Fine Wine as Hedge against Inflation: Cointegration, Time-Varying Cointegration – or no Cointegration at all?

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Abstract

There seems to be a general belief in financial markets that fine wine, as an alternative asset class, could be attractive for asset and portfolio managers fearing higher inflation rates in the future. Different cointegration tests are employed to analyze whether buying wine can be an effective strategy for investors who want to hedge against inflationary risk. At best there only seems to be time-varying cointegration between wine prices and macroeconomic price level in the United Kingdom, the United States and Germany. The non-parametric test which was developed by Breitung (2002) even suggest that there is no cointegration at all. Consequently, investors who primarily search for an asset class that can act as useful inflation hedge should most probably not consider buying fine wine.

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1. Introduction

Low interest rates in many developed countries have been a major driver of new trends in the asset management community. Institutional investors now have started to search for attractive yields in rather unusual places (see, for example, Jackwerth and Slavutskaya, 2016 and Kräussl, Lehnert and Rinne, 2017). Consequently, alternative assets have clearly profited from the current interest rate environment. In order to explain why bond yields of German or Austrian government bond yields have fallen into negative territory the US subprime debacle and the accompanying European sovereign debt crisis seem to be of central importance. As a matter of fact, these two crisis events clearly seem to have had a lasting effect on the risk aversion of investors in almost all parts of the world. Asset managers working in investment funds, banks and insurance companies back then started to avoid risky assets due to fears about a possible breakdown of the global financial system. In combination with interest rate cuts and asset purchases ("quantitative easing") by many central banks this changed investment sentiment in financial markets caused a fall to government bond yields issued by countries with AAA or AA credit ratings (see, for example, Guidolin and Pedio, 2017 and Corsi et al. 2018). While some central banks meanwhile have started to alter their strategic plans by stopping bond purchases, increasing short term interest rates and selling assets to reduce the volumes of their balance sheets the European Central Bank still has not been able to make changes to its very loose stance of monetary policy. Consequently, the yields of sovereign bonds issued by countries like Germany, Austria or the Netherlands still remain on very low levels. Generally speaking, this interest rate environment is problematic for asset managers. In particular, low bond yields do create some challenges for the European insurance industry (see, for example, Linderkamp et al., 2013 and Basse et al., 2014). Especially life insurers that have sold products with relatively high guaranteed returns to their customers in the past now have to face some difficulties resulting from the structure of their liabilities (see, most importantly, Berdin and Gründl, 2015 and Kräussl, Lehnert and Rinne, 2017). Without any doubt, given the low level of interest rates in the Euro Zone financing these guarantees has become very problematic for life insurance companies (see, for example, Linderkamp et al., 2013 and Niedrig, 2015). As a result, alternative assets have become more and more popular among asset managers in the European insurance industry (see, most importantly, Linderkamp et al., 2013 and Kräussl, Lehnert and Rinne, 2017).

The term "alternative investments" describes very different types of assets ranging from more traditional untraditional investment objects (for example, gold, commodities, private equity and hedge funds) to less traditional assets (e.g., art, fine wine or other collectables). Meanwhile, investors seem to search for attractive yields in almost all places. As a result, alternative assets have become quite popular among very different types of market participants (see, for example, Schulaka 2011 and Reddy, 2016). In any case, the low interest rate environment in many countries clearly has been an important cause for the new popularity of alternative assets. Moreover, the returns offered by alternative assets normally seem to have low correlations with other more traditional investment objects. Stalebrink (2016), for example, has stressed the importance of this point for Swedish pension funds and has noted that these investment objects are perceived to be important vehicles that can help to increase the portfolio diversification.

Schulaka (2011) has made similar observations examining the behavior of investment advisers in the United States. The return correlations among different asset classes, of course, are determined by economic fundamentals. Phrased somewhat differently, certain groups of investment objects that are quite similar from a fundamental point of view should have more strongly correlated returns than assets that have very different specific characteristics. Bryan (1985), for example, has calculated a quite high and statistically significant (5% level) positive asset return correlation between paintings and gold, a slightly positive – but statistically insignificant – asset return correlation between paintings and real estate assets and practically a zero asset return correlation between paintings and stocks. He then discusses the relationship between changes of painting prices and inflation taking the perspective of an U.S. investor. Compared to investment objects that are hurt by higher inflation rates two or more different assets that are useful hedges against inflation should, for instance, show more uniform price movements. As will be discussed in more detail later on collectables usually are considered to be good inflation hedges. Moreover, these investment objects are often traded in quite illiquid markets. Therefore, they could be attractive investment alternatives for life insurers and pension funds. In fact, given their liability structures these institutional investors have the time to harvest liquidity premia holding rather illiquid assets.

Examining collectables as investment alternatives this empirical study focuses on one very specific aspect – namely the ability of wine to act as useful inflation hedge. In order to do so the paper takes the perspective of investors in the UK, the U.S. and Germany and employs different techniques of cointegration analysis. More specifically, traditional cointegration tests, tests for time varying cointegration and nonparametric cointegration tests are used. The paper is structured as follows: The second paragraph briefly discusses collectables as investment objects. Paragraph 3 focuses on wine as a possible alternative asset. Then the literature on asset classes as hedge against inflation will be reviewed briefly in the 4th section. Paragraph 5 discusses some methodology issues and introduces the data that is analyzed. Before concluding in paragraph 5, the 6th section presents and evaluates the empirical evidence from different cointegration tests.

2. Collectables as investment objects

As already noted, institutional investors recently have become more interested in collectibles as alternative investment. Obviously, this is also a consequence of the current low interest rate environment in many countries (see, amongst others, Linderkamp et al., 2013 as well as Kräussl, Lehnert and Rinne, 2017). As a consequence, investors have started to look in unusual places for assets that can offer attractive returns or other advantages relative to more traditional investment objects. Meanwhile, more and more asset managers are willing to accept the idea that collectibles like jewelry, art, antiques, classic cars or fine wine could be interesting investment objects (see, for example, Fogarty and Sadler, 2014 and Laurs and Renneboog, 2019). The difficulties to determine the fundamental value of pieces of art have, for example, recently been stressed by Kräussl, Lehnert and Martelin (2016). Laurs and Renneboog (2019) have argued that unlike many more traditional financial assets collectables usually do not

generate significant cash flows, which can cause additional problems trying to determine their intrinsic value. However, there is also a rental market for art. This has briefly been discussed by Bryan (1985). Moreover, it also has to be noted in this context that collectibles can provide consumption value (see Bryan, 1985 and Campbell, 2008). In fact, investors might be able to derive pleasure from the usage of the collectables they own (e.g., by enjoying the beauty of paintings or by playing violins). Burton and Jacobsen (1999) have argued convincingly that this is a potentially important source of nonpecuniary return to an economic agent owning collectables.

Laurs and Renneboog (2019) have stressed that collectables usually can be bought and sold through either of three channels: auctions, specialized dealerships, and private sales. The markets for collectables are often characterized by a very low level of liquidity (see, for example, Burton and Jacobsen, 1999 as well as Masset and Weisskopf, 2018). As already noted, these quite unusual assets therefore could be attractive investment alternatives for life insurers and pension funds because of the long-term liabilities of these institutional investors. As a matter of fact, Burton and Jacobsen (1999) have noted that between the years 1974 and 1994 the British Rail pension fund had invested a significant amount of its assets in art.

One important reason for investments in collectibles obviously can be the hope for an attractive investment performance. Examining the historical evidence there is no really clear picture (see, amongst others, Burton and Jacobsen, 1999 as well as Masset and Weisskopf, 2018) but the rates of return that investor were able to generate in the past seem to lie somewhere between the return on equities and the return on government bonds (a finding which should probably be no major surprise). In some cases collectables even were more attractive than stock market investments. Most importantly, Masset and Weisskopf (2018) have pointed to the good performance of classic cars and fine wine. However, Burton and Jacobsen (1999) have argued that collectibles in general could provide a rather low rate of return because the nonpecuniary benefits from their ownership should result in a situation where buyers of collectables accept lower expected financial rewards. In fact, Frey and Eichenberger (1995) have stressed the importance of behavioral anomalies in art markets.

Investing in collectables can also help to diversify a portfolio of more traditional assets (see, for example, Burton and Jacobsen, 1999 and Laurs and Renneboog, 2019). On the one hand, Bryan (1985) has reported that there practically is a zero asset return correlation between the markets for paintings and stocks. Goetzmann (1993) and Chanel (1995), on the other hand, have argued that changes to stock prices could be a driver for changes in the art market. In fact, economic theory might suggest that gains in the stock market could result in a positive wealth effect that – at least under certain conditions – should spill over into the markets for collectables. Phrased somewhat differently, increases to stock prices could improve the financial situation of households and thereby might cause additional demand for collectables. Ginsburgh and Jeanfils (1995) have used traditional techniques of cointegration analysis and have in general not found empirical evidence indicating the existence of long-run cointegrating relationship between the markets for art and stocks; however, especially in Tokyo there seems to be a short-run positive impact of stock prices on the prices of the paintings of the Great Masters.

There is also the idea that investing in collectables could help to hedge portfolios against inflation (see, for example, Burton and Jacobsen, 1999 and Laurs and Renneboog, 2019). As a matter of fact, many investors seem to believe that collectables are real assets. Froot (1995), for example, has defined real assets as those investment opportunities that increase in nominal value as inflation rises. Therefore, economic theory seems to suggest that the prices of jewelry, paintings or classical cars will increase with higher inflation rates. Some investors might even hope that in an inflationary environment the prices of collectables could rise stronger than the macroeconomic price level.

3. Fine wine as investment object

Fine wine could be seen as a quite special alternative asset. Compared to other collectables the wine market seems to be characterized by a rather high level of liquidity (see, for example, Sanning, Shaffer and Sharratt, 2008 and Coffman and Nance, 2009). This is, of course, only a relative statement. Using more traditional assets as measure the wine market still has to be called quite – not to say very – illiquid. In this context Fogarty and Sadler (2014) have noted that the potential of wine to improve with age has clearly helped to create a quite active secondary market for this product. Bouri, Chang and Gupta (2017) have argued convincingly that wine prices in this market are affected by a number of non-financial factors that include the ranking of the wine, the type of grape used to make the wine, the year of vintage, the reputation of the producer and the production technology that was used by the vineyard in the process of wine-making. Fine wine that was made in the three traditional European wine producing countries France, Italy and Spain seems to be of special importance for investors. However, wines from other European countries can sell at high prices, too. Moreover, there are also fine wines that are made outside of Europe and still seem to be attractive for investors. Examples for New World wines with high prices can mainly be found in the United States, Australia and Chile. However, many investors buying this alternative asset class seem to have a clear focus on red wine that was made in the two French regions Bordeaux and Burgundy. Additionally, Fogarty and Sadler (2014) have stressed that investors are not interested in the prices of retail bottles of wine but in prices of wines that will benefit from extended aging. Moreover, they have also noted that very old and rare wines are more traded than antiques than as investment wine.

Given that fine wine is one important example for a collectable good that is also used as investment object it should be no surprise that the reasons for investors to buy wine are very similar to those for investing in other collectables. Most importantly, buyers have the intention to resell their wine at a higher price in the future trying to obtain attractive returns form the investment in this alternative asset. However, empirical evidence with regard to the ex post performance of wine investments does not show a clear picture. In fact, one of the earliest studies by Krasker (1979) has often been cited to show that wine might not be an attractive investment object at all. Nevertheless, Jaeger (1981) has argued that this result could be a result of the period examined by Krasker. Moreover, there might also be some problems with the assumed costs for storing wine (see, for example, Jaeger, 1981 and Burton and Jacobsen, 1999).

As already noted, Masset and Weisskopf (2018) recently have reported quite favorable results examining the performance of investments in fine wine. Additionally, buying fine wine could also help to diversify a portfolio that is invested in other assets (see, for example, Kourtis, Markellos and Psychoyios, 2012 and Aytaç and Mandou, 2016). While there is some empirical evidence pointing in this direction, Fogarty and Sadler (2014) have warned not to overestimate the potential diversification benefits that can be achieved by adding wine to a portfolio consisting of more traditional financial assets. Moreover, many market participants seem to believe that investing in fine wine could help to hedge against inflation (see, for example, Bouri, 2014 as well as Aytaç and Mandou, 2016). The importance of this reason to buy wine certainly should not be underestimated.

4. Financial Assets as Inflation Hedge: Literature Review

The introduction of the concept of cointegration by Engle and Granger (1987) has been very influential in the field of empirical economics. The new approach to modelling relationships among non-stationary time series clearly also has affected the research agenda in the area that is now commonly called financial econometrics. While there was empirical research analyzing the inflation-hedging characteristics of different financial assets before the techniques of cointegration analysis became popular in the late 1980s and early 1990s (see, for example Kolluri, 1981 and Bryan, 1985) the new concept in time series econometrics that was introduced by Engle and Granger (1987) has been very important for this strand of the literature. As a matter of fact, real assets have to be cointegrated with the macroeconomic price level in order to be a useful hedge against inflation (see, for example, Basse and Friedrich, 2010 and Beckmann and Czudaj, 2013).

Meanwhile, numerous studies have employed this approach to examine whether investing in certain assets can help to escape the loss of purchasing power that more or less by definition is a direct consequence of inflation. Especially data from different equity markets has been analyzed quite extensively. In fact, economic theory seems to suggest that stocks are claims representing the ownership of income generating real assets (see, for example, Fama, 1981 and Geske and Roll, 1983). Viewed from a slightly different perspective the dividend payouts that firms make ought to rise with inflation (see, amongst others, Basse and Reddemann, 2011 as well as Baker and Jabbouri, 2017).

However, the empirical findings that have been reported in the literature are mixed (see, for example, on the one hand Anari and Kolari, 2001 and on the other hand Floros, 2004). Bampinas and Panagiotidis (2016), for example, have examined whether individual stocks can hedge investors against inflation in the U.S. and have reported that the ability of the simple strategy to own shares in companies to escape the negative real wealth effects of inflation seems to have declined steadily over the past ten years. More specifically, their empirical findings seem to imply that buying stocks from the energy and industrial sectors should be the best choices for investors fearing inflation. Additionally, Ciner (2015) has reported empirical evidence implying that mall company stocks are better inflation hedges than large company

stocks analyzing U.S. data. Moreover, Basse and Reddemann (2011) have shown that in the U.S. there is a statistically significant positive reaction of dividend payouts to inflationary shocks. Luintel and Paudyalin (2006) have analyzed the relationship between inflation and share prices from seven industry groups in the UK and in most cases have reported significant shifts in the cointegrating vectors among stocks and retail price indexes. Examining data from 18 countries Maghyereh (2006) has also stressed the need to find ways to cope with the nonlinearities in the relationship between stock returns and inflation.

Buying property has also been suggested as a strategy to hedge against inflation. At the moment, there is mixed evidence reported in the literature. In fact, some empirical studies have found cointegration between house prices and relevant macroeconomic price indices while other have not (see, for example, on the one hand Stevenson, 2000 and on the other hand Tarbert, 1996). Anari and Kolari (2002), for example, have shown that house prices are a stable inflation hedge in the long run even when examining macroeconomic price data that does not include housing costs. Purchasing shares of real estate investment trusts might also be a good strategy to protect investors from a loss of purchasing power due to inflation. Real estate investment trusts are companies that own, operate and/or finance real estate assets. Cointegration tests have also been used to examine whether this quite special asset class can be an effective hedge against inflation. Again, there is mixed empirical evidence (see, amongst others, Chatrath and Liang, 1998 as well as Stevenson, 2001). Chatrath and Liang (1998), for example, have shown that the empirical technique employed seems to affect the results. Moreover, Basse (2012) has reported that in the U.S. real estate investment trusts seem to be cointegrated with the headline consumer price index. However, his results do indicate that investing in real estate investment trusts mainly can help to hedge against housing-related changes of the US consumer prices.

Some alternative assets could also be useful inflation hedges. Especially gold, silver and other commodities might be attractive for investors that fear a loss of purchasing power due to a rising general price level. Empirical research that examines whether gold is a good hedge against inflation has become quite popular since the acceleration of inflationary pressures in the 1970s. Earlier studies have used standard techniques of time series analysis (e.g., Kolluri, 1981 and Jaffe, 1989). Meanwhile there also are many empirical studies that employ techniques of cointegration analysis. Evidently, there still is no clear picture at the moment. Some papers have reported empirical evidence showing that gold can be an effective long-run hedge against inflation (see, for example, Gosh et al., 2004; Shahbaz et al., 2014). However, there is also less favorable empirical evidence indicating that the gold price is not cointegrated with different relevant macroeconomic price indices (see, amongst others, Van Hoang, Lahiani and Heller, 2016 and Kumar, 2017). Taylor (1998) has reported that the specific techniques to test for cointegration seem to matter in this context. In fact, his study shows that the results obtained by using the technique suggested by Engle and Granger (1987) differ from the findings employing the approach developed by Johansen (1988). Cointegration techniques meanwhile have also been used to examine the relationship between the silver price and inflation data on a macroeconomic level (see, for example, Taylor, 1998 and Adrangi, Chatrath and Raffiee, 2003). Additionally, there is also some empirical evidence examining broader commodity

indices (see, for example, Mahdavi and Zhou, 1997 and Basse and Friedrich, 2010). One of the most important empirical studies showing that the gold price and U.S. consumer prices are cointegrated is Bampinas and Panagiotidis (2015). This paper examines UK and U.S. data from 1791 to 2010 and uses different techniques testing for contegration. Comparing the experiences in the two countries the inflation hedging ability of gold is on average higher in the US compared to the UK. Moreover, Bampinas and Panagiotidis (2015) also have examined the capability of silver to act as effective inflation hedge. Their empirical findings suggest that silver does not hedge investors agiants movements to U.S. consumer prices but that there is evidence in favor of a time-varying long-run relationship with the macroeconomic price level in the UK. Aye et al. (2017) have even examined data from 1257 to 2016 and have stressed the importance of changes to the grade of integration of the time series included in the model. In spite of these problems, they have also shown that there is clear evidence for cointegration among gold and the UK retail price index in the last century. In any case, structural change clearly is a problem testing for cointegration among the gold price and macroeconomic measures of inflation. As a matter of fact, Worthington and Pahlavani (2007) have demonstrated that gold and inflation are cointegrated taking into account the structural breaks identified using a test procedure suggested by Saikkonen and Lütkepohl (2000). The importance of structural breaks has, for example, also been stressed by Aye, Chang and Gupta (2016). In fact, Beckmann and Czudaj (2013) have argued that the cointegration relationship between the gold price and inflation is regime-dependent. Batten, Ciner and Lucey (2014) also have reported empirical evidence indicating that there is significant time variation in the relationship between the gold price and inflation. These findings clearly are of major relevance for our empirical study. In fact, it seems to be necessary to cope with time-variation in cointegraton relationships and nonlinearities in general when examining whether fine wine can be regarded as effective inflation hedge. Moreover, it has to be noted that most empirical studies examining whether buying gold can help to hedge a portfolio against inflation have taken the perspective of U.S. investors. One very notable exception is a paper by Chua and Woodward (1982) demonstrating that for investors outside the U.S. gold is not necessarily a useful inflation hedge. This finding also is of some importance for our empirical study. In fact, given that the currency area examined could affect the results we will take a more international perspective by not only focusing on inflation data from the U.S. (respectively asset prices denominated in U.S. dollars).

5. Data and Methodology

This empirical study analyzes whether buying fine wine can help investors in the UK, the U.S. and in Germany to hedge against inflation. In order to do so official monthly price data at the consumer level is examined. From the perspective of economics this type of inflation number is of major importance. Consequently, the central banks in all three countries are very strongly focused on controlling inflation at the consumer level (see, for example, Pollard, 2003 and Hills and Macallan, 2011) With regard to the U.S. the price index used here is the Consumer Price Index for Urban Consumer which is published by the Bureau of Labor Statistics. The macroeconomic price index for the UK is the Retail Price Index (all items) which is obtained

from the Office for National Statistics. The inflation data for Germany that is used here is the Harmonized Consumer Price Index (all items). This time series is published by Eurostat. All three price indices are not seasonally adjusted.

The measure used to represent wine prices is the Liv-ex 100 Fine Wine Index. This is an important benchmark for financial markets (see, amongst others, Coffman and Nance, 2009 as well as Yeo, Fletcher and Shawe-Taylor, 2015). The data is taken from Bloomberg. The index is based on prices that are obtained from the wine exchange Liv-ex. This is the leading global trading platform for fine wines. The time series has a monthly frequency and its observations start in July 2001. The Liv-ex 100 Fine Wine Index represents the price movements of the 100 most popular fine wines for which there is a liquid secondary market. Most wines that are included in this index are from the Bordeaux region in France (see, for example, Masset and Henderson, 2010 and Kourtis, Markellos and Psychoyios, 2012). However, wines from some other French regions as well as from Italy are also included in this benchmark wine price index. The index value is calculated using Liv-ex mid prices, which are derived from transactions on the Liv-ex exchange. The composition of index (which means the selection of the wines that are included) is reviewed on a quarterly basis. The wine prices are denominated in GBP. Bloomberg exchange rate data is used to also convert the index in USD and EUR values.

Unit root test do indicate that all the six time-series examined here are non-stationary and integrated of order 1 (see tables 1 to 6). More specifically, the test suggested by Philips and Perron (1988) is employed. Given the results reported here cointegration among wine prices and the general price level could be a phenomenon of relevance. This study examines data from July 2001 to April 2019. As already indicated, the sample size is determined by the limited availability of wine price data. As already noted the Liv-ex 100 Fine Wine Index was created in summer 2001.

Table 1: Unit Root Tests. (*** denotes significance at 1% level)

	t-Stat (levels)	**t-Stat (first diff)**
US Consumer Prices	0.946955	-15.39019***
UK Retail Prices	-0.520142	-6.997060***
German Consumer Prices	0.066417	-19.10091***
Liv-ex 100 [USD]	-1.886184	-9.760067***
Liv-ex 100 [GBP]	-1.277855	-6.766197***
Liv-ex 100 [EUR]	-1.440896	-10.53960***

As already noted, a financial asset can only be regarded as an effective hedge against inflation when its price is cointegrated with the general level of prices. Quite clearly, cointegration is one of the most important concepts in modern time series econometrics. Two non-stationary time series integrated of order 1, for example, are said to be cointegrated when there is a linear combination of these variables that is stationary (see, most importantly, Engle and Granger, 1987). If cointegration exists, then there is a long run equilibrium relationship between the two

time series – which in the case examined here means that the price of an asset and the general price level follow a common stochastic trend. This paper at first uses the traditional technique introduced by Johansen (1988) to test for cointegration. This test procedure is based on the econometric technique of vector autoregressions of order n (see Johansen, 1988 and Johansen, 1991):

$$(1) \qquad y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_n Y_{t-n} + c_0 + c_1 t + u_t \, .$$

In equation (1) y is a vector of m possibly non-stationary variables, A_i is a m × m matrix (with i = 1, … , n), c_0, c_1 and u_t are vectors of constants, trend coefficients respectively error terms satisfying the usual assumptions. Equation (1) can be rewritten:

$$(2) \qquad \Delta y_t = (A_1 - I) y_{t-1} + A_2 y_{t-2} + \ldots + A_n Y_{t-n} + c_0 + c_1 t + u_t \, ,$$

$$(3) \qquad \Delta y_t = (A_1 - I) \Delta y_{t-1} + (A_1 + A_2 - I) y_{t-2} + \ldots + A_n Y_{t-n} + c_0 + c_1 t + u_t \, ,$$

$$(4) \quad \Delta y_t = \Pi_1 \Delta y_{t-1} + \Pi_2 \Delta y_{t-2} + \ldots + \Pi y_{t-n} + u_t = \sum_{i=1}^{n-1} \Pi_i \Delta y_{t-i} + \Pi y_{t-n} + c_0 + c_1 t + u_t,$$

where:

$$\Pi_i = - (I - \sum_{h=1}^{i} A_h) \, ,$$

$$\Pi = - (I - \sum_{i=1}^{n} A_i) \, .$$

At this point the rank of the long run impact matrix Π is of central importance. More specifically, k cointegration relationships among the m variables examined are said to exist when the rank of the matrix Π is k < m. Two likelihood ratio tests for the reduced rank of Π – the trace test and the max-eigenvalue test – are commonly used:

$$(5) \text{ Trace Stat} = - T \sum_{i=k+1}^{m} \ln (1 - \lambda_i) \text{ and}$$

$$(6) \text{ Max Eigenvalue Stat} = - T \ln (1 - \lambda_{k+1}).$$

In the equations (5) and (6) T is the number of observations. The trace statistic tests the null hypothesis that there are at most k cointegration relationships w where λ_i are the m – k ordered eigenvalues from the reduced rank regression. The max-eigenvalue test is very similar and tests

the null hypothesis that the rank of the matrix Π is k against the alternative that the rank of Π is k+1.

Given that time-varying cointegration could be a phenomenon of economic relevance and that there also may be other problems with nonlinearities in the relationships among the variables examined here the time-varying test that was developed by Bierens and Martins (2010) and the non-parametric cointegration test of Breitung (2002) are also used. As a matter of fact, the Breitung test should be able to more adequately handle the difficulties that result from non-linear dynamics in the data than the traditional Johansen procedure.

6. Empirical Evidence

First of all, the very popular Johansen procedure (see Johansen, 1988 and Johansen and Juselius, 1990) is used to test for cointegration among wine prices and the general price level in the three countries examined in this study. In order to analyze how wine can help investors in the US or Germany the Liv-ex 100 time series that have been converted to USD respectively EUR must be examined. Consequently, these wine prices expressed in different currencies are used to test for cointegration with the respective inflation data that is not from the United Kingdom. Thus, three vector error correction models have to be estimated employing the Johansen approach. The numbers of time lags that are included in these models are determined using the Schwarz criterium. Intercepts but no deterministic time trends are considered in the vector error correction models. The results of the tests are reported in table 2. The table reports results for the Trace Test. Results with Max Eigenvalue Test are similar and are available upon request.

Table 2: Cointegration among Wine Prices and Country Price Levels (** denotes significance at the 95% level)

Hypothesized Nr of CE(s)	None (t-Stat)	At most 1 (t-Stat)
Price Level UK	28.0**	3.8
Price Level US	53.2**	5.3
Price Level Germany	25.5**	3.8

The results from the traditional Johansen cointegration tests seem to imply that wine prices are cointegrated with the general price level in the UK, the U.S. and in Germany. In this context deterministic trend assumptions can matter (and, in fact, do seem to). This problem will be briefly discussed later on when the results of the Breitung (2002) cointegration tests are reported. However, it already has to be noted at this point that the results of the Johansen cointegration tests are sensitive to different deterministic trend assumptions (empirical evidence is not reported to conserve space). Moreover, the results of the time-varying conitegration tests (see Bierens and Martin, 2010) that are reported in the table 3 seem to imply that the estimated cointegration vectors are not stable over time. In these tables m is the order of the Chebyshev polynomial considered in the model. The results for different values of m

(always from 1 to 5) are reported. The results are quite robust against modifications of m. Only in one case (m=1 in the UK model) the 5% critical value is a little bit higher than the test statistic. The resulting p-value is 0.0626. Thus, it can be stated with some confidence that according to the empirical evidence reported here there is time-varying cointegration between wine prices and the general price level in all three countries. Consequently, the results of the tests suggest that fine wine is no perfect hedge against inflation (see Beckmann and Czudaj, 2013 who have reported similar results for gold).

Table 3: Time-Varying Cointegration Tests (*,** denote 90% and 95% level significance)

Polynomial order	UK	US	Germany
m=1	5.54*	8.09**	10.57**
m=2	12.99**	16.66**	10.67**
m=3	25.82**	16.97**	18.00**
m=4	33.62**	21.87**	33.62**
m=5	44.06**	33.99**	44.06**

Table 4: Cointegration among Wine Prices and Country Price Levels: Results from the Breitung Approach (no result is statistically significant)

Hypothesized Nr of CE(s)	None (t-Stat)	At most 1 (t-Stat)
Price Level UK	96.02	10.17
Price Level US	67.12	10.00
Price Level Germany	100.76	10.05

Moreover, the non-parametric test of Breitung (2002) suggests that there is no cointegration at all (see table 4). Employing this technique, it is assumed that there is no drift in the time series examined – which should at least be a very realistic assumption focusing on the second part of the history of the three macroeconomic price indices. The question of drift versus no drift processes is also important for the deterministic trend assumption to be made using the Johansen approach. With regard to the Breitung tests performed it is interesting to note that assuming the existence of drift in the time series does not affect the empirical findings. As a matter of fact, in this case there is also no empirical evidence for the existence of cointegration among wine prices and the general price level in the three countries (results are not reported to conserve space). In sum, there is no clear empirical evidence for cointegration among wine prices and the macroeconomic price level in the UK, the U.S. and Germany. Quite clearly, the relationship between the two variables wine price and inflation seems to be more complex than the simple linear cointegration model would suggest.

7. Conclusion

This paper has used different cointegration tests to analyze whether buying fine wine can be an effective strategy for investors that want to hedge against a loss of purchasing power which is

caused by the macroeconomic phenomenon of inflation. As a matter of fact, there seems to be a general believe in financial markets that the alternative asset class fine wine could be a useful hedge against inflation (see, for example, Bouri, 2014 and Aytaç and Mandou, 2016). However, at the moment there is no clear empirical evidence pointing in this direction. Most importantly, until now modern techniques of cointegration analysis (for example tests for time-varying cointegration) have not been used to analyze in some detail whether the asset class fine wine could be an attractive investment for asset managers fearing higher inflation rates. The empirical evidence reported above should be helpful to shed some light on this question. However, in spite of our research efforts there still is no really clear picture. While there seems to be some kind of relationship between wine prices and the general price level in the UK, the U.S. and Germany linear cointegration models most probably are not an adequate way to analyze the linkages among the variables examined above. At best there only seems to time-varying cointegration among wine prices and the macroeconomic price level in the three countries examined here. This empirical finding probably is no major surprise. In fact, there are quite similar results examining the more traditional alternative asset class gold (see, most importantly, Beckmann and Czudaj, 2013 and Batten, Ciner and Lucey, 2014). There are more puzzling results. Somewhat surprisingly, the non-parametric test which was developed by Breitung (2002) even does suggest that there is no cointegration at all. Therefore, investors most probably should not consider to buy wine when they are primarily searching for an asset class that is an effective hedge against inflation in the UK, the U.S. or Germany.

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