecté par les facteurs de la demande en provenance des États-Unis ou de la Chine, tels que le pouvoir d'achat des ménages, les taux d'intérêt et les taux de change bilatéraux. L'émergence du Nouveau Monde et du Nouveau Nouveau Monde peut se manifester non seulement par la production et la consommation, mais aussi par leur influence considérable sur l'industrie mondiale du vin. Comme l'ont indiqué Anderson et Wittwer (2013, 2015), les perspectives du marché mondial du vin pourraient dépendre fortement de l'évolution des taux de change bilatéraux réels, des opportunités de croissance en Asie et de l'évolution de la Chine en matière d'importation et de développement de sa propre production de vin.

L'évolution de l'industrie mondiale du vin reproduit les changements liés à nos époques, de telle façon qu'elle reflète l'environnement de l'économie mondiale. D'autre part, elle est influencée par l'évolution dans les cycles économiques. En outre, avec la financiarisation, le vin a obtenu un autre titre, celui d'un actif financier alternatif. Les investisseurs induisent une demande supplémentaire en vins prestigieux en dehors de la consommation et de la collection. Les comportements des investisseurs, la diversification ou la spéculation peuvent contribuer à l'évolution des prix. En conséquence, le prix du vin n'est plus seulement déterminé par ses fondamentaux (le temps, le terroir, le savoir-faire), il répond également à divers facteurs macroéconomiques et financiers lorsqu'il évolue au fil du temps sur le marché. Ainsi, au sein de la thèse, nous testerons l'hypothèse selon laquelle l'évolution des prix du vin est influencée par les déterminants macroéconomiques et la fluctuation des marchés financiers.

Déterminants macroéconomiques et financiers du prix du vin

Cette thèse vise à découvrir les déterminants macroéconomiques et financiers du prix du vin. Nous commençons par une revue de la littérature présentant les principales contributions académiques sur la formation du prix du vin. Un nombre important d'études s'est concentré sur l'analyse hédonique pour expliquer la détermination du prix (voir par exemple Cardebat & Figuet, 2009; Cardebat & Figuet 2004; Ashenfelter, 2008; Jones & Storchmann, 2001; Combris et al., 2000; Lecocq, & Visser, 1997). D'autres, en estimant le rendement, la performance et les avantages de diversification des portefeuilles de l'investissement du vin, se sont concentrés sur le sujet du vin considéré comme un actif financier alternatif (voir par exemple Dimson et al., 2015 Masset et al., 2015; Fogarty et Sadler, 2014; Masset et Henderson, 2010; Sanning et al., 2008; Burton et Jacobsen, 2001). Cependant, il existe peu de recherches dédiées à la découverte de

l'influence des facteurs macroéconomiques sur le prix du vin et le lien entre les marchés financiers et les marchés des vins fins. Ainsi, nous nous consacrons directement à la recherche des variables macroéconomiques influentes afin de saisir les impacts directs des chocs macroéconomiques sur le prix du vin. En outre, nous avons observé qu'au cours des 20 dernières années, le prix du vin a évolué en fonction du cycle économique, et qu'il y a eu un point de rupture significatif en 2004, lorsque le marché du vin a commencé à être de plus en plus financiarisés. La littérature récente a révélé l'existence de retombées de la volatilité des marchés boursiers et des matières premières au marché du vin fin (Bouri, 2013, Faye et al., 2015, Le Fur et al., 2016), et a indiqué une relation importante entre la création de la richesse boursières et le prix du vin (Dimson et al., 2015). Par conséquent, dans une prochaine étape, il est nécessaire d'étendre notre étude en justifiant l'impact de la financiarisation sur le marché du vin. En appliquant les tests de cointégration et de causalité, nous avons constaté, d'une part, l'existence de relations à long terme entre les indices de prix du vin et les indices boursiers à différents niveaux et, d'autres part, confirmé la transmission des fluctuations des prix des marchés financiers vers les marchés du vin à court-moyen terme. De cette manière, les chocs macroéconomiques affectent indirectement les marchés du vin via les marchés financiers.

Chapitre I – Détermination vs. fluctuation - la voie de la financiarisation sur le marché du vin

Dans la littérature académique, les études sur la détermination du prix du vin ont commencé avec le modèle hédonique développé par Rosen (1974). De ce cadre, le prix du vin a été analysé à travers ses caractéristiques intrinsèques et extrinsèques, ses facteurs objectifs et subjectifs, et l'interaction entre l'offre et la demande. Fondamentalement, la qualité d'un vin est le facteur décisif de la détermination du prix. La qualité est déterminée par trois aspects majeurs: le temps, le terroir et le savoir-faire. En outre, les producteurs demanderont les avis d'experts sur leur vin. Si l'opinion d'un expert est crédible et qu'il contient des informations complètes et correctes sur les trois facteurs ci-dessus, cet avis peut alors être considéré comme un reflet fidèle de la qualité du vin. Dans ce cas, cet avis aura une influence sur le prix. Par ailleurs, si le prix est déterminé de manière efficace, en tenant compte de toutes les informations, il peut aussi être un bon indicateur de qualité. De plus, la quantité de production, le niveau des stocks, la demande actuelle et future des clients auront également une incidence sur la décision du producteur lors de la fixation du prix.

La méthode hédonique a bien expliqué la détermination du prix d'un vin et les différences de prix entre différents vins. Mais, il ne suffit pas d'expliquer l'évolution du prix et la fluctuation au fil du temps générée par les facteurs extérieurs du côté de la demande. Que ce soit les bulles créées par la demande chinoise pour les vins de luxe Bordelais ou la baisse significative provoquée par la crise financière, le prix de certains vins a fluctué au-delà de ce que ses fondamentaux pourraient expliquer. Nous nous rendons compte que les prix du vin ont réagi aux chocs macroéconomiques et financiers: ils semblent s'être comportés de la même façon que les matières premières. En outre, ils ont présenté des mouvements comparables à plusieurs indices boursiers et ont été corrélés avec certains indices macroéconomiques. De plus, la financiarisation du marché du vin fin a suivi une trajectoire similaire à celle des marchés des produits de base. Ainsi, nous explorons les résultats académiques sur la financiarisation des marchés des matières premières et les comparons avec des études similaires menées dans le domaine du vin. Comme tel, nous pouvons avoir une meilleure compréhension sur l'évolution du marché du vin. En outre, nous avons décrit les impacts des facteurs macroéconomiques, en soulignant les influences des marchés émergents. Aussi, nous développons ce sujet dans le chapitre suivant. À la fin du chapitre, nous discutons des défis pour les universitaires et les professionnels qui sont confrontés aux particularités du marché du vin.

Chapitre II - Déterminants macroéconomiques du prix du vin

Le deuxième chapitre présente l'idée que les facteurs macroéconomiques peuvent influencer les marchés du vin directement et indirectement. Lorsque les chocs macroéconomiques ont lieu, les marchés financiers réagissent immédiatement. Leurs réactions auront des impacts sur les marchés du vin (en particulier les vins fins) via des canaux tels que l'effet de richesse et la transmission de la volatilité. Ces facteurs macroéconomiques peuvent également affecter directement les marchés du vin. Par contre, la réponse des marchés du vin sera retardée car les vins ne possèdent pas autant de liquidités que les autres actifs financiers.

De façon empirique, nous avons modélisé les indices du prix du vin Liv-ex avec les variables macroéconomiques des marchés émergents et développés sur une base mensuelle de 1996 à 2015. Notre analyse prolonge l'étude de Cevik et Saadi Sedik (2014). Nous avons élargi la base de données, introduit de nouvelles variables explicatives et fourni un test de robustesse concernant la sous-période. Les résultats sont conformes à nos attentes. La demande croissante dans les pays émergents a affecté de

manière significative l'industrie du vin, ainsi que l'affaiblissement du dollar américain consolide davantage le pouvoir d'achat dans ces pays. Suite à la financiarisation, l'offre de monnaie relativement abondante associée à la baisse des taux d'intérêt en termes réels a favorisé l'investissement dans les vins haut de gamme. En conséquence, le prix s'est davantage fluctué. Ainsi, il est crucial de mener une étude consacrée au comportement des prix du vin sous l'influence de la financiarisation.

Chapitre III - Les moteurs financiers à long terme du prix du vin: le rôle des marchés émergents

Au final, ce troisième chapitre se consacre à l'analyse du lien entre marchés du vin et marchés boursiers. Nous avons appliqué une approche de cointégration et de causalité sur une base de données mensuelle de 21 ans (1994-2015) du niveau mondial à celui des pays spécifiques. Cette analyse comprend 7 indices de prix du vin (l'indice Liv-ex Fine Wine Investables et 6 sous-indices Liv-ex) et 35 indices boursiers (25 indices MSCI et 10 indices nationaux). Nous avons découvert des relations de cointégration entre les marchés du vin et les marchés boursiers des pays émergents et de l'Asie-Pacifique, ainsi que les causalités de la bonne direction de ces derniers vers les premiers. De plus, les Premiers Grands Crus Classés Bordelais sont particulièrement touchés par la Chine continentale, tandis que la Bourgogne et la Champagne sont plus liées aux marchés Européens. Par conséquent, nous suggérons que les transmissions (via l'effet de richesse et la volatilité) des marchés financiers aux marchés du vin soient pris en compte dans la prévision du prix et la stratégie de diversification du portefeuille. Aussi, il faudrait équilibrer les compositions du portefeuille afin de réduire la dépendance vis-à-vis de certains marchés.

General Introduction

Take a glass of wine. We first admire its color and guess which grape it is made from and how old it may be. Next, we can be surprised by its smell that may remind us of a delicious bakery shop around the corner, a blanket of berries picked from the forest, or a little elegant flower blossoming in the night. And finally, our palates are ready to be thrilled by its flavors, fresh or soft, jammy or delicate, powerful or velvety. These unique characteristics reveal specific geographic and climatic environments and specific choices of grape varietals and winemaking technologies. All of these features give a wine its style and its quality, and also, in a way, predict its price.

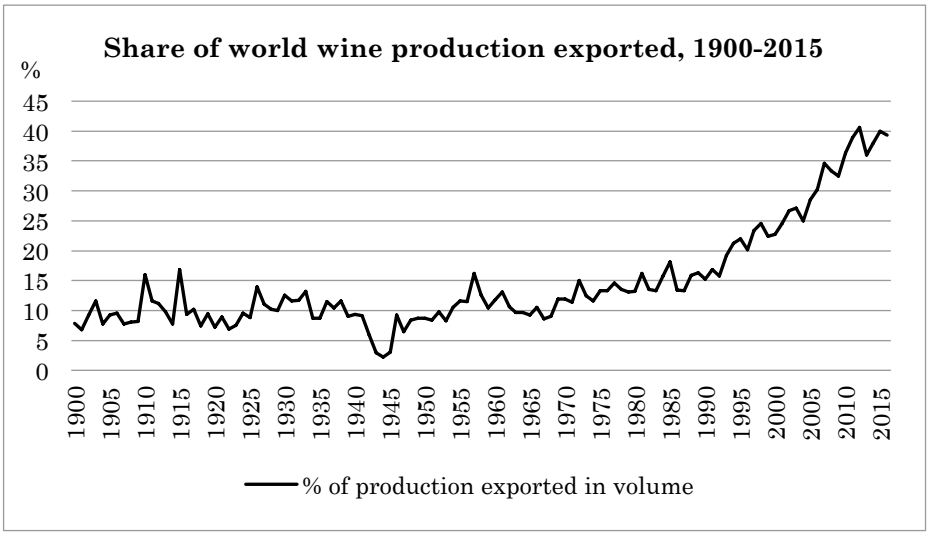
We have a long history of wine culture, and it can be traced back to the Bronze Age when our ancestors started to trade wine over long distances (Anderson et al., 2016). However, not until the end of the twentieth century, owing to globalization, did the percentage of wine traded abroad become important. Nowadays, the evolution of the global wine industry mirrors changing times inasmuch as the industry reflects the macro-environment of the global economy on one hand and the influences exerted by changes in business cycles on the other. Furthermore, due to financialization, wine has obtained another title – that of an alternative financial asset. Investors have created a supplementary demand in prestige wines in addition to their consumption and collection. The behaviors of investors, as well as the act of hedging or speculation, may contribute to the price evolution. As a result, the price of wine is not only determined by its fundamentals (weather, terroir, know-how), it also responds to various macroeconomic and financial factors when it evolves over time on the market. It is not surprising that the price of a French bottle can be affected by demand factors from the U.S. or China, such as household purchasing power, interest rates and bilateral exchange rates. The emergence of New World and New New World countries can be manifested not only in terms of production and consumption, but also in their macro influential power on the global wine industry. In addition, the factors that are related to the structure of the wine sector, such as the organization of distribution channels and the behavior of intermediaries can also have impacts on wine prices in a long-term[1].

[1] As a complement to the studies in price evolution, we provide an analysis at industry level. We compare the organization of the national wine market of a traditional wine country and that of an emerging wine country – France vs. China. On one hand, China provides the essential demand, and on the other hand, France is the main supplier of fine wines. The industrial structures of these two countries are important for the price evolutions in a long-term. This part of work is included in *The Palgrave Handbook of Wine Industry Economics,* edited by Alonso Ugaglia, A., Cardebat, J. M., and Corsi, A., Palgrave MacMillan 2018 forthcoming.

Evolution of the global wine industry

The world's wine industry has been going through considerable structural changes since globalization over the last two decades (Anderson et al. 2003, 2016). "The world's economy is transformed from a set of national and regional markets into a set of markets that operate without regard to national boundaries" (Fraser and Oppenheim, 1997) and industry players compete with each other under a worldwide marketplace environment (Lee, 2009; Houssain et al., 2008). Since the 1980s, the decreases in logistics and communication costs and the lowering of tariff and non-tariff barriers in international trade provide the possibilities for wine producers to enlarge their commercial activities abroad. International wine trade has expanded at a high speed, accompanied by a rapid spread of know-how and technologies in winegrowing and winemaking. Emerging new wine-producing countries have come to challenge the Old World with their advantages in pricing and marketing strategies. Large players establish strategic alliances or invest directly abroad in order to strengthen their competitive position on a global scale. On the demand side, the growth in wealth, together with the development of new media facilitate the spread of wine culture in new wine-consuming countries. And thanks to globalization, consumers have the opportunity to enjoy a diversified choice of worldwide products at reasonable prices regardless of national boundaries (Anderson et al., 2016; Lee, 2009).

Figure 0.1: Share of world wine production exported

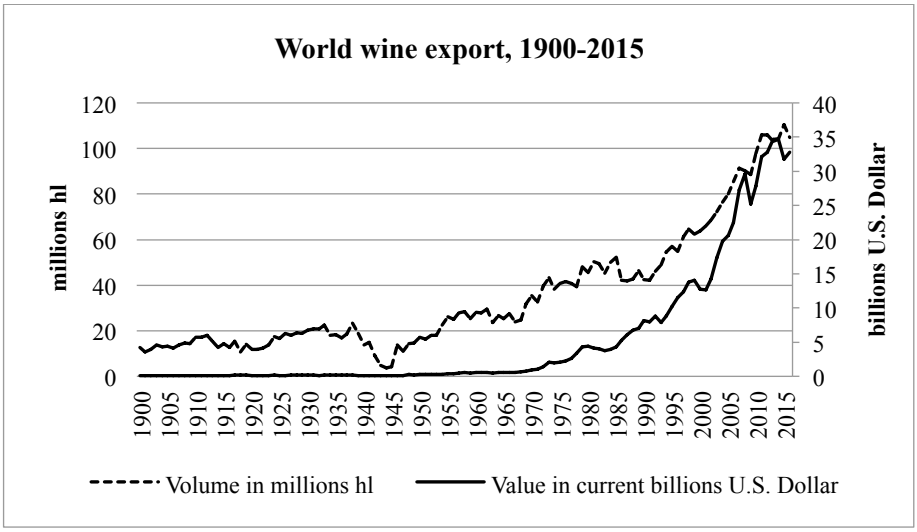


Source: Anderson and Pinilla (2017)

It would have been hard to imagine this picture twenty years ago. Before the 1990s, wine producers were concentrated around the Mediterranean area. The market was rather fragmented and there was little interaction between producers. Most of the

production was consumed by local consumers or exported to neighbor countries (Houssain et al., 2008; Anderson et al., 2016). According to the annual database of global wine markets collected by Anderson and Pinilla (2017), over the last century, the share of global wine production exported oscillated around 10% until the 1990s when it started to increase. Now it has reached 40% (see Figure 0.1). While the share of European production exported has increased steadily and progressively, the share of New World production exported has experienced dramatic growth from less than 5% to nearly 40% since the 1990s. As a result, global wine exports have increased by almost three times in volume and five times in value over the last two decades (see Figure 0.2). France, Italy and Spain occupy over half of the entire world's wine export in volume and in value. Spain, with a high proportion of export in low-priced bulk wines, has gained share in volume in recent years, but the share in value remains relatively low (in 2015, 22.4% in volume, 9.3% in value). Although the share for French wines has been gradually declining since the 1980s, France still holds the highest share in value – one third of the world's wine export, with no more than a 15% share in volume. Italy is positioned between the two. Over the last thirty years, its share in volume has slightly decreased from 30% to approximately 20%, with a share in value stabilizing around 20%.

Figure 0.2: World wine export, 1955-2015



Source: Anderson and Pinilla (2017)

Although the three European countries still dominate global wine trade, the degree of concentration has been diluted by New World producers. Australia, the U.S., Chile, South Africa, Argentina and New Zealand, present as the majority stand out as major players in the top 10 exporters' list (OIV, 2017). In 2016, they supplied 29% of the world's export in volume and 24% in value. When intra-European Union trade is excluded, the participation of the New World in global export becomes more important -

it counts for 40% in value (Anderson and Pinilla, 2017). The leading brands of New World producers demonstrate certain advantages in terms of price competition and marketing strategy when facing the challenges of globalization. For instance, E&J Gallo Winery and Constellation from the U.S., Treasury Estates from Australia, and Concha y Toro from Chile hold a significant market share of global sales. In addition, the growth in value of the New World's wine exports is particularly noticeable. New World producers have launched products that have adapted well to the tastes and consumption habits of the Millennials along with those of less experienced consumers, and moreover, they are keen to expand their sales of high-end wines. New Zealand has a strong focus on the quality of its exported wines. Thanks to its famous Chardonnay, the average export price per bottle takes top place in the world, well ahead of French wines. In the search for high-end products and innovations in technology, Napa Valley makes wines whose quality and price are comparable to a classic prestigious Haut-Médoc. As indicated by Gergaud and Ginsburgh (2008), "the wine-making technology has become so sophisticated that it can completely shade the effect of terroir and vines can be grown in almost any place, as long as weather permits and the right combination of vines is made". Moreover, a new chapter of emergence in production and export is being opened by the New New World – the countries around the Black Sea, and in particular China which is ranked sixth in the world in wine production (Cardebat, 2017; OIV, 2017).

While trade has become more active, domestic consumption in major traditional European producers has dropped since the 1970s, although recently this decline has come to a pause. Germany has had rather stable consumption for several decades. Demand in the U.K. has increased and stays strong despite the volatility engendered by the financial crisis. The decrease in France, Spain and Portugal has slowed and since the 2010s, demand has stabilized. Italy has experienced a recovery of 19% in volume since 2010. In terms of import, Germany occupies the highest rank in volume and the third highest in value. The U.K. remains the second-biggest buyer in volume, as well as in value despite a fairly significant drop since 2015. As for France, Spanish bulk wine represents most of the import as regards volume. In terms of value, the U.S. has increased imports nearly six times over since 1990 and overtaken the U.K. into first place since 2010. In 2016, it represents 18.1 % of the world's imports while in volume, the U.S. is still in third position behind Germany and the U.K.. Canada has experienced a fourfold increase in import value during the 2000s but this has been declining in recent years. Nevertheless, the most spectacular growth in wine consumption has come from emerging markets. The increase in income and purchasing power, enhanced by a weaker

U.S. dollar, has encouraged consumers in emerging markets to discover western products and life style. In 1995, the share of Chinese wine imports on the global wine market was near zero. Twenty years later, it represents more or less 7% in volume and 12% in value (including Hong Kong, knowing that the Chinese mainland and Macau take up over 90% of the wine re-exported from Hong Kong), positioning China fifth in volume and fourth in value (OIV, 2017; Anderson and Pinilla, 2017). Regarding market size, according to IWSR (International Wine & Spirits Research), China is predicted to become the second-largest wine market and the largest non-sparkling wine consumer by 2020. In addition, the surge in demand of Chinese buyers has favored the rise in wine prices and more significantly those of high-end wines. Their obsession for Bordeaux First Growths was largely responsible for the peak in Lafite's price around 2011.

The huge potential in wine markets has been attracting wine producers or consumers to directly invest aboard in order to get closer to the demand or to the supply with fewer intermediaries. For example, several prestige French families have cultivated vines in emerging wine countries, British auction houses have brought sales to Hong Kong to approach Asian buyers, and Chinese investors have acquired a significant number of Bordeaux vineyards. Cardebat (2017) presents four types of foreign direct investment in the wine industry: a wine producer invests in another producer country in order to diversify risks related to the supply and to search for product differentiation; a wine producer invests in a consumer country with the objective of facilitating and increasing sales; a wine consumer invests in a producer country so as to secure the upstream supply-chain and consolidate his market position; a wine consumer invests in another consumer country, aiming to diversify the risks related to the demand and expand into a new market. Also, these foreign investments stimulate the mobility of people working in the wine industry and encourage international exchanges in technology and culture.

The consumption patterns of wine consumers have been changing following the rapid expansion of wine culture. In Western European markets, consumption outside the household has risen significantly, together with a growing preference for higher-quality wines. In addition, an increasing number of young consumers have been attracted by wine culture and have been incorporating wine-drinking into their life styles (Bernetti et al., 2006). According to reports from Vinexpo, the alcohol consumption of millennials is more diversified by beers and spirits than generations before them, and the "habits are changing from common consumption of wine to more thoughtful drinking". Young consumers are more curious about what is inside the glass and more adventurous about

trying unfamiliar products. And globalization provides possibilities for this. In the U.S., globalization has enlarged the choices for American drinkers in terms of the country of origin and grape varietals, and it guarantees the supply of quality wines under more advantageous prices (Gokcekus and Fargnoli, 2007). Also, the market is experiencing an upstream trend that the demand for higher-quality wines is raising. For Asian countries, wine is not present in their traditional food and beverage culture. However, along with the processes of globalization, open-minded Asian consumers have progressively accepted wine during or outside meals. Asia has shown significant growth in wine consumption and a varied demand for both domestic and imported wines. China, in particular, is leading the growth. Meanwhile, the Chinese wine market has been shifting from luxury towards the mass market, and the behavior of consumers has been mutating from prestige seeking towards adventurous quality seeking.

Anderson and Wittwer (2013, 2015) projected the outlook for the global wine market. They indicated that the outcome could depend highly on changes in real bilateral exchange rates, growth opportunities in Asia, and the evolution of China in wine importation and the development of its own production. Indeed, on this worldwide marketplace, wine has become a globalized product that is exposed to all kinds of factors that potentially have impact on it from every corner of the world. There are fundamental factors, such as ongoing climate change and innovation of viniculture technologies to adapt to environmental risks. And there are external factors outside the wine industry - the macroeconomic and financial influences coming from the countries of supply or those of demand. Moreover, the increasing investment in prestige wines favors financialization in the wine market and it exposes prestige wines to the risks linked to the volatility of financial markets and the behaviors of investors. As a result, the wine price can fluctuate far beyond what the fundamentals can determine. Therefore, in this thesis, we will test the hypothesis that the evolution of wine prices is influenced by macroeconomic determinants and fluctuation in financial markets.

Macroeconomic and financial determinants of wine prices

This thesis fills the gap in the research on the discovery of the macroeconomic and financial determinants of fine-wine prices. We start with an up-to-date literature review presenting the main academic contributions on wine pricing. A significant number of studies have focused on hedonic analysis to explain price determination (see, for exemple, Cardebat & Figuet, 2009; Cardebat & Figuet 2004; Ashenfelter, 2008; Jones & Storchmann, 2001; Combris, Lecocq, & Visser,2000; Combris, Lecocq, & Visser, 1997).

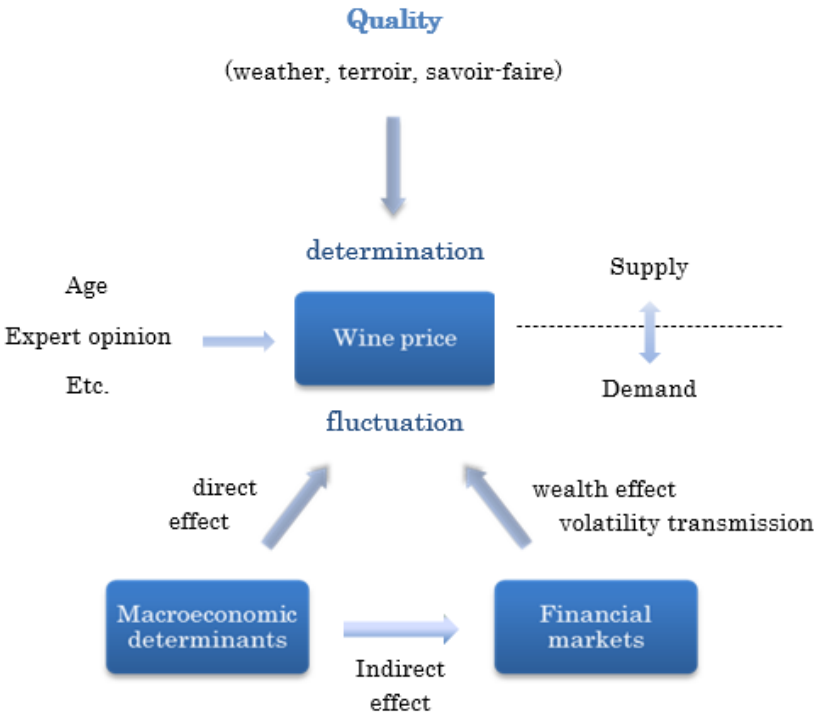


Figure 0.3: Determination and evolution of wine price (drawn by author)

Others, by estimating the return, the performance and the portfolio-diversification benefits of wine investment, have concentrated on the subject of fine wines regarded as an alternative financial asset (see, for instance, Dimson et al., 2015; Massetet al., 2015; Fogarty and Sadler, 2014; Masset and Henderson, 2010; Sanning et al., 2008; Burton and Jacobsen, 2001). However, there is little existing research dedicated to discovering the influence of macroeconomic factors on wine prices and the linkage between financial markets and fine-wine markets. As such, we devote ourselves directly to the search for influential macroeconomic variables, which enable us to capture direct impacts of macroeconomic shocks on wine prices. Besides, we have observed that throughout the past 20 years, the price of fine wines has been moving in accordance with economic cycles and that there was a significant breakpoint at 2004 when fine wines started to be increasingly financialized. The latest literature has revealed the existence of volatility spillovers from stock and commodity markets to the fine-wine market (Bouri, 2013; Faye et al., 2015; Le Fur et al., 2016) and it has indicated an important relation between the creation of financial wealth and fine-wine prices (Dimson et al., 2015). Consequently, as a next step, it is necessary to extend our study by justifying the impact of financialization on the wine market. By applying cointegration and causality tests, we have witnessed the existence of long-term relationships between fine-wine price indices and stock-market indices at different levels and confirmed the transmission of price

fluctuation from financial markets to fine-wine markets in a short-medium term. In this way, macroeconomic shocks affect wine markets indirectly via financial markets. Figure 0.3 presents the logic and structure of the thesis.

In the first chapter, "*Price determination vs. price fluctuation – the path of financialization in the fine-wine market*", we first review the hedonic analysis of wine-price determination by presenting each of the main attributes, including intrinsic and extrinsic, objective and subjective characteristics. The hedonic pricing method provides an effective explanation of the price determination of a wine and of the price differences between different wines. However, the method does not sufficiently explain the price evolution and fluctuation over time generated by exterior factors from the demand side. We realize that fine-wine prices have been responding to macroeconomic and financial shocks: they appear to have behaved like commodities, have exhibited comparable movements with several stock market indices, and been correlated with certain macroeconomic indices. Moreover, the financialization of the fine-wine market has followed a similar trajectory to that of commodity markets. Thus, in the second part, we explore academic findings on the financialization of commodity markets and present similar studies carried out in the wine area. Thereby, we can gain a better understanding of the evolution of the wine market. In addition, the impacts of macroeconomic factors are described, with a highlight given to the influences of emerging markets. This issue is expanded in the following chapter. Finally, we discuss the challenges for both academics and professionals facing the particularities of fine-wine markets.

Subsequently, the second chapter, "*Macroeconomic determinants of wine prices*", addresses the idea that macroeconomic factors can influence wine markets directly and indirectly. Wine markets can react to the shocks directly but with a delay because of the limitation in liquidity. On the other hand, financial markets will immediately respond to macroeconomic shocks and transmit their reactions to wine markets. With the objective of discovering influential macroeconomic factors, we model Liv-ex fine-wine price indices with the macroeconomic variables of both emerging and developed markets on a monthly basis from 1996 to 2015. This framework extends the study of Cevik and Saadi Sedik (2014). We have expanded the database, introduced new explanatory variables and provided a robust sub-period analysis. The outcome is in line with our expectations. The increasing demand in emerging markets has significantly affected the wine industry and the weakening of the U.S. dollar further consolidates purchasing power in emerging economies. Along with financialization, relatively abundant money supply associated

with lower interest rates in real terms has favored the investment in investable-grade wines. As a result, the price has fluctuated to a greater extent. Thus, it is crucial to carry out a study devoted to the behavior of wine prices under the influence of financialization.

Finally, the third chapter, "*The long-term financial drivers of fine-wine prices: the role of emerging markets*", analyzes the linkage between fine-wine markets and stock markets. We have applied a cointegration and causality approach to a 21-year (1994-2015) monthly database from the world level down to specific countries. This analysis includes 7 fine-wine price indices - the Liv-ex Fine Wine Investables Index and 6 Liv-ex sub-indices, and 35 stock market indices - 25 MSCI Indices and 10 national indices. We have discovered cointegration relationships between fine-wine markets and emerging and Asia-Pacific markets, and also causalities in the right direction from the latter to the former. In addition, the Bordeaux First Growths are particularly affected by Mainland China. As a result, we suggest that the potential wealth effect and volatility transmission from financial markets to fine-wine markets should be taken into consideration in fine-wine price forecasting and in portfolio-diversification strategy, and also when balancing the components of a portfolio so as to reduce the dependency on specific markets.

Chapter I

Price determination vs. price fluctuation - The path of financialization in fine-wine markets

Price determination vs. price fluctuation - the path of financialization in fine-wine markets

Abstract

This article reviews the long journey of academic research on wine pricing and compares it with the literature on commodity markets. This study justifies our interest in the dynamic of fine-wine prices and their macroeconomic and financial determinants. In addition, it may help us to have a better understanding of financialization in the fine-wine market, so as to enlighten subsequent research projects.

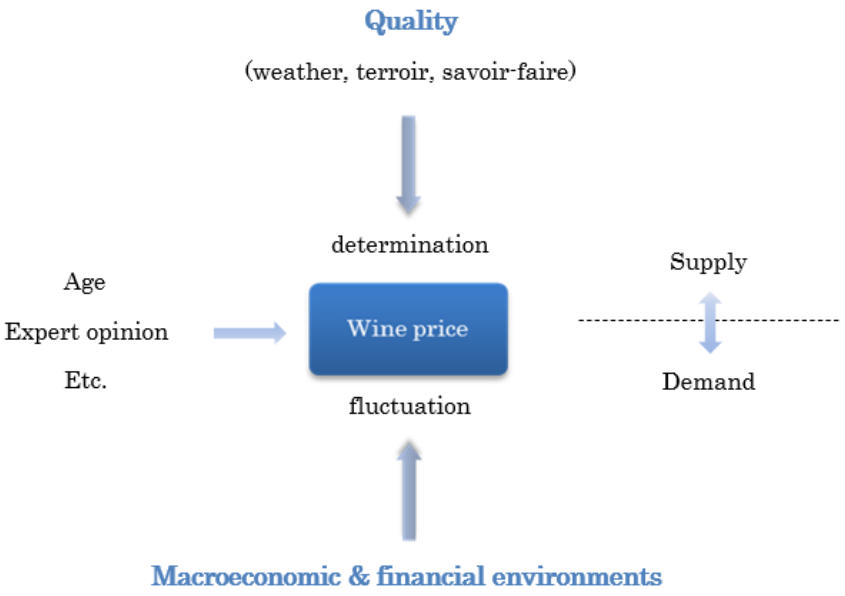
Keywords: wine, price, financialization

1.1. Introduction

In wine economics literature, studies on the determination of wine prices started with the hedonic model developed by Rosen (1974). From this framework, the price of wine has been analyzed across its intrinsic and extrinsic characteristics, objective and subjective factors, and the interaction between supply and demand. Fundamentally, the quality of a wine is the decisive factor in wine pricing. This quality is determined by three major aspects: weather, terroir and savoir-faire. Weather varies during the growing, the maturing and the harvest seasons of grapes; the terroir marks where the grapes are cultivated and the wines vinified and the savoir-faire is inherited from generation to generation and progresses through time. In addition, producers will ask experts for their opinions on their wine. If an expert's opinion is credible and contains complete and correct information on the three above factors, it can be considered as an accurate reflection of wine quality. In this case, it will have influence on pricing. On the other hand, if the price is efficiently determined, taken all information into account, it can also be a good quality indicator. Furthermore, production quantity, inventory level and current and future demand from clients will also affect the producer's decision when setting the price.

The hedonic pricing method is used to explain the price determination of a wine and the price differences between different wines. However, once the bottle is on the market and the price starts to evolve through time, hedonic methodology will not be sufficient to clarify the price variation generated by the variables on the demand side, especially for investable-grade wines traded on secondary markets. Over the last decade, as well as experiencing wide fluctuations, fine-wine prices have seen a dramatic increase. Indeed, major wine-price indices tripled from 2004 to 2011. Since fine wine has been regarded as an alternative financial asset, its price does not vary independently of macroeconomic and financial environments. Whether it were the bubbles created by the obsessive Chinese demand for Bordeaux luxury wines or the significant decrease caused by the financial crisis, the price of certain wine has fluctuated beyond what its fundamentals could explain. Due to the dual nature of fine wine, it is important to be inspired by a wider range of literature, so as to embrace elements influenced by macroeconomic determinants and financial variables, and incorporate them within the analysis of wine-price dynamics.

Figure 1.1: Determination and evolution of wine price (drawn by author)



Observing historical data, when responding to common macroeconomic and financial shocks, fine-wine price indices do not appear to have behaved differently to commodities, and they have exhibited comparable movements with certain stock market indices (Cevik and Saadi Sedik, 2014; Cardebat and Jiao, 2017). Indeed, the development of a fine-wine market, and particularly financialization, has followed a similar trajectory to that of commodity markets. Since the 2000s, commodity-index investment has emerged and interdependency across different commodity markets along with dependency between commodity and stock markets has increased. Commodity futures are traded as an alternative asset in response to the needs of portfolio diversification. Since then, commodities have faced higher exposure to common shocks, and the risks from other financial markets have spilled over into commodity markets. The price of an individual commodity is no longer solely determined by its fundamentals but is also related to aggregated risks, fluctuations of financial markets and the behavior of investors.

To our knowledge, numerous successful studies exist which analyze the impact of macroeconomic factors and financialization on commodity markets, but there are currently very few studies of this type in the area of wine prices. Moreover, in terms of subjects and methodologies, studies on fine wine seem to be inspired by those on commodity markets. Thus, exploring the literature in commodity markets may help us gain a better understanding of the fine-wine market and also enlighten subsequent research projects.

This article is constructed as follows. Firstly, we will review the hedonic analysis of wine-price determination by presenting each of the main attributes. Then, we will explore the findings related to financialization in commodity markets, the interrelationship between commodity markets and the link between commodity and stock markets. Furthermore, we will present similar studies carried out in the wine area which mirror the financialization observed in the fine-wine market. Our study will contain the analysis of return, price volatility, the portfolio-diversification benefits of wine assets and the linkage between the fine-wine and financial markets. Besides, the role macroeconomic factors play in price evolution will be described in this section. Following this, we will underline the influences of emerging markets. Finally, we discuss the particularities of fine-wine markets, the limitations of current work and the challenges faced by academics and professionals.

1.2. Determination of wine prices – a question of quality

At the end of 1990s, studies on the determination of wine prices emerged. They used hedonic price modeling to discover the relationship between price and quality and compared objective characteristics vis-à-vis subjective opinions. The framework developed by Rosen (1974) provides a theoretical support for these studies. "Hedonic prices are defined as the implicit prices of attributes", suggesting that the observed market prices of differentiated products are comparable regarding the specific characteristics embodied in them. The model interposes a market between producers and consumers, where producers tailor their products with attributes desired by consumers and consumers evaluate product characteristics to make purchasing decisions. These characteristics can be intrinsic or extrinsic, objective or subjective. During the last twenty years, research in this area has been well-developed and refined. For example, the correction of measurement errors related to subjective bias, spatial analysis aiming to improve earlier results and meta-analysis devoted to summarizing all the findings. In the first section, we present a review of wine-price determination based on the hedonic approach through each of the main attributes – the weather, terroir, savoir-faire, expert opinion and age.

1.2.1. Weather – the key factor

Fundamentally, the quality and the price of wine are sensitive to the weather conditions where the grapes were cultivated (Ashenfelter and Storchmann, 2016). In the context of global warming, the impact of climate change on wine quality and prices has

gained increasing attention. This is a crucial topic that concerns every professional, politician and academic involved in the wine industry and every wine lover. In 2017, Vinexpo Bordeaux organized a conference dedicated to the current situation and future perspectives of the global wine industry in the face of climate change. The invited wine makers (Gaja Winery, Hall Wines and Bodegas Torres) have been shifting their habits and have become keen to build eco-friendly systems for their wineries and environs in multiple ways. In addition, they invoked the media to draw greater attention to this subject, so as to bring positive reactions from the public and from politicians. Academics like us have also been working on it in our way. The Journal of Wine Economics published a special issue devoted to the studies of climate change in the wine field. Numerous researchers have focused on this topic and contributed vast analyses of diversified wine-producing regions associated with different climate zones (see for example van Leeuwen and Darriet, 2016; Roehrdanz and Hannah, 2016; Ferrise et al., 2016; Mozell and Thach, 2014).

It is generally agreed that climate change will result in rising temperatures. Based on Jones et al. (2005), from 1950-1999, the growing-season temperatures in high-quality wine-producing regions increased by 1.26°C on average, and it was predicted that the average increase in temperature for the period of 2000-2049 would be 2.04°C. However, the change in precipitation and the impact on other factors such as wind and hail remained uncertain.

With these predictable and unpredictable changes, wine-producing regions are facing both opportunities and challenges. "The impact of future climate change will be highly heterogeneous across varietals and regions" Jones et al. (2005). In general, poleward wine-producing locations will benefit from further warming. However, it may cause an increase in the frequency of extreme weather events and pest disasters. Adversely, global warming will bring more challenges to warmer wine-producing regions (Ashenfelter and Storchmann, 2016).

Furthermore, there are concerns that many European regions appear to be at or near their optimal growing-season temperatures (Jones et al., 2005). It will progressively make the balance of fruit flavor and the style of wine difficult to maintain. However, compared with the New World, their ability to adapt to climate change is limited. For Old World wines, the notion of terroir and appellation is of vital importance. They are more attached to the image of geographic origins than wines from the New World.

Furthermore, the planting rights in European regions are strictly regulated which leaves limited choices for regional or varietal substitutions.

So far, the impact of climate change on the world's wine industry is not yet clear. Whether it represents opportunities or challenges, what cannot be ignored are the adjustment abilities of winegrowers and winemakers. Ignoring these will lead to an overestimation of the long-term costs of climate change. According to "Climate change: field reports from leading winemakers" carried out by the Journal of Wine Economics in 2016, the leading winemakers of different regions with different climate patterns have already adopted various methods to insure the production of high-quality wines under the scenario of future changes in climate.

Moreover, the impact of climate change on wine prices should be an important issue of concern. Will wine prices vary with climate change, and by how much? To answer this question, many successful studies have been made on wines from various regions and grape varieties in order to discover the mysterious linkage between weather and wine prices.

Researchers first focused on Bordeaux Cru Classés. Overall, sufficient rainfall during the dormant period, higher temperatures during the growing season, followed by a warm and dry summer will benefit wine quality, leading in turn to higher prices. However, extreme temperature is detrimental and there will be a quadratic effect once the growing-season temperature exceeds its optimum (Jones et al., 2005).

Ashenfelter et al. (1995) (see also Ashenfelter, 2008) indicated that the auction prices of mature prestige Bordeaux wines could be explained by the weather conditions that made the wines: the average temperature over the growing period from April to September, the average temperature in September, the precipitation before harvest from August to September and the precipitation during the dormant stage from October to March. These weather factors, together with the age of the wine explained over 80% of the price variation in the vintages 1960-1969. Di Vittorio, A., & Ginsburgh, V. (1996) also found expected impacts of weather conditions on wine pricing based on an auction's data of Haut-Medoc fine wines. On the other hand, suggested by Ashenfelter and his colleagues, the market for young Bordeaux wines was inefficient. Producers were more likely to price young wines inversely related to quantity which might not be in accordance with their quality. However, when the wines matured, their prices usually converged to what had been predicted from the weather. Similar results were obtained for Australian fine wines: the market for young Penfolds was not efficient either (Byron

and Ashenfelter, 1995). Later, Ashenfelter and Jones (2013) updated the previous studies and examined the auction prices of Bordeaux fine wines over the vintages 1952-1980 (excluding 1954 and 1956). As expected, the results verified the important explanatory powers that weather variables had on prices.

Jones and Storchmann (2001) confirmed the favorable effect of warmer temperatures on Bordeaux Cru Classés. In addition, their results indicated that Merlot-dominated wines were more responsive to weather variation than Cabernet Sauvignon-dominated wines. And for both, smaller properties could take advantage of absolute scarcity since it showed a significant positive impact on price. Based on their findings, prestige domains on the right bank of the Garonne River such as Petrus and Le Pin would benefit the most from further global warming.

Chevet et al. (2011) analyzed prices and yields of a first growth chateau in Pauillac during the period 1800-2009 and found that over the last two centuries, the growing-season temperature had a significant positive impact on both of them. Since the 19th century, with the improvement of viticulture technologies, the influence of climate on yields has fallen over time. On the contrary, prices have become more responsive to weather factors. In particular, between 1980 and 2009, thanks to the emergence of wine media, information related to wine was more accessible to consumers. This may be one of the explanations for this tighter linkage between prices and climate. In line with Ashenfelter, O. (2008), their results also suggested that the quantity-based pricing strategy for young wines was inefficient. Wine quality and market demand had stronger impact on price determination.

Ginsburgh et al. (2013) studied the impact of hail, temperature and rainfall on Médoc wine prices. Clearly, hail strongly and negatively affected wine prices. Higher temperature had a positive impact during the blossom. However, too much heat in summer led to negative results. Rainfall in June and July was beneficial while a rainy September was always bad news.

Comparing New World wines with Old World wines, Byron and Ashenfelter (1995) applied the same analysis as the Bordeaux study for Penfold's Grange Hermitage. Similar to the Bordeaux study, the weather variables showed significant impacts with the expected signs, but their explanatory powers were weaker. In addition, for a warmer region like Australia, they found it was more appropriate to estimate the relationship between temperature and wine price in a quadratic model. The results approved that increasing temperatures improved wine prices but at a decreasing rate. Later, Wood and

Anderson (2006) used quadratic and also cubic variables to study the impact of temperatures on three iconic Australian wines and obtained similar nonlinear results.

Haeger and Storchmann (2006) studied the impact of weather variables on the price of American Pinot Noir wine. Unlike in European regions, precipitation did not show important impacts. On the other hand, similar to Australian wines, a quadratic relationship between prices and growing-season temperatures was proved. Since the growing-season temperature of many U.S. regions has already passed its optimum (22°C, the same as in Burgundy), further warming could lead to a decrease in American Pinot Noir prices. Ramirez (2008) examined the price of Napa Cabernet Sauvignon wines and indicated that Napa was not different to Bordeaux, in the sense that wine prices were highly sensitive to weather conditions.

In order to achieve more precise studies, researchers have applied spatial analysis to conduct further investigations into the impact of weather conditions on wine prices. Lecocq and Visser (2006) compared the results obtained from the main weather station of the Bordeaux region with the results obtained from local weather stations of each sub-region. Oczkowski, (2016) used refined weather- station information to test the impact of temperature and rainfall on each of the grape varieties. Both studies indicated that the specification with local data did give a better fit but the data from the main weather station was sufficient to obtain accurate results. However, they suggested that it was important to analyze each wine variety separately, since the impact of weather depended noticeably on grape varieties.

1.2.2. Terroir, humans and reputation

In wine language, the notion of terroir – savoir-faire is defined by the entire natural and cultural environment where and how the vine is cultivated and the wine vinified. It incorporates all the geographic and climatic characteristics combined with this environment's unique biodiversity and the specific choice of grape varietals and winemaking techniques. All the above gives the style of the wine originating from this terroir, thanks to which a wine can be recognized without the name being given. After years of production and commercialization, a wine-producing region or a winery establish their reputations (collective or individual), based on the recognition and the appreciation of the typicality of their wines. Some of them are more successful in promoting regional collective reputations while others own renowned brand names that rely on individual reputations.

The designation of origin has great importance for European wine-producing countries. The systems of appellation and classification[2] are mature and well-organized, and both of them can have significant impacts on prices. Academic studies first focused on French wines of well-known regions. With their interest in fine-wine auctions, Di Vittorio and Ginsburgh (1996) tested the impact of the Château (individual winery) on auction prices of Haut-Médoc premium wines. The results were significant with the most prestigious 1st Grands Crus Classés achieving the highest coefficients. They first reviewed the 1855 classification by comparing it with expert scores and suggested that although certain wines should be upgraded, the 1855 classification provided a satisfactory explanation of quality reflected by prices. Ginsburgh et al. (2013) also defended the status of the 1855 classification. The reputation effects formed by the classification conveyed a very strong signal. They indicated that the fundamental variables (weather, soil and wine-making technologies) could explain two-thirds of the variance of prices and this proportion rose to over 80% when the effect of the 1855 classification was included. Combris et al. (1997) found that the Bordeaux or the Côtes appellations showed negative impacts on price while the appellations signalling higher quality such as St. Emilion and Pomerol presented positive effects. They also indicated that the 1855 classification was significant and positive in the hedonic price function. Later, Combris et al. (2000) carried out a similar study on Burgundy wines and confirmed the important positive effect of ranking. In line with previous research, Cardebat and Figuet (2004) agreed that the appellations with high reputations (Pomerol, Margaux, Pauillac, St. Estephe) gained the most advantages on pricing. However, it was not the case for all French wine- producing regions. Cardebat and Figuet (2009) revealed that in Provence, the appellations contributed a major explanation for the power to price, but for Beaujolais and Alsace, only few appellations appeared to have significant impact on price. They interpreted this to mean that Bordeaux wines had a higher exposure to international competition, thus the quality signal presented by appellations was better informed. However, these appellations faced lower competitive pressures, and as a result, the prices were fixed less restrictedly. Thus, for these regions, the authors suggested that the strategy of establishing and promoting identifiable brands attracted consumers' attention.

Also, studies to estimate the effect of terroir associated with winemaking technologies have been made for other Old World (see, for example, Maria Angulo et al.,

[2] Since the 1855 classification has been established for well over a century and is still in use, the author considers it as an objective factor representing reputation, complementary to the Bordeaux appellations.

2000; Benfratello et al., 2009) and New World (see, for example, Oczkowski, 1994; Schamel and Anderson, 2003; Steiner, 2004; Haeger and Storchmann, 2006; San Martin et al., 2008) wine-producing countries. Results generally confirmed the importance of the notion of origin for all of the well-recognized wine countries, while in less-renowned countries; the regional and varietal differentiation seemed to be weak. Moreover, Orrego et al. (2012) suggested that New World wines might not to be appreciated for the same attributes as Old World wines. In terms of regional differentiation and reputation, the New World has been catching up with the Old World with an accelerating trend over time, especially for premium-wine regions. The specification of labelling of the origin showed a positive impact on price. However, for the leading brands, labelling origins do not; only their names are sound enough to make much of the price differential. Still, promoting the origin could make these brands benefit from a collective reputation, such as the Napa Valley. On the other hand, Old World producers have decided to advertise more to develop their brand or family names.

In addition, it is worth noting that with the progress of winemaking technology, the ability of winemakers might "completely shade the effect of terroir and that vines can be grown in almost any place, as long as weather permits and the right combination of vines is made", argued by Gergaud and Ginsburgh (2008). And it has been a fact that the quality and the price of many wines grown and produced in the New World are comparable to a classically prestigious Haut-Médoc, and they have gained worldwide reputations.

Speaking of reputation, Shapiro (1983) presented a theoretical framework for examining the impact of reputation on price under an imperfect-information environment. He revealed that "reputation can operate only imperfectly as a mechanism for assuring quality". High-quality items can be sold for a premium above cost, and this premium can be considered as the flow of profits that keep producers investing in their reputations. On the other hand, credible measures of product reputation regarding its quality can effectively reduce consumers' decision-making costs. In the case of wine, it is commonly agreed that reputation is one of the most influential characteristics on pricing. Landon and Smith (1997) carried out one of the most notable studies on analyzing the impact of the reputation indicator on consumers' willingness to pay, in the case of Bordeaux wine commercialized in the United States. Results revealed that the effect of short-term changes in quality (measured by current experts' score) was significant but relatively small. Long-term reputation had a greater impact on consumers' decision-making. In addition, the collective reputation was as important as the individual

reputation, since consumers placed a high value on the government-determined regional designations and the industry-determined classifications. Ali and Nauges (2007) confirmed the previous finding on the *en primeur* market, stating that reputation dominated the determination of price while the impact of short-term qualities was limited. The individual reputation-of-château effect was significant and it was particularly important for the elite wineries of prestigious appellations, such as the most expensive one – Château Petrus, and it could be also explained as an effect of scarcity. Besides, the authors defended the importance of collective reputation for European wine producers. Promoting an individual label would involve massive costs in order to compete with the large brands of the New World. Cardebat and Figuet (2009) also agreed that brand strategy would not work for high-end French wines. Because establishing a well-identified brand would entail concentrating the production, prestigious French wineries should keep the unique styles of their own. In the meta-regression analysis of Oczkowski and Doucouliagos (2015), a wine's reputation, reflected by its quality of previous vintages, was far more important than its present sensory quality, but it was the sustained sensory quality of a wine over time that led to its high reputation. Again, results confirmed the importance of regional reputation, especially for Old World wines. Also, the impact of a producer's reputation could work directly on price. Schamel (2000, 2006, and 2009) made several studies on the subject of comparing individual/brand with collective/regional reputation in wine markets. He agreed that both of them were crucial factors influencing consumers' willingness to pay. He further suggested that wines with a favorable producer's reputation were more dependent on their own strengths and less on their regional reputation. However, it could also be important for brands to have a positive regional image as a strong source of support and in the study dedicated to New World wines, the author indicated that there exist significant regional differences across wine varieties for all reputation indicators, with Napa Valley serving as the benchmark. Besides, the individual indicator also revealed a scarcity or snob effect. Furthermore, with the emergence of wine media, expert opinions have come to occupy an important place in consumer's decision-making and it seems to have a more significant influence on New World wines.

1.2.3. Objectivity vs. Subjectivity – the impact of expert opinion

As wine tasting is a personal experience of enjoyment, our tastes for wine are highly heterogeneous. Although we may share common opinions on certain characteristics presented by a wine, this kind of experience carries a high degree of

subjectivity. Several experiments based on blind tasting have been carried out to study the relationship between enjoyment and the price. They commonly observe a discrepancy between non-experts and experts (Goldstein et al., 2008; Ashton, 2014). Under the circumstances of blind tasting, non-expert consumers do not necessarily appreciate a wine with a higher price in terms of sensory impressions, in other words, they do not necessarily derive more pleasure from a more expensive wine than a cheaper one. But disclosing the price of a wine during tasting can have significant influences on their experiences (Almenberg and Dreber, 2011; Lewis and Zalan, 2014). A higher price can bring more pleasure and consequently result in higher ratings. By contrast, disclosing a lower price does not result in significantly lower ratings. Besides, Mastrobuoni et al. (2014) indicated that price signals showed a greater importance for inexperienced young consumers. Obviously, it is not the case for wine experts. A positive relationship between the overall rating of blind tasting and the price has been reported. In addition, a number of studies have found positive impacts of expert opinions on prices (*en primeur* prices as well as market prices). We believe that a credible expert opinion, correctly embodying all the information revealed by fundamental factors (weather, terroir and savoir-faire), can be considered as a good indicator of the current quality of wine. In this case, for amateurs who do not have full access to wine-production information or do not possess the tools to analyze them, consulting expert scores can be the easiest way to make purchasing decisions. Of course, certain consumers, like connoisseurs, may trust their own judgements – the reputation they give to the wine from previous experiences. Also, consumers can indicate their preference on the basis of regional or individual reputations provided by the objective elements marked on the label. So, in order to discover the relationship between the price and the current quality of wine (measured by expert subjective judgements based upon sensory characteristics), academics raised questions like “does quality matter?”, and we will discuss this here.

According to the meta-analysis of hedonic price regressions, Oczkowski and Doucouliagos (2015) revealed a moderate partial correlation of +0.3 0 between wine prices and sensory quality ratings. Throughout the literature, it is commonly agreed that fundamental factors, objectively labelled on the bottle, have stronger influences on price than sensory ratings, even after the correction of the subjective bias of experts. However, results differ according to region. For New World (Australian) wines, the relationship between the price and the expert rating seems to be tighter than for French wines.

Combris et al. (1997) analyzed the data of a blind-tasting experiment with two equations: one to estimate the weight of sensory characteristics composed in jury grades

and another to compare the impact of sensory and objective characteristics on hedonic pricing. They indicated that the price and the jury grade were two independent variables with a correlation of 0.44. Besides, the market price of Bordeaux wine was primarily determined by the objective characteristics while the quality measured by jury grade was primarily determined by sensory characteristics. Comparable findings have been confirmed for Bordeaux and Burgundy wines in Lecocq and Visser (2006). The authors suggested that these results might reveal a discrepancy between jury preference and consumer choice. Objective attributes of wine were easily identified or perceived by consumers while the sensory characteristics were more difficult to ascertain. As an extension, Combris et al. (2000) made a comparable study on Burgundy wines. The main findings were in accordance with the results obtained in the Bordeaux study, in other words, the objective characteristics, in particular ranking and vintage, presented the strongest impacts on price. However, more sensory variables were found to be statistically significant but their effects were less important than the objective variables. It was the same for the jury grades which were significant but hardly affected the prices. Besides, unlike the 1855 classification, the Burgundy ranking appeared to be consistent with jury grades, suggesting that the Burgundy ranking could be a good indicator of quality, while the Bordeaux classification, as mentioned before, should make slight adjustments (Vittorio and Ginsburgh, 1996; Combris et al., 1997; Ginsburgh et al., 2013). Given the decrease of asymmetric information and the increasing competitive pressure on Bordeaux wines on national and international markets, in the study of Cardebat and Figuet (2004), sensory characteristics showed greater explanatory power than previous studies and they indicated that the jury grade influenced the price through sensory characteristics. However, as discovered by Cardebat and Figuet (2009), Alsace, Beaujolais and Provence wines exhibited poor price-quality relations. Ashenfelter and Jones (2013) tested the efficiency of experts' opinion. The authors indicated that experts' opinions were not efficient because they failed to incorporate all the publicly-available information; including additional information on weather conditions improved the explanation of prices. However, when price data was not available, experts' ratings could be valuable predictors. In addition, it was interesting to consider experts' opinions as a result of self-fulfilling prophecies. Highly-rated wines triggered higher prices. "Experts' opinions are in demand to produce values that are entirely in the eye of the beholder".

Researchers also recognized the measurement bias potentially presented in the estimations. Oczkowski (2001) warned that with the presence of measurement errors in the attributes (in his case, quality and reputation), inappropriately employing OLS

techniques for wine hedonic price models could lead to serious estimation bias. Lecocq and Visser (2006) revealed that judge grade measured quality imperfectly due to the subjective bias of each expert. After the correction for measurement errors, the true effect of quality was larger. Cardebat et al. (2014) applied a two-stage econometric model to investigate the impact of expert opinions on retail wine prices, so as to avoid the subject bias of experts. This study contained the wines from Bordeaux, Napa Valley and Spain. Results indicated that the subjective component affected wine prices significantly but the fundamental influence of weather was deeper. Besides, the highest rating of a wine displayed the strongest impacts on pricing because it could be a marketing strategy that the best score was the best-known among consumers. However, mishandling the subjective components could lead to an underestimation of the impact of the scores.

On the *en primeur* market, producers have considered expert ratings as a valuable factor when fixing the price, particularly the opinions of influential wine critics. Ali and Nauges (2007) suggested that the impact of current quality ratings was significant but relatively small compared to reputation. They also observed that consumers regarded *en primeur* price as a quality signal, thus a higher *en primeur* price could attract a higher spot price. Ali et al. (2008) found Robert Parker grades have an overall positive effect of almost 3 euros per bottle. In addition, consistent with the studies based on auction or retail prices, the impact of a critic's scores was much more important for highly-rated wines than lowly-rated wines. Also, Jones and Storchmann (2001) pointed out that the auction prices of Cabernet Sauvignon-dominated Bordeaux Crus Classés were found to be highly dependent on Robert Parker scores while Merlot-dominated wines exhibited a decreasing rating sensitivity. Further, Masset et al. (2015) and Ashton (2016) compared the impact of different expert opinions on *en primeur* prices, and were in no doubt that Robert Parker was the most influential critic. Masset et al. (2015) indicated that a 10% rise in the scores of Robert Parker and Jean-Marc Quarin could lead to an overall price increase of around 7%. Beyond that, the best vintages and the appellations and wineries not listed on the 1855 classification showed a higher sensitivity to the scores. However, the impact of the quality ratings could be overestimated if we failed to control the endogeneity between the scores and objective quality reputations (Landon and Smith, 1997; Dubois and Nauges, 2010).

As for the New World, Oczkowski (1994) showed that high-quality ratings (from 4.5 out of 5 upwards) were significant and positive on Australian wine prices while ratings lower than 4 out of 5 resulted in significant price reduction. Schamel and Anderson (2003) estimated hedonic price functions for Australian and New Zealand

premium wines. The authors suggested that sensory quality ratings (including the vintage rating, winery rating and classic wine categorization) had significant positive impacts on prices. However, the price premium that consumers were willing to pay for higher-rated wine exhibited a downward trend. These results might reveal that consumers valued the information provided by critics but they also became more confident about their own judgments. San Martin et al. (2012) showed that objective attributes were more influential on Argentinean wine prices than expert opinions. However, Oczkowski (2016) indicated that for Australian premium wines, the impact of subjective opinions on wine pricing appeared to be similar to the impact of objective quality attributes. Also on Australian wines, Oczkowski (2016) found a highly-significant positive relation between quality ratings and prices. Moreover, adding the weather variables into the price equation did not significantly improve the explanatory power. This result implied that the weather effects on prices had been adequately captured by the quality ratings, in other words, weather variables presented an indirect effect on prices via the quality ratings.

As European countries and the United States are based upon different rating scales, this led to a certain difficulty when comparing the impact of different expert critics on wine prices. In order to facilitate the use of scores for consumers and industry players, Cardebat and Paroissien (2015) provided a methodology to express the scores of each wine expert on the same rating scale and developed the Global Wine Score calculated from the average of available scores for each wine[3]. As a consequence of the popularization of wine media, wine experts have a growing voice. Nevertheless, the key, or the most difficult part of being a successful wine critic, is to be credible and continue to be so.

1.2.4. Age – the life cycle

Age is built around two elements, the year of birth and the years of growth. The vintage refers to the year of birth of the wine, a symbol that embodies the weather conditions during the growing season that produced the wine. In other words, the quality of the vintage can be expressed and predicted by the weather variables. About 0.8 of the price can be explained by weather variables themselves (Ashenfelter et al. 1995, Ginsburgh 1996) or with age (Ashenfelter and Jones, 2013) for Bordeaux prestigious wines, and 0.5-0.8 for Australian premium wines. Of course, better vintages attract significant price premiums (Combris et al., 1997, 2000). However, young wines could be

[3] See https://www.globalwinescore.com for more information

mispriced. As indicated by Ashenfelter et al. (1995) and Byron and Ashenfelter (1995), on the auction market, the pricing for young Bordeaux Crus Classés and Penfold's Grange Hermitage was not efficient. But their prices converged to what had been predicted based on the weather conditions of the vintage once the wines matured. Also, on the *en primeur* market, the market trend could significantly influence the pricing strategy of wine producers. For example, the vintage 1990 was found to be underpriced at that time while several ordinary vintages such as the vintages 1996-1998 were overestimated in favor of the combined effects of the "French Paradox" and the emergence of new buyers from Asian countries (Ali and Nauges, 2007).

During the life-cycle of a wine, aging generates a return from storing wine and best vintages associated strongly with scarcity value in the eyes of collectors. Vittorio and Ginsburgh (1996) analyzed the prices of Haut-Médoc Crus Classés of the vintages 1949-1989 sold at auctions during 1980-1992. They found that the aging of wine provides a gain of around 3.7% per year. Jones and Storchmann (2001) reported that the average per château real annual profit ranged from 1 to 10% for 21 Grand Cru Classés of vintages 1980-1994. Among them, rare wines dominated by Merlot produced by small properties achieved the highest profits. For Australian wines, Oczkowski (1994) found that a significant positive aging effect occurred from 4 years, while wines aged less than 2 years resulted in significant price reduction. Wood and Anderson (2006) studied the auction prices of Grange vintages 1960-1986, St. Henri vintages 1965-1991 and Hill of Grace vintages 1971-1991. Results presented a linear increase of 2.2% per year for Grange, ceteris paribus, and for St Henri and Hill of Grace, their price increased with a decreasing rate over the first twenty years. Then the price rose again when the wine became antique. Also, they believed that the price of these wines was determined by quality during the first years after bottling, but later the price was driven by relative scarcity.

Dimson et al. (2015) estimated the effect of aging on wine prices over time – the life-cycle price dynamics of low-quality vintages and high-quality vintages. Over a century, the Bordeaux First Growths showed considerable returns from aging, with a net average return of 4.1% per year. However, the pattern of wine-price evolution differs according to the quality of the vintage. The authors described the wine of high-quality vintages appreciating strongly during the years of maturation. Afterward, the price stabilized over a few decades but the price increased again when the wines became antiques. By contrast, the wine of low-quality vintages appreciated little during the few

years after release but the price showed a near-linear increase as soon as the storage dried up.

Wine is an experience good and it has also become an alternative asset. It presents many advantages compared to other collectables such as being the least illiquid, but its most interesting one is that a bottle can always be consumed and therefore carries pleasure, no matter what the return is. Ashenfelter might be the first academic who took an interest in wine investment and devoted himself to studying it. He has displayed enthusiasm in wine since one of his first papers on wine auctions (Ashenfelter, 1989). Over these decades, auctions, like the fine- wine market in a nutshell, have effectively illustrated the price evolution of collectable wines. The hedonic approach presented here has successfully accomplished its mission in fixing the price and explaining part of the price evolution through aging. However, it is not sufficient to explain the strong fluctuations of fine-wine prices since the 1990s. And that is what we will strive to answer in the next section.

1.3. Financialization, the dynamics in fine-wine prices

On the path towards the financialization of the fine-wine market, we observe some similarities with the development of commodity markets. Besides, to some extent, research in fine-wine markets was inspired by those in commodity markets, in terms of subjects and methodologies. Numerous successful studies exist which analyze the impact of macroeconomic factors and financialization on commodity markets. However, to our knowledge, there are currently still very few studies of this type in the area of wine prices. By exploring the literature in commodity markets, it may help us to gain a better understanding of financialization in the fine-wine market and of the fluctuation of wine prices beyond the fundamentals, thus enlightening subsequent research projects. In this section, firstly we explore the literature covering the characteristics of commodity prices, the interrelationship among commodity markets and the relationship between commodity and stock markets. Then we present similar studies carried out in the wine area. Three topics will be discussed: (1) the interrelationship among commodity/wine markets; (2) the linkage between commodity/wine and stock markets; (3) the relationship between commodity/wine markets and macroeconomic influences.

1.3.1. The Interrelationship between markets

It is not a recent phenomenon that researchers have paid attention to commodity prices. However, under the context of financialization, commodity prices have

experienced dramatic fluctuations, and this fact has an increasing interest in the analysis of price evolution and market volatility.

There has been a debate on the co-movement of commodity prices since Pindyck and Rotemberg (1990) introduced the well-known "excess co-movement hypothesis", suggesting that the prices of unrelated commodities move together due to traders' herding behavior, a fact which cannot be explained by fundamentals. However, several studies came out against the idea of "excess co-movement" and argued that most of the common tendencies in demand and supply factors are responsible for the co-movement (Deb et al., 1996 and Ai et al., 2006). Recent literature supported the existence of co-movement between crude-oil and non-energy commodity prices but also indicated that co-movement could be a dynamic time-varying concept and that economic and political uncertainties could affect the relationship (Natanelov et al., 2011; Nazlioglu and Soytas, 2012).

Evidence revealed an increasing interdependency within commodity markets. Beyond common factors on the demand and supply sides, this could come from a growing presence of index investment in commodity markets for hedge or speculation purposes. Tang and Xiong (2012) indicated that since the early 2000s, prices of non-energy commodity futures included in commodity indices (S&P GSCI and the Dow Jones-UBS) have become increasingly and significantly correlated with oil prices. Their results mirrored the financialization in commodity markets. The price of an individual commodity is no longer solely determined by its fundamentals but also related to the aggregated risks and fluctuations of financial markets and the behavior of investors.

It is commonly agreed that crude oil, among all commodities, occupies a core position. Recent literature generally supported that the oil price was an important factor in determining the behavior of other commodity prices in the long run and in predicting their price fluctuation in the short run. Moreover, the volatility spillover effect from the oil market to non-energy commodity markets was mostly significant and the financial crisis in 2008 significantly affected the mechanism of volatility transmission (Ji and Fan, 2012; Tang and Xiong, 2012). Nevertheless, researchers indicated that the food-price crisis of 2006 played an important role in the behavior of agricultural markets. The existence of volatility spillover between crude oil and agricultural markets was only detected in the post-crisis period (Nazlioglu et al., 2013; Du et al., 2011). Furthermore, the production of biofuel led to an even closer connection between food markets (corn and wheat) and the crude-oil market.

Speaking of investable wines, it may be Bordeaux fine wines that take this core position. According to Liv-ex, although the market share of Bordeaux wines has decreased in recent years, it still represents around 70 percent of the total trade by value and within this percentage; the First Growths are among the wines that have the most liquidity[4]. Nevertheless, fine wines are diversified. On a global scale, wine regions such as Italy and Spain for the Old World and Australia and the U.S. for the New World have gained increasing popularity[5]. It is obvious that we cannot have the same expectation for all kinds of wines and not only as regards their tastes. Several studies have been devoted to comparing the returns and diversification benefits of wines of different categories. Fogarty (2006) and Masset and Henderson (2010) demonstrated that outstanding wines achieved higher returns and had a lower volatility than poorer wines. Lucey and Devine (2015) revealed that the returns on individual wines and on sub-regional level indices were highly heterogeneous and volatile compared to general wine-price indices. Kourtis et al. (2012) found that returns and diversification benefits of wines varied from one production region to another and they suggested there were international diversification benefits from investing in wines from Italy, Australia and Portugal in addition to French wines. Aytac and Mandou (2016) studied the performance of French luxury wines when included in a French investment portfolio and they showed that compared to wines from other French regions, Bordeaux wines exhibited the highest efficiency.

Therefore, what is the relationship between fine wines from different categories or regions? Is there any interdependency within them? Will the price movement of one category/region affect the others? Masset and Henderson (2010) analyzed the relationships among the five ranking categories of Bordeaux Grand Cru. They found that wines of different categories seem to follow a similar trend in the long run, and their returns were significantly correlated, but there was no clear evidence that one caused another in the short run. Therefore, they suggested that the prices of the five categories might evolve synchronously. Faye et al. (2015) studied the relationships among the most traded high-end wines of different regions: Bordeaux, Burgundy, Rhone, Italy, California, Australia and Portugal. Within a given group, some wines appear to be more exogenous/endogenous than others. And between these groups, they revealed a certain consistency in the fact that an exogenous wine of a group could Granger cause an endogenous wine of another group. Moreover, they found that a long-run equilibrium existed among some price series. Studies in the field may provide advice to investors

[4] See http://www.insights.liv-ex.com for more information
[5] For example, Italian: Masseto, Gaja, Solaia; Spanish: Pingus, Vega Sicilia; Australian: Grange, Hill of Grace and American: Screaming Eagle, Opus One, Scarecrow, etc.

concerning the composition of their wine portfolios, based on their purposes – hedging or speculation. In addition, investors can improve the degree of diversification of the portfolio so as to optimize the returns. However, there is still very little research to answer all these questions.

1.3.2 The linkage with stock markets

Meanwhile, the change in behavior and the increase in dependency between commodity markets and stock markets reflected the financialization of commodity markets outside the commodity class (Adams and Glück, 2015). As index investors treat commodity futures as an alternative asset in response to the needs of portfolio diversification, commodities face a higher exposure to common shocks and the risks from other financial markets could spill over into commodity markets (Cheng and Xiong, 2014; Tang and Xiong, 2012). By analyzing the correlations between commodity, stock and bond returns, Silvennoinen and Thorp (2013) supported the view that stronger interest of investors in commodity markets favored a closer integration of commodity markets and financial markets. Büyüksahin and Robe (2014) pointed out that apart from the macroeconomic fundamentals, the participations of speculators and hedge funds in commodity future markets "do help predict fluctuations in the extent of commodity–equity co-movements." Henderson et al. (2014) also found evidence that the flows of financial investors had an important impact on commodity future prices based on commodity-linked notes. In line with previous studies, Basak and Pavlova (2016) discovered that in the presence of institutional investors, futures prices, volatilities and correlations of all commodities went up and those of index commodities displayed a higher increase. Besides, the correlation between commodity and equity markets also increased. Adams and Glück (2015) added that "the financial crisis may have uncovered and even amplified the dependence structure caused by financialization", but the behavior of institutional investors – the style effect – seems to have a greater impact on co-movements and spillovers. They also envisaged that the spillovers between commodities and stock markets would remain high as investors still kept their interests in commodity markets. However, Stoll and Whaley (2010) argued that fundamental forces of supply and demand were more influential in explaining the change in commodity futures prices than index investment. They claimed further that index investors, aiming to diversify their portfolios, were not speculative, but that traders classified as speculators did have an impact on commodity futures prices. Besides, Hamilton et al. (2015) indicated that index investment might have little influence on

commodity futures prices but they did not discover much significant evidence to support this view. In addition, they found that the linkage between the two has broken down since 2009.

With the objective of studying the portfolio-diversification potential of commodities, literature was established to analyze the correlation and volatility transmission between commodity and stock markets. Again, crude oil attracted researchers' greatest attention. Studies showed significant evidence of the existence of volatility spillover between oil and stock returns (Park and Ratti, 2008; Arouri et al., 2011, 2012). They found a significant unidirectional shock transmission from oil to stock markets in European countries and a bidirectional one in the United States. Besides, they presented complex results indicating that the signs and effects depended on the country and sector they analyzed. They supported the hedging role of crude oil by suggesting the taking of a short position in the oil market. Later, Mensi et al. (2013) investigated a wide range of commodities. In line with previous studies, their results revealed significant volatility transmission among stock and commodity markets, particularly oil and gold markets, and that they received substantial impacts from stock markets. They also suggested adding commodities to a stock portfolio to adjust risks. Similar studies were made by Creti et al. (2013). The correlations between commodity and stock markets were highly volatile and evolved over time, with the financial crisis playing an important role in this. At the moment when stock markets crashed, the linkage between commodity and stock markets broke down, but only for a very short time period. Then the correlation between them was reestablished and greatly increased during the crisis. Their results provided further proof of the financialization in commodity markets and indicated that the portfolio-diversification potential of commodities might be reduced as a result of the correlation. Nevertheless, gold preserved its role as a safe haven, while oil, coffee and cocoa "were characterized by a speculation phenomenon".

As for wine, the "fine-wine investing industry" has grown up over the past two decades (Storchmann, 2012). Several facts mirrored the financialization phenomenon of the fine-wine market, such as the establishment of Liv-ex in 1999 and the emergence of private or institutional fine-wine investment funds since the end of the 1990s[6]. This appealing subject – "fine wine as an alternative financial asset" – has attracted a lot of attention, not only from investors but also from academics. Substantial successful

[6] A table presenting the characteristics of the main wine investment funds is available in Jiao (2017).

literature has been devoted to assessing the returns on wine, to testifying to the portfolio-diversification benefits provided by wine assets and to analyzing the correlations between fine wine and financial markets.

Principally, there were two resources of price data that researchers used to calculate the returns: auction price data obtained from auction houses or websites (such as Chicago wine company, Langton's, Christie's and WinePrice.com), and wine-price indices (such as Liv-ex, Idealwine and Wine Owners). Occasionally, the price list from dealers, such as the Berry Bros. & Rudd, could be available. In terms of methodology, repeat sales and hedonic price regression approaches were the most commonly used.

Krasker (1979) first estimated the returns on storing Bordeaux and California red wines, and indicated that the expected return was below the rate of return of riskless assets such as government bonds. By expanding the time period of the same database as Krasker's, Jaeger (1981) found an opposite result: that the return on wine was much higher than that on government bonds, but that when all the fees related to storage, insurance and transaction were subtracted, the return became less attractive. Recent studies, mostly based on the auction price of French and Australian fine wines, commonly agreed that wine outperformed government bonds and other collectables (stamps, art, etc.) but underperformed equities (see, for example, Burton and Jacobsen, 2001; Fogarty, 2006, 2010; Dimson et al., 2015). Few found that the cumulated return on wine was above the Dow Jones Industrial Average (Masset and Henderson, 2010; Lucey and Devine, 2015). With calculations based on wine-price indices, Aytac and Mandou (2016) indicated that wine outperformed equities during the period 2007-2014. In the beautiful seminal paper by Dimson et al. (2015), the authors contributed an impressive historical database that contained auction (Christie's) and dealer prices (Berry Bros. & Rudd's) of the five left-bank First Growths (Haut-Brion, Lafite-Rothschild, Latour, Margaux, and Mouton-Rothschild) for over a century. Based on their model, between 1900 and 2012, in real GBP terms, the net annualized return on wine (net of insurance and storage costs) was estimated at 4.1%, which underperformed equities but outperformed government bonds, art and stamps. A similar study was made by Breeden and Liang (2017) using pooled French fine-wine auction data from 2002 to 2017. Their results were in line with the previous one.

At the end of the 2000s, studies focusing on the portfolio-diversification benefits provided by wine assets appeared. Based on returns calculated from the raw price data or existing indices, the Sharpe ratio, the CAPM model and the Fama-French Three-

Factor model were commonly used to estimate performances and furthermore, the mean-variance efficient frontier was applied for testing the diversification potential. In the earlier publications, researchers generally agreed that wine assets could provide several diversification advantages. They indicated that investment-grade wine assets presented low exposure to market risks (small beta), and including fine wines in a portfolio, even a well-diversified one, would optimize the Sharpe ratio and thus benefit from the same return with lower risk. In addition, the correlations between wine and financial assets (equities and bonds) were found to be around 0 – negative or slightly positive (see, for example, Sanning et al., 2008; Masset and Henderson, 2010; Fogarty, 2010; Kourtis et al., 2012). During the financial crisis, fluctuation and correlation increased significantly, but compared to traditional financial assets, the loss in wine was less extreme and the return was less volatile (Masset and Henderson, 2010). However, with the deepening of research, academics discovered several limitations in previous studies and started to question whether fine wine had such a high diversification potential as previously believed. Firstly, Fogarty and Jones (2011) revealed that the return and diversification benefits of wine are dependent on the estimation method; the repeat sales approach could overestimate the return, and a hybrid approach might provide the most efficient estimates. Further, Fogarty and Sadler (2014) found that in addition to the return-estimation method, the results of diversification benefits were also sensitive to the sample period, whether raw or excess return was used, and to the type of diversification-benefit test. Subsequently, the authors re-examined the results of Fogarty (2010) and indicated that in the case of Australian fine wines, the diversification benefits were smaller than what they had found previously. Again, in the analysis of wine performance over a century, Dimson et al. (2015) reversed previous findings. They discovered a significant positive correlation between wine and equity return, and that the exposure to risks was much higher. The beta was estimated at 0.73 for the full period 1900-2012 and at 0.57 if the periods of World War I and II 1941-1948 were excluded. In contrast to earlier studies that used monthly or quarterly data with a relatively shorter time period, Dimson et al. (2015)'s study was based on annual returns over a significantly longer time period. As indicated in Masset et al. (2015), the beta went higher when the data frequency was lower. This contradiction was not particularly surprising. However, this finding revealed a crucial issue. As wine provided less liquidity than other financial assets, the price recorded in the database could be lagged, thus the real transaction frequency could be lower. Besides, the results on the performance of wine are sensitive to the data frequency. Therefore, were earlier estimations accurate? Masset and Weisskopf

(2017) introduced the illiquidity impact to the existing fine-wine price indices and simulated wine performances on the basis of different frequencies. They found that the true volatility of the Bordeaux First Growths was close to 20% and the beta was estimated at 0.45-0.60, making both higher than what we earlier believed. Besides, illiquidity is not the only factor that could bias the estimations. We will discuss this later in the section on the limitations of wine investment. In addition, a chronological table summarizing the existing literature of "wine as a financial asset" is available in Cardebat and Jiao (2017) (see Appendix 3.1).

On the other hand, like commodities, since fine wines have been included in portfolios, the dependency between fine-wine markets and financial markets has become stronger and the fine-wine price more volatile. Financial markets may influence fine-wine markets through the wealth effect. Also, wine assets can be affected by the volatilities of other financial assets. This phenomenon can be the best reflection of financialization in the fine-wine market. Several recent research papers have tried to explain this linkage. They used cointegration and causality analysis to explore the long-term equilibrium and short-term dynamics between the two markets, and applied multiple GARCH models to examine the transmission of volatility.

Bouri (2013) detected a mean transmission from the crude-oil market to the fine-wine market, but there was no long-term relationship between the two. Bouri (2014) and Bouri and Roubaud (2016) investigated fine wine's hedging potential against the equity markets of major developed markets. In comparison to equity markets, the wine market showed an inverted asymmetric volatility where positive shocks increased the conditional volatility more than negative shocks. Consequently, fine wine could provide diversification benefits hedging against equities. However, under market stress, fine wine could act only as a very weak safe haven. Faye et al. (2015) found a high impact of the MSCI World index on several fine-wine auction prices in the short term. Under the circumstances of the financial crisis, Le fur et al. (2016a) tested the time-varying volatilities of regional sub-indices included in the Liv-ex Fine Wine 1000[7]. They indicated that Bordeaux luxury wines, notably the First Growths, exhibited extreme volatility caused by the financial crisis and that this subsided during a non-crisis period. Burgundy was the second most volatile. However, the Rest of the World showed diversification advantages since it moved in the opposite direction to general fine-wine indices. Le fur et al. (2016b) explored the contagion effects between different fine-wine

[7] Liv-ex Fine wine 1000 contains Liv-ex Bordeaux 500, Bordeaux Legends 50, Burgundy 150, Champagne 50, Rhone 100, Italy 100 and Rest of the World 50.

and financial indices. They confirmed again that Bordeaux wines were the most exposed to systematic risks. Moreover, there might exist a regional-proximity effect involved in the contagion transmission of financial market volatility to fine-wine indices. Cardebat and Jiao (2017) discovered the existence of cointegration relationships between stock markets and luxury wines of leading regions (Bordeaux, Burgundy, Champagne and Rest of the World) and causalities from stock indices to fine-wine prices. Results revealed that the demand from emerging markets, and particularly Mainland China was the main driver of Bordeaux wine prices However, Burgundy and Champagne wines seemed to be more affected by developed economies. Breeden and Liang (2017) also indicated that the "Lafite bubble" was caused by a surge of Chinese demand and it was correlated with Chinese stock market indices.

1.3.3 The influences of macroeconomic factors

Both commodity and stock markets are exposed to business cycles and macroeconomic changes. Common influential factors may conduct common behaviors in commodity and financial markets. Bailey and Chan (1993) examined the correlation between commodity futures risk premiums and stock/bond yields and indicated that the macroeconomic risks were common across all kinds of assets. Labys and Maize (1993) analyzed the relationship between commodity price fluctuations and the macroeconomic and financial adjustment in developed countries. Reinhart and Borensztein (1994) first built a framework to model commodity prices according to variables of both the demand and supply sides, while emphasizing the important role the real exchange rate plays in commodity pricing.

Many successful studies have been carried out to explore the relationship between exchange rates (mostly the real exchange rate of the U.S. Dollar) and commodity prices (e.g., Bui and Pippenger, 1990; Harri et al., 2009), as well as to analyze the impact of monetary factors – the interest rate or the money supply –on commodity price fluctuations (e.g., Frankel and Rose, 2010; Frankel, 1986; Beck, 1993; Hua, 1998; Akram, 2009, Browne and Cronin, 2010). As usual, crude oil markets have gained particular attention, especially the issue of the relationship between oil prices and exchange rates (e.g., Chaudhuri and Daniel, 1998; Zagaglia, 2009; Chen et al., 2010; Basher et al., 2012). Also, researchers have shown high interest in metal/precious metal markets (e.g., Labys et al., 1999; Batten et al., 2009; Frankel and Rose, 2010).

Besides, in the reverse direction, indicated by Hong and Yogo (2012), as the behaviors of hedgers in commodity future trading were related to their anticipation of

future economic activities, commodity futures open interests were found to behave pro-cyclically and contained valuable information for predicting future economic activities and asset returns.

With no exception, fine-wine markets are also exposed to economic cycles. Macroeconomic determinants can have an impact on wine prices in the medium/long run, which may help to explain the positive correlation in returns between fine wines and other financial assets, particularly during a period of crisis.

There are studies using macroeconomic factors such as household income, population and exchange rates to analyze the wine trade in the U.S. (Lindsay, 1987) and to model the global wine market under the background of globalization (Anderson et al., 2003; Anderson and Wittwer, 2013). And over the last few years, academics have been investigating macroeconomic aspects to explain the evolution of wine prices. However, there is still very little literature existing on this topic.

Cevik and Saadi Sedik (2014) suggested that under the influences of common macroeconomic factors, fine wines do not seem to behave differently to commodities. Thus, they first modeled the Liv-ex Fine Wine Investables Index with macroeconomic variables (the same as what they used for modeling crude-oil indices) during the period 1998-2010 and approved the explanatory power of macroeconomic determinants in fine-wine pricing. By analyzing the demand impacts from developed markets and emerging markets separately, they were able to specify that the rise in demand from emerging economies was the main source of support for fine-wine prices. Also, the abundant global liquidity associated with low interest rates might have played a role in increasing the amplitude of the price increase. Later, Jiao (2017) expanded the previous study by prolonging the time period to 1996-2015 and introducing new macroeconomic variables into the empirical models. The results confirmed the influential power of emerging economies on fine-wine pricing, particularly for the Bordeaux Crus Classés. However, in line with the results of Cardebat and Jiao (2017), the impact became very limited with regard to the wines from other regions. Besides, exchange rates played an important role during the entire time period. The weakening of the US dollar in real terms favored the purchase of fine wines for consumers from emerging markets. In addition, in the period 2004-2015, the author verified the impact of financialization in the fine-wine market. The short-term real interest rate showed a negative impact but a very limited one. However, low interest rates associated with the growth of the money supply did support the increase of wine prices. In addition, the growth of investment funds also played a

positive role. Furthermore, by introducing a time dummy variable for the year 2008, the models presented the strong significant negative influence induced by the financial crisis.

Economic cycles can be reflected in the evolution of fine-wine prices. On the other hand, the evolution of fine-wine prices may illustrate the predictions of future economic activity. Qiao and Chu (2014) tried to forecast the GDP of major developed counties with fine-wine prices, because they believed that the evolution of fine-wine prices might illustrate the predictions of future economic activity. They indicated that an increase in the fine-wine price might reflect an optimistic/pessimistic expectation of wealthy consumers and wine investors. Accordingly, consumption and investment would increase/drop, which in turn would cause GDP to increase/drop. They tested nonlinear Granger Causalities between Liv-ex fine-wine price indices and the GDPs of eight developed economies and their results suggested that fine-wine prices could reveal information to predict the GDPs for the U.S., the U.K., and Australia.

1.3.4 How much could emerging markets influence wine markets?

It has been a fact that emerging economies, particularly China, have caused ups and downs in the wine-business world. Cumming and Zhang (2016) showed an increasing interest among academics in alternative investments in emerging markets, including fine wine. Based on the annual index of Google scholar hits, interest in fine wine, together with other alternative investment topics, has emerged and steadily increased during the 2000s, before starting to decrease from 2014 onwards. It may implicitly reflect the cooling down of investment fever since the slowdown of economic growth in emerging markets. Two types of study exist on fine wine related to emerging markets. Most of them take the perspective of trade and marketing: the development of the wine market and wine tourism, and the analysis in consumer behaviors (e.g. Anderson and Wittwer, 2013, 2015; Ye et al., 2014; Zhang et al., 2013; Yang and Paladino, 2015, Liu et al. 2014). Now, another type of literature has appeared, but not until recently. It investigates the impact of emerging markets on fine-wine prices (Masset et al., 2016; Cardebat and Jiao, 2017; Jiao, 2017). Both types have placed a strong emphasis on Chinese markets (Mainland China and Hong Kong).

Anderson and Wittwer (2013 and 2015) showed a special interest in Chinese markets when projecting the picture for future global wine markets. They indicated that during the last decade, Chinese imports have become increasingly important and they suggested that China could continue to be a prominent player on the global wine-

business stage. Moreover, other emerging economies in Asia, such as India could become potentially more involved in wine markets.

Indeed, the evolution of fine-wine markets has been closely linked with demand from emerging economies. Thanks to the support of emerging markets, the last decade could be seen as one of the most prosperous periods for the wine business in history, featuring a continued increase in demand, a steep rise in wine prices and a rapid development of the wine market in emerging countries. There are three major aspects that may explain this spectacular phenomenon: the response to the wealth effect, the change in life style and the need for an alternative investment choice.

The growth in wealth was the most direct catalyst. Studies found a positive linkage between private consumption growth and stock returns, and this stock market wealth effect also existed in emerging markets (Funke, 2004; Poterba, 2000). Dimson et al. (2015) reported "a strong relation between the creation of financial wealth and wine prices". The boom of the stock market during the 2000s favored consumption in luxury products and investment in alternative assets, and fine wines gained particular attention. At the same time, consumption and collection of fine wines were regarded as synonymous with the pursuit of a fashionable and high-quality life style, and the upper classes considered it as a reflection of their wealth and social status. In China, during the last decade, these prestige seekers represented the majority of fine-wine consumers and a Veblen effect dominated the behaviors of this type of consumer (Sun et al., 2014; Vigneron and Johnson, 1999). They were fully aware of the country-of-origin notion and of top-brand names; as a result, the top-end Bordeaux wines were favored. In addition, the trend not only concerned private consumption but also a preference for gift giving (Yang and Paladino, 2015).

However, the upward trend shifted in 2011, not only because of macroeconomic and political changes but also due to a transformation in consumer behaviors. The slowdown of economic growth in all emerging economies hit wine markets severely. As a result of the anti-corruption campaign of the Chinese government, the entire luxury industry, including fine wines, underwent three difficult years from 2013 to 2015. However, based upon the numbers, the outlook has turned positive again and the markets have resumed steady growth since 2016. Meanwhile, wine markets have evolved from earlier irrational growth, transiting to a more mature and healthier stage. According to the reports of Wine intelligence for the Chinese market, since 2015, the "prestige-seeking traditionalists" who were attracted to expensive French wines have

been overtaken by a new group of consumers who are seeking value in wine and are developing wine-drinking as a life habit.

But whatever the changes, well-known wineries associated with outstanding vintages and expert scores are always popular among collectors and investors. Speculation on these wines on the secondary market, where buyers from emerging markets have made significant contributions, has pushed the price of a bottle to fluctuate beyond its fundamentals. However, as indicated by Cardebat and Jiao (2017) and Jiao (2017), this strong impact of emerging markets was only detected on Bordeaux luxury wines. When it came to a more balanced wine portfolio that including wines from diversified regions, the demand from the developed market also showed an important impact. As a result, the influence of emerging markets was nuanced.

Over the past 30 years, traditional wine markets in developed economies have been exhibiting a state of equilibrium. The demand for fine wines has been maintained by the upper classes and these activities have operated with lower dependence on the macroeconomic surroundings. The market for collectable wines strongly persists in Europe as well as in the USA. In contrast, emerging markets have been more sensitive to economic cycles and the volatility in their demand has been a good reflection of this. Evidence showed that wine markets were vulnerable in the face of economic and political changes in emerging economies. Thus, it is important to lessen the dependence on emerging economies by rebalancing market shares and diversifying export flows on a global scale.

1.4. Particularities, limitations, challenges in fine-wine investment

There are many differences between commodities and fine wines. Unique characteristics make fine wines a particular asset. Unlike commodities, the number of bottles is limited by the production each year, and each bottle of wine has its intrinsic heterogeneity. Under these circumstances, a market which trades merchandize in quantity, based on its standardization and homogeneity cannot be established, thus there is no futures market, identical to that of commodities, for fine wines (sometimes people refer to "*en primeur*" as the futures market of fine wine, literally, it is, but it may bring confusion with commodity futures). In addition, extrinsic and intrinsic properties of a bottle as well as its degree of scarcity can make buyers and sellers have a certain degree of subjectivity when pricing and trading.

Besides, a unique market price does not exist for fine wines. The prices of an identical bottle can diverge significantly depending on the channels and places where it is exchanged. Cardebat et al. (2017) found that the law of one price is not respected in fine-wine markets and that certain markets provide a premium compared to others. During the emergence of the Chinese market in the 2000s, fine wine was sold at a higher premium, taking into account transaction costs, by the auction houses located in Hong Kong, and certain auction houses recorded higher hammer prices than others. This premium related to the red obsession of Chinese consumers has declined since 2012 (Masset et al., 2016).

Nowadays, studies on fine-wine markets have become deeper and more diversified. For academics or professionals, one of the biggest issues in wine investment is the illiquidity of fine-wine assets and how to deal with it (Masset et al. (2017) in progress). Fortunately, compared to other collectables, the liquidity of fine wine is moderate. Furthermore, the resources regarding wine prices and transaction data have been increasing; merchant-price data and auction-price data are available and there are several wine-price indices with Liv-ex occupying a leading position. Thanks to this, academics are able to construct frameworks to analyze fine-wine prices, adapting to their properties.

Nevertheless, when facing the shocks generated from macroeconomic or financial fluctuations, the response of fine-wine markets will be delayed because fine wines do not possess enough liquidity to react immediately (Jiao, 2017). And even during a flat period, the frequency of transaction cannot be guaranteed; as such, the recorded data may be out of date. In addition, although increasing quantities of information can be accessed via public channels, the fine-wine market is far from transparent. Wine prices fail to incorporate all available information in the market and information asymmetry is present among every market participant. This market exhibits a low degree of efficiency. Bouri et al. (2017) investigated the efficiency of the wine market and suggested that the market is not efficient; market participants who held exclusive information could profit from this information asymmetry.

Illiquidity, opacity and inefficiency lead to price information being inaccurate, which will in turn bias the risk estimates for fine-wine assets. Masset & Weisskopf (2017) pointed out the above limitations in fine-wine investment and the weaknesses of existing wine-price indices in terms of price resources and calculation methodologies. They indicated that the risk was underestimated for fine wine. Both the volatility and

sensitivity related to systematic risk were higher than we usually believed and as a result, the diversification potential was more limited. They also provided applicable methodologies to adjust wine-price data so as to improve the accuracy of return and risk estimations.

These limitations have brought challenges to wine-investment funds. Since fine wine has gained increasing attention as a valuable alternative financial asset, private or institutional wine-investment funds emerged during the 2000s. But only a few of them have survived to the present day and delivered a satisfactory performance. In this rather opaque and inefficient market, successful wine- fund managers should be able to catch the right timing to adjust their positions, in awareness of asymmetric information. However, most of them have failed to take advantage of the superior information they possessed to secure efficient arbitrage (Masset and Weisskopf, 2015). Also, as there is no unique price for fine wine, the evaluation of wine funds raises difficulties. Certain wine funds cannot provide transparent information which increases the opacity in this market. The Luxembourg authorities shut down Nobles Crus in 2013 because the credibility of its evaluation, using auction and merchant prices, was highly questionable. Currently, major wine funds use Liv-ex to assess their assets. Cardebat et al. (2017) indicated that in general, their calculations were based on average prices that are helpful for picturing the fund's performance in the middle or long term, but they were not able to obtain an accurate valuation at time t when the transaction took place with the real sale price. And significant price differences could occur between the evaluation and the final sold price of a wine portfolio - "Depending on the marketplace where a wine portfolio is sold, the portfolio value may vary by a factor of around 1.6 on average". They argued that for the assessment of a wine fund, the prices and methodologies applied should be more transparent and factors such as the range of volatility against average price and the degree of asset liquidity (to adjust returns and risks) should also be taken into account.

1.5. Conclusion

By means of a literature review of the long journey of academic research on wine pricing, this article has tried to clarify how the price of wine has been determined and how it has evolved. The models based on hedonic pricing approach have effectively explained the determination of a wine as well as the price differences between different wines. Complementary to this, the studies devoted to discovering the impact of macroeconomic factors and financial markets on wine prices have filled the gap in the

research on the price dynamic over time, under the influence of financialization in the fine-wine market.

We highlighted the strength of the wealth effect from emerging economies on price fluctuation, and underlined the vulnerability of the wine market in the face of such circumstances. As such, we suggested lightening the dependence on emerging markets in favor of a search for equilibrium among the continents.

Meanwhile, we have been fully aware of the particularities and the limitations related to wine investment: the illiquidity of wine assets, the opacity of price information and the inefficiency of market operations. These problems have raised challenges for us, but also enlightened subsequent research projects. Finally, we argue for more transparency on the wine market and remain eager to see a market with a higher degree of efficiency. Maybe it is possible that a real futures market for wine assets will be established and the index investment in wine will not be far over the horizon.

Chapter II

Macroeconomic determinants of wine prices

Macroeconomic determinants of wine prices·

Abstract

This paper identifies the macroeconomic determinants of fine-wine prices and estimates their impacts. We model the Liv-ex fine-wine price indices with the macroeconomic variables of emerging and developed markets on a monthly basis from 1996 to 2015. The demand from emerging markets plays a key role in fine-wine pricing, and more precisely, in the price fluctuation of prestige Bordeaux wines. Furthermore, the continuous weakening of the U.S. Dollar in real terms favors an increase in fine-wine prices. Since 2011, the slowdown in economic growth in emerging markets, followed by the depreciation of national currencies has negatively affected the luxury wine market. Along with the process of financialization in the fine-wine market, prices have become more volatile. Factors such as money supply, real interest rates and the growth of investment funds have started to show their influence on fine-wine pricing. Complementary to the hedonic price modeling, our research can provide an analysis to wine-price modeling and forecasting within the macroeconomic approach.

Keywords: Economics, Pricing, Regression, Wines, Econometric model, Time series

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2.1. Introduction

In the wine economic literature, many successful studies exist on the movement of wine prices taken from the perspective of supply. Empirical analyses are mainly based on the hedonic price approach to estimate the impact of each wine's characteristic on price determination.

Since Krasker (1979), the returns and the portfolio-diversification benefits of fine wines have been progressively studied by using auction prices and Liv-ex indices. The results have mainly confirmed the interest of fine wines as an attractive alternative financial asset. And recently, researchers have started to explore the linkage between financial markets and wine markets, and discovered the impact of macroeconomic factors on wine-price determination.

Fine-wine price is sensitively related to economic dynamics. Since the first half of the 2000s, fine-wine prices have skyrocketed thanks to the growth of demand from emerging markets. In 2008, this growth came to a sudden halt on the eve of the financial crisis. Then prices started to fluctuate, following the recession and the recovery of the economy. After the peak of 2011, fine-wine prices have undergone a continuous decline. This decline can be mainly explained by the drop in demand: the slowdown of economic growth in emerging economies, the weakness of the national currencies of certain emerging countries, and other unpredictable factors such as the anti-corruption/gift-giving crackdown in China.

The establishment of the London International Vintners Exchange (Liv-ex) and the emergence of wine investment funds have accelerated the pace of financialization of the fine-wine market. A prosperous financial environment associated with low interest rates has favored fine-wine investment. On the other hand, fine-wine prices have become more volatile in consequence of the fluctuating nature of economic cycles.

Through existing literature and evidence, the main idea of our research is developed as illustrated in Figure 2.1: macroeconomic factors can influence wine markets directly and indirectly. When macroeconomic fluctuations take place, financial markets react immediately. And their reactions will have impacts on wine markets (especially fine wines) via channels such as wealth effect and the transmission of price volatilities. These macroeconomic factors can also affect wine markets directly, but the response of wine markets will be delayed because wine assets do not possess as much liquidity as other financial assets (Masset and Weisskopf, 2017).

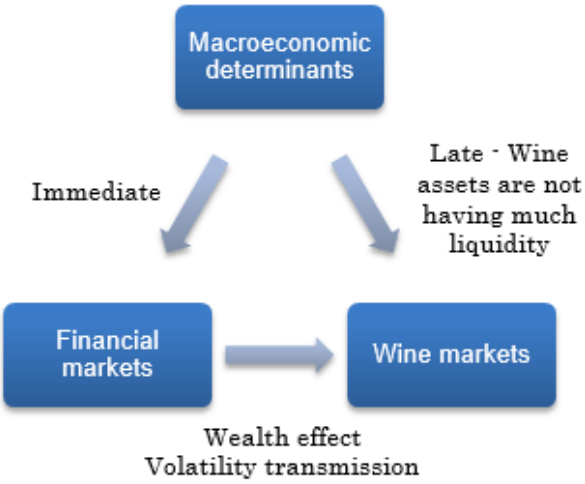


Figure 2.1: Relationship between macroeconomic determinants and wine markets (drawn by author)

As there is little existing research on macroeconomic analysis of wine pricing, the aim and the originality of this paper is to identify the macroeconomic determinants of wine prices and to estimate their impacts, thereby contributing to the research and literature in this area.

This paper extends the study of Cevik and Saadi Sedik (2014). Firstly, we expand the database. Secondly, we attempt to use alternative estimates for existing explanatory factors. Thirdly, we introduce new explanatory variables in our model. Furthermore, this article provides a sub-period analysis with the year 2004 as a significant breakpoint. Our results confirm the previous findings concerning the influence of emerging markets on fine-wine pricing, and the new variables play significant roles as well.

2.2. Literature review

Wine literature has contributed significantly to the analysis of wine-price determination through the hedonic price approach (Combris et al., 1997, 2000; Cardebat and Figuet, 2004 and 2009; Ashenfelter, 2008; Oczkowski and Doucouliagos, 2015), estimating the return, the performance and the portfolio-diversification benefits of wine investment (Dimson et al., 2015; Masset and Henderson, 2010; Masset and Weisskopf, 2016; Bouri, 2014; Lucey and Devine, 2015;). However, few papers have been devoted to discovering the influence of macroeconomic and/or financial factors on wine prices.

2.2.1. Fine-wine price and macroeconomic factors

Anderson et al. (2001) modeled and forecasted the developments in world wine market based on household income, population, and taste trends on the demand side,

along with wine-production factors on the supply side, all this under the background of wine industry globalization. Cevik and Saadi Sedik (2014) pointed out that fine wines did not appear to behave differently to commodities since they are influenced by common macroeconomic factors. They modeled fine-wine prices with the same macroeconomic variables as crude-oil prices, and their results confirmed the role of macroeconomic determinants in fine-wine price modeling. With regard to the demand side, they analyzed the demand impacts from developed economies and those from emerging economies separately, along with the effects of world monetary developments. They included global wine production in their model as a variable from the supply side. Results showed that the growth in demand from emerging economies supports fine-wine prices, and the abundant global liquidity associated with low interest rates seemed to increase the amplitude of the price increase. As for the supply side, the effect of wine production was limited.

Other factors can be also taken into account regarding wine-price modeling. The literature indicates that the real effective exchange rate influences commodity prices through the effect of demand (Reinhart and Borensztein, 1994). For dollar-priced tradable goods, a decline in the value of the dollar in real terms can raise the purchasing power of foreign consumers in real terms, leading to expanded demand and a lifting of prices. The literature also discusses the impact of the exchange rate on the wine market. Lindsay (1987) analyzed the effects of exchange rate and trade barriers on U.S. wine imports and exports. Anderson and Wittwer (2013) included bilateral real exchange rates and the growth in China's import demand in global wine-market modeling.

Since fine wine has been integrated into portfolios as an alternative financial asset, the interest rate, apart from the money supply, can be identified as another influential monetary factor. In theory, the real interest rate negatively affects the price of financial assets through the discount factor: a lower interest rate in real terms decreases the discount factor, raises the present value of expected future return and therefore increases the current price. Speculation behaviors may accentuate price volatility in the short term when they are associated with weaker real interest rates. Besides, a low interest rate may encourage investors to invest in equities or alternative assets with higher returns. Studies exist in this area for stock markets (e.g., Fama and Schwert, 1977; Fama, 1981; Christie, 1982) or commodity markets (e.g., Frankel, 1986, 2008; Beck, 1993). To the best of our knowledge, there are currently no such studies in the area of wine prices.

2.2.2. Financialization in the fine-wine market

In the past two decades, fine wines have gained increasing attention from investors and have been accepted as a valuable alternative financial asset. The "wine-investing industry" has grown up around this phenomenon (Storchmann, 2012). Fine-wine investment funds have emerged since the end of 1990s[1] as a result of the steady return in fine wine and the need of portfolio diversification for investors (see Table 2.1).

The emergence of private or institutional wine-investment funds, along with the establishment of Liv-ex has accelerated the process of financialization of the fine-wine market. Wine investment, such as the speculation on the outstanding vintages of Bordeaux's First Growths, creates a supplementary demand to wine consumption. The fine-wine price is more volatile due to the fluctuating nature of investment, affected as it is by the volatilities of other financial assets under the influence of economic cycles.

Faye et al. (2015) showed short-term causalities between several fine-wine auction prices and the MSCI World index; Bouri and Roubaud (2016) examined the co-movements between Liv-ex fine-wine prices and the FTSE 100 index; Cardebat and Jiao (2017 forthcoming) demonstrated the cointegration relationships of Liv-ex fine-wine price indices with certain stock-market indices from the world level to specific countries, as well as the causalities between stock markets and fine-wine markets; Le Fur et al. (2016) studied the volatility of wine return within the context of the financial crisis with the price indices of luxury wines from several appellations; Analyzing with the commodity price; Bouri (2013) revealed a transmission of the crude-oil price on fine-wine prices.

[1] Ascot Wine Management Fine Wine Fund (Bahamas) is founded in 1999; Wine Investment Fund (UK) in 2003; Vintage Wine Fund (UK) in 2003.

Table 2.1 : Main wine investment funds

Fund	Start	Domicile	Manager	Currency	Investor	Min.Invest.	Subscription	Redemption	Fees	Investment	Valuation
Fine Wine Fund	2006	St Kitts and Nevis	Wine Asset Managers LLP	GBP	Private	GBP 50,000	Monthly	Quarterly	Manegement-2% Performance-15%	Bottles	Liv-ex
Fine Wine Investment Fund	2007	Cayman Islands	Wine Asset Managers LLP	USD	Private	USD 100,000	Monthly	Quarterly	Manegement-2% Performance-20%	Bottles	Liv-ex
Wine Investment Fund	2003	Bermuda	Anpero Capital Ltd.	GBP	Private; Institutional	GBP 10,000; GBP 1,000,000	Monthly	Quarterly	Manegement-1.5%; 2% Performance-20%	Bottles	Liv-ex
Nobles Crus	2007	Luxembourg	Elite Advisers	EUR	Private; Institutional	EUR 125,000	Monthly	Fund closed in 2013	Manegement-2% Performance-20%	Bottles & *En Primeur*	Auction & merchant prices
Vintage Wine Fund	2003	Cayman Islands	OWC Asset Management	EUR	Private	EUR 100,000	Monthly	Fund closed in 2013	Manegement-2% Performance-15%	NA	NA

Note: Information obtained from their websites, online resources and Masset and Weisskopf (2010)

Accordingly, a financial factor - financial asset of investment funds as percentage of GDP - may be a useful explanatory variable for fine-wine prices. This indicator is considered as a measurement of financialization representing the changing amounts of capital invested in financial assets and reflecting the volatility in financial markets over economic cycles.

Apart from the abovementioned macroeconomic and financial factors, several additional unpredictable elements can affect wine prices. Evidence has shown that political elements cannot be ignored. The announcement of a new policy may modify the conditions of supply or demand (the negative impact of the Chinese government's gift-giving crackdown, for instance). Other random variables include technological progress in wine production or the changes in wine-production surface areas, together with other unpredictable factors on the supply side such as weather conditions; they can all be captured by the production. All these factors related to a supply or demand shock can be seized by dummy variables in our model.

2.3. Methodology

2.3.1. Data



Figure 2.2: Liv-ex Fine Wine Investables Index

The database covers a timeframe from 1996 to 2015 in monthly frequency and consists of the Liv-ex Fine Wine Investables Index (and the Liv-ex Fine Wine 1000 index in the robustness check) as the fine-wine price, and explanatory variables on both the supply side and the demand side. The length of the database allows us to capture

information at different steps of the development of the fine-wine market along with the macroeconomic fluctuations over the past 20 years (see Figure 2.2). The time period of study is also based on the need to access available data for all variables of interest[2].

Liv-ex provides a global platform for fine-wine traders. Professionals often consider their price indices as a benchmark of fine-wine exchange. The Liv-ex Fine Wine Investables index started in 1988, and is one of their leading fine-wine price indices, composed of the most dominant investment-grade wines. It contains around 200 Bordeaux red wines from 24 top chateaux dating back to the 1982 vintage and chosen on the basis of their Robert Parker rating scores. This index is price-weighted and calculated by the Liv-ex Mid Price method (the midpoint between the current highest bid and lowest offer price) for each component wine, taking into account its scarcity[3]. We also include the Liv-ex Fine Wine 1000 index to enrich our analysis in the robustness-check section. The indices are sterling-based monthly price series. We convert it to a dollar-based price series with historical monthly average sterling-dollar exchange rates and then deflate it to real terms with the U.S. consumer price index.

We take global wine production as the variable from the supply side. The data is available in the database of the *Organisation Internationale de la Vigne et du Vin* (OIV). Since wine grapes harvest once a year, the production data is only available annually. For the demand side, we can also find the annual global wine consumption in the database of the OIV. To construct monthly data, we employ a constant level of production or consumption for each of the twelve months of a given year.

In place of the Industrial Production Index in Cevik and Saadi Sedik (2014), we use GDP as the estimate of demand. It concerns two real-economy variables – the aggregated GDP of G-4 economies (the United States, the United Kingdom, the Euro Zone and Japan) and the aggregated GDP of BRIC economies (Brazil, Russia, India and China). The G-4 economies can represent both developed economies and "old" wine-consuming countries; in contrast, the BRIC countries represent emerging economies and "new" wine-consuming countries. These two variables allow us to estimate, respectively, the impact of developed and emerging economies on fine-wine prices, thus to distinguish the source of influence. The aggregated GDPs are weighted on the basis of the size of

[2] The Source of all macroeconomic data is from OECD Statistics.
[3] A coefficient of scarcity is applied to the vintages older than 15 years and Petrus and Ausone because of their small production. For more information concerning Liv-ex indices and their components, see https://www.liv-ex.com/.

each economy[4]. National GDPs expressed in national currencies are converted and deflated to real dollars. Given that the measurement of GDP is on a quarterly basis, we employ, in the analysis, a constant level of GDP for each month within the given quarter.

We also include the real effective exchange rate (REER) of the U.S. Dollar to capture the effect of real exchange rate on fine-wine price. This data is published monthly by the Bank of International Settlements.

Normally, wine investment is a middle-/long-term engagement. For instance, wine investment funds often recommend a duration of 3 to 5 years. And by definition, the broad money covers assets with less liquidity[5]. Thus, we choose the aggregated M3 of G-4 economies instead of the excess liquidity (the difference between the changes in M2 and the long-term potential growth rate and velocity) in Cevik and Saadi Sedik (2014), to estimate the impact of global monetary development on fine-wine prices. The aggregated M3 of the G-4 is in monthly frequency, weighted by GDPs and expressed in real dollars. Another monetary variable is U.S. real interest rates, whose calculation is based on the nominal interest rates.

As mentioned above, we use the financial assets (U.S. households' and institutions') of investment funds as percentage of GDP in the U.S. to estimate the impact of financialization on fine-wine prices.

We include dummy time variables to capture all other elements that can lead to production or demand shocks (such as the financial crisis or the Chinese government gift-giving crackdown), and exceptionally good or poor vintages. If an event or several events happen in a specific year, all months equal 1 for this year and all the other time periods equal 0. For example, the indicator variable DM2008 takes the value of 1 for each of the twelve months of 2008 and zero otherwise.

2.3.2. Econometric modeling

The logarithms of the data series are used in further econometric estimations. To deal with the seasonality of certain variables (GDPs and M3), we use the X12 seasonality-adjustment tool to smooth the data. We apply the Augmented Dickey-Fuller unit root test to test the stationarity of data series in level or in difference. According to the tests, the series of global wine production and aggregated M3 of the G-4 are

[4] On average for the entire period: in the aggregated GDP of G-4 economies, the U.S. represents 42.5%, the U.K. 7.2%, the Euro Zone 33.8% and Japan 16.5% ; in the aggregated GDP of BRIC economies, Brazil represents 20.8%, Russia 13.5%, India 15.5%, and China 50.2%.
[5] "Broad money is the sum of M2, repurchase agreements, money market fund shares/units and debt securities up to two years." Source OECD.

stationary in level, and other variables are integrated of the first order. In further regressions, all variables are stationary; we include the wine production and M3-G4 in level and other variables in difference. For the aggregated GDPs and the global wine consumption, we use, respectively, three-month and twelve-month differences instead of the first-month differences. Detailed results of the ADF test are presented in Appendix 2.1.

Variables will be estimated in two econometric models to avoid the potential correlation problem among explanatory variables.

- Model 1(with aggregated M3 of G-4 economies):

$$\Delta \boldsymbol{P_t} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\Delta \boldsymbol{GDP_{G4,t}} + \boldsymbol{\beta_2}\Delta \boldsymbol{GDP_{BRIC,t}} + \boldsymbol{\beta_3 PROD_t} + \boldsymbol{\beta_4}\Delta \boldsymbol{CONS_t} + \boldsymbol{\beta_5}\Delta \boldsymbol{REER_t} + \boldsymbol{\beta_6 M3G4_t} + \boldsymbol{\beta_7 DM} + \boldsymbol{\varepsilon_t}$$

- Model 2 (with U.S. real interest rate and U.S. investment funds as percentage of GDP):

$$\Delta \boldsymbol{P_t} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\Delta \boldsymbol{GDP_{G4,t}} + \boldsymbol{\beta_2}\Delta \boldsymbol{GDP_{BRIC,t}} + \boldsymbol{\beta_3 PROD_t} + \boldsymbol{\beta_4}\Delta \boldsymbol{CONS_t} + \boldsymbol{\beta_5}\Delta \boldsymbol{REER_t} + \boldsymbol{\beta_6}\Delta \boldsymbol{IR_t} + \boldsymbol{\beta_7}\Delta \boldsymbol{IF_t} + \boldsymbol{\beta_7 DM} + \boldsymbol{\varepsilon_t}$$

where $\Delta \boldsymbol{P_t}$ is the growth rate of the real fine-wine price calculated from Liv-ex Fine Wine Investables or Liv-ex Fine Wine 1000 (in robustness check); $\Delta \boldsymbol{GDP_{G4,t}}$ is the growth rate of aggregated GDP of G-4 economies; $\Delta \boldsymbol{GDP_{BRIC,t}}$ is the growth rate of aggregated GDP of BRIC economies; $\boldsymbol{PROD_t}$ is the global wine production; $\Delta \boldsymbol{CONS_t}$ is the growth rate of global wine consumption. $\Delta \boldsymbol{REER_t}$ is the growth rate of real effective exchange rate of the US Dollar; $\boldsymbol{M3G4_t}$ is the aggregated money supply of G-4 economies; $\Delta \boldsymbol{IR_t}$ is the growth rate of the U.S. real interest rate; $\Delta \boldsymbol{IF_t}$ is the growth rate of financial assets of investment funds as percentage of GDP in the U.S.; $\boldsymbol{DM}$s are the time dummy variables; βs denote the parameters to be estimated and ε_t is the error term.

Firstly, we use the Ordinary Least Squares Method to estimate the equations. Following the suggestion of Cevik and Saadi Sedik (2014)[6], we also apply the Generalized Method of Moments to correct the potential endogeneity problem of explanatory variables. We use J-statistic as a test of over-identifying moment conditions. Our results indicate the null hypothesis that the over-identifying restrictions are satisfied cannot be rejected. In the presence of residual heteroscedaticity and autocorrelation, the Newey-West estimator is used to address this problem.

[6] They indicate that some explanatory variables may be correlated with the error term, because the fluctuation of the wine price could have impacts on its production and demand, and also the explanatory variables may be measured with error. Therefore, they suggested using GMM to avoid potential problems above.

2.4. Results

2.4.1. Econometric results and interpretations

Compared with the results of Cevik and Saadi Sedik (2014) (see Appendix 2.2), our results confirm the findings on the major influence of emerging markets on fine-wine pricing. In their models, the demand from advanced economies and wine production are significant in certain equations but relatively limited. Somewhat different from their results, the two variables do not show any noteworthy impact in our estimations. Besides, we do not find significant constant terms in our models. However, the new variables and the dummies play important roles instead.

Table 2.2: Results for Model 1 without time dummy variables

	Equation 1		**Equation 2**		**Equation 3**		**Equation 4**	
	1996 - 2015		**1996 -2015**		**2004 - 2015**		**2004 - 2015**	
	LS		**GMM**		**LS**		**GMM**	
Variable	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**
GDP G4	-0.04	-0.35	-0.22	-2.01**	-0.05	-0.33	-0.02	-0.22
GDP BRIC	0.23	2.22**	0.17	2.29**	0.34	2.24**	0.26	2.63**
PROD	0.07	1.22	0.03	0.55	0.07	1.01	0.06	0.99
CONS	0.18	1.09	0.24	1.78*	0.41	2.08**	0.40	3.61***
REER	-1.22	-6.45***	-1.73	-7.02***	-1.36	-6.49***	-1.61	-7.09***
M3G4	-0.02	-0.96	-0.01	-0.48	0.06	1.42	0.07	2.41**
C	-0.33	-1.02	-0.12	-0.44	-0.68	-1.29	-0.62	-1.50
Adj. R^2	0.34		0.32		0.48		0.47	
Num. Obs.	231		227		141		141	
Breakpoint Test: 2004m01		**t-Stat.**			**Prob.**			
Andrews-Fair Wald Stat.		18.00			0.01			
Hall and Sen O Stat.		29.73			0.76			

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Andrews-Fair Wald Stat. H0 : there are no structural breaks in the equation parameters.
Hall and Sen O Stat. H0 : the over-identifying restrictions are stable over the entire sample.

Tables 2.2 and 2.3 show the results of our first model on the full time period and the sub-period, and Tables 2.4 and 2.5 present the results of the second model.

We consider 2004 as a time point where the financialization of the fine wine market activated, thus representing a breakpoint in our estimation. The reasons are as follows: firstly, through the figures, we can observe directly that the significant evolution of fine-wine prices started in 2004. Before this date, the index was flat except during the

period of the Asian financial crisis; secondly, the majority of Liv-ex fine-wine indices started in December 2003 and all indices were based or rebased at 100 in December 2003; thirdly, several large and credible wine-investment funds were established in the U.K. from 2003. In addition, the Andrews-Fair Wald and Hall and Sen Statistics confirm that January 2004 is a significant breakpoint over the entire sample[7]. The variables suit better in the period 2004-2015 than in the full time period, with an improvement of 0.15 for the adjusted R^2 on average.

Table 2.3: Results for Model 1 with time dummy variables

	Equation 5		Equation 6		Equation 7		Equation 8	
	1996 - 2015		1996 -2015		2004 - 2015		2004 - 2015	
	LS		GMM		LS		GMM	
Variable	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**
GDP G4	-0,07	-0,56	-0,18	-1,65	-0,09	-0,67	-0,07	-0,60
GDP BRIC	0,22	2,33**	0,18	2,29**	0,31	2,53**	0,27	3,39***
PROD	0,02	0,33	-0,03	-0,58	0,01	0,19	-0,01	-0,16
CONS	-0,10	-0,53	-0,14	-0,84	0,14	0,47	0,28	1,15
REER	-1,22	-7,20***	-1,75	-7,10***	-1,34	-7,15***	-1,51	-6,79***
M3G4	-0,01	-0,42	0,00	-0,06	0,04	1,15	0,05	2,04**
DM1997	0,02	2,46**	0,02	3,82***				
DM2006	0,03	2,24**	0,03	2,41**	0,02	1,22	0,02	1,21
DM2008	-0,04	-2,38**	-0,04	-3,03***	-0,03	-2,16**	-0,03	-3,18***
DM2010	0,01	2,15**	0,01	1,93*	0,01	1,45	0,01	2,07**
DM2011	-0,01	-1,34	-0,02	-1,71*	-0,02	-1,59	-0,02	-2,52**
C	-0,07	-0,23	0,15	0,60	-0,25	-0,49	-0,16	-0,37
Adj. R^2	0.44		0.41		0.56		0.55	
Num. Obs.	231		227		141		141	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Global wine consumption and the aggregated GDP of the BRICs have significant positive signs. In contrast, global wine production and the aggregated GDP of G-4 economies are not statistically significant[8]. This may indicate that during the relevant time period, the fluctuation the fine-wine price is mainly driven by the demand side, and

[7] Andrews-Fair Wald and Hall and Sen Tests are applied to the equation estimated by GMM. We also applied Chow Breakpoint test for the equation estimated by LS, the null hypothesis that no break at specified breakpoint is rejected.

[8] The aggregated GDP of G-4 appears significant with a negative sign in equations 2, 10 and 14 estimated by GMM. It is a coincidence that can be only explained by the pure statistic movements. Besides, the variable is not significant in any other equation.

more precisely, driven by the demand from the emerging markets. However, the fine-wine prices are not sensitive to production, or global wine production may not be an appropriate factor to explain the price of fine wine, as the volume of fine wine is negligible in the total volume of global production.

The real effective exchange rate of the U.S. Dollar appears with strong and highly- significant negative coefficients in every equation. The continuous weakening of the U.S. Dollar in real terms favored the purchasing power of consumers or collectors from emerging markets, which encouraged further their wish to buy fine wines. In contrast, the depreciation of national currencies, together with the slowdown of economic growth in emerging countries, harmed their purchasing power in real terms.

Table 2.4: Results for Model 2 without time dummy variables

	Equation 9		Equation 10		Equation 11		Equation 12	
	1996 - 2015		1996 -2015		2004 - 2015		2004 - 2015	
	LS		GMM		LS		GMM	
Variable	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**
GDP G4	-0,06	-0,51	-0,20	-2,11**	-0,09	-0,66	-0,10	-0,97
GDP BRIC	0,20	2,07**	0,18	2,52**	0,24	1,73*	0,18	1,83*
PROD	0,07	1,10	0,02	0,43	0,01	0,21	-0,03	-0,67
CONS	0,22	1,34	0,22	1,72*	0,35	1,69*	0,39	3,03***
REER	-1,18	-6,88***	-1,26	-5,70***	-1,24	-6,09***	-1,28	-7,09***
Interest Rate	0,00	-0,74	-0,01	-0,96	0,00	-0,50	-0,01	-2,04**
Invest. Fund	0,05	0,74	0,06	1,03	0,19	2,02**	0,19	2,52**
C	-0,37	-1,10	-0,11	-0,43	-0,08	-0,23	0,17	0,66
Adjusted. R^2	0.35		0.35		0.52		0.50	
Num. Obs.	228		224		138		138	
Breakpoint Test: 2004m01		**t-Stat.**			**Prob.**			
Andrews-Fair Wald Stat.		29.39			0.00			
Hall and Sen O Stat.		29.68			0.92			

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Andrews-Fair Wald Stat. H0 : there are no structural breaks in the equation parameters.
Hall and Sen O Stat. H0 : the over-identifying restrictions are stable over the entire sample.

The aggregated money supply of G-4 is not statistically significant on the full time period. However, it performs significantly and positively in the period 2004 – 2015. The impact of monetary factors appeared when the financialization of the fine-wine market started, indicating that fine wines became more exposed to capital flows and

more sensitive to economic cycles. The abundance of money supply, associated with low interest rates, may favor the investment in fine wines, and as a result, increase the supplementary demand in the financial dimension. When investors were short of liquidity during the financial crisis, they could cash in their fine-wine assets to reduce difficulties.

Table 2.5: Results for Model 2 with time dummy variables

	Equation 13		Equation 14		Equation 15		Equation 16	
	1996 - 2015		1996 -2015		2004 - 2015		2004 - 2015	
	LS		GMM		LS		GMM	
Variable	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**
GDP G4	-0,09	-0,79	-0,21	-2,01**	-0,14	-0,97	-0,10	-1,07
GDP BRIC	0,22	2,27**	0,23	2,83**	0,23	2,05**	0,21	2,55**
PROD	0,02	0,39	-0,01	-0,15	0,00	-0,05	-0,06	-1,22
CONS	-0,09	-0,47	-0,12	-0,73	0,12	0,40	0,23	1,14
REER	-1,24	-7,71***	-1,63	-7,17***	-1,27	-6,89***	-1,43	-7,52***
Interest Rate	-0,01	-1,31	-0,01	-1,16	-0,01	-1,00	-0,01	-1,95*
Invest. Fund	-0,03	-0,59	-0,06	-1,21	0,10	1,17	0,06	0,72
DM1997	0,02	2,77**	0,02	3,30***				
DM2006	0,03	2,34**	0,03	2,32**	0,02	1,27	0,01	1,26
DM2008	-0,04	-2,56**	-0,04	-3,45***	-0,03	-1,73*	-0,03	-3,36***
DM2010	0,01	2,41**	0,01	2,37**	0,02	1,98**	0,01	1,93*
DM2011	-0,02	-1,62	-0,02	-2,39**	-0,01	-1,31	-0,02	-3,04***
C	-0,11	-0,39	0,04	0,15	0,02	0,04	0,32	1,21
Adjusted R^2	0.45		0.43		0.58		0.56	
Num. Obs.	228		224		138		138	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Tables 2.4 and 2.5 confirm the previous results of model 1. In addition, the U.S. real interest rate[9] and the U.S. investment fund as percentage of GDP appear significant in the period 2004 - 2015. The influence of real interest rate is not very robust; it only has a weak negative coefficient of 0.01 at 10% significance, and only in the GMM equations. On the other hand, the growth of the investment fund has a clearer positive impact on fine-wine prices, which confirms financialization has played an important role since 2004. We also estimate the impact of the investment fund with the first model,

[9] Here, it presents the results of the U.S. short-term real interest rate. The author also tries the long-term real interest rate, but it appears less significant. Additional results are available on request.

creating a combination of the investment fund and the development of the money supply. We also obtain positive and significant coefficients for the investment fund as well[10]. However, when we include dummy variables in the equations, the influence of the investment fund – the supplementary demand in fine wine seems to be absorbed.

The introduction of dummy variables improves the adjusted R^2. In Tables 2.3 and 2.5, we list the time dummy variables that appear significant. The dummy variables absorb the shocks from the consumption, rendering the global consumption no longer significant in these equations. The results also confirm the negative influence of the subprime crisis in 2008, the China-led boom during 2009-2010 and the market depression followed by the slowdown of economic growth in emerging markets since 2011.

2.4.2. Discussion – The power of emerging markets?

During the 2000s, the increasing demand from emerging countries was a powerful factor that caused the fine-wine price to rise steeply. The popularity of fine wine among wealthy classes from emerging countries led to a strong growth in demand. For instance, in China, fine wine has come to be regarded not only as a healthier alternative to traditional cereal alcohol but also as a reflection of wealth and social status. In addition, wealthy Chinese have shown a growing interest in investing in collectibles including prestigious wines; bottles from top-ranked wineries combined with high expert scores are their preference (Masset et al., 2016). As a result, the price of high-end wines skyrocketed due to speculation on the secondary market where significant demand was recorded by consumers or investors from emerging countries.

On the other hand, in response to the shock of the global financial crisis, actions were taken by central banks, such as China' RMB 4 trillion stimulus package. The fine-wine market was able to benefit from these actions, and as a result, quickly recovered from the crisis.

From the middle of 2011, following the fall in demand due to the slowdown of economic growth in emerging markets, the fine-wine market started to decline. Another responsible factor could be the gift-giving crackdown policy of the Chinese government. In addition, prestige-seeking consumers started to become more rational regarding the "red obsession".

[10] Relevant results are available on request.

Statistically, the aggregated GDP of G-4 does not show any significant impact on fine-wine prices. Nevertheless, the G-4 economies are important markets. Imagining if the shock caused by the financial crisis could be removed, the demand from the developed countries – the traditional wine-consumption markets – may be relatively less volatile over the entire time period. For many prestige Bordeaux wine estates like the best-performing First Growth – Mouton Rothschild, great trust is placed in *La Place*[11]. Indeed, a strong market persists in Europe for such wines as it does in the U.S. (Interview with Philippe Dhalluin of Mouton Rothschild by Liv-ex).

Over the last 30 years, traditional markets have been in a state of stable equilibrium. The demand maintained by the upper classes has operated relatively independently from the macroeconomic environments. In contrast, emerging markets have proved to be sensible to economic cycles, and this has been reflected in the volatility of demand.

2.4.3. Robustness check - Liv-ex Fine Wine 1000 index analysis

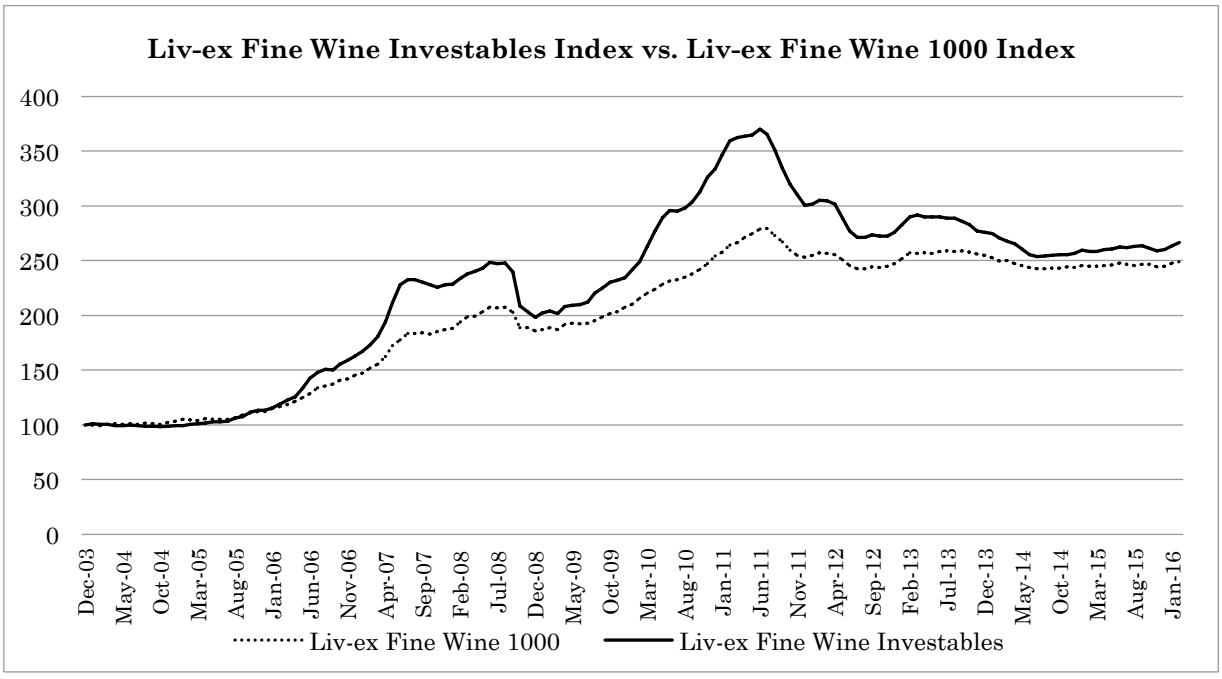


Figure 2.3: Liv-ex Fine Wine Investables Index and Liv-ex Fine Wine 1000 Index

According to Liv-ex, the Bordeaux region dominates the fine-wine market, and represents nearly 80 per cent of the total trade by value. The Liv-ex Fine Wine Investables index is considered as one of the most representative fine-wine price indices. However, it is composed of only the most financialized Bordeaux wines. Thus, to confirm the previous results, one needs to apply our model to a fine-wine price index that covers

[11] *La Place*, *La Place* of Bordeaux, refers to the brokers and *négociants* in Bordeaux.

a wider range of wine regions – the Liv-ex Fine Wine 1000 index. This index is price-weighted, including 7 sub-indices from six main regions: Bordeaux 500, Bordeaux Legend 50, Burgundy 150, Champagne 50, Rhone 100, Italy 100, Rest of the World 50[12]. Each sub-index represents the price movement of the ten most physical vintages for the leading wines of the region, except for Bordeaux Legend 50 that includes only 50 top Bordeaux wines from exceptional older vintages. The data of Liv-ex Fine Wine 1000 has only been available since December 2003. As we can see from the figure below, the composition of other regions' wines makes the Fine Wine 1000 index less volatile than the Fine Wine Investables index.

Table 2.6: Results for Liv-ex Fine Wine 1000 (model 1 and 2) without time dummy variables

	Equation 17		**Equation 18**		**Equation 19**		**Equation 20**	
	2004 – 2015		**2004 - 2015**		**2004 - 2015**		**2004 - 2015**	
	LS		**GMM**		**LS**		**GMM**	
Variable	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**
GDP G4	0,07	0,90	0,03	0,45	0,05	0,58	-0,04	-0,60
GDP BRIC	0,18	1,63	0,13	1,56	0,08	1,00	0,10	1,59
PROD	0,06	1,29	0,08	2,00**	0,02	0,50	0,03	0,67
CONS	0,30	2,31**	0,23	2,34**	0,26	2,06**	0,19	1,78*
REER	-1,24	-7,38***	-1,64	-7,77***	-1,12	-6,92***	-1,25	-6,75***
M3G4	0,04	1,53	0,05	2,48**				
Interest Rate					0,00	-0,85	0,00	-0,74
Invest. Fund					0,15	2,34**	0,17	3,69***
C	-0,54	-1,53	-0,69	-2,45**	-0,11	-0,50	-0,15	-0,68
Adjusted R^2	0.57		0.54		0.60		0.59	
Num. Obs.	141		141		138		138	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Tables 2.6 and 2.7 show the results obtained using the Liv-ex Fine Wine 1000 index. These results confirm the expected impacts of macroeconomic variables on fine-wine prices, but with less influence from the emerging markets. The impact of the BRIC economies is only significant in model 1 with dummies. This finding coincides with the results of Cardebat and Jiao (2017) that the linkages between emerging markets and

[12] Liv-ex Fine Wine 1000 Index is price weighted: Bordeaux 500 – 46%; Bordeaux Legends 50 – 22%; Burgundy 150 – 14%; Champagne 50 – 3%; Rhone 100 – 4%; Italy 100 – 7%; Rest of the World 50 – 4%. See https://www.liv-ex.com/ for more details concerning the component wines and vintages.

fine-wine markets are less significant when it comes to the wines from regions other than Bordeaux. This might indicate that the major role of emerging markets on the Liv-ex Fine Wine Investables index is due to their high demand for prestige Bordeaux wines, especially the First Growths. With respect to the wines from other regions, their influence is limited. The real effective exchange rate of the U.S. dollar is highly significant in every equation. However, the results regarding the impact of aggregated money supply are mixed and the real interest rate does not show any significant effect on Liv-ex Fine Wine 1000. In addition, the results confirm the positive sign of the increase in investment funds on fine-wine pricing.

Table 2.7: Results for Liv-ex Fine Wine 1000 (model 1 and 2) with time dummy variables

	Equation 17		**Equation 18**		**Equation 19**		**Equation 20**	
	2004 – 2015		**2004 - 2015**		**2004 - 2015**		**2004 - 2015**	
	LS		**GMM**		**LS**		**GMM**	
Variable	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**	**Coef.**	**t-Stat.**
GDP G4	0,04	0,48	0,02	0,21	0,02	0,23	-0,03	-0,39
GDP BRIC	0,16	1,93*	0,15	2,05**	0,09	1,13	0,11	1,55
PROD	0,02	0,51	0,01	0,30	0,01	0,25	-0,02	-0,57
CONS	0,11	0,57	0,25	1,39	0,11	0,59	0,19	1,35
REER	-1,22	-8,44***	-1,47	-7,09***	-1,14	-8,09***	-1,34	-6,90***
M3G4	0,03	1,38	0,04	2,12**				
Interest Rate					0,00	-1,29	0,00	-0,81
Invest. Fund					0,10	1,88*	0,09	1,73*
DM2006	0,01	1,38	0,00	0,47	0,01	1,38	0,01	0,91
DM2008	-0,02	-1,74*	-0,01	-2,68**	-0,01	-1,33	-0,01	-1,78*
DM2010	0,00	0,58	0,00	0,37	0,01	1,27	0,00	1,01
DM2011	-0,01	-1,16	-0,01	-1,91*	0,00	-0,71	-0,01	-1,54
C	-0,26	-0,83	-0,24	-0,80	-0,06	-0,25	0,12	0,57
Adjusted R^2	0.61		0.59		0.62		0.61	
Num. Obs.	141		141		138		138	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

2.5. Conclusion

This paper empirically identified the macroeconomic determinants of fine-wine prices. It estimated the impacts of these macroeconomic determinants on a monthly basis from 1996 to 2015. By capturing information at different stages of the development of the fine-wine market through the past 20 years, it was found that the price of fine wines move in accordance with the economic cycles, and there was a breakpoint at 2004 where fine wines started to be increasingly financialized.

According to our results, the growth of fine-wine demand from emerging markets seemed to play a major role in fine-wine price modeling, while the demand from developed markets did not appear statistically significant. The continuous weakening of the U.S. Dollar in real terms encouraged consumers from emerging economies to purchase fine wines. Since 2011, the slowdown of the economic growth in emerging markets, followed by the depreciation of national currencies, has negatively affected the growth of the fine-wine market. However, the results of our robustness check showed that because of the "red obsession" for Bordeaux First Growths, emerging markets seemed to solely dominate the price fluctuation of prestige Bordeaux wines. Their impact was very limited with regards to the wines from other regions.

Along with the process of financialization in the fine-wine market, aggregated money supply, real interest rate and the financial assets of investment funds as percentage of GDP are found to influence the fine-wine pricing. While the real interest rate presented a limited negative impact, the growth of money supply associated with lower interest rates in real terms did incite investment in alternative financial assets including prestige wines. At the same time, this wine investment, by private collectors or professional investment funds, created a supplementary demand in addition to wine consumption. As a result, the fine-wine markets can be influenced directly by financial markets through the wealth effect. It was concluded that a thriving financial environment could boost fine wine prices. On the other hand, under unstable financial conditions, fine wine prices became volatile.

Implications and recommendations for future research

Firstly, the drop of fine-wine prices since 2011 did not only have its negative side, it hauled back the irrational growth towards a long-term equilibrium; secondly, fine-wine markets are under the influence of macroeconomic cycles and thirdly, the fluctuation of the exchange rate is a vital factor that could affect the return on

investments directly. On the basis of our analysis above, it is suggested that investors commit to a mid- to long-term contract and wisely choosing currencies to invest may create profits accordingly; in addition, the macroeconomic environment should be taken into consideration when deciding the timing of a transaction. For collectors and consumers, timing is also a substantial issue when purchasing their favorite wines. As for wine professionals, it is important to lessen the dependence on emerging economies and to rebalance market share among Europe, Asia, and the Americas.

Complementary to the hedonic price modeling, our research can provide an analysis for wine-price modeling and forecasting within the macroeconomic approach. Nevertheless, it should be noted that certain limitations can be improved. First, lagged variables may contain valuable information, but our econometric models were not able to estimate their impacts (we only included lagged variables as instruments). Second, certain macroeconomic factors may be measured in more adequate ways to enhance their quality in explaining fine wine prices. For instance, the demand may be estimated by household income instead of GDP.

In future research, our model can be examined with alternative or new macroeconomic elements. Besides, to enrich the approaches in wine research, advanced econometric models used in other fields (such as autoregressive distributed lag model, state-space model, and machine-learning models) can be largely applied to explore wine prices. Furthermore, it is worth drawing attention to the price transmissions between fine wine and traditional financial assets (such as equities and commodities) or other collectibles.

Chapter III

The long-term financial drivers of fine-wine prices: The role of emerging markets

The long-term financial drivers of fine wine prices:

The role of emerging markets·

Abstract

We analyze the long-term relationship between the fine wine market and stock markets, from world level to specific countries, by applying a cointegration approach on a 21-year monthly database. Our database includes the Liv-ex Fine Wine Investables Index, 6 Liv-ex sub-indices, 25 MSCI Indexes and 10 national stock market indexes. Results suggest significant cointegration between emerging markets, especially Asia, and fine wine markets, and also causality from the former to the latter. As a result, the slowdown of economic growth in emerging countries can be a risk to the fine wine market. Furthermore, Mainland China appears to be one of the main drivers of fine wine markets, and more precisely, the leading Bordeaux wines. We suggest that along with single-index analysis, our approach can be taken into consideration in fine wine price forecasting and portfolio diversification strategy.

Keywords: Wine, cointegration, financial markets, emerging markets

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3.1. Introduction

Between 1900 and 2012, the net annualized return on wine investments (net of insurance and storage costs) has been estimated by Dimson, Rousseau, and Spaenjers (2015) at 4.1%. In the last decade, this growth rate has accelerated while the price of fine wines has experienced a dramatic rise. The major fine wine price indexes[1] tripled over the period 2001-2011. This increase has been largely commented upon by the press and analyzed by the academic literature which has attempted to explain the price of wine and to understand what the drivers are.

Due to the dual nature of fine wines, two approaches have been adopted to answer this question. The first one concentrated on the highly-differentiated product nature of wines. Many papers then focused on a hedonic analysis to explain the price evolution of fine wines (for a meta-analysis of hedonic methodology applied to wine, see Oczkowski & Doucouliagos, 2014). Among other determinants such as objective quality (for oenological comments: see for example Ashenfelter, 2008; Cardebat & Figuet 2004; Cardebat & 2009; Combris, Lecocq, & Visser, 1997; Combris, Lecocq, & Visser, 2000; Jones and Storchmann, 2001), these papers show the crucial role of the brand name. Reputation appears as one of the main determinants of wine prices, especially in China where the name of Bordeaux and more precisely of the first growth wines of the Bordeaux 1855 classification was a synonym of exorbitant prices until 2011. The Chinese demand for Bordeaux red wines is obviously a major driver of their prices but it is difficult to assess with a hedonic approach (Masset, Weisskopf, Faye, & Le Fur, 2015).

A second strand of the literature concentrates on fine wines regarded as an alternative financial asset[2]. Since the seminal papers of Krasker (1979) and Jaeger (1981), many studies have tried to assess the return on fine wines and to check whether they can be considered as a good tool for portfolio diversification[3]. A large proportion of these papers, using a CAPM approach, found higher returns for fine wines compared to stocks or bonds and a low correlation between fine wine prices and financial markets (see notably Aytaç & Mandou, 2016; Fogarty, 2010, Masset & Weisskopf, 2010; Sanning,

[1] The Liv-ex company, created in 1999, publishes several wine price indexes presented as the reference on the fine wine markets. Their fine wine indexes are built on the basis of transaction prices recorded on their site. See https://www.liv-ex.com/home.do for a complete description of their methodology, including the wine composition of each index. These indexes are extensively used in the literature; see for example Masset & Henderson (2010), Kourtis, Markellos & Psychoyios (2012), Bouri (2013), Cevik and Saadi Sedik (2014).

[2] Notably because such a price increase has attracted investors seeking portfolio diversification. This trend widely contributes to a "financialization" of the fine wines market (Cardebat, Faye, Le Fur, & Storchmann, 2017).

[3] The market for fine wines is an over-the-counter market. The return trajectories of fine wines and financial assets would be different and would obey different determinants.

Shaffer, & Sharratt, 2008).

However, some recent papers reveal some ambiguity as regards the correlation between financial markets and fine wine markets. Masset et al., (2015) have shown a stronger correlation and indicate that this correlation depends on the frequency of the fine wine price data. A lower frequency permits the transmission effect from financial markets to the fine wine market and then exhibits a higher correlation. Faye, Le Fur, and Prat (2015) showed a causality relationship between fine wine prices and the MSCI world index, while Bouri (2013) presented a MTGARCH analysis and revealed a transmission of the crude oil price on fine wine prices.

Consequently, if the intrinsic characteristics of wines might explain their price in level [4], it seems that the price variation of fine wines might be influenced by macroeconomic determinants (Chinese demand, etc.) and financial variables (stocks markets, etc.). In fact, several theoretical channels might justify some links between financial markets and the fine wine market, such as wealth or cash effect. Common macroeconomic determinants might also help to explain a positive correlation between wines and financial asset prices, especially during the 2008 crisis. However, most of these links play in the medium/long term.

Few papers have been devoted to the discovery of the macroeconomic and/or financial determinants of wine prices[5]. Our paper aims to fill this gap in the literature and to determine whether stock markets might be considered as a major driver of fine wine prices. A particular focus will be placed on the geographical aspect of the links in order to verify the specific effect of China compared to other countries. We then apply a cointegration and causality analysis on a long-period (1994-2015) monthly database from world level (in line with Faye et al., 2015) to specific countries.

Our results suggest significant cointegration between emerging markets, especially Asia, and fine wine markets, and also causality from the former to the latter. China appears as one of the main drivers of fine wine prices. Due to the illiquid nature of wine (Masset et al., 2015), the link between the stock market and the fine wine market is not contemporaneous. Wine prices adjust with a lag. These linkages should be an important aspect to be taken into consideration in portfolio diversification strategies. This approach can then provide a more accurate anticipation of wine price fluctuation.

[4] As established by the abundant hedonic literature applied to wine. Hedonic equations allow for the explanation of the price differences between different wines but cannot really explain the changes over time in the price of wines.

[5] The notable exceptions are Cevik and Saadi Sedik (2014), Faye et al. (2015) and Bouri (2013).

The remainder of the paper is constructed as follows: section 2 provides an overview of existing literature on wine as a financial asset; section 3 presents the database used in further analysis and section 4 outlines the methodology and procedures of our approaches; section 5 describes the results and gives their interpretations and a robustness check; lastly, we conclude in section 6.

3.2. Wine as a financial asset

In recent years, fine wines have often appeared in wine economic literature as an alternative financial asset. By using Liv-ex indexes and wine auction prices (Chicago wine company, Langton's auction house, Christie's, WinePrice.com), several studies estimate the returns, the performance and the portfolio diversification benefits of wine investment. Various methods are applied in this literature but repeat sales and hedonic price regression are the most common approaches to calculate wine returns; the Sharpe ratio, the CAPM model and the Fama-French Three-Factor Model estimate the performances; the mean-variance efficient frontier is applied to testify the portfolio diversification. A chronological summary of existing literature is presented in Annex 3.1.

Krasker (1979) first estimates the return on storing wines, and concludes that the return on wine is not higher than the return on riskless assets such as government bonds. Jaeger (1981) reverses Krasker's findings by expanding the sample period. She finds that wine impressively outperformed Treasury bills. When storage, insurance and transaction costs are taken into account, wine assets may become less attractive. However, several recent studies reveal that the return on wine is still higher than government bonds and other collectable assets such as art or stamps, but lower than equities (Burton & Jacobsen, 2001; Fogarty, 2006, 2010; Dimson et al., 2015). Yet, Masset and Henderson (2010) find that the cumulated return in the wine index is above the Dow Jones Industrial Average. Lucey and Devine (2015) obtain similar results. Later, Aytac et al. (2015) indicate that French wines outperform equities for a more recent and shorter time period (2007-2014). In addition, it is worth noting that outstanding wines perform better than more basic wines. The best wines achieve higher returns and have a lower volatility than more basic wines (Fogarty, 2006; Masset & Henderson, 2010). Lucey and Devine (2015) point out that the performance of wine is attractive, and compared to other collectibles, wine has a great advantage in trading volume and frequency. But they advise individual investors to invest indirectly through wine funds or traded indexes since the individual and sub-regional level returns on wine are highly heterogeneous.

Meanwhile, researchers have found that wine assets can provide portfolio diversification benefits. Sanning et al. (2008) find that investment-grade wine assets provide excess risk-adjusted returns and benefits "from low exposure to market risk factors", thus offering portfolio diversification benefits. Fogarty (2010) points out that including wine in a portfolio, even an already well-diversified one, maximizes the Sharpe ratio, thus providing a diversification benefit by achieving the same level of portfolio return with lower risk. Masset and Henderson (2010) indicate that the addition of wine assets can improve the performance of a portfolio in terms of skewness, but also increase the kurtosis. They also find a slight correlation between the wine returns and other assets, but during the financial crisis, the return on wine fluctuated considerably, and the correlation between wine and other financial assets significantly increased. However, wine returns declined less and have a lower volatility than other assets. Aytac and Mandou (2016) focus on French markets. They analyze the performance of fine wine in French portfolio diversification. Results show that Bordeaux fine wines are the most efficient for improving the performance of French portfolios compared to other French fine wines. Besides, they suggest risk-averse investors include wine in their portfolios. Kourtis, Markellos, and Psychoyios (2012) demonstrate the potential of international diversification benefits of investing in wines from a wide range of origins such as Italy, Australia and Portugal, since the correlation coefficients with these wines are relatively low, while the diversification benefits of investing only in French wines are limited. Fogarty and Jones (2011) and Fogarty and Sadler (2014) review different approaches in return estimations and diversification benefit tests. They point out that the conclusion about diversification benefits offered by wine is sensitive to the return-estimation method, the sample period, whether raw return or excess return is used, and the type of diversification benefit test. In conclusion, the repeat-sales approach can overstate the return. As for the diversification benefit test, the mean-variance efficient frontier approach is preferred. Subsequently, Fogarty and Sadler (2014) apply a pooled model to improve the accuracy of return in the estimation. His results indicate that in the case of Australian fine wines, including wines in a portfolio can provide diversification benefits, but the benefits are small.

The above studies generally find a negative or limited correlation between fine wines and other financial asset returns. By contrast, Dimson et al. (2015) find a significant positive correlation between wine and equities. This contradiction may be explained as following: their estimation is based on an annualized wine return calculated from wine auction prices between 1900 and 2012, which differs from other

recent studies which use monthly returns with a relatively shorter time period. This explanation is then supported by Masset et al. (2015). They compare the results obtained from monthly and quarterly data samples, and find that for a classical CAPM, the beta go higher when the frequency of data sample is lower.

In addition, the methodology of estimation may also have an impact on the results of correlation between fine wines and other financial assets. Other methodologies like cointegration and causality analysis can be experimented to explore the long-term relationship and short-term dynamics between these two markets. Moreover, with the financialization in the fine wine market, the fine wine market receives the impacts from financial markets via the channels such as the wealth effect and the transmission of volatilities. This aspect should be taken into account in portfolio diversification strategies when including wine assets in a portfolio. However, very little literature is devoted to discovering this linkage between financial markets and the fine wine market:

- With commodity markets: Bouri (2013) applies the Johansen cointegration test, the Granger causality test and a multivariate Garch model to examine the price dynamic and the long-run equilibrium between the fine wines market and the crude oil market. Results indicate that a mean transmission exists from the crude oil market to the fine wine market, but there was no long-term equilibrium relationship between the two markets. Cevik and Saadi Sedik (2014) point out that under influences of common macroeconomic factors, fine wines seem not to behave differently from commodities. Above evidence shows that the potential of portfolio diversification may be reduced when we include fine wine and commodities in the same portfolio.
- With stock markets: Faye et al. (2015) use auction prices to analyze the dynamic and the long-term relationship among fine wines themselves, by applying cointegration and Granger causality procedures. They also include a global equity index – the MSCI World Index – in their analysis. Results indicate short-term and long-term causalities among wines themselves, and short-term causalities between several fine wines and the MSCI World Index.

In the following sections, we also propose a cointegration approach with causality tests as well as a robustness check. But, we offer a richer analysis with a panoramic view of the connections between the fine wine market and stock markets - from global level to specific countries, so that we are able to determine the major influencers of the fine wine market coming from stock markets.

3.3. Data

We have a database of 21 years in monthly frequency. It covers the period from September 1994 to February 2015 and consists of the Liv-ex Fine Wine Investables Index. As indicated on the liv-ex website: "The Liv-ex Fine Wine Investables […] aims to mirror the performance of a typical wine investment portfolio. The Liv-ex Fine Wine Investables Index is a dominant price index of investment-grade wines. It contains Bordeaux red wines, around 200 wines from 24 leading chateaux, from the 1982 vintage and chosen on the basis of their Robert Parker rating scores[6]. This index is calculated monthly using the method of Liv-ex Mid Price – the mid-point between the current highest bid price and lowest offer price for each component wine, and weighted according to their coefficients of scarcity[7]. In addition, we include six regional sub-indices, which will be discussed in our robustness check section.

For financial indexes, we use a set of 25 MSCI indexes. These indexes have the interest of providing a "fully integrated view across all sources of equity returns in 46 developed and emerging markets" [8] and are commonly used by professionals and academics. These 25 MSCI indexes (large and mid-cap) are chosen from three categories – All Country (including developed markets and emerging markets), Developed Markets or Emerging Markets and specific countries (see MSCI index categories and corresponding components in Annex 3.2):

- 4 MSCI All Country (AC) indexes: ACWI (All Country World Index), AC Asia Pacific, AC Americas, and AC Europe[9];

- 6 MSCI Developed Markets (DM) indexes: Developed Markets (World), G7, Pacific, EAFE (Europe, Australasia and Far East), DM EU (European Union), and North America;

- 3 MSCI Emerging Markets (EM) indexes: Emerging Markets (World), BRIC (Brazil, Russia, India and China), and EM Asia;

- 3 MSCI China Markets indexes: Zhong Hua (China and Hong Kong), China, and Hong Kong[10];

[6] To qualify for the index, the score must be at least 95/100 points. For the eight first brands of Bordeaux – Lafite Rothschild, Latour, Margaux, Haut-Brion, Mouton-Rothschild, Ausone, Cheval Blanc and Petrus, a score of at least 93/100 points is required.
[7] The coefficient of scarcity is applied to the vintages older than 15 years and the wines produced in small quantities (Ausone and Petrus). Source Liv-ex
[8] https://www.msci.com/indexes for further details.
[9] MSCI AC Asia Pacific Index contains 5 Developed Markets countries and 8 Emerging Markets countries; AC America Index contains 2 Developed Markets countries and 5 Emerging Markets countries. AC Europe Index contains 15 Developed Markets countries and 6 Emerging Markets countries. Source MSCI

- 6 MSCI DM Countries indexes: USA, UK, Germany, France, Japan, and Australia;

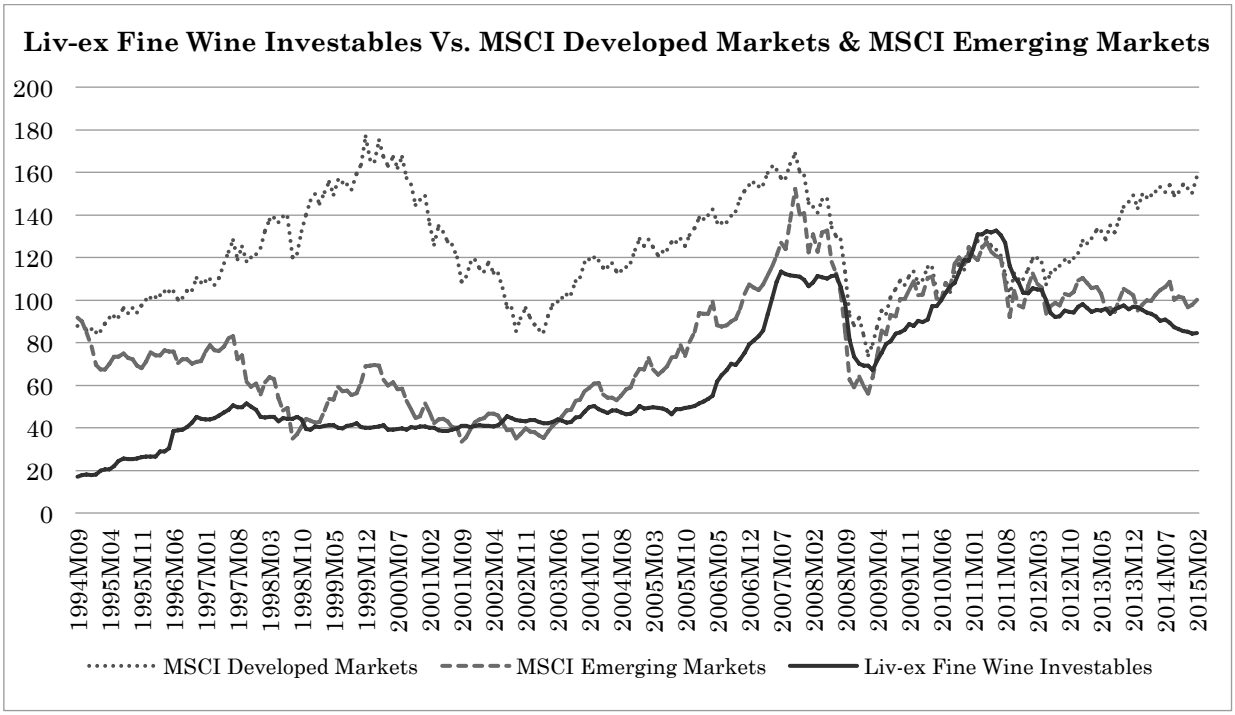
- 3 MSCI EM Countries indexes: Brazil, Russia, and India.

We have also gathered 10 stock markets indexes that will be used in our robustness analysis to control for the impact of stocks indexes series. These 10 stock market indexes include the most influential developed markets and emerging markets: Dow Jones Industrial Average, Nasdaq Composite, FTSE100, DAX, CAC40, Nikkei225, Hang Seng, BVSP (Brazil), RTS (Russia) and BSE SENSEX (India).

Figure 3.1 displays the index evolution of the liv-ex Fine Wine Investables and the MSCI for developed and emerging markets during the studied period. The ten first years do not show clear links between the curves. The emerging markets have been affected by the Asian crisis in 1997 whereas developed markets drop with the explosion of the Internet bubble in 2000. By contrast, during the sub-period 2003-2012, the rises and falls (due to the financial crisis) are common to the three indexes, and the curves reveal similar movements. Moreover, in the following figures, we can observe that all indices exhibit extreme values when the markets are at the top of the boom or at the bottom of the recession. The above phenomenon suggests that wine prices would not be independent of macroeconomic and financial evolutions. In particular, the fine wine market has experienced a significant decrease with the financial crisis. To go further in analyzing the links between stocks indexes and the liv-ex index, we now turn to the cointegration analysis.

[10] According to MSCI, Chinese markets include both developed markets (Hong Kong) and emerging markets (Mainland China). Regarding this specialty, MSCI creates MSCI China Markets that include both.

Figure 3.1: Liv-ex Fine Wine Investables vs. MSCI indexes in real Dollar (2010=100)



3.4. Methodology

3.4.1. Cointegration tests

We first applied augmented Dickey-Fuller (ADF) unit root tests to verify the stationarity of all variables. The lag length of ADF tests is selected automatically by information criteria. The unit root tests are conducted step by step for all variables, to see if there are a deterministic trend and a constant in a time series. It will help us to specify the cointegration test models in the next step (Dolado, Jenkinson, & Sosvilla-Rivero, 1990).

Only non-stationary series and being integrated of the same order could be used in cointegration tests. For conducting the cointegration analysis, we propose a vector error correction model (VECM). This model is more flexible and it allows us to make a bilateral analysis of the relationship between fine wine prices and stock market prices.

In our case, where we test the cointegration relation between the fine wine price and each stock market index respectively, we consider a two-variable system with one cointegrating equation. Therefore, the general (the most restricted) VECM is:

$$\Delta p_{wine,t} = Dt + \gamma(p_{wine,t-1} - \beta p_{stock,t-1} - dt) + \sum_{i=1}^{j-1} \Delta p_{wine,t-i} + \sum_{i=1}^{j-1} \Delta p_{stock,t-i} + \varepsilon_t$$

$$\Delta p_{stock,t} = Dt + \gamma'(p_{wine,t-1} - \beta p_{stock,t-1} - dt) + \sum_{i=1}^{j-1} \Delta p_{wine,t-i} + \sum_{i=1}^{j-1} \Delta p_{stock,t-i} + \eta_t$$

where $p_{wine,t}$ is the fine wine price series in logarithm; $p_{stock,t}$ is the stock market price series in logarithm; Dt is a vector of deterministic term (trend or constant) in VAR; $\gamma(p_{wine,t-1} - \beta p_{stock,t-1} - dt)$ is the cointegration equation (CE) which represents the long-run relationship between the two variables; dt is a deterministic term in the CE; $\sum_{i=1}^{j-1} \Delta p_{wine,t-i}$ are the lagged difference variables which represent the short-run dynamic of fine wine price series; $\sum_{i=1}^{j-1} \Delta p_{stock,t-i}$ are the lagged difference variables which represent the short-run dynamic of stock market price series; ε_t, η_t are two uncorrelated white-noise series.

The specification of a VECM depends on the specificity of each price series (Johansen & Juselius, 1990). We include a linear deterministic trend (a constant in the cointegration equation and also a constant in the VAR) in the VCE models with MSCI EM World, MSCI EM Asia, MSCI Hong Kong, MSCI Australia, and MSCI India, respectively, because these series have statistically-significant linear trends in data in level. For any other price series, we do not restrict any linear deterministic trend for the VCE models, as they do not have statistical significant linear trends in data in level. So the model is simplified – we only include a constant in the cointegration equation if it is statistically significant. But in our empirical work, the different specifications of a VEC model do not change the major conclusion of the cointegration tests. Furthermore, the national/regional GDPs are included in the cointegration equations as a control variable[11] to absorb the macroeconomic shocks.

Choosing the lag length is an important step for cointegration tests. So firstly, we construct a two-variable VAR, and the optimal lag length of the VAR is selected by standard information criteria. Additionally, we apply an autocorrelation LM test to confirm that the residuals are not auto-correlated under the selected lagged structure.

[11] Depends on region or country, the GDP is not always significant in the estimations, and including it or not does not affect major conclusions.

Then, we apply Johansen's cointegration test to determine the number of cointegrating relations. Johansen's cointegration tests consist of two tests based on a maximum likelihood ratio – trace test and maximum eigenvalues test:

$$Trace = -T \sum_{i=r+1}^{p} \log(1 - \hat{\lambda}_i)$$

$$MaxEigenvalue = -T \log(1 - \hat{\lambda}_{r+1})$$

where T is the sample size, $\hat{\lambda}_i$ estimates the i-th largest eigenvalue. Both tests examine the rank of the cointegrating matrix, in other words, the number of cointegrating vectors. The null hypothesis of the Trace test is that there are r or fewer cointegrating vectors against the alternative that there are more than r cointegrating vectors, while maximum eigenvalue statistic tests the null hypothesis of r cointegration vectors against the alternative of r+1 cointegration vectors.

In our case, if the fine wine price is cointegrated with the stock market price, the cointegrating parameter γ will be negative and significant, and there will be one cointegrating relation in the two-variable models (r = 1) verified by the Johansen's cointegration test. In the literature, Faye et al. (2015) points out a transmission from MSCI World Index to several fine wine auction prices. Cevik and Saadi Sedik (2014) indicate that the demand from emerging markets is a major factor prompting fine wine prices. Jiao (2017) confirms the results of the former and shows that the fluctuation of fine wine price is affected by the macro environment of financial markets. Therefore, we expect cointegrating relations between fine wine price and emerging market stock indices.

3.4.2 Granger Causality

In our case, a two-variable Granger causality model is defined as following:

$$p_{stock,t} = \sum_{i=1}^{j} a_i p_{stock,t-i} + \sum_{i=1}^{j} b_i p_{wine,t-i} + u_t$$

$$p_{wine,t} = \sum_{i=1}^{j} c_i p_{stock,t-i} + \sum_{i=1}^{j} d_i p_{wine,t-i} + v_t$$

where u_t, v_t are two uncorrelated white-noise terms. We test the null hypothesis that p_{wine} does not Granger cause p_{stock} ($b_1 = b_2 = \ldots = b_i = 0$) and that p_{stock} does not Granger

cause p_{wine} ($d_1 = d_2 = \ldots = d_i = 0$) against the alternative. If not all b_i are zero, we say p_{wine} cause p_{stock}, which means the available information of p_{wine} helps to predict p_{stock}. Similarly, if not all d_i are zero, p_{stock} cause p_{wine} which means p_{stock} helps the prediction of p_{wine}. If causation occurs in both directions, we can say that there is a feedback relationship between p_{wine} and p_{stock}.

3.5. Empirical results and interpretation

The logarithms of the real price indexes are used in further econometric estimations[12]. All the series are integrated of first order I(1), except for the MSCI DM Pacific Index and Dow Jones Industrial Average, which are stationary in level at 10% significance. As a result, we exclude MSCI DM Pacific and Dow Jones Industrial Average from further tests. The table of results of Augmented Dickey-Fuller unit root tests is presented in Annex 3.3.

3.5.1 Johansen Cointegration Test Results

We aim to analyze the linkage between the fine wine market and stock markets to determine how stock markets influence the fine wine market, and where the influences come from (from the whole world or specific regions or specific countries), so that we can tell which are the main drivers of the fine wine market. Our procedure of the cointegration analysis is constructed as following: firstly, we perform a cointegration analysis on All Country level. We test the cointegration between the Liv-ex Fine Wine Investables Index and each MSCI All Country index, respectively, in a two-variable VEC model; secondly, we distinguish, between developed markets (DM) and emerging markets (EM), with an emphasis on the Chinese market (CM). We test the cointegration between the Liv-ex Fine Wine Investables Index and each MSCI DM, EM, and CM index, respectively, in a two-variable VEC model; lastly, we narrow the scope to specific countries. Thus, we test the cointegration between the Liv-ex Fine Wine Investables Index and each MSCI Countries index and representative stock market price indexes (as complementary tests), respectively, in a two-variable VEC model. As mentioned before, the optimal lag length is selected by standard information criteria, and the trend assumptions of the Johansen cointegration test are specified above[13].

[12] We have converted all prices in national currency to US Dollar, and transformed the prices to price indexes on the base year of 2010, then deflated the nominal price indexes with the US Consumer Price Index (Source OECD, base year 2010 = 100) to real term.

[13] On account of the large size of the results table, only cointegrated relations are presented here, the rest can be found in Annex.

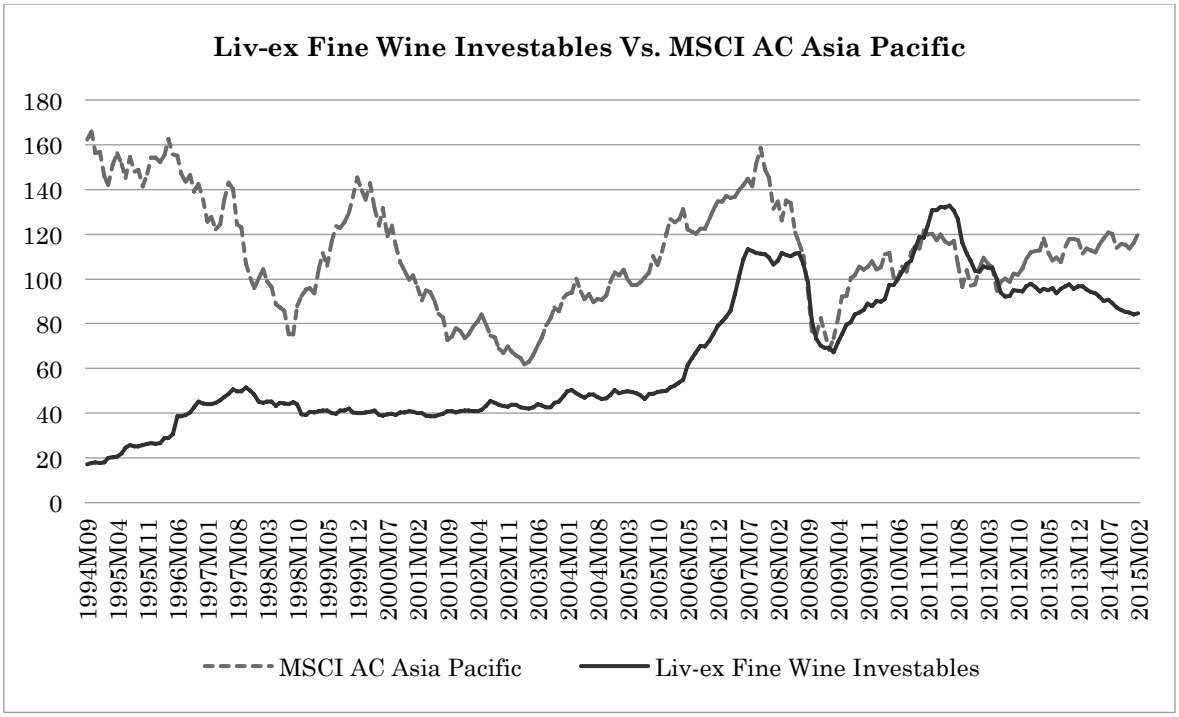
Among the four MSCI All Country indexes (see Table 3.1 and others in Annex 3.4), only AC Asia Pacific is cointegrated with the fine wine price (at 5% statistical significance). In other words, only the Asia Pacific region's stock price generates a long-term relationship with the fine wine price. The AC Asia Pacific index is composed of 5 developed markets and 8 emerging markets of the Asia Pacific region, in which Japan, China and Australia are the three highest-weighted countries constituting 68.04% of the index[14]. Evidence shows that around the world, the Asia Pacific region would be the most influential area for the fine wine market during the period considered, and Japan, China, Australia are the three major contributors.

Table 3.1: Johansen Cointegration Test result - Liv-ex Fine Wine Investables vs. MSCI All Country (see more results in annex 3.4)

Series: Liv-ex Fine Wine Investables vs. MSCI AC Asia Pacific			
Lags interval: 1 to 4			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None**	0.0698	23.1061**	17.4434**
At most 1	0.0232	5.6627	5.6627

** denotes rejection of the hypothesis at the 5% significance level.

Figure 3.2: Liv-ex Fine Wine Investables vs. MSCI AC Asia Pacific in real dollar (2010=100)



[14] Country weights of MSCI AC Asia Pacific: Japan 43.64%, China 12.29%, Australia 12.11%, South Korea 8.3%, Taiwan 6.37% and other countries 17.29%. Source MSCI Nov. 2015

Table 3.2: Johansen Cointegration Test result - Liv-ex Fine Wine Investables vs. MSCI Developed Markets and Emerging Markets (see more results in annex 3.4)

Series: Liv-ex Fine Wine Investables vs. MSCI Developed Markets			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0535	16.0121	13.2400
At most 1	0.0114	2.7722	2.7722
Series: Liv-ex Fine Wine Investables vs. MSCI Emerging Markets			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.1014	28.2651***	25.9678***
At most 1	0.0094	2.2973	2.2973
Series: Liv-ex Fine Wine Investables vs. MSCI BRIC			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.0756	19.5121***	18.8784***
At most 1	0.0026	0.6338	0.6338
Series: Liv-ex Fine Wine Investables vs. MSCI EM Asia			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.0835	23.5966***	21.1804***
At most 1	0.0099	2.4162	2.4162

*** denotes rejection of the hypothesis at the 1% significance level.

Then we run a cointegration analysis on "Markets" level – Developed Markets and Emerging Markets. The results are represented in Table 3.2. None of the MSCI Developed Markets indexes are cointegrated with Liv-ex Fine Wine Investables. These results can be found in Annex 3.4. By contrast, all the three Emerging Markets indexes are highly-significantly cointegrated with the fine wine price. Obviously, emerging markets win a greater impact on fine wine markets against developed markets. Similar evidence is shown in Cevic and Saadi Sedik (2014) that the increasing demand from emerging markets is a key factor influencing the fine wine market. Through Figure 3.3, we can observe co-movement trends between the fine wine price and emerging market stock prices under macroeconomic shocks since the beginning of 2000. Besides, China is the highest weighted country in all the three indexes with 24.01% in MSCI Emerging Markets[15], 34.11% in MSCI EM Asia[16] and 56.88% in BRIC[17]. Thereafter, we place

[15] Country weights of MSCI Emerging Markets Index: China 24.01%, South Korea 16.21%, Taiwan 12.44%, India 8.35%, South Africa 7.68%, and other countries 31.32%. Source MSCI Nov. 2015

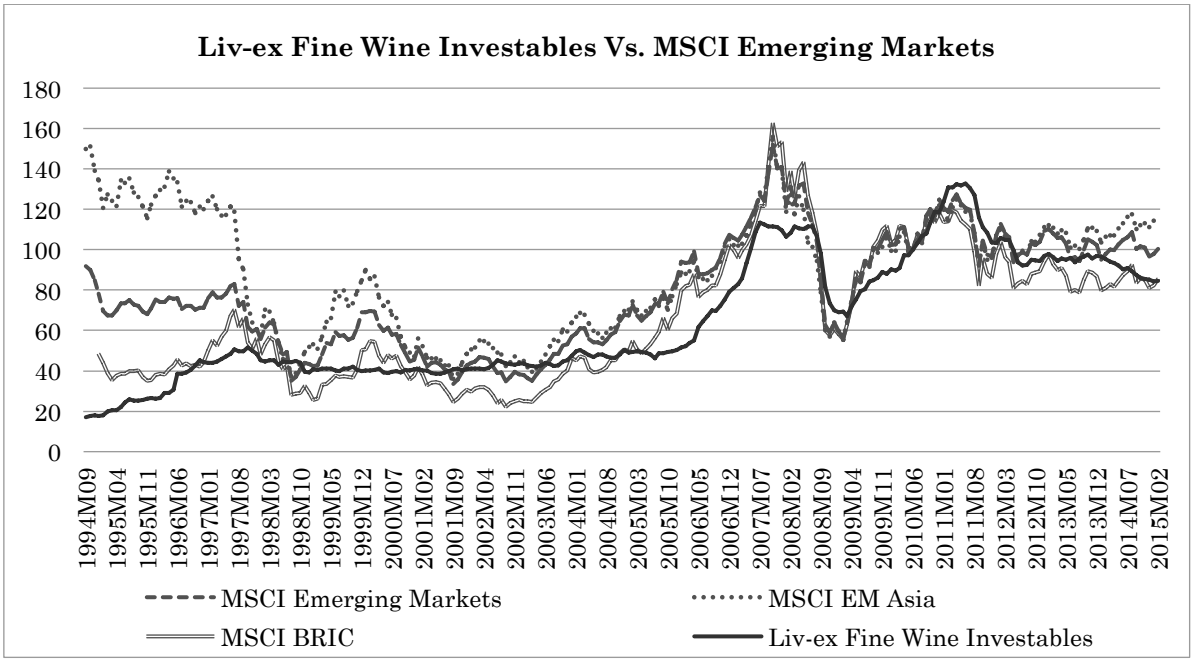
emphasis on Chinese markets regarding the high weight they hold in emerging markets. The Table 3.3 shows the results.

Table 3.3: Johansen Cointegration Test result - Liv-ex Fine Wine Investables vs. MSCI Chinese Markets

Series: Liv-ex Fine Wine Investables vs. MSCI Zhong Hua (China & HK)			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None**	0.0661	20.2534***	16.6186**
At most 1	0.01485	3.6348	3.6348
Series: Liv-ex Fine Wine Investables vs. MSCI Hong Kong			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None*	0.0629	21.7613**	15.7748*
At most 1	0.0243	5.9865	5.9865
Series: Liv-ex Fine Wine Investables vs. MSCI China			
Lags interval: 1 to 5			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.0720	18.0920***	17.9300***
At most 1	0.0007	0.1621	0.1621

***, **, * denote rejection of the hypothesis at the 1%, 5%, and 10% significance level

Figure 3.3: Liv-ex Fine Wine Investables vs. MSCI Emerging Markets in real Dollar (2010=100)



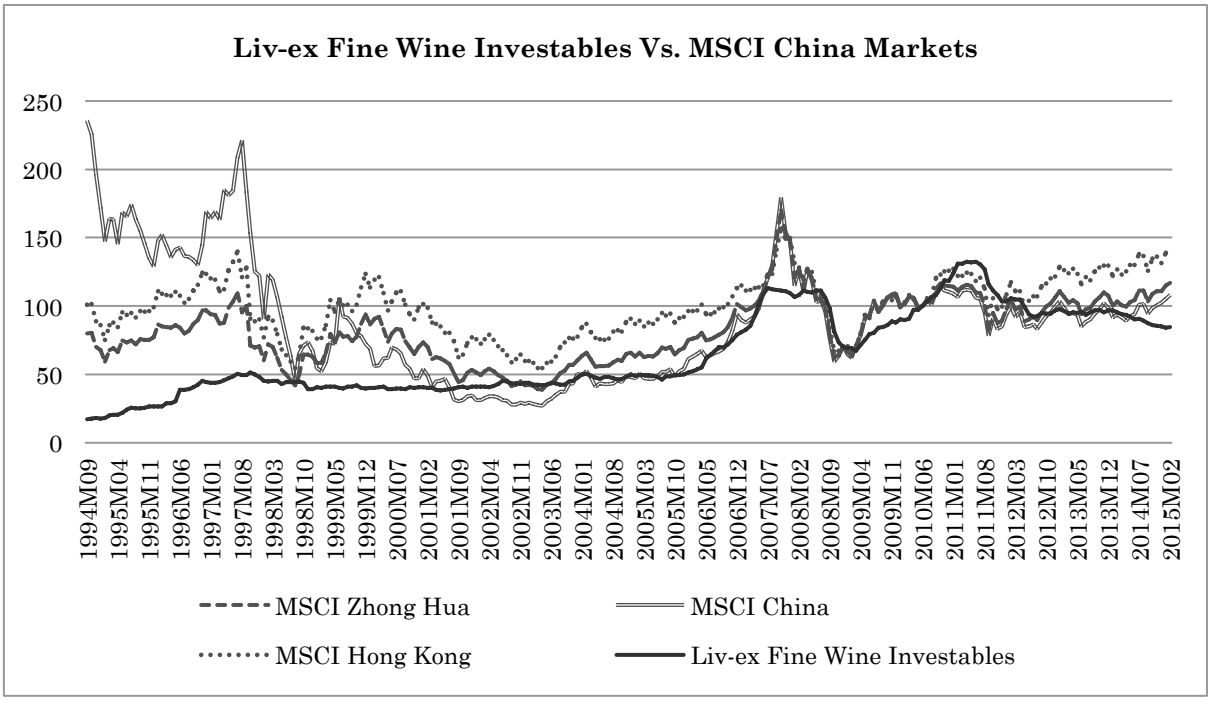
[16] Country weights of MSCI EM Asia Index: China 34.11%, South Korea 23.03%, Taiwan 17.67%, India 11.87%, Malaysia 4.63%, and other countries 8.68%. Source MSCI Nov.2015

[17] Country weights of MSCI BRIC Index: China 56.88%, India 19.8%, Brazil 14.07%, and Russia 9.25%. Source MSCI Nov. 2015

It is not surprising to find a long-term equilibrium between the fine wine market and the Chinese stock market. As we can see in Figure 3.4, the movement of the fine wine price has performed similarly to Chinese stock prices since the beginning of the 2000s. According to OIV, wine consumption in China increased 67% from 2000 to 2012, and then came a decrease since 2012: a drop of 3.8% between 2012 and 2013 and 7% between 2013 and 2014[18].

Besides, we notice that the statistical significance of the cointegration relation between the fine wine price and MSCI Hong Kong is rather weak, while the statistic for MSCI China is highly significant. This evidence indicates that the major role is played by Mainland China. Hong Kong would not have a significant enough impact on the fine wine market, without the support of the huge demand from Mainland China. Because more than two-fifths of imported wine in Hong Kong is re-exported to Mainland China[19].

Figure 3.4: Liv-ex Fine Wine Investables vs. MSCI China Markets in real Dollar (2010=100)



[18] Beyond the Chinese stock market evolution, Bordeaux fine wines have been influenced by two major shocks on the Chinese market. In particular, in 2007, Hong Kong reduced the taxes on imported wine by half and then removed them in 2008. The importation of wine soared and the prices skyrocketed with the ending of taxation. But since 2011, fine wine prices have decreased. One reason commonly evoked is the Chinese anti-corruption policy of Xi (gift-giving crackdown, fine wines are often presented as gifts or consumed during business meals in China).

[19] Source: IWSR (International Wine and Spirit Research).

In country level, based on previous findings, the stock prices of Japan, Australia and the BRIC countries have the highest probabilities to generate long-term relations with fine wine prices. The results are presented in Table 3.4:

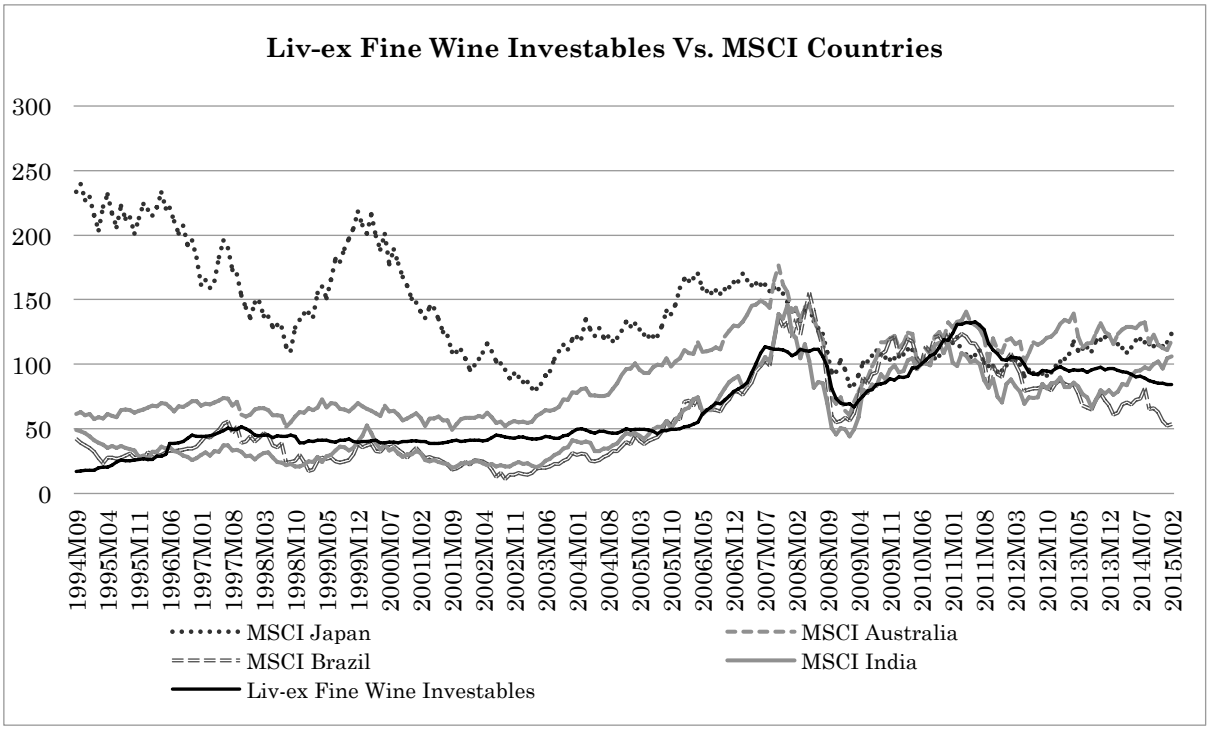
Table 3.4: Johansen Cointegration Test result – Liv-ex Fine Wine Investable vs. MSCI Countries

Series: Liv-ex Fine Wine Investables vs. MSCI Japan			
Lags interval: 1 to 4			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0513	19.8808*	12.6813
At most 1	0.0294	7.1995	7.1995
Series: Liv-ex Fine Wine Investables vs. MSCI Australia			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.0770	22.3173***	19.4663***
At most 1	0.0117	2.8511	2.8511
Series: Liv-ex Fine Wine Investables vs. MSCI Brazil			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.0906	26.3261***	23.0771***
At most 1	0.0133	3.2490	3.2490
Series: Liv-ex Fine Wine Investables vs. MSCI India			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None***	0.1063	33.1459***	27.2989***
At most 1	0.0238	5.8470	5.8470

***, * denote rejection of the hypothesis at the 1% and 10% significance level

The results for Australia, Brazil and India are highly significant. Long-run equilibriums between the fine wine price and stock market prices of the three countries can also be observed through their plots (see Figure 3.5). However, Japan produces conflicting results: the Trace statistic rejects the null hypothesis of non-cointegration at 10% significance level, while the Max-Eigen statistic cannot reject the hypothesis. Then we tried Nikkei225, and the results show that the null hypothesis is rejected by the Trace and Max-Eigen statistics at 10% and 5% significance level respectively (see Annex 3.5). For other countries, we also provide a cointegration analysis based on national stock market indexes in the robustness check.

Figure 3.5: Liv-ex Fine Wine Investables vs. MSCI Countries in real Dollar (2010=100)



To summarize, the above cointegration test results can be presented in a world map figured below. Underlined letters refer to the cointegration at 1% significance level, bold letters for 5% significance level, and italic letters for 10% significance level (see Figure 3.6).

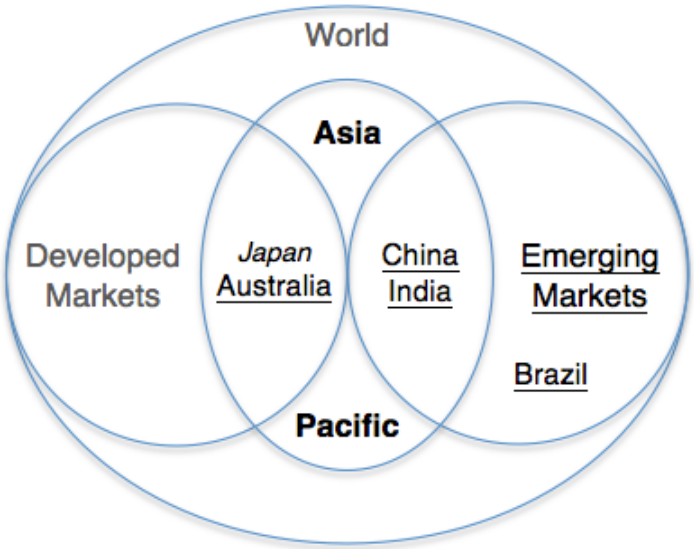


Figure 3.6: World map - cointegration test procedure and results (see also Annex 3.6)

3.5.2. Robustness check

3.5.2.1. Liv-ex sub-indices analysis

The first robustness check concerns the wine price indexes. To confirm the previous results, one needs to test the cointegration with different wine indexes and not only the fine wine investables index which is simply composed of Bordeaux wines. Therefore the cointegration analysis is extended to other Liv-ex indexes including the fine wines from the five main regions considered by Liv-ex: Bordeaux, Burgundy, Champagne, Rhone and the Rest of World. In searching further information, we use six Liv-ex sub-indices to refine the impact of each stock market on each wine region index. Each sub-index represents the price movement of the ten most physical vintages for the leading wines of the region, except for Bordeaux Legend 50 that includes only 50 top Bordeaux wines from exceptional older vintages[20]. The data of sub-indexes are only available since December 2003.

Table 3.5: Johansen Cointegration Test Results – Liv-ex sub-indices vs. MSCI indices

	Zhong Hua	China	Hong Kong	EU	UK	France	Australia
Bordeaux 500	*						**
Bordeaux Legend 50		**					**
Burgundy 150	**		**	**	***	**	**
Champagne 50	***	*	**	**	***		***
Rest of World 50	*		**			**	**
Rhone 100				*			

***, **, * denote rejection of null hypothesis at 1%, 5% and 10% significance level
Period: Dec. 2003 – Feb. 2015; Number of observations: 132 after adjustment.

Table 3.5 shows the Johansen cointegration results (for countries exhibiting significant results[21]). These results confirm that a cointegration link does exist between stock markets and fine wine indexes. However, this table provides another outcome. Stock markets not only influence Bordeaux fine wines but all the luxury wines from leading regions, because at least some cointegration links appear for these top wine indexes (with the exception of Rhone 100 where the cointegration appears very weak). Developed markets therefore seem to influence the prices of Champagne and Burgundy

[20] See https://www.liv-ex.com/ for more details concerning the component wines and vintages.
[21] For readability concerns, the other results are available on request.

wines. It might indicate that the major role of Asia on Liv-ex Fine Wine Investables would be partially due to a compositional effect and the over-representation of Bordeaux wines in this index.

3.5.2.2. Cointegration analysis with national stock market indexes

As a robustness check, we analyze the cointegration relationships between Liv-ex Fine Wine Investables and 10 national stock market indexes: Dow Jones Industrial Average, Nasdaq Composite, FTSE 100, DAX, CAC40, Nikkei225, Hang Seng, BVSP (Brazil), RTS (Russia) and BSE SENSEX (India)[22]. The results are in line with our previous findings[23] (see Annex 3.5): Nikkei 225 is cointegrated with the fine wine price as mentioned above; Hang Seng and BVSP are respectively cointegrated with the fine wine price at 5% significance level; no cointegration relationship between the fine wine price and other indexes. Overall, the result is robust to the choice of stock market index.

3.5.2.3. Granger Causality Test Results

Granger (1988) indicates that in the case of two cointegrated variables, there must exist causation in at least one direction. So, to ensure the robustness of our results, we apply Granger causality tests to see whether the cointegration relations are associated with causations in the "correct direction" (i.e. from stock markets to fine wines). In our case, we examine the causation between the fine wine price and each stock market price that they are cointegrated with, respectively. The lag lengths of Granger causality tests correspond to the lag lengths of VARs. The results are presented in Annex 3.7.

All of the tests reject the null hypothesis of non-causality for the MSCI Indexes to Liv-ex direction. As a result, these stock market prices impact the fine wine prices. In other words, we can have a better prediction of fine wine prices with the help of all available information of these stock market prices. The results confirm the transmission of price fluctuation from financial markets to the fine wine market in the short-medium term.

3.5.2.4. Sub-periods analysis

We analyze separately the pre-crisis period and the post-crisis period with May 2008 as a demarcation point, because May 2008 is the highest point of Liv-ex before the crash. We run cointegration tests on several representative relationships – Liv-ex Fine

[22] The data series of BSE SENSEX is from July 1997, shorter than other series (from September 1994).
[23] Except for India where there is no cointegration. This result suggests that we should be cautious about drawing conclusions about India. However our general conclusion is still valid.

Wine Investables with the MCSI of Developed Markets, Emerging Markets, EU, G7, BRIC, Japan, China and Australia, respectively. MSCI BRIC, China and Australia are cointegrated with the fine wine price on sub-periods. The index of emerging markets is only cointegrated with the fine wine price on the pre-crisis period. The indices of developed markets, EU, G7, and Japan[24] do not show a cointegration relationship with the fine wine price on any of the sub-periods[25]. The financial crisis has tremendous impacts on all the markets. Results indicate that under the same macroeconomic shocks, the fine wine market does not respond to the financial crisis differently to stock markets, especially with the influences of cash effect and transmission of market volatilities. Therefore, compared to our full-period results, the relationship between the fine wine market and stock markets on sub-periods does not change significantly.

3.5.2.5. Outliers analysis

In Figures 3.2 and 3.3, concerning the indices of Asia Pacific and Emerging Markets, we observe that there are extreme values generated by the macroeconomic turning point on 2007-2008. This might disturb our econometric estimations. Therefore, we control this peak by the inclusion of dummy variables for this specific period to verify if it affects the results of cointegration tests. Outcomes indicate that the cointegration relationships remain valid with the presence of dummy variables. The results presented in the precedent section are not qualitatively changed by using dummy variables[26].

3.5.3. The impact of emerging markets

Since the beginning of the 2000s, fine wine markets are more closely linked with emerging markets than with developed markets. This phenomenon may be explained as following.

The consumption of wine in emerging markets has rapidly increased during the 2000s thanks to economic growth and the increase in households' disposable income. Studies show that the existence of a stock market wealth effect explains the link between private consumption growth and stock returns, and it is also the case for emerging markets (Funke, 2004; Poterba, 2000). The boom of stock market-created wealth allows for consumption or reinvestment in other assets, such as in fine wines. But, since the end of the 2000s, the slowdown of economic growth in emerging markets has had a negative effect on the wine market. As for the developed markets, wine

[24] To complement, Nikki225 also shows its ambiguity on sub-period analysis.
[25] All the results of sub-period analysis are available on request.
[26] Results available on request.

consumption has dropped generally except in the USA and the UK[27], following slower growth in disposable income.

With the growth in wealth, a well-educated and open-minded population drives and encourages the pursuit for more fashionable and qualified life styles. For instance, in China, with government promotions, wine is considered as a healthier alcoholic drink compared to traditional alcohol made with cereals. As the Veblen effect dominates the prestige-seeking behavior of Chinese consumers, wealthy people regard the consumption and collection of fine wines as a reflection of their wealth and social status (Vigneron & Johnson, 1999). Combined with the awareness of country of origin and top brands, this Veblen phenomenon can explain the old-and-top-Bordeaux fever in the Chinese fine wine market. However, the Chinese wine market is a market in evolution. According to the China Portraits report of Wine Intelligence in 2015, the "prestige-seeking traditionalist" wine consumers are being overtaken by a new generation of wine drinkers who are developing their wine habit and seeking value in wines. Meanwhile, high-end products are often used for "gifting" purposes. When paying for themselves, Chinese consumers, especially the growing middle classes, are willing to pay for higher quality or better taste rather than a higher social status[28]. Luxury brands, including fine wines, have been suffering since the government's "gift-giving" crackdown. Evidence shows that when consumers become more rational and the market steps towards to maturity, the irrational growth comes to a sudden end while the market moves to a healthier stage.

Nevertheless, the influence of emerging markets, and especially China, has to be nuanced. Indeed, the robustness check for the Liv-ex index indicates that Chinese stock markets are the main drivers of Bordeaux wine prices, but this outcome might be different for wines from other regions. Overall, luxury wine prices (especially Burgundy and Champagne wines) are influenced by developed as well as emerging stock markets. However, Bordeaux wines still dominate any wine price index, including Liv-ex Fine Wine Investables which we used, because of their notoriety and their liquidity[29].

[27] According to OIV, between 2000 and 2014, major "old world" wine countries consume less wine – with a decrease of 19% in France, 34% in Italy and 29% in Spain; wine consumption increased 45% in the USA and 30% in the UK.
28 Source : Wine Intelligence and Decanter China
[29] Bordeaux wines are traded more also because they are available in higher quantity than Burgundy wines. In fact, Burgundy can be seen as a very small luxury wine-producing region compared to Bordeaux.

3.6. Conclusion

This article analyzes long-term bilateral relations between the fine wine market and stock markets, by applying a cointegration approach on a 21-year monthly database.

The analysis is conducted from world level to specific countries. At the world level, the Asia Pacific region, which includes China, Australia, and Japan, is found to be the most influential region on the fine wine market, in the long-term as well as in the short term. Comparing developed markets versus emerging markets, emerging markets, especially the BRIC countries (except Russia), exhibit a greater impact on fine wine markets, since the increasing demand from emerging markets is a key factor influencing the fine wine market. As a result, the slowdown of economic growth in emerging countries might be a risk to the fine wine market. Then we place a greater emphasis on Chinese markets. Evidence shows that Mainland China plays a major role in fine wine price fluctuation, more precisely, as regards the leading Bordeaux wines. The uncertainty of Chinese politics can be another risk to the fine wine market. The robustness checks seem to confirm these entire results even if for a more balanced wine portfolio (i.e. with less Bordeaux and more wines from other regions) this outcome (Chinese influence) would have to be nuanced in the sense that developed markets would also play a role in the price evolution.

Our results indicate the fine wine prices are significantly dependent of the demand from the emerging markets, which makes the wine market vulnerable facing the economic and political changes of these countries. Therefore, it is important to diversify and balance the market shares on a global scale, in order to lessen the dependence on emerging economies. For instance, over the past two decades, Chili has signed numerous bilateral trade agreements with neighbor countries and major economies worldwide. Being in the part of these agreements, Chilean wine has considerably benefited from the commercial advantages they deliver by widely diversifying their exports flows. Therefore, in terms of strategy, fine wine sellers have to diversify their exports to be less exposed to emerging markets. They have to be supported by their governments, especially by the European Union (where fine wines come from in their vast majority), when they face strong tariff- and non-tariff barriers.

Finally, we suggest that the above evidence can be taken into consideration in a portfolio diversification strategy. And along with single-index analysis, our approach can be useful to provide a more accurate forecast of fine wine price fluctuation.

General conclusion

This thesis fills the gap in the research on the discovery of the macroeconomic and financial determinants of fine-wine prices. Starting with a literature review of the long journey embarked upon by academic research on wine pricing, we have tried to clarify how the price of wine has been determined and how it has evolved. Complementary to the hedonic pricing approach, it is necessary to study the impact of macroeconomic factors and financial markets on the dynamics of the wine price evolving over time. Following this idea, we have empirically identified the macroeconomic determinants of fine-wine prices. Throughout the past 20 years, the price of fine wines has been moving in accordance with economic cycles and we observed a significant breakpoint in 2004 when fine wines started to be increasingly financialized. Finally, we have testified the existence of long-term relationships between fine-wine price indices and stock market indices and confirmed the transmission of price fluctuation from financial markets to fine-wine markets in a short-medium term.

All three parts have underlined the significant impact of emerging markets. Directly, economic growth in emerging countries has positively affected the increase in fine-wine prices. And the continuous weakening of the U.S. dollar in real terms has strongly encouraged consumption and consolidated demand. Indirectly, fluctuation in the stock markets of the emerging economies has influenced fine-wine markets via the wealth effect and the transmission of volatility. The impacts have been reflected most significantly in the evolution of Bordeaux First Growths, while Burgundy and Champagne have been more closely linked to European markets.

By estimating the effect of financialization on the wine market, it is indicated that less attractive interest rates in real terms, associated with abundant liquidity, have favored investment in alternative financial assets and high-end wines have been an attractive choice since the 2000s.

Compared to the traditional wine markets in developed economies, the emerging countries have been more sensitive to economic cycles and the volatility in their demand has been an accurate reflection of this. Because of the high dependency, wine markets were found to be vulnerable in the face of economic and political changes in emerging economies. Subsequently, we have suggested balancing the market shares on a global scale and diversifying the portfolio with wines other than those from Bordeaux.

Meanwhile, to deal with the delayed reaction of fine-wine markets when facing macroeconomic shocks, lagged variables may contain valuable information. In future research lagged fine-wine prices and macroeconomic variables can be included, by

applying autoregressive distributed lag models, in order to improve the estimations (in this thesis, we only included lagged variables as instruments).

As for fine-wine investment, particularities and limitations, such as the illiquidity of wine assets, the opacity of price information and the inefficiency of market operations, have brought challenges but also enlightened subsequent work for us. We can improve the calculation of wine-price indices and the accuracy of wine fund assessment and adjust the risks and returns by taking the range of volatility against average price and the degree of asset liquidity into consideration. Last but not least, we are eager to say that it is our hope to see a wine market emerge with a higher degree of transparency and efficiency.

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Appendix

Chapter II

Appendix 2.1: Unit Root Test – Augmented Dickey-Fuller Test

Series	t-Stat. in Level	t-Stat. in Difference	Result
Liv-ex Fine Wine Investables	-2.19 trend / cons**	-9.94*** trend/cons	I(1)
Liv-ex Fine Wine 1000	-1.82 trend / cons*	-5.72*** trend/cons	I(1)
GDP G4	0.45 trend/cons	-7.26*** trend/cons	I(1)
GDP BRIC	-1.87 trend* / cons*	-4.12*** trend/cons**	I(1)
World wine production	-3.42*** trend/cons***		I(0)
World wine consumption	0.74 trend/cons	-2.95*** trend/cons	I(1)
Real effective exchange rate $	0.42 trend/cons	-10.13*** trend/cons	I(1)
M3 G4	-3.58** trend***/cons***		I(0)
Real interest rate US	-1.56 trend / cons	-7.32*** trend/cons	I(1)
Investment fund in % of GDP US	-2.72 trend**/cons***	-15.97*** trend/cons***	I(1)

***, **, * denotes rejection of null hypothesis (non-stationary for unit root test, non-significance for trend or constant) at 1%, 5%, and 10% significance level.

Appendix 2.2: Results of Cevik and Sedik (2014)

Results for Real Wine Prices, 1998–2010

	LS		*LS*		*LS*		*GMM*	
	(1)		*(2)*		*(3)*		*(4)*	
Variable	*Coef.*	t-*Stat.*	*Coef.*	t-*Stat.*	*Coef.*	t-*Stat.*	*Coef.*	t-*Stat.*
Constant	−17.5	−8.7***	−19.2	−9.2***	−26.0	−6.4***	−23.8	−3.9***
IPI for advanced countries	0.5	2.1**	0.5	2.4***	1.0	3.0***	0.8	1.8*
IPI for emerging countries	3.3	9.0***	3.5	9.2***	3.5	8.8***	3.4	9.5***
Wine production			−1.0	−4.8***	−0.6	−2.2**	−0.7	−1.6
Excess liquidity					3.9	1.9*	2.8	0.8
Adjusted R^2	0.55		0.59		0.61		0.60	

Source: Datastream, Energy Information Administration, International Financial Statistics, Liv-ex, Organization Internationale de la Vigne et du Vin, and authors' calculations.
Notes: The sample covers monthly data from January 1998 to June 2010; all variables are year-on-year percentage changes with the exception of excess liquidity; all variables are stationary; Newey-West estimator were used to address both heteroskedasticity and autocorrelation issues. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix

Chapter III

Appendix 3.1: Wine as Financial Asset Literature Summary

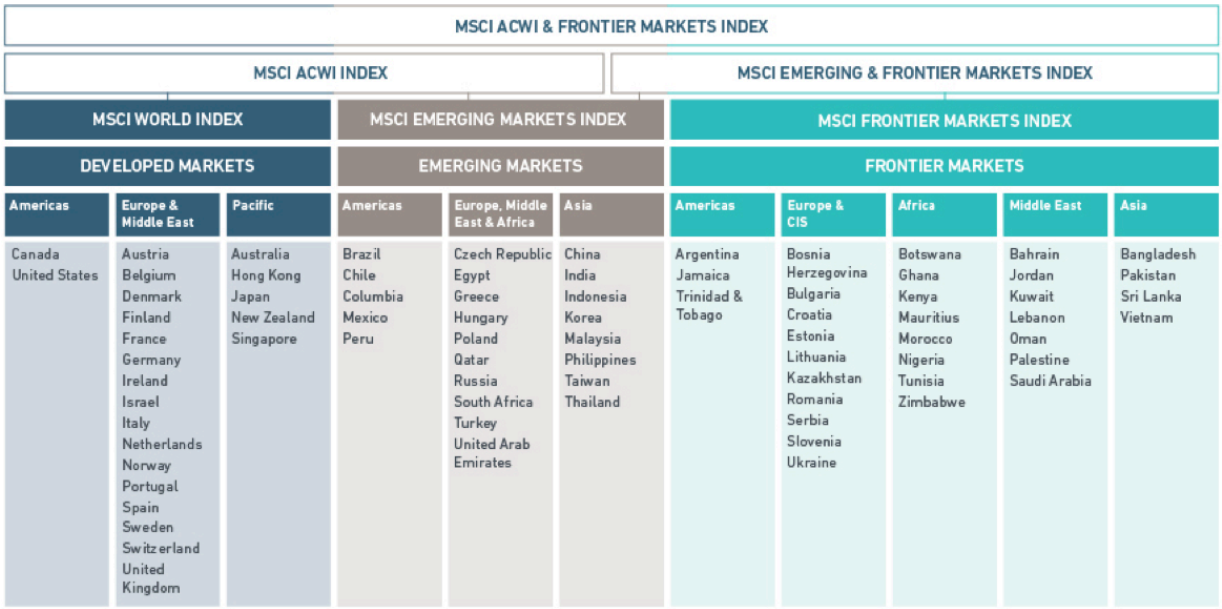
Study	Data period	Estimation method	Conclusions
Krasker (1979)	Annual Heublein Wine Auctions 1973-1977; Red Bordeaux and California Cabernet Sauvignon; Excluded vintages before 1950;	Repeat sales approach; Weather Expected return to storing wine exceeds the rate of return of riskless assets?	The expected return on storing wines is below the rate of return of riskless assets.
Jaeger (1981)	Annual Heublein Wine Auctions 1969-1977; Red Bordeaux and California Cabernet Sauvignon; Exclude vintages before 1950;	Repeat sales approach; Weather Expected return to storing wine exceeds the rate of return of riskless assets?	Reverse Krasker's finding; Wine impressibely outperforms government bonds.
Burton & Jacobsen (2001)	Edgerton 1986-1996 bi-annual data; Red Bordeaux; Exclude vintages before 1960	Repeat sales approach	Considering the high volatility and transaction costs, the return on wine is above government bonds but below equities.
Fogarty (2006)	Langtons' Auction; 1989Q4-2000Q4; Premium Australian wine Exclude vintages before 1965	Hedonic price regression approach	The return on wine is above government bonds but below equities. Best wines achieve higher returns and have a lower volatility than poorer wines. Premium Australian wine probably achieves higher return than Bordeaux wine.
Sanning et al. (2008)	The Chicago Wine Company; Eight-year series of monthly auction data; Red Bordeaux vintages from 1893 to1998	Average return; Repeat sales approach; Fama-French Three-Factor Model; Capital Asset Pricing Model	Wine provides excess risk-adjusted returns. β negative or not significantly different from zero (average is at -0.006). "Investment grade wine assets benefit from low exposure to market risk factors", thus offers portfolio diversification benefits.

Masset & Henderson (2010)	The Chicago Wine Company; Auction data; January 1996-February 2007	Weighted average of observed prices; VECM; GARCH; Sharpe ratio; Mean-variance efficient frontier; Mean-variance-Skewness-Kurtosis analysis	Cumulated return on wine is above Dow Jones Industrial Average; Best wines achieve higher returns and have a lower volatility than poorer wines. Wines of different categories follow a similar trend in long-run, but partially independent in short-run. Including wine in a portfolio provides diversification benefits: Optimal Sharpe ratio, increase in skewness, but also in kurtosis. Slight correlation (-0.22 to 0.5) between the wine returns and other assets, while during financial crisis, the correlation increased very significantly.
Fogarty (2010)	Langton's auction house; Quarterly auction data; 1990Q1-2000Q4; Premium Australian wine Exclude vintages before 1965	Repeat sales approach; Sharpe ratio; Mean-variance efficient frontier	In the case of Australian wine, the return to and the risk adjusted excess return are both lower than standard financial assets. The correlation with equities is 0.14, and -0.11 with bonds. Including wine in a portfolio, even already well diversified one, provides diversification benefits by achieving the same level of portfolio return with lower risk.
Fogarty & Jones (2011)	Langton's auction house; Quarterly auction data; 1988Q1-2000Q4 Premium Australian wine Exclude vintages before 1965	Hedonic, repeat sales, and hybrid approaches; Mean-variance spanning test;	The return and diversification benefits of wine are dependent on the estimation method. Repeat sales approach may overstate the return of wine. Hybrid approach provides the most efficient estimates.

Kourtis et al. (2012)	WinePrice.com (2005-2010) Monthly data of 7 wine production regions; Liv-ex indexes (2001-2010) Monthly data	Logarithmic returns of observed prices; Skewness- kurtosis analysis; Continuous time dynamics models	Returns and diversification benefits vary from different wine production regions. Slight correlation (< 0.3) between the wine returns and other assets. International diversification benefits for investing in wines from Italy, Australia and Portugal as addition to French wines.
Fogarty & Sadler (2014)	Langton's auction house; Quarterly auction data; 1988Q1-2000Q4 Premium Australian wine Exclude vintages before 1965	Approach review: - Return estimations: hedonic, repeat sales, pooled, hybrid approaches; - Diversification benefit tests: Jobsen approach, Blume and Elton et al., mean-variance spanning approach, mean-variance efficient frontier	The diversification benefits of including wine in a portfolio are sensitive to the return estimation method, the sample period, whether raw return or excess return used, and the type of diversification benefit test. Repeat sales approach overstates the return on wine. In the case of Australian wine, the diversification benefits of including wine in a portfolio are small.
Dimson et al. (2015)	Auction data from Christie's; Dealer data from Berry Bros. & Rudd; Historical database; Since end 1899 from now on	Repeat sales approaches; The effect of aging on wine prices through time (life-cycle price dynamics of low quality vintage and high quality vintage)	Between 1900 and 2012, in real GBP terms, wine (net annual return 4.1%) underperforms equities, but outperforms government bonds, art, and stamps. A positive correlation between wine and equity returns. β is 0.73 for the full period, 0.57 if excluding 1941-1948.

Lucey & Devine (2015)	The Chicago Wine Company; Auction data 1996-2006 5 wine funds 2003-2010 Bordeaux and Rhone fine wines	Repeat sales approach; Sharpe ratio	Average return on wine is above Dow Jones Industrial Average; Wine is attractive, but individual and sub-regional level returns to wine are highly various and volatile. Authors suggest individual investors to Invest indirectly through wine funds or traded indexes.
Aytac & Mandou. (2016)	IdealWine and Liv-ex indexes January 2007-October 2014 Bordeaux, Bourgogne, Rhone Wines	Returns of observed prices; Skewness- kurtosis analysis; Mean-variance efficient frontier; Mean-modified value at risk	Wines outperform equities for the considered period. Including wine in a portfolio provides diversification benefits. Bordeaux fine wines are the most efficient for improving the performance of French portfolio compared to other French fine wines.

Appendix 3.2: MSCI index categories and components



Appendix 3.3: Augmented Dickey - Fuller Unit Root Test Results

Category	Series	t-Stat. in Level	t-Stat. in First Difference	Result
Wine Prices	Liv-ex Fine Wine Investables Index	-2.41 trend/constant***	-9.69*** trend/constant*	I(1)
	Bordeaux 500	-1.84 trend/constant*	-6.04*** trend/constant	I(1)
	Bordeaux Legend 50	-1.77 trend/constant*	-6.61*** trend/constant	I(1)
	Burgundy 150	-2.62 trend**/constant***	-6.02*** trend/constant	I(1)
	Champagne 50	-1.93 trend/constant**	-8.86*** trend/constant	I(1)
	Rest of World 50	-2.61 trend**/constant***	-10.66*** trend/constant	I(1)
	Rhone 100	-2.09 trend/constant**	-6.56*** trend/constant	I(1)
MSCI All Country (DM & EM)	ACWI	-2.09 trend/constant**	-13.88*** trend/constant	I(1)
	AC Asia Pacific	-2.60 trend/constant**	-13.34*** trend/constant	I(1)
	AC America	-2.19 trend/constant**	-14.33*** trend/constant	I(1)
	AC Europe	-2.42 trend/constant**	-13.80*** trend/constant	I(1)
MSCI Developed Markets	World	-2.06 trend/constant**	-13.90*** trend/constant	I(1)
	G7	-1.97 trend/constant**	-13.98*** trend/constant	I(1)
	Pacific	-2.61* trend/constant**	-13.53*** trend/constant	I(0)*
	EAFE	-2.46 trend/constant**	-13.69*** trend/constant	I(1)
	EU	-2.36 trend/constant**	-13.89*** trend/constant	I(1)
	North America	-2.26 trend/constant**	-14.26*** trend/constant	I(1)
MSCI Emerging Markets	World	-2.43 trend**/constant**	-13.41*** trend/constant	I(1)
	BRIC	0.28 trend/constant	-13.64*** trend/constant	I(1)
	Asia	-2.53 trend*/constant**	-12.71*** trend/constant	I(1)

MSCI China Markets	Zhong Hua	-2.41 trend*/constant**	-14.08*** trend/constant	I(1)
	Hong Kong	-2.28 trend/constant**	-14.31*** trend/constant	I(1)
	China	-2.22 trend/constant**	-14.20*** trend/constant	I(1)
MSCI DM Countries	USA	-2.19 trend/constant**	-14.28*** trend/constant	I(1)
	UK	-2.16 trend/constant**	-13.94*** trend/constant	I(1)
	Germany	-2.38 trend/constant**	-14.88*** trend/constant	I(1)
	France	-2.42 trend/constant**	-14.56*** trend/constant	I(1)
	Japan	-2.41 trend/constant**	-13.63*** trend/constant	I(1)
	Australia	-2.46 trend*/constant**	-15.09*** trend/constant	I(1)
MSCI EM Countries	Brazil	-0.08 trend/constant	-15.04*** trend/constant	I(1)
	Russia	-2.39 trend/constant**	-13.16*** trend/constant	I(1)
	India	-2.65 trend***/constant**	-14.41*** trend/constant	I(1)
Stock Markets Indexes	Dow Jones Industrial Average	-2.58* trend/constant***	-15.22*** trend/constant	I(0)*
	Nasdaq Composite	-1.88 trend/constant**	-14.19*** trend/constant	I(1)
	FTSE 100	-2.28 trend/constant**	-13.41*** trend/constant	I(1)
	DAX	-1.78 trend/constant*	-14.58*** trend/constant	I(1)
	CAC 40	-2.27 trend/constant**	-14.12*** trend/constant	I(1)
	Nikkei 225	-2.24 trend/constant**	-14.75*** trend/constant	I(1)
	Hang Seng	-3.03 trend*/constant***	-14.95*** trend/constant	I(1)
	BVSP	0.10 trend/constant	-13.09*** trend/constant	I(1)
	RTS	-2.16 trend/constant**	-12.29*** trend/constant	I(1)
	BSE SENSEX	-2.30 trend**/constant**	-12.77*** trend/constant	I(1)

***, **, * denotes rejection of null hypothesis (non-stationary for unit root test, non-significance for trend or constant) at the 1% , 5%, and 10% significance level.

Appendix 3.4: Johansen Cointegration Test Results (non-cointegrated)

Liv-ex Fine Wine Investables vs. MSCI All Country (AC) (DM & EM)	Series: Liv-ex Fine Wine Investables vs. MSCI ACWI			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0518	16.2887	12.8271
	At most 1	0.0143	3.4616	3.4616
	Series: Liv-ex Fine Wine Investables vs. MSCI AC America			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0562	15.4881	13.9400*
	At most 1	0.0064	1.5481	1.5481
	Series: Liv-ex Fine Wine Investables vs. MSCI AC Europe			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0420	14.2494	10.4206
	At most 1	0.0156	3.8288	3.8288
Liv-ex Fine Wine Investables vs. MSCI Developed Markets (DM)	Series: Liv-ex Fine Wine Investables vs. MSCI DM World			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0535	16.0121	13.2400
	At most 1	0.0114	2.7722	2.7722
	Series: Liv-ex Fine Wine Investables vs. MSCI G7			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0547	15.9419	13.5595
	At most 1	0.0098	2.3824	2.3824
	Series: Liv-ex Fine Wine Investables vs. MSCI EAFE			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0441	18.3981*	10.8734
	At most 1	0.0307	7.5248	7.5248
	Series: Liv-ex Fine Wine Investables vs. MSCI DM EU			
	Lags interval: 1 to 2			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0428	14.2961	10.6217
	At most 1	0.0150	3.6744	3.6744
	Series: Liv-ex Fine Wine Investables vs. MSCI North America			
	Lags interval: 1 to 2			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0553	15.0574	13.8195
	At most 1	0.0051	1.2380	1.2380

Liv-ex Fine Wine Investables vs. MSCI Countries	Series: Liv-ex Fine Wine Investables vs. MSCI USA			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0562	15.2573	13.9519*
	At most 1	0.0054	1.3054	1.3054
	Series: Liv-ex Fine Wine Investables vs. MSCI UK			
	Lags interval: 1 to 2			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0465	15.6497	11.5673
	At most 1	0.0167	4.0824	4.0824
	Series: Liv-ex Fine Wine Investables vs. MSCI Germany			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0488	16.8569	12.0578
	At most 1	0.0197	4.7992	4.7992
	Series: Liv-ex Fine Wine Investables vs. MSCI France			
	Lags interval: 1 to 4			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0463	15.0800	11.4269
	At most 1	0.0150	3.6532	3.6532
	Series: Liv-ex Fine Wine Investables vs. MSCI Russia			
	Lags interval: 1 to 3			
	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
	None	0.0332	9.1624	8.0573
	At most 1	0.0046	1.1050	1.1050

* denotes rejection of null hypothesis 10% significance level.

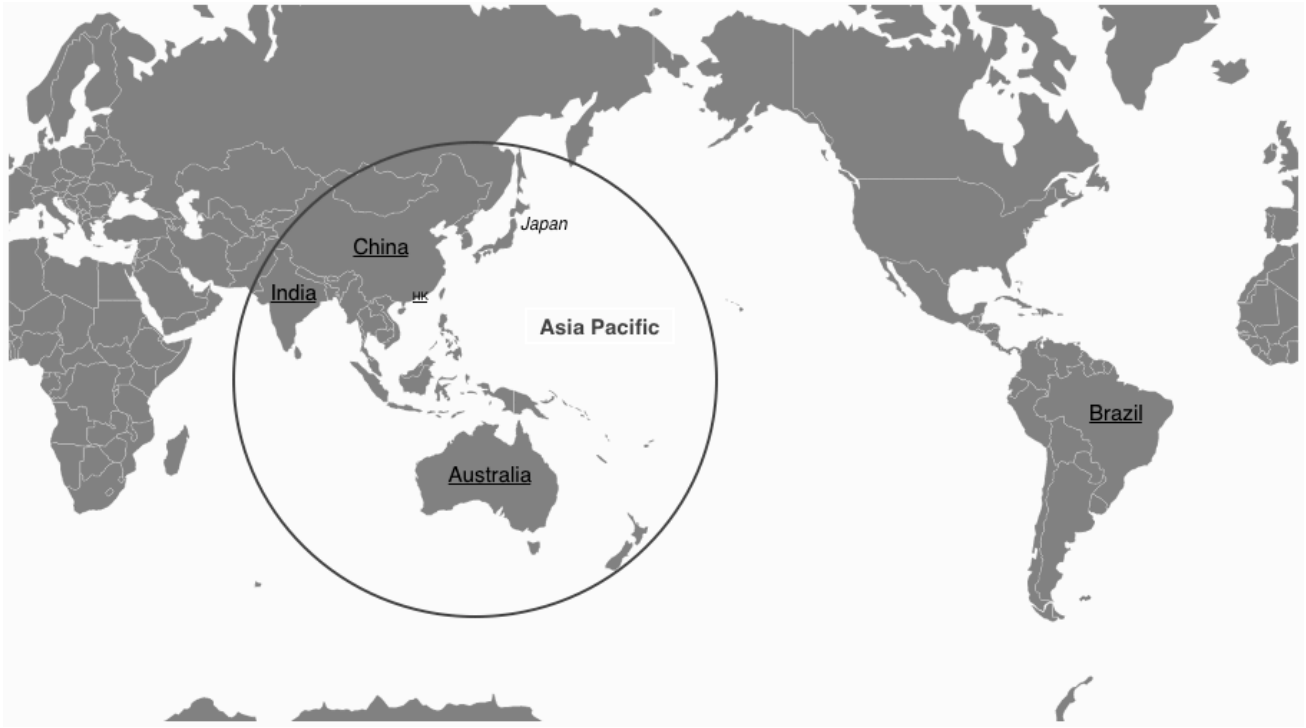
Appendix 3.5: Johansen Cointegration Test Results – National stock market indexes

Series: Liv-ex Fine Wine Investables vs. Nasdaq Composite			
Lags interval: 1 to 4			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0506	14.6099	12.5133
At most 1	0.0087	2.0966	2.0966
Series: Liv-ex Fine Wine Investables vs. FTSE100			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0464	15.1683	11.5345
At most 1	0.0015	3.6338	3.6338

Series: Liv-ex Fine Wine Investables vs. DAX			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0400	14.1927	9.9320
At most 1	0.0174	4.2608	4.2608
Series: Liv-ex Fine Wine Investables vs. CAC40			
Lags interval: 1 to 4			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0450	14.8542	11.0962
At most 1	0.0155	3.7580	3.7580
Series: Liv-ex Fine Wine Investables vs. Nikkei225			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None*	0.0642	20.1455*	16.1272**
At most 1	0.0164	4.0183	4.0183
Series: Liv-ex Fine Wine Investables vs. Hang Seng			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None**	0.0680	24.5259**	17.1062**
At most 1	0.0301	7.4197	7.4197
Series: Liv-ex Fine Wine Investables vs. BVSP			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None**	0.0778	23.7285**	19.6792**
At most 1	0.0165	4.0493	4.0493
Series: Liv-ex Fine Wine Investables vs. RTS			
Lags interval: 1 to 3			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0294	11.9793	6.8697
At most 1	0.0220	5.1096	5.1096
Series: Liv-ex Fine Wine Investables vs. BSE SENSEX (data from 1997)			
Lags interval: 1 to 2			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic
None	0.0451	11.0896	9.6362
At most 1	0.0069	1.4535	1.4535

**, * denote rejection of null hypothesis 5% and 10% significance level.

Appendix 3.6: World map 2 - cointegration test procedure and results



Appendix 3.7 : Granger Causality test results

Causes →	Liv-ex	AC Asia Pacific	EM World	BRIC	EM Asia	Zhong Hua	Hong Kong	China	Japan	Australia	Brazil	India
Liv-ex											**	
AC Asia Pacific	***											
EM World	***											
BRIC	***											
EM Asia	***											
Zhong Hua	***											
Hong Kong	**											
China	***											
Japan	**											
Australia	***											
Brazil	***											
India	***											

***, ** denotes rejection of the hypothesis at the 1%, 5% significance level