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OF WINE PRICES**

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Macroeconomic determinants of wine prices

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Abstract

This paper identifies the macroeconomic determinants of fine wine prices and estimates their impacts on a monthly database from 1996 to 2015. The fine wine demand from emerging markets plays a key role in fine wine pricing, and more precisely, on the fluctuation of Bordeaux fine wine prices. Furthermore, the continuous weakening of the U.S. Dollar in real term favors the fine wine prices to increase. Since 2011, the slowdown of economic growth in emerging markets, followed by the depreciation of national currencies has engendered negative effects on the fine wine market. Along with the process of financialization in the fine wine market, fine wine prices have become more volatile. Factors such as money supply, real interest rate and the growth of investment funds start to show their influence on fine wine pricing.

Keywords: wine, price, macroeconomics, emerging markets, financialization

JEL classification codes: C22 C26 Q11

1. Introduction

In the wine economic literature, many successful studies exist in the evolution of wine prices are taken in the perspective of supply. The empirical analyses are mainly based on the hedonic price approach to estimate the impact of each wine characteristic on the price determination (Ashenfelter, 2008; Lecocq and Visser, 2006; Cardebat and Figuet, 2004).

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 mainly confirmed the interest of fine wines started to become an attractive alternative financial asset.

With the financialization in the fine wine market, few researchers started to explore the linkage between financial markets and wine markets, and discover the impact of macroeconomic factors on wine price determination.

Fine wine price is sensitively related to economic dynamics. Since the first half of 2000s, fine wine prices skyrocketed thanks to the growth of demand from emerging markets. In 2008, the growth came to a sudden end on the eve of the financial crisis. Then the prices started to fluctuate following the recession and the recovery of the economy. After the pick at 2011, fine wine prices have been undergoing a continuous decline. This decline can be mainly explained by the drop in demand: the slowdown of economic growth of 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 accelerated the pace of financialization of the fine wine market. The wine investment creates another type of demand in addition to the wine consumption. A prosperous financial environment associated with low interest rates favors the fine wine investment. On the other hand, fine wine prices have become more volatile following the up-and-down of economic cycles.

Through existing literatures and evidences, the main idea of our research is developed as illustrated in figure 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 (preferable fine wines) via the canals such as wealth

effect, cash effect, and the transmission of price volatilities. The macroeconomic factors can also affect wine markets directly, but the response of wine markets will be delayed, because wine assets are not having much liquidity as other financial assets (Masset et al. 2016 forthcoming).

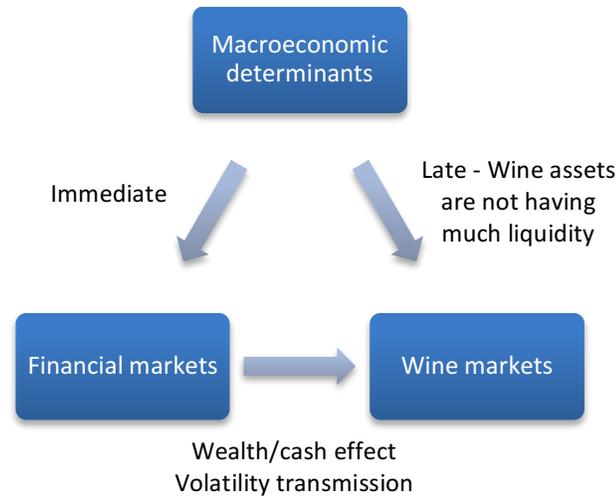


Figure 1: Relationship between macroeconomic determinants and wine markets

Since there are only few researches existing in 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, thus to contribute to the research and literature in this area.

The author extends the study of Cevik and Sedik (2014). Firstly, we expand the database. Secondly, we try 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 2004 as a significant break point. Our results confirm the previous findings about the influence of emerging markets on fine wine prices, and the new variables play significant roles in fine wine pricing as well.

This paper constructs as follows: section 2 provides an overview of existing literature on the relationship between macroeconomic factors and fine wines; section 3 presents the database of our analysis; section 4 outlines the econometric models and the methodology; section 5 describes the results together with their interpretations as well as a robustness check; in the end, section 6 concludes the paper.

2. Fine wine price and macroeconomic factors

Wine literature has contributed a lot on analyzing wine price determination through hedonic price approach, estimating the return, the performance and the portfolio diversification benefits of wine investment. However, few papers have been devoted to discovering the influence of macroeconomic and/or financial factors of wine prices.

Anderson K. et al. (2001) modeled and forecasted the world wine market based on household income, population, and taste trends on the demand side along with the wine production factors on the supply side under the background of wine industry globalization. Cevik and Sedik (2014) pointed that, under the influences of common macroeconomic factors, fine wines seemed to behave not differently from commodities. 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. While on the demand side, they analyzed separately the demand impacts of developed economies and emerging economies, also 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 of demand from emerging economies, supports fine wine prices, and the abundant global liquidity associated with low interest rates seemed to amplify the space of price increase. As to the supply side, the effect of wine production was limited.

Other factors can be also taken into account of wine price modeling. 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 dollar in real term can raise the purchasing power of foreign consumers in real term, then the demand can be expanded and the price will be lifted.

It can also find the impact of exchange rate on the wine market in literature. Lindsay P.J. (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 portfolio as an alternative financial asset, apart from the indicator of money supply, the interest rate is another important 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 term drops the discount factor, raises the present value of expected future return and therefore the current price will be elevated. The behaviors of speculation may accentuate the price volatility in the short-term when they are associated with weaker real interest rates. Besides, low interest rate may encourage investors investing in equities or alternative assets with higher returns; therefore they would raise their prices through demand. Studies exist in this area for stock markets (e.g., FAMA and Schwert (1977), FAMA (1981) and Christie (1982)) or commodity markets (e.g., Frankel (1986, 2008) and Beck (1993)). To our knowledge, there still no such studies in the area of fine wine prices for now.

The fine wine investment fund has emerged since the end of 1990s¹ as a result of the steady return in fine wine and the need of portfolio diversification for investors, thereafter, wine investment has been accepted as a valuable alternative financial asset by investors. The emergence of private or institutional wine investment funds, along with the establishment of Liv-ex accelerated the process of financialization of the fine wine market. The wine investment creates a supplementary demand in addition to the wine consumption, such as the speculation of the outstanding vintages of Bordeaux First Growth. The fine wine price is more volatile due to the up-and-down of investment, which is affected by the volatilities of other financial assets under the influence of the economic cycles. Faye et al. (2015) showed short-term causalities between several fine wine auction prices and the MSCI World index; Cardebat and Jiao (2016 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 from stock markets to fine wine markets. Thus, 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, which represents the evolution of capital invested in financial assets and reflects the volatility in financial market along with the economic cycles.

Aside from financial crisis, several additional unpredictable factors can affect wine prices. Evidences showed that the political elements could not be ignored. The announcement of a new policy may modify the condition of supply or demand (taking the negative impact of Chinese government gift-giving crackdown for instance). Other random variables include technology

¹ Ascot Wine Management Fine Wine Fund (Bahamas) is founded in 1999 ; Orange Wine Fund (Amsterdam) in 2001 ; Wine Investment Fund (UK) in 2003 ; Vintage Wine Fund (UK) in 2003 (no defunct)

progress in wine production or the changes in wine production surfaces, together with other unpredictable factors in 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.

3. Data

The database covers a timeframe from 1996 to 2015 in monthly frequency and consists of Liv-ex Fine Wine Investables index (and Liv-ex Fine Wine 1000 index in the robustness check) as the fine wine price, and explanatory variables on both supply side and demand side. The length of the database allows us to capture information on different steps of the development of the fine wine market along with the macroeconomic fluctuations during the last twenty years. Also, it is based on the need of the availability of data for all concerned variables².

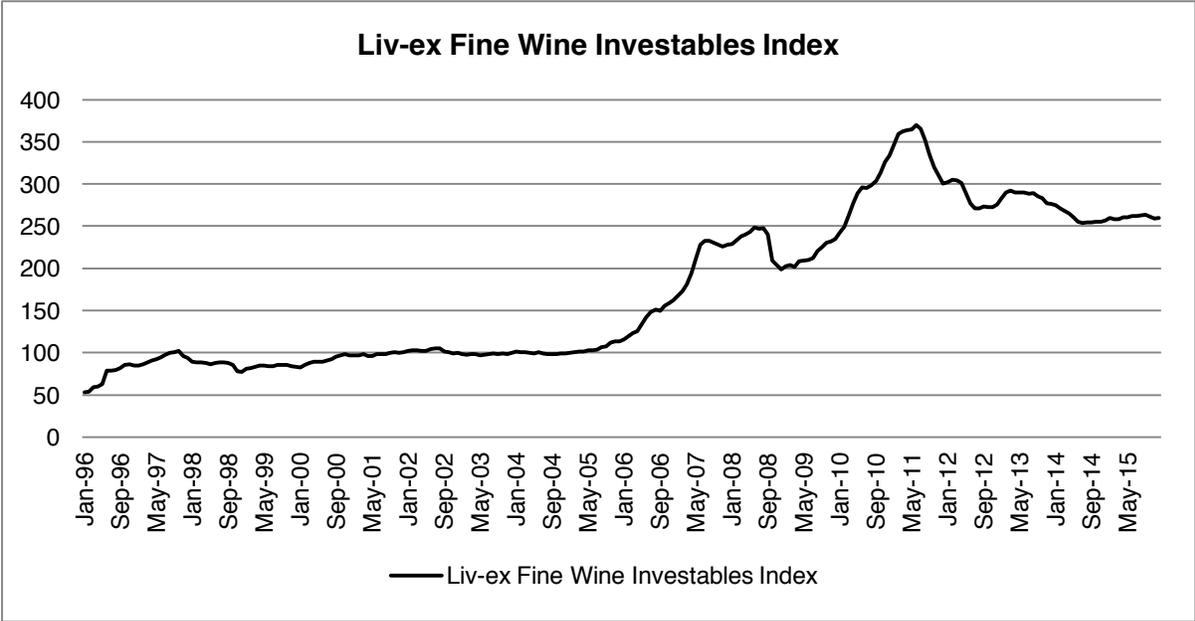


Figure 2: Liv-ex Fine Wine Investables Index (Source: Liv-ex)

Liv-ex provides a global platform for fine wine traders. Professionals often consider their price indices as a benchmark of fine wine exchange. Liv-ex Fine Wine Investables index started from 1988, and is one of their leading fine wine price indices, composed of most dominant

² The Source of all macroeconomic data is from the OECD Statistics.

investment-grade wines. It contains around 200 Bordeaux red wines from 24 top chateaux dated back to the 1982 vintage and chose 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 with taking into account of its scarcity³. We also include 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 term with the U.S. consumer price index.

We take the global wine production as the variable from the supply side. The data is available in the database of Organisation Internationale de la Vigne et du Vin (OIV). Since the 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 put the same production or consumption level for the twelve months of a given year in our estimation.

In place of the Industrial Production Index in Cevik and Sedik (2014), we use the 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, by contrary, 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 each economy⁴. National GDPs expressed in national currencies are converted and deflated into real dollar. Since GDPs are in quarterly frequency, all months have the same GDP level for a given quarter in our estimation.

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/>.

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%.

Then we introduce the real effective exchange rate (REER) of U.S. Dollar to capture the effect of real exchange rate on fine wine price, the data which is published monthly by the Bank of International Settlement.

Normally, wine investment is a middle/long term engagement. For instance, wine investment funds used to provide contracts for a minimum 5-year engagement. And by definition, the broad money covers assets with less liquidity⁵. 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 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 dollar.

Another monetary variable is the U.S. real interest rates. According to the Fisher equation, the real interest rate is calculated approximately from the nominal interest rate minus the inflation rate.

As mentioned before, we use the financial assets of investment funds as percentage of GDP in the U.S. to estimate the impact of financialization on fine wine prices. This indicator is calculated from the sum of U.S. households and institutions' financial assets of investment funds divided by the U.S. GDP.

We put time dummy variables to capture all other elements which can conduct production or demand shocks (such as the financial crisis or the Chinese government gift-giving crackdown), and extraordinary or appalling vintage. If an event or several events happen in a specific year, all months equal to 1 for this year, and all the other time spots equal to 0. For example, DM2008 represents all the twelve months of 2008 equal to 1 and the others equal to 0.

4. Methodology

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 X12 seasonality adjustment tool to smooth the data. We apply 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

⁵“Broad money is the sum of M2, repurchase agreements, money market fund shares/units and debt securities up to two years.” Source OECD.

aggregated M3 of the G-4 are 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 first differences. Detailed results of ADF test are presented in annex 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):

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

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

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

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

Firstly, we use the Ordinary Least Squares Method to estimate the equations. Followed by the suggestion of Cevik and 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. According to our statistics, the null hypothesis that the

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

over-identifying restrictions are satisfied cannot be rejected. In the presence of residual heteroscedasticity and autocorrelation, the Newey-West estimator is used to address this problem.

5. Empirical results and interpretation

Table 1 and 2 show the results of our first model on the full time period and the sub-period, and Table 3 and 4 present the results of the second model (to compare with the results of Cevik and Sedik (2014), see annex 2).

Table 1: 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
Adjusted								
R²	0.34		0.32		0.48		0.47	
Num. Obs.	231		227		141		141	
Breakpoint Test: 2004m01			t-Stat.			Prob.		
Andrews-Fair Wald Stat.⁷			18.00			0.01		
Hall and Sen O Stat.⁸			29.73			0.76		

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

⁷ H0 : there are no structural breaks in the equation parameters.

⁸ H0 : the over-identifying restrictions are stable over the entire sample.

Table 2: 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
Adjusted								
R²	0.44		0.41		0.56		0.55	
Num. Obs.	231		227		141		141	

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

We consider 2004 as a time point where the financialization of the fine wine market activated, thus a breakpoint in our estimation. The reasons are as follows: firstly, through the figure, we can observe directly that the significant evolution of fine wine prices started from 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 from December 2003 and all indices were based or rebased at 100 in December 2003; thirdly, several Large and credible wine investment funds have been established in the U.K. since 2003. In addition, the Andrews-Fair Wald and Hall and

Sen Statistics confirm that January 2004 is a significant breakpoint over the entire sample⁹. The variables suit better on the period of 2004-2015 than on the full time period, with an improvement of 0.15 for the adjusted R² on average.

The global wine consumption and the aggregated GDP of the BRICs have significant positive signs. By contrary, the global wine production and the aggregated GDP of G-4 economies are not statistically significant¹⁰. This may indicate that during the relevant time period, the fluctuation of fine wine price is mainly driven by the demand side, and more precisely, driven by the demand from emerging markets. However, the fine wine prices are not sensitive to the production, or the global wine production may be not 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.

During the 2000s', the increasing demand from emerging countries was a powerful factor that has pushed the fine wine price to rise steeply. In response to the shock of the global financial crisis, actions were taken by central banks, including China's RMB 4 trillion stimulus package. In the meanwhile, the popularity of fine wine among wealthy consumers from emerging countries, have brought a strongly growing demand. The fine wine market quickly recovered from the crisis and experienced a strong upward momentum. Since the middle of 2011, following the chute 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 Chinese government. Besides, prestige-seeking consumers started to be rational against the "red obsession".

Statistically, the aggregated GDP of G-4 does not show any significant impact on fine wine prices, but still, the G-4 economies are important markets for fine wines. Imagining if we could remove the shock caused by the financial crisis, the demand from the developed countries – the traditional wine consumption markets may be relatively less volatile on the entire time period. For many prestige Bordeaux wine estates like the best-performing First Growth – Mouton

⁹ 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.

¹⁰ The aggregated GDP of G-4 appears significant with a negative sign in equation 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.

Rothschild, they trust *La Place*¹¹ a lot and keep a strong market in Europe¹². In the meanwhile, the U.S. has been a growing market in fine wine as well. However, the price of top-end wines skyrocketed due to the speculation on the secondary market where a considerable demand was contributed by the consumers or investors from emerging countries.

The real effective exchange rate of U.S. Dollar appears with strong and highly significant negative coefficients in every equation. The continuous weakening of the U.S. Dollar in real term favored the purchasing power of consumers or collectors from emerging markets, which encouraged further their wish of buying fine wines. The depreciation of national currencies together with the slowdown of economic growth in emerging countries harmed their purchasing power in real term, and therefore the demand declined and the price dropped.

The aggregated money supply of G-4 is not statistically significant on the full time period. However, it performs significant and positive on the period of 2004 – 2015. The impact of monetary factor appeared when the financialization of the fine wine market started. Along with the process of financialization, fine wines have been more exposed to capital flows and more sensitive to the 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 financial dimension. When investors are short of liquidity during the financial crisis, they can cash the fine wine assets to reduce the difficulties.

¹¹ *La Place*, *La Place* of Bordeaux, refers to the brokers and negociants in Bordeaux.

¹² Source : Interview with Philippe Dhalluin of Mouton Rothschild by Liv-ex.

Table 3: 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								
R²	0.35		0.35		0.52		0.50	
Num. Obs.	228		224		138		138	
Breakpoint Test: 2004m01			t-Stat.				Prob.	
Andrews-Fair Wald Stat.¹³			29.39				0.00	
Hall and Sen O Stat.¹⁴			29.68				0.92	

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

¹³ H0 : there are no structural breaks in the equation parameters.

¹⁴ H0 : the over-identifying restrictions are stable over the entire sample.

Table 4: 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								
R²	0.45		0.43		0.58		0.56	
Num. Obs.	228		224		138		138	

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

Table 3 and 4 confirm the previous results of model 1. In addition, the U.S. real interest rate¹⁵ and the U.S. investment fund as percentage of GDP appear significant on the period of 2004 - 2015. The influence of real interest rate is not very robust, since it only has a weak negative coefficient of 0.01 at the 10% significance, and only in the GMM equations. The growth of the investment fund has a clearer positive impact on fine wine prices, which confirms the financialization has played an important role in the fine wine market since 2004. We also

¹⁵ 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.

estimate the impact of the investment fund with the first model: create a combination of the investment fund and the development of the money supply. We obtain positive and significant coefficients for the investment fund as well¹⁶. However, when we add dummy variables in the equations, the influence of investment fund – the supplementary demand in fine wine seems to be absorbed by the dummies.

The introduction of dummy variables improves the adjusted R². In Table 2 and 4, we list the time dummy variables that appear significant. The dummy variables absorb the shocks from the consumption, so the global consumption is not significant any more in the equations with dummies. The results also confirm the negative influence due to the Subprime crisis in 2008, China-led boom during 2009-2010 and the market depression followed by the slowdown of economic growth in emerging markets since 2011.

Robustness check

Liv-ex Fine Wine 1000 index analysis

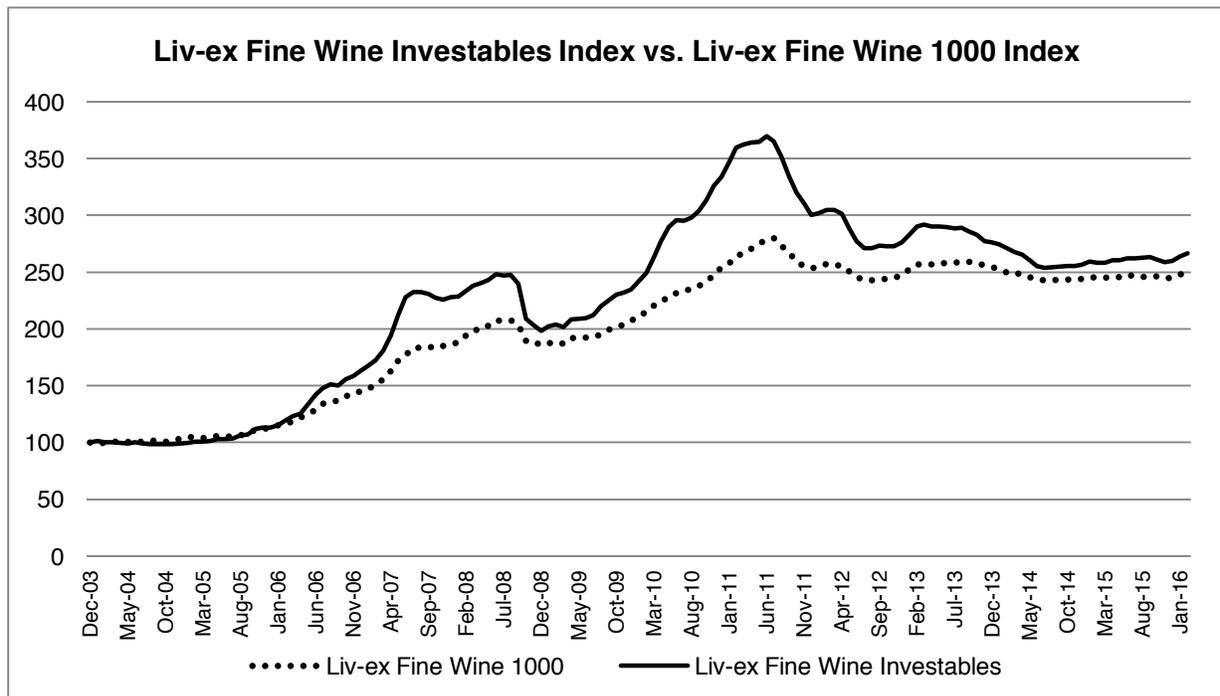


Figure 3: Liv-ex Fine Wine Investables Index and Liv-ex Fine Wine 1000 Index (Source: Liv-ex)

¹⁶ Relevant results are available on request.

According to Liv-ex, Bordeaux region dominates the fine wine market, and represents nearly 80% of the total trade by value. 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 a wider range of wine regions - 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 50¹⁷. 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 elder vintages. The data of Liv-ex Fine Wine 1000 is only 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 Fine Wine Investables index.

Table 5 and 6 show the results with 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 BRIC economies is only significant in model 1 with dummies. This finding coincides with the results of Cardebat and Jiao (2016 forthcoming) that the linkages between emerging markets and fine wine markets are less significant when come to the wines from other regions apart from Bordeaux. It might indicate that the major role of emerging markets on Liv-ex Fine Wine Investables index is due to their high demand on prestige Bordeaux wines, especially the First Growths, as 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 impact of aggregated money supply comes out with mixed results 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.

¹⁷ 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.

Table 5: 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								
R²	0.57		0.54		0.60		0.59	
Num. Obs.	141		141		138		138	

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

Table 6: 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								
R²	0.61		0.59		0.62		0.61	
Num. Obs.	141		141		138		138	

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

6. Conclusion

This paper empirically identified the macroeconomic determinants of fine wine prices and estimated their impacts on a monthly database from 1996 to 2015. This time period allowed us to capture information on different stages of the development of the fine wine market along with the macroeconomic fluctuations during the last twenty years. And we chose 2004 as a breakpoint where fine wines started to be more financialized and behave more sensitively to the economic cycles.

Based on 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 term favored the fine wine prices through the increasing of demand. Stronger national currencies encouraged the buyers from emerging economies of purchasing fine wines. Since 2011, the slowdown of economic growth in emerging markets followed by the depreciation of national currencies has engendered negative effects on fine wine market. However, based on our results of the robustness check, the strong influence of emerging markets seemed could only dominate the price fluctuation of Bordeaux fine wines, due to their “red obsession” in Bordeaux First Growths. As to the wines from other regions, the impact of emerging markets was very limited.

Along with the process of financialization in the fine wine market, the aggregated money supply, the real interest rate and the financial assets of investment funds as percentage of GDP started to show their influence on fine wine pricing. The real interest rate seemed to have a limited negative impact. Nevertheless, the growth of money supply associated with lower interest rates in real term did incite the investment in alternative financial assets including fine wines. The wine investment, by private collectors or professional investment fund, created a supplementary demand in addition to the wine consumption. As a result, the financial markets can influence fine wine markets directly through wealth or cash effect. A prosperous financial environment could favor the fine wine prices to increase; on the other hand, fine wine prices became more volatile under unstable financial conditions.

In the author’s opinion, 2016 is a new start. For investors, the fine wine investment is better to be a mid to long-term engagement; the drop of fine wine prices since 2011 does not only have its negative side, because it hauls back the irrational growth to a long-term equilibrium. As for wine professionals, facing the slowdown of economic growth in emerging markets, it is important to rebalancing the market share among Europe, Asia, and the Americas.

Along with hedonic price modeling, our research can provide a complementary analysis in the macroeconomic approach for wine price modeling and forecasting.

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Annex 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.

Annex 2: Results of Cevik and Sedik (2014)

Variable	Results for Real Wine Prices, 1998–2010							
	LS (1)		LS (2)		LS (3)		GMM (4)	
	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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.