Investing in the wine market: a country-level threshold cointegration approach

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Abstract

This paper investigates for a selection of countries the long-run relationship between wine share price indexes and general stock market indexes in order to exploit the potential of wine for trading strategies. Whilst most of the literature on wine investments analyses the return of investments of fine wine, this paper focuses on "normal" (i.e. non-fine) wine. We apply a Threshold Vector Error Correction Model (TVECM) to data from the Mediobanca database, which covers companies in the wine industry listed on regulated stock market in Australia, Chile, China, France and the US. The dataset covers the time period going from January 1, 2001, to the end of February 2009.

The estimates of the TVECM lead to the following conclusions: i) in more mature markets like France and the US, the presence of a threshold in the relationship between wine index and composite index permits informed investors to anticipate wine price movements and to make gainful investments; ii) in less mature markets, like Chile and China, the speed of adjustment of the composite index is the same as that of the wine index, providing evidence of a reduced space for similarly profitable gains in the wine sector; iii) no evidence of asymmetric cointegration was found for the Australian market.

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1. Introduction

Increasing interest in alternative investments has motivated fields of studies aimed at understanding the return and risk characteristics of stock prices in these alternative markets; in particular, there has been a rise in interest in the wine market, especially in the case of fine wine. Produced by the most prestigious estates in famous areas, fine wines have attracted attention due to their desirable market characteristics, such as low correlations with traditional stocks which allows for portfolio diversification strategies.
Despite the growing literature on financial wine markets, to the best of our knowledge there are no studies on non-fine wines (which will be referred to as "normal" wines in the remaining part of the article). A better understanding of the use of normal wine as a financial investment may be important not only from the perspective of investors, but also for the wine industry as a whole, which, in recent decades, has shown dramatic changes. In fact, while historically the wine market was dominated by European countries (often referred to as Old World countries), since the beginning of the 1990s new producing countries have found their way into the market, showing strong competitive potential thanks to their innovative strategies in production and trade (Campbell and Guibert, 2006). Europe (in particular France, Italy, Germany and Spain) still occupies a leading position on the world wine market, accounting globally for 49% of growing areas and 63% of wine production (data from the FAO databank for the year 2007). However, wine is also currently produced in Argentina (accounting for 9% of world production), the USA (8%), China (5%), Australia (4%), South Africa (4%) and Chile (3%). Contrary to many traditionally wine growing countries, where production has dropped by 25% compared to volumes in the 1990s, "New World" countries have registered astonishing rates of growth, at times with extraordinary speed (like in the case of China), entering not only the lower quality segment, but reaching up to the medium-high segment, once the exclusive domain of traditional long-established producers (Aylward, 2003; Aylward and Turpin, 2003).
The aim of this paper is to analyze the long-run relationship between wine share price indexes and general stock market indexes, enquiring about their causal relationship and their different speed of adjustment to the long-run equilibrium. In particular, the goal is to improve understanding of wine indexes, since they can be a potential financial benchmark of the wine sector as a whole, and provide investors with signals of informational inefficiency that could be exploited to make profitable investment strategies.
To achieve this objective, the paper makes use of the Mediobanca Global Wine Industry Share Price Indexes and the composite stock market indexes for a selection of countries – Australia, Chile, China, France and the United States - where wine shares are listed. The Mediobanca Wine Indexes encompasses companies operating in the wine industry listed on stock markets worldwide. The data series are analysed using threshold cointegration techniques to investigate the presence of asymmetric dynamic adjustment processes between these indexes. Non-linear adjustment allows prices to adjust in a different way to large or small deviations from the long-run equilibrium level. This is particularly suitable in the presence of market frictions, where traders act on the market only when expected profits exceed costs. In this sense, threshold cointegration constitutes an adequate specification, since the error correction mechanism is active only when the fluctuation away from equilibrium is above a certain limit (the threshold).

The novelty in this work is threefold. Firstly, the focus of the analysis is not on *fine* wine, as in most of the current literature, but on *normal* wine, in order to analyse investment opportunities. Secondly, the threshold cointegration methodology is applied to the wine sector; to the authors' knowledge no previous study has investigated the long-term dynamics between the share price of wine companies and whole stock market indexes. However, such an analysis is relevant since it enables a better understanding of wine share price adjustments, and it allows a better understanding of financial investment opportunities in this market segment. Finally, the paper presents the first use of the Mediobanca Global Wine Industry Share Price Indexes in an academic context, presenting this databank to the wider research community through the one of the uses that can be made of this resource.
The paper is organized as follows. Section 2 describes the theoretical framework. Section 3 presents the dataset used for the purpose of the study and a brief analysis of indexes performance. Section 4 proposes the econometric methodology and section 5 develops the empirical results. Section 6 includes the discussion and final remarks.

2. Theoretical framework

The economic literature on wine presents a wide range of interesting studies that have analysed the potential of wine as a financial investment (Fogarty, 2006, presents a well detailed overview on the subject). The most investigated has been the estimation of the rate of return of wines, comparing this value to the return from other common assets, both in the mean value and in the conditional volatility or covariance (among others, Krasker, 1979; Weil, 1993; Burton and Jacobsen, 2001; Sanning et al., 2007).
This literature has been interested only in fine and rare wines, and using auction data of specific wines or some composite indexes (e.g. *LiveEx*), its results have encompassed a broad mix of empirical findings that provided financial guidance in areas such as prices (Jaeger, 1981; Weil, 1993; Fogarty, 2006), buyer's premium (De Vittorio and Ginsburgh, 1996), speculative bubbles (Jovanovic, 2007), excellence of vintage and respective ranking (Jones and Storchmann, 2001; Masset and Henderson, 2008) and fluctuations in inventories (Bukenya and Labys, 2007). Among these studies, French fine wines are the most commonly analysed, together with the Australian high quality production.
Economists have also focused their attention on exploring the investment potential of wine within certain portfolio strategies, in particular those related to portfolio diversification. Their results indicate that wine has a low covariance with risk factors and thus might be used to improve the diversification of equity portfolios: that is to say, inclusion of wine in a portfolio, and especially more prestigious wines, increases portfolio returns while reducing risks, principally during episodes of financial upheaval. In particular, Sanning et al (2007) use the Fama-French three factors model and the Capital Asset Pricing Model to directly assess the risk-return profile of wines as compared to equities and find that investment grade wines benefit from low exposure to market risk factors, thus offering a valuable dimension of portfolio diversification. Masset and Henderson (2008) find that investing in the wine market might permit to achieve an attractive performance in terms of both average returns and volatility since wine returns are only slightly correlated with other assets and as such they can be used to reduce the risk of an equity portfolio. Moreover, Fogarty (2006) finds that the

performance of Australian wines is comparable to that of Australian equities; and Burton and Jacobsen (2001) demonstrate that the returns of a wine portfolio consisting only of wines from the 1982 vintage compare favourably with that of the Dow Jones.
Despite the extensive empirical literature on the wine market, there seems to be no studies that have analysed, from a financial viewpoint, normal wine instead of fine wine; moreover, to our knowledge, no previous studies have analysed the long-run dynamics of the wine stock market and the general trend of the stock market in order to exploit the potential of wine for trading strategies.
From a methodological standpoint, many academic studies analyse the interdependence between stock markets, their causal relationship, and the speed of adjustment to the long-run equilibrium. These studies are generally conducted in a framework of cointegration analysis and/or threshold cointegration analysis.
Testing for cointegration is relevant in view of the fact that if two economic time series are cointegrated, there must be a causal relationship in at least one direction. This implies that movements of one series can be used to predict fluctuations of the other: in other words, it is possible to anticipate the evolution of the dynamics of a stock market index through knowing that of another stock market index. In this context, it is possible to test the efficiency hypothesis[1], to study stock prices' adjustment dynamics and to investigate the opportunities of financial investments. In simpler words, if there is no efficiency in the market then active traders can anticipate price movements over the short run and make profitable investments from buying and selling stocks (Siourounis 2002).
Since the efficiency hypothesis assumes no transaction costs, free and symmetric information, as well as rational investors, studying stock prices and efficiency using linear cointegration techniques corresponds to the assumption of symmetric, linear and continuous stock prices adjustment dynamics. These set of assumption seem to be very constraining, since markets present frictions such as transaction costs, noise traders and imitative behaviour, and this can imply price adjustment dynamics towards fundamental values which are discontinuous and nonlinear (Enders and Siklos 2001, Shively 2003, Prat and Jawadi 2008).
To address these limitations, part of the literature extends linear modelling to the nonlinear case by adopting the threshold cointegration technique, following the seminal paper of Balke and Fomby (1997). This econometric technique allows for non-linear adjustments in the long-run equilibrium (Perez-Quiros and Timmermann 2000, Maasoumi and Racine 2002, Anderson 1997).
The economic rationale for considering the possibility of a non-linear rather than a linear type of adjustment to the long-run equilibrium is that the first allows prices to adjust in a different way to large or small deviations from the long-run equilibrium level. This implies that the dynamic behaviour of the rate of return differs according to the size of the deviation. In fact, this methodology captures those adjustments that are active only when deviations from the equilibrium exceed a threshold, which is often represented by transaction costs (Jawadi and Koubaa, 2004; Aslandis and Kouretas 2005, Sercu et al. 1995). In fact, traders may not act immediately as prices move, due to the possibility of "mis-price deepening" (Shleifer, 2000), but they act only when the expected profits exceed the costs. In this sense, the threshold cointegration constitutes

[1] According to Fama (1965) in an efficient market all available information is instantaneously and completely reflected in stock prices. Thus, it is not possible to forecast future price evolution on the basis of previous stock prices variations because this information is already integrated in the present price.

an adequate specification, since the error correction mechanism is active only above a certain size of the variation compared to the equilibrium.
In other words, in the linear cointegration approach the adjustment parameters are assumed to be constant within the period analysed, while in the threshold cointegration approach the error correction terms (ECTs) are inactive when the value is inside a given range, but are active above a certain threshold. When the deviation from equilibrium is above the critical threshold, agents enter the market to implement profitable arbitrage activities, moving the system back to the equilibrium (McMillan, 2003 and 2005).

3. The Mediobanca indexes: evidence on stock performance

3.1 The data

The analysis presented in the paper makes use of data on the wine share price index and the composite stock market index of the stock exchange for five countries: Australia, Chile, China, France and the US. The dataset covers the period starting on January 1, 2001 up to the end of February 2009. All series are expressed in euro and appear in the econometric model in logarithmic form. The wine series is the Mediobanca Global Wine Industry Share Price Index from Mediobanca[2], which covers companies operating in the wine industry, listed on regulated stock markets and quoted for at least six months. Prices are computed daily and represent a financial benchmark of wine, measuring and monitoring the dynamic of risk and return of wine stocks. The index is calculated for each of those countries whose stock had traded at least three titles that meet some specific selection criteria[3].
Data on the composite stock market series are daily prices supplied by Datastream, and represent the performance of the whole stock market for a given country. Specifically, the data used is for the Australian S&P/ASX200 index, the Chilean IPSA index, the Chinese SSE index, the French CAC40 index and the US S&P500 index[4].
All indexes are "capitalisation-weighted", that is the components are weighted according to the total market-value of their outstanding shares.
Both series are "price" indexes, expressive of the dynamics of stock prices alone and without the component of income represented by the distribution of dividends. "Total return" indexes, which also include dividends, are available for all series, but the pure price index is preferred. The rationale of this choice is that the dividend policy adopted by each company is not relevant in the analysis presented here, as in general dividends do not reveal the level of volatility that would be necessary to influence the null hypothesis of "no cointegration" among a set of share price indices (Dwyer and Wallace 1992, Subramianan 2009).

[2] http://www.mbres.it/

[3] The Mediobanca indexes include wine companies selected according to the following characteristics: companies listed on regulated markets; series of quotes of at least six months; at least 50% of revenues must come from initiating wine; commitment as direct management in the production cycle. The panel index is comprised of 42 stocks and has an aggregate market capitalization of €14.3bn.

[4] The S&P/ASX200 index is the stock market index of Australian stocks listed in the Australian Securities Exchange; the IPSA is a stock market index composed of the 40 stocks with the highest average annual trading volume in the Santiago Stock Exchange; the SSE is the composite index from the Shanghai Stock Exchange; CAC40 is the benchmark French stock market index and includes the 40 most significant stocks in terms of liquidity; and finally the S&P500 includes the prices of 500 large-cap common stocks actively traded on the two largest American stock markets, NYSE and NASDAQ.

3.2 The performance

Figure 1 shows the cumulative stock return for wine indexes over the period from 2001 to 2009.

(insert Fig. 1)

At the end of this eight year period France, the US and Australia had achieved almost similar total cumulated returns (respectively 37%, 37% and 40%), although with very different dynamics. In particular, the French wine index suffered a decline between the beginning of 2001 and mid 2002, followed by a stable rise and then steeper growth from the beginning of 2005 up to the beginning of 2008. During this last period the French wine index almost tripled. Since mid 2008, however, the index has decreased in line with other financial assets and stock markets as a result of the global economic crisis,.
In Australia, after an initial bearish trend, the wine index showed a stable pattern over the period, while in the US the wine index rose between 2003 and 2006 and later declined, although to a lesser extant than its French counterpart.
Chile and China have reached a higher level of cumulative returns over the 2001-2009 period (respectively 101% and 94%), but again with different patterns. In particular, the value range of the Chilean index went from a minimum of 99.50 points to a maximum of 290 points, while in China the index declined significantly until the end of 2005 and then climbed sharply at the beginning of 2008. The strong performance of the index for China continued into 2009.
Estimates of average daily return and volatility for the wine and composite index were also calculated and are summarised in Table 1.

(insert Tab. 1)

For France, the US, Chile and China the average daily return of wine indexes is higher than that of composite indexes (respectively CAC40, S&P500, IPSA, and SSE) over the 2001-2009 period. More specifically, while the average return of wine indexes is always positive, the average return of composite indexes is negative for all countries except Chile. The most significant difference is that from the US, where the average daily return of the wine index is 95% while the S&P500 average daily return is -28%. Looking at yearly intervals, it becomes apparent that only rarely wine indexes yield negative returns, almost always outperforming the composite indexes.
Australia is the only exception. There, apart from the 2001-2002 interval, the wine index average return is lower than that of the S&PASX200. The Australian wine sector has achieved many successes in recent decades through government measures promoting exports and low taxes. Moreover the Australian wine industry is characterised by high levels of concentration (four companies accounting for over 75% of production), providing economies of scale in producing value-for-money wines. However, after a planting boom during the mid to late nineties, from 2001 onwards this country has gone through a very difficult period mainly due to strong supply pressure. As a result a number of listed companies have announced profit downgrades (including

Southcorp company, Australia's largest wine producer), perhaps contributing to making wine stocks less of a profitable investment.
Elsewhere risk features of both indexes are more heterogeneous. Chile and France show a lower wine index volatility, while for Australia, the US and China the volatility of the wine index is slightly higher than that of the composite. It is interesting to note that during the financial crisis across the period of 2007-2008 all countries except the US show a conditional volatility of wine index that is lower to that of the composite index.
Overall, what emerges from the analysis of the returns is that in general wine indexes performed well during the last decade and investors could have earned greater returns by investing in these indexes rather than solely investing in the domestic composite indexes, although in some cases they would have been exposed to greater volatility.
The superior performance of the wine index is clearly visible from the following graphs in Figure 2, which represent the cumulative abnormal return of the wine indexes, that is the market-adjusted abnormal return.

(insert fig. 2)

The abnormal return is estimated by subtracting the composite stock market index from the return of the wine index. The resulting evidence is quite interesting. Apart from Australia, whose wine industry suffered a crippling financial crisis during the mid 2000s (see above), the cumulative abnormal returns remained significantly positive for almost all years and in all countries.
From Figure 2 it is noticeable that the US registered the best performance of the countries under analysis. This is not surprising given that the American. wine industry leads the group of New World wine producers and is the world's fourth largest wine producer, however remaining a net importer of wine (Canning and Perez, 2008; Goodhue et al., 2008). The growth of the sector started several decades ago and continues to this day, not having had any apparent slowdown recorded since its early days. Like in other New World wine industries, firm concentration is particularly high, even if the industry has been evolving recently with the proliferation of new wineries (Insel, 2008). In addition the sector benefits from a concentrated and efficient distribution system for products. These factors together help explain the good performance of US wine stocks in the financial markets.
Elsewhere, the abnormal return for France is high, but lower than that of the US. The country, traditionally one of the largest world producers and consumers of wine, has a fragmented industry subjected to too many controls (Terblanche et al. 2008). Since 2001, French wines have been going through a slowdown period, losing market share both in domestic and in export markets, a situation exacerbated by negative currency effects arising from a strong euro (Castaldi et al. 2006).

On the other hand, the Chilean wine sector has developed an notable production and export record during the last decade and many wine firms have developed the competences to be present in an increasingly large number of countries (Giuliani and Bell, 2005; Gwynne, 2008). Concha Y Toro, the market leader, has become the most successful Chilean exporting company transforming its business radically and becoming the world's first winery to list on the New York Stock Exchange. It should not be surprising, therefore, that the Chilean wine sector's performance in terms of return should have been positive.

Finally, the Chinese wine industry although still oriented towards the domestic market (which is still relatively small and is dominated by the medium and low quality segment), has made very rapid progress in recent years (Jenster and Cheng, 2008; Mitry et al., 2009), with the performance of wine in the stock market having been always satisfactory, surpassing that of the Shanghai Stock Exchange.
As a concluding remark, it can therefore be argued that in general wine indexes have performed well compared to composite indexes during the last decade, and that investors could have earned greater returns by investing in this market. Moreover, in addition to potential greater returns, investments in wine can be used as part of a strategy of portfolio diversification to reduce risks (Sanning et al.,2007; Masset and Henderson, 2008; Masset and Weisskopf, 2010) or may allow for the application of trading rules in order to exploit stock market inefficiencies. The importance of investments in wine as a trading rule to take advantage of market inefficiencies has been overlooked in the relevant literature until now, and it is therefore the focus of our analyses. The key question we pose is whether investors can exploit the dynamic of stock markets to predict wine indexes returns and thus make profitable investments by buying and selling stocks.

4. Econometric methodology

Evidence of cointegration (Granger, 1981) among several indexes of stock prices suggests that series have the tendency to move together in the long-run even if they experience short-term deviations from their common equilibrium path (Masih and Masih 1997, Patra and Poshakwale 2008). These traditional models assume that the adjustment process to maintain the *equilibrium* occurs at every time period. However, many situations, and in particular stabilisations of commodity prices, are often characterized by discrete interventions. In recent years two main classes of models have been proposed in the literature to characterise this kind of non-linear adjustment process. One class considers Markov-Switching Vector Error Correction models, assigning probabilities to the occurrence of different regimes (Hamilton, 1989; Krolzig, 1997). The second class is based on Tong and Lim's (1980) approach using a Self-Exciting Autoregressive Model where the regimes that have occurred in the past and the present are known with certainty, "certainty" being established using statistical techniques. In this framework, Balke and Fomby (1997) introduced the concept of "threshold cointegration", a feasible estimation methodology that allows the adjustment process to move differently in separate regimes. They hypothesised that this movement towards a long-run equilibrium may not occur in every time period, but only when the deviation from equilibrium exceeded a critical threshold. Following Balke and Fomby (1997), in this paper we apply a threshold vector error correction model (TVECM), with a threshold effect based on an error correction term. In the case of two regimes, Balke and Fomby (1997) present a TVECM of order L+1 that takes the form:

$$\Delta x_t = \begin{cases} A_1' X_{t-1}(\beta) + u_t, & if\ w_{t-1}(\beta) \le \gamma \quad regime1 \\ A_2' X_{t-1}(\beta) + u_t, & if\ w_{t-1}(\beta) > \gamma \quad regime2 \end{cases} \qquad [1]$$

where

$$X_{t-1}(\beta) = \begin{Bmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \Delta x_{t-2} \\ \vdots \\ \Delta x_{t-l} \end{Bmatrix} \qquad [2]$$

and x_t is a *p*-dimensional time series I(1) cointegrated with one *(p* x *1)* cointegrating vector β, $w_t(\beta)$ is the ECT, u_t is the error term assumed to be an *iid* Gaussian sequence with a finite covariance matrix. A_1 and A_2 are matrices of coefficients describing the dynamics in each regime, while γ is the threshold parameter. The values of w_{t-1} below or above the threshold γ allow the coefficients to switch between regimes 1 and 2; in particular, the estimated coefficients of w_{t-1} of each regime denote the different adjustment speeds of the series towards equilibrium.

Hansen and Seo (2002) provided an estimation method for TVECM via maximum likelihood, which involves a joint grid search over the threshold parameter and cointegrating vector. In order to test for threshold cointegration, Tsay (1989, 1998) proposed non-parametric non-linearity tests, while Andrews (1993), Hansen (1996), Balke and Fomby (1997) and Lo and Zivot (2001) presented different methods of estimation based on the Lagrange Multiplier (LM) statistics. More recently, Hansen and Seo (2002) developed two SupLM (Supremum Lagrange Multiplier) tests for a given or estimated β using a parametric bootstrap method to calculate asymptotic critical values with the respective *p*-values. The first test is denoted as:

$$\sup LM^0 = \sup_{\gamma_L \le \gamma \le \gamma_U} LM(\beta_0, \gamma)$$

and would be used when the true cointegrating vector β is known *a priori*. The second test is used when the true cointegrating vector $\tilde{\beta}$ is unknown and the test statistic in this more general case corresponds to:

$$\sup LM = \sup_{\gamma_L \le \gamma \le \gamma_U} LM(\tilde{\beta}, \gamma)$$

where $\tilde{\beta}$ is the null estimate of the cointegrating vector. In these tests, the search region $[\gamma_L, \gamma_U]$ is set so that γ_L is the π_0 percentile of $\tilde{w}_{t-1}$, where $\tilde{w}_{t-1} = w_{t-1}(\tilde{\beta})$, and γ_U is the $(1-\pi_0)$ percentile[5].

[5] Andrews (1993) argued that setting π_0 between 0.05 and 0.15 is a generally good choice.

5. Empirical results

To implement the asymmetric cointegration approach, we carried out several steps. First, we tested the degree of integration of the variables via the Augmented-Dickey Fuller test (ADF) and the Philips-Perron test (PP). Subsequently, cointegration (Johansen, 1988; Johansen and Juselius, 1990) and Granger causality (Granger, 1969) between the price pairs (wine and composite index) were tested for each of the countries analysed. The following step entailed a test for the presence of threshold cointegration. Finally, TVECM was run using the Hansen and Seo (2002) procedure.
Table 2 shows the results of the ADF and PP tests, were Δ in front of variable names indicates the differentiated series. It emerges that all the series are I(1) with and without trend.

(insert tab. 2)

Since the price series have a unit root, the presence of cointegration between the series can be tested following the Johansen approach, using the Trace and Maximum-Eigenvalue tests. Both tests were conducted including an intercept in the cointegrating equations and estimating the model with a linear trend. The results in Table 3 indicate the presence of a linear cointegration relationship only in France. In the other countries the results indicate the absence of a cointegration vector at 0.05 critical value, leading to the conclusion that the Australian, Chilean, Chinese and American wine share price indexes and composite stock market indexes have a unlikely long-term linear relationship.

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In order to find which price is unresponsive to deviations from a long run relationship, causality is tested using the Granger approach (Granger, 1969). The Granger causality Wald test, reported in Table 4, highlights that the composite stock market index Granger-causes the wine share price index in Chile, France and the United States, while Australia shows a significance level just above 0.10.
In the case of China, the tests seem to show that the price relationship has no clear causality relationships between variables. This result could be due to the structure of the Chinese financial market, which is a substantially closed market, as confirmed by the financial indicator provided by the Institutional Profiles Database (CEPII, 2009). In fact, in the period considered in this study the Chinese market exhibited a low level of financial openness (Table 5). Moreover, a s a matter of comparison, it is possible to notice that the three developed economies (France, United States and Australia) and the two developing countries (Chile and China) have a substantial difference in the degree of openness.

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(insert tab. 5)

In order to empirically investigate the opportunity of financial investment in wine shares, we perform a threshold cointegration analysis. As already pointed out, this approach appears more appropriate, since traders act on the market only when the

deviation from long-run equilibrium is over a critical threshold. The presence of a threshold was estimated via the application of the Hansen and Seo (2002) SupLM test (when β is estimated) using a parametric bootstrap method with 3,000 replications. The results of the tests are reported in Table 6. The residual bootstrap value of SupLM test provides evidence of the presence of threshold cointegration for all the cases studied except for Australia.
The robustness of the TVECMs results are also supported by the rejection of the null of the equality of ECT coefficients between the two regimes detected. Apart from the Australian case of no threshold cointegration, the p-value of the Wald test is significant for all countries.

(insert tab. 6)

The threshold value identified in the French series detects the presence of two regimes with different adjustment speed in the long run equilibrium. Table 7 reports the estimated coefficients for the TVECMs and the related graphs that exhibit the error correction effect, i.e.: the estimated regression functions of wine and composite index as a function of ECT, holding the other variables constant. The first regime, defined as *usual regime*, includes the majority (94%) of the observations, while the second, defined as *unusual*, contains the remaining 6% of observations. As we can see in the figure, in the usual regime the ECT coefficients are quite close to zero, indicating that the variables are close to a random walk.
In the unusual regime the speed of the adjustment coefficient of the composite index (CAC40) is significant and higher with respect to the wine index. In particular, when the gap between the two price series exceed a critical threshold (γ>-9.477) the speed of the domestic stock market index's response in restoring the long run equilibrium is seven time faster than the wine share price index. Therefore, considering that the long-run relationship is governed by the composite index, as previously outlined by the Granger causality test, the different speed of adjustment could be used by investors to achieve profitable gains. Hence, when the price gap is over a critical threshold, informed investors operating in the wine sector exploiting market inefficiency can make gainful investments just by looking at the price adjustment dynamics of the domestic stock market.

(insert tab. 7)

Similar considerations to those relating to the French case could be formulated for the United States, whose TVECMs results are reports in Table 8. Here the usual regime include 61% of observations and, like in France, it's close to a random walk. Only when the price gap is over a critical threshold the adjustment coefficient becomes active in restoring the long-run equilibrium Granger-caused by the composite index. In contrast with the findings on France, however, in the United States the speed of adjustment of the composite index to the long run equilibrium is slower, but the adjustment process involves substantially more observations (39%). On the other hand, the composite index is three time faster than the wine share price index's response to the disequilibrium. Hence, also in the United States there is a boundary of profitable arbitrage in managing wine share price indexes. In particular, in the United States the differences in the adjustment speed are smaller but more frequent than in France. Consequently, agents

have more opportunities to make profitable investment, but with a shorter operating time span.

(insert tab. 8)

The findings on France and the United States differ from those related to the two developing countries analysed here, whose TVECMs results appear in Table 9 and 10. In Chile the unusual regime starts as a critical threshold of 3.48, but this regards only 10% of observations, while in China, where the threshold is -1.35, the usual regime includes 39% of observations. In both countries the ECTs of the usual regime exhibit small levels of significance and minimal dynamics, whilst becoming significant for both indexes in the unusual regime.
In the case of Chile, the coefficient of the speed of adjustment of the composite index is slightly larger than the wine coefficient, providing evidence of a reduced profitable space for investment.
In China, were most of the shares are held by Chinese retail investors, the results need to be interpreted with caution, due to the low degree of market openness to foreign investment discussed earlier in the paper. Nevertheless, the TVECMs give similar and significant ECT coefficients in the unusual regime for both series, showing no space for arbitrage, hence no profitable investments.

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(insert tab. 10)

6. Conclusion

This paper makes use of the Mediobanca Global Wine Industry Share Price index with the aim to consider the wine market like a possible alternative investment. The analyses regard five wine producing countries, Australia, Chile, China, France and the U.S. between January 1, 2001 to end of February 2009.
A first-step investigation of the Mediobanca Indexes' returns and abnormal returns shows that, apart from Australia, whose wine industry suffered an important financial crisis during the mid 2000s, in all the countries the wine indexes outperformed the composite indexes, revealing investment in wine stocks as a profitable investment *per se*.
We then focus our analyses on the potential of wine for trading strategies. Specifically, we investigate the long-run relationships between wine share price indexes and stock market indexes in the same wine producing countries in order to find market inefficiencies that can be exploited to make economic gains. This is done using non-linear cointegration to capture price adjustments, which are activated when deviations from the equilibrium values exceed some threshold.
Results confirm the existence of threshold cointegration between wine and composite indexes for the period under study for all countries except Australia. In particular, in more mature markets (i.e. France and the US), when the gap between wine index and composite index exceeds a critical threshold, the speed of adjustment of the wine index is lower than that of the composite index. This means that wine price deviations from

equilibrium last a longer time. Considering that the long-run relationship between the wine and composite indexes is Granger-caused by the composite index, informed traders can anticipate wine price movements over the short-run and make profitable investments as a result of the weak-form efficiency and different speeds of adjustments.

In less mature markets (i.e. Chile and China), the wine index and the composite index are still non-linearly cointegrated, but there is not a marked difference on the speed of adjustment between composite and wine prices. In those countries, results from threshold cointegration analysis lead to the conclusion that these markets are still not sufficiently effective to allow certain types of trading strategies.

Although results may need to be interpreted with caution, the evidence from Chile and China is likely to be the consequence of the different economic situations that characterise the different countries in the analysis, which include a different level of development of financial markets, and a different level of market openness, as outlined earlier in the paper. Erb et al. (1997) and Garten (1997) have already noted that in general emerging markets are complex and a proper understanding of the dynamics they experience hinges upon many factors. In particular, in an emerging context financial markets may be "thin": their size may be comparatively small in terms of market capitalisation, number of listed companies and trading volumes. Furthermore, they may be characterised by a different level of free-market capitalism and democracy, as well as other specific factors that shape the economic and political context that sets them apart within the countries under analysis.

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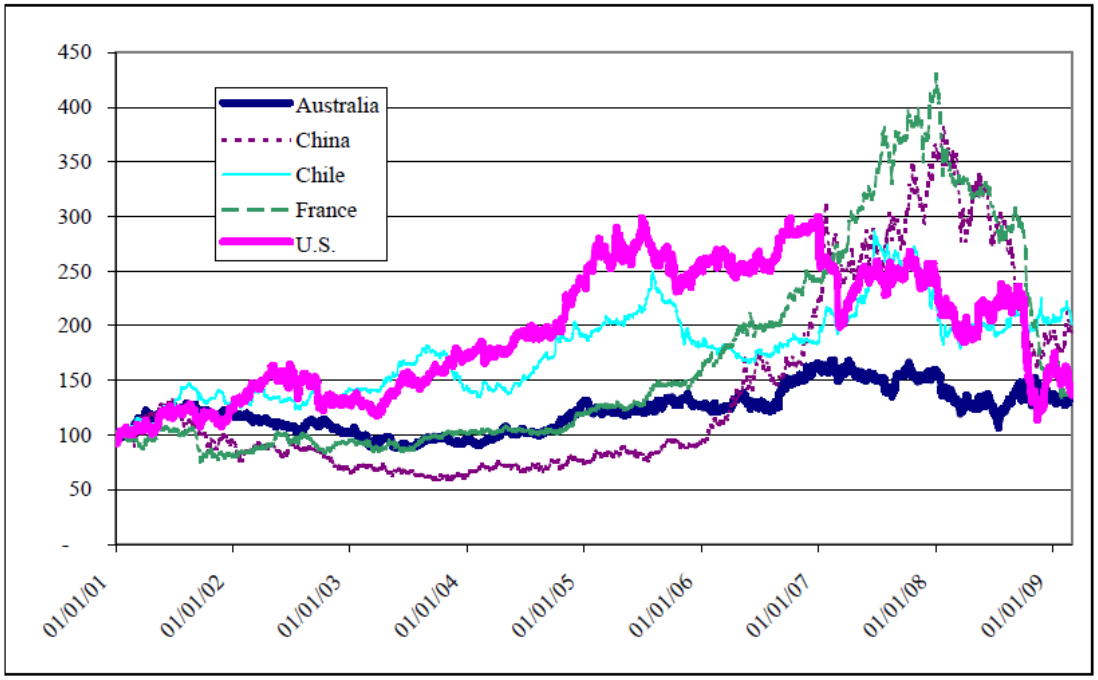
Fig. 1 – Cumulative stock return for wine indexes for the five countries



Source: our calculations on Datastream data

Fig. 2 – Abnormal return in each of the five countries

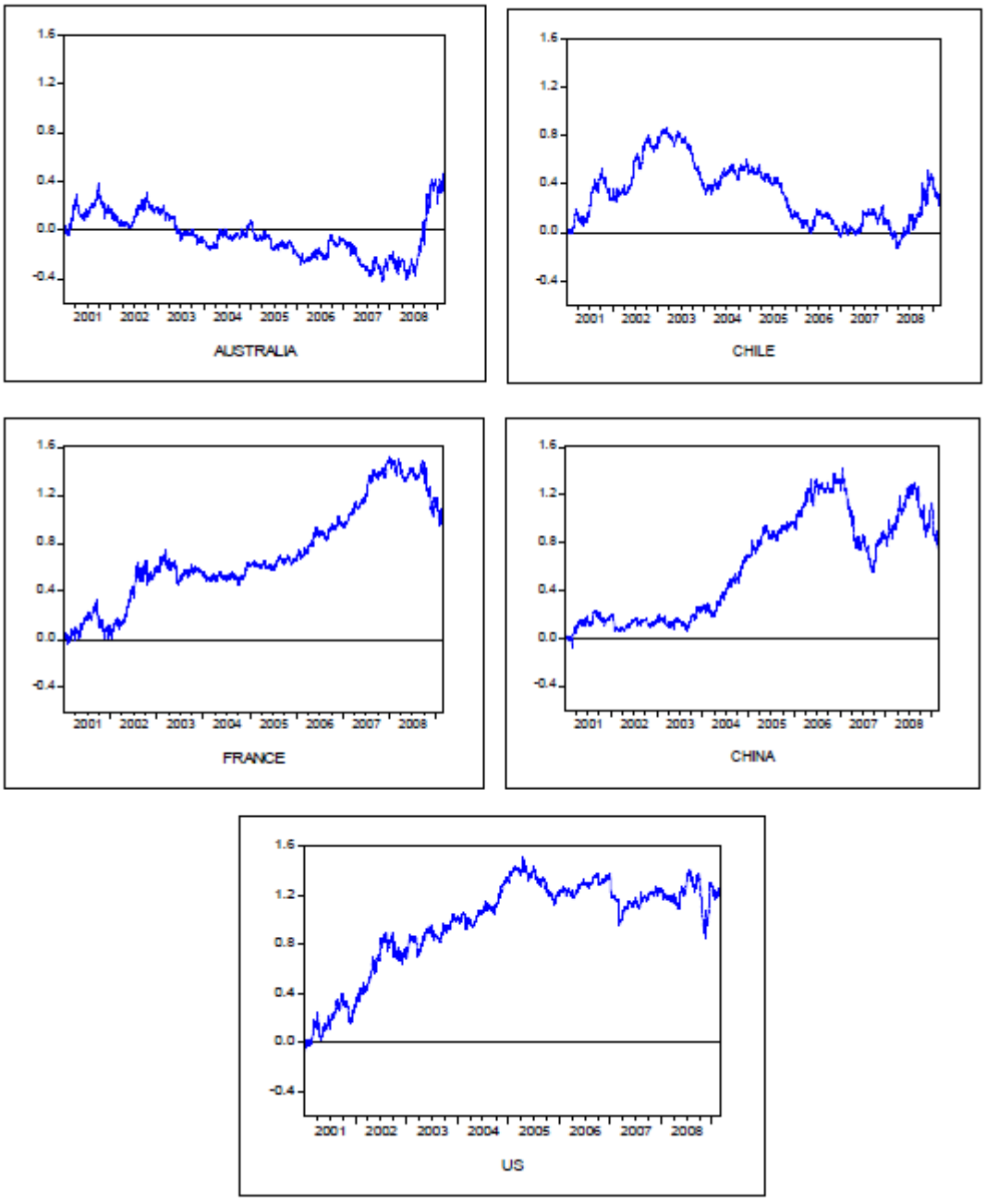


Table 1 – Daily wine and composite index returns and volatility

	Average daily return %		Cond. Volatility[(a)]	
	Wine	Comp.	Wine	Comp.
		Australia		
2001-2002	13.81	-1.24	1.02%	1.08%
2003-2004	-2.49	19.42	0.90%	0.78%
2005-2006	0.49	23.18	1.21%	0.90%
2007-2008[(b)]	-12.40	-5.05	1.81%	2.69%
all period	**22.40**	**30.96**	**1.37%**	**1.27%**
		Chile		
2001-2002	29.02	-10.40	0.90%	1.28%
2003-2004	11.33	36.38	0.90%	1.13%
2005-2006	0.90	32.09	0.80%	0.95%
2007-2008[(b)]	17.19	3.71	1.40%	1.73%
all period	**75.54**	**32.84**	**1.05%**	**1.28%**
		China		
2001-2002	-4.19	-14.98	4.54%	1.70%
2003-2004	2.50	-9.74	1.32%	1.38%
2005-2006	58.92	7.79	1.67%	1.44%
2007-2008[(b)]	21.80	77.40	2.46%	2.69%
all period	**41.14**	**-28.39**	**2.03%**	**1.93%**
		France		
2001-2002	-7.09	-25.73	1.28%	1.95%
2003-2004	5.02	11.06	0.91%	1.02%
2005-2006	40.07	21.63	0.90%	0.80%
2007-2008[(b)]	22.83	-11.89	1.45%	3.07%
all period	**67.45**	**-26.53**	**1.15%**	**1.78%**
		U.S.		
2001-2002	28.15	-14.58	1.68%	1.69%
2003-2004	31.91	4.95	1.15%	1.13%
2005-2006	9.74	12.90	1.37%	0.81%
2007-2008[(b)]	-28.03	-13.58	2.51%	1.90%
all period	**95.05**	**-28.52**	**1.87%**	**1.36%**

Source: own calculations with Datastream data

(a) All the volatilities were computed via GARCH(1,1) model except for the USA-composite index within the 2003-2004 range were the GARCH(2,1) was used

(b) The 2007-2008 range includes also 42 observations for 2009

Tab. 2- Test for unit root and stationary*

		ADF	PP	ADF	PP
		no trend		with trend	
AUSTRALIA	Wine	-1.904	-1.817	-2.442	-2.331
	ΔWine	-45.599	-45.665	-45.588	-45.653
	Composite	-0.980	-0.952	0.191	0.294
	ΔComposite	-45.995	-46.007	-46.032	-46.048
CHILE	Wine	-2.312	-2.304	-2.160	-2.432
	ΔWine	-42.741	-43.048	-42.767	-43.063
	Composite	-0.770	-0.895	-1.508	-1.713
	ΔComposite	-38.502	-38.390	-38.493	-38.381
CHINA	Wine	-0.561	-0.561	-1.502	-1.503
	ΔWine	-44.661	-44.638	-44.659	-44.636
	Composite	-1.098	-1.130	-1.205	-1.230
	ΔComposite	-46.186	-46.211	-46.229	-46.248
FRANCE	Wine	-0.803	-0.866	0.887	0.371
	ΔWine	-43.223	-43.858	-43.248	-43.870
	Composite	-1.360	-1.110	-1.329	-1.060
	ΔComposite	-48.517	-48.975	-48.508	-48.967
U.S.	Wine	-1.869	-1.855	-0.604	-0.522
	ΔWine	-46.838	-46.846	-46.922	-46.940
	Composite	-1.306	-0.877	-1.734	-1.298
	ΔComposite	-48.517	-48.975	-48.508	-48.967

**1% critical value: ADF and PP -3.430; ADF and PP with trend -3.960.*

Tab.3- Cointegration test between wine and composite index

Series	Hypothesized No. of CE(*s*)	Trace test	0.05 critical value	Max-Eigen test	0.05 critical value
AUSTRALIA	None	6.882	15.410	6.270	14.070
	At most 1	0.612	3.760	0.612	3.760
CHILE	None	12.227	15.410	10.363	14.070
	At most 1	1.864	3.760	1.864	3.760
CHINA	None	8.124	15.410	5.730	14.070
	At most 1	2.394	3.760	2.394	3.760
FRANCE	None	23.735	15.410	22.640	14.070
	At most 1	1.097	3.760	1.097	3.760
US	None	6.591	15.410	6.290	14.070
	At most 1	0.301	3.760	0.301	3.760

Lag(s) interval: lag=1 for Australia and China, lag=2 for France, United States and Chile (selected by Akaike Information Criterion in VAR). Trend assumption: linear deterministic trend.

Tab. 4 - Results of the Granger causality test between wine and composite index

Null Hypothesis	AUSTRALIA			CHILE			CHINA			FRANCE			US		
	χ^2	*df*	*p-value*	χ^2	*df*	*p-value*	χ^2	*df*	*p-value*	χ^2	*df*	*p-value*	χ^2	*df*	*p-value*
Composite does not Granger cause wine	2.527	1	*0.112*	20.072	2	*0.000*	3.343	1	*0.067*	55.186	2	*0.000*	5.237	2	*0.073*
Wine does not Granger cause composite	1.048	1	*0.306*	2.497	2	*0.287*	4.524	1	*0.033*	2.568	2	*0.277*	0.060	2	*0.970*

Tab.5- Capital market: financial openness to the outside world

	2001	2006	2009
AUSTRALIA	*na*	*na*	3.2
CHILE	1.0	3.4	2.8
CHINA	1.6	1.9	1.6
FRANCE	3.6	3.6	3.6
US	3.5	3.6	3.6

Source: CEPII- Institutional Profile Database

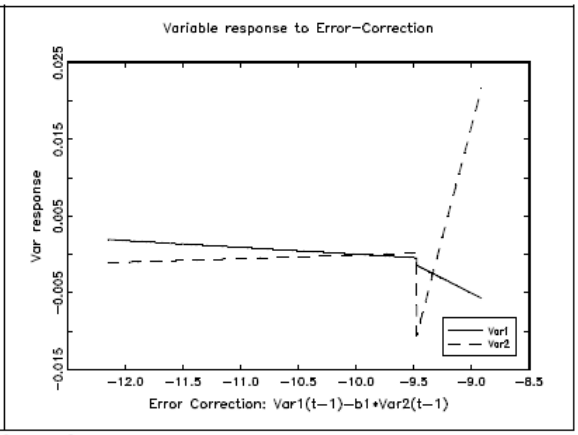
0 = prohibited. If authorised, from 1 = authorisation necessary to 3 = simple declaration and 4 = no declaration

Tab. 6 - Threshold cointegration test

	AUSTRALIA	CHILE	CHINA	FRANCE	USA
Test statistic value (Sup LM)	15.177	25.282	20.650	23.178	24.500
- *Residual bootstrap value*	*0.133*	*0.049*	*0.030*	*0.066*	*0.040*
Threshold value		3.480	-1.348	-9.477	0.284
Estimate of the cointegration vector		0.381	1.562	3.624	1.212
Wald test for equality of ECM coefficient		5.416	10.736	8.231	7.242
- *p-value*		*0.067*	*0.005*	*0.016*	*0.027*

Table 7 - Threshold VECMs between France Wine index and CAC40 composite index

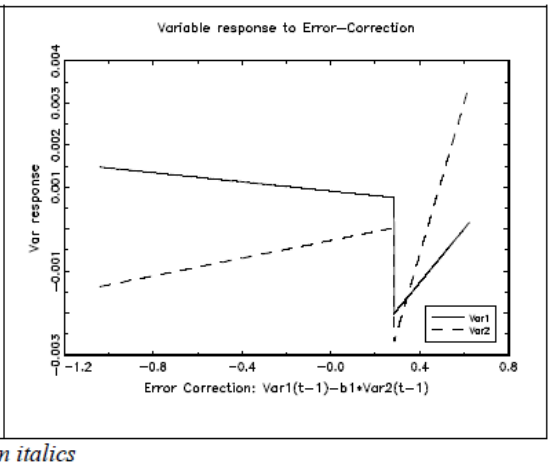
FRANCE				
	Usual regime (94% of obs.)		Unusual regime (6% of obs.)	
	Wine	Comp.	Wine	Comp.
W t-1	-0.001	0.000	-0.008	0.057
	-1.830	*0.696*	*-0.520*	*2.480*
Intercept	-0.009	0.005	-0.074	0.533
	-1.730	*0.639*	*-0.538*	*2.466*
ΔWine t-1	-0.009	-0.013	0.037	-0.143
	-0.315	*-0.376*	*0.330*	*-0.757*
ΔWine t-2	0.000	0.014	0.273	0.166
	-0.012	*0.347*	*2.070*	*0.768*
ΔComposite t-1	0.080	-0.076	0.160	0.143
	3.541	*-2.504*	*2.665*	*1.455*
ΔComposite t-2	0.037	-0.016	0.020	-0.090
	1.795	*-0.466*	*0.263*	*-0.946*



Note: Eicker-White standard errors are reported in italics

Table 8 - Threshold VECMs between U.S. Wine index and S&P500 composite index

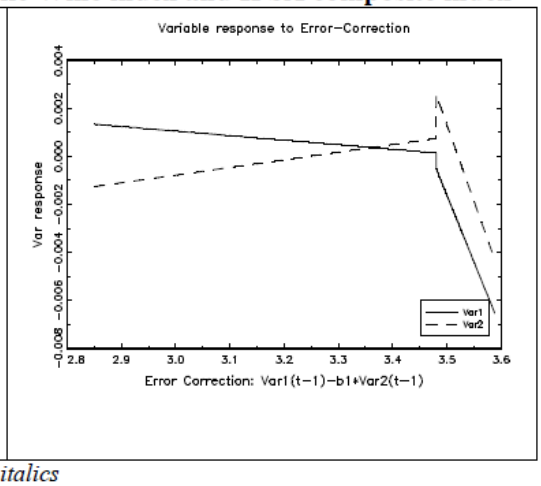
USA				
	Usual regime (61% of obs.)		Unusual regime (39% of obs.)	
	Wine	Comp.	Wine	Comp.
W t-1	-0.001	0.001	0.006	0.018
	-0.503	*1.039*	*0.790*	*2.811*
Intercept	0.001	0.000	-0.004	-0.008
	1.821	*-0.635*	*-1.176*	*-3.059*
ΔWine t-1	-0.005	0.000	0.015	0.005
	-0.113	*-0.008*	*0.308*	*0.111*
ΔWine t-2	0.019	-0.004	0.033	0.006
	0.530	*-0.108*	*0.687*	*0.159*
ΔComposite t-1	-0.063	-0.103	-0.082	-0.214
	-1.804	*-2.824*	*-1.235*	*-3.886*
ΔComposite t-2	0.029	-0.026	-0.250	-0.115
	0.665	*-0.656*	*-2.912*	*-1.320*



Note: Eicker-White standard errors are reported in italics

Table 9 - Threshold VECMs between Chile Wine index and IPSA composite index

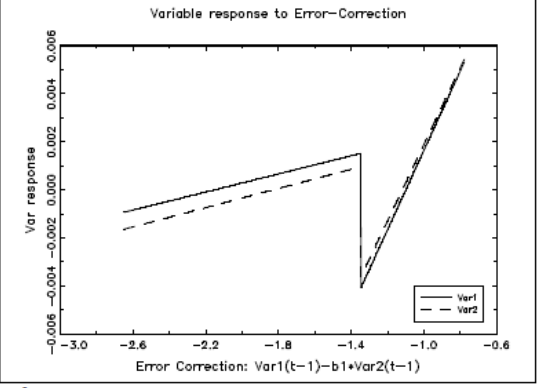
CHILE	Usual regime (90% of obs.)		Unusual regime (10% of obs.)	
	Wine	Comp.	Wine	Comp.
W t-1	-0.002	0.003	-0.056	-0.064
	-1.151	*1.511*	*-1.723*	*-1.933*
Intercept	0.007	-0.010	0.193	0.225
	1.253	*-1.501*	*1.705*	*1.941*
ΔWine t-1	0.028	0.013	0.156	-0.096
	0.858	*0.330*	*1.642*	*-1.196*
ΔWine t-2	0.069	0.100	0.059	0.087
	2.170	*2.378*	*0.561*	*1.258*
ΔComposite t-1	0.064	0.187	0.193	0.224
	2.942	*5.319*	*1.695*	*3.390*
ΔComposite t-2	0.017	-0.080	-0.300	-0.144
	0.755	*-2.018*	*-3.003*	*-1.593*



Note: Eicker-White standard errors are reported in italics

Table 10 - Threshold VECMs between China Wine index and SSE composite index

CHINA	Usual regime (68% of obs.)		Unusual regime (32% of obs.)	
	Wine	Comp.	Wine	Comp.
W t-1	0.002	0.002	0.017	0.016
	1.305	*1.258*	*3.490*	*3.270*
Intercept	0.004	0.004	0.018	0.018
	1.319	*1.055*	*3.509*	*3.539*
ΔWine t-1	-0.048	-0.009	0.198	0.084
	-1.189	*-0.200*	*3.226*	*1.460*
ΔComposite t-1	0.042	0.025	-0.169	-0.100
	0.909	*0.562*	*-2.997*	*-1.812*



Note: Eicker-White standard errors are reported in italics