COINTEGRATING ANALYSIS OF THE LEADING WESTERN ART MARKETS

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Abstract: *In the paper, we test the cointegrating relationship between the Art Market Price Index for the United States, France and the United Kingdom, the main Western art markets. Usually, the price indices are calculated in US dollars for USA, in Euros for France and in pounds sterling for the United Kingdom (such as Artprice data). We found that, for the period 1998:Q1 – 2018:Q2, if the art market price indices are calculated in one and the same currency, then there is a long-run relationship between the Western art markets and there are no cointegration relationships if the price indices are in different currencies (USD, EUR, GBP).*

Keywords: *Art Market Price Index, cointegrating analysis*

JEL Codes: Z21, C5

1. Introduction

There are many studies on main financial markets co-integration and the crisis impact on decoupling and/or recoupling of these markets. Before the great financial crisis, (Chou, Ng and Pi 1994) found the long-run equilibrium (cointegration) relationships among the stock market prices of the United States, Canada, the United Kingdom, France, Germany, and Japan. Furthermore, "Subsample and subgroup analyses also indicate that the cointegration relationships have become stronger over time. This is consistent with greater stock market integration amid the increasing liberalization and globalization of capital markets" (Chou, Ng and Pi 1994, 1). Through the analyse of financial markets in the countries from the Nord of Europe, during 1989-2011 (Emanuelsson, Katinic and Petersson 2012, 1, 32), found "strong support for the existence of cointegration between the Belgian, Norwegian, Swiss and British stock markets in the period after the launch of the euro" and that "the financial integration has increased between these countries". Moreover, (Assidenou 2011, 212) proved that, during September 2008 / August 2009, the financial indices "of economies (OECD group, Pacific group and Asia group) have at least one cointegrating vector". That is "because the increasing globalization favours the transmission effect on either major or emerging markets" (Assidenou 2011, 217). Before it (Yang, Kolari and Min 2003, 477) showed that Asian financial markets "have generally been more integrated after the crisis than before the crisis".

On the other hand, (Haque and Shamsub 2015) argued that "as the 2008 financial crisis deepened, S&P 500 and G-20 stock indices moved towards less cointegration", so that "The 2007–2009 financial crises can be considered a structural break in the long-run relationship and may have resulted from effective joint intervention/responses taken by members of G-20 nations". Similar findings have been obtained by (Hellstrand and Korobova 2010): through analysing the financial sectors in Brazil,

Russia, India, US, UK, and Japan over 2000-2009 period, they found that "there is less cointegration during the recent financial crisis" (1, 43), but not an undeniable decoupling.

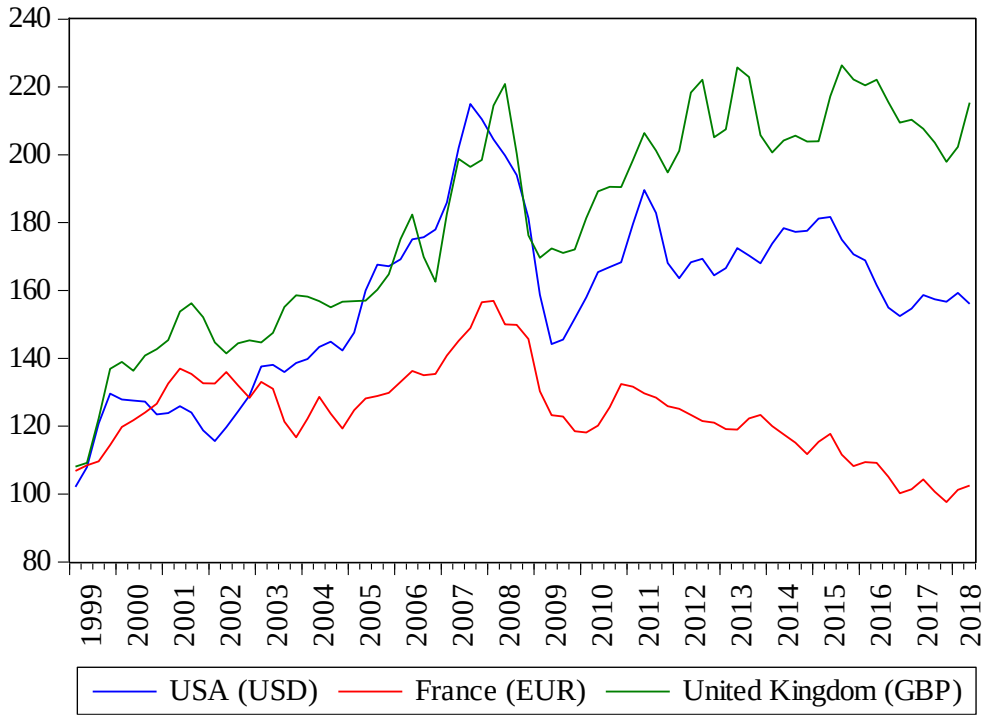
Although there are some remarkable studies, however the literature concerning art markets cointegration aren't so rich. (Worthington and Higgs 2003, 649) obtained that "there is a stationary long-run relationship and significant short and long run causal linkages between the various painting markets and between the equity market and painting markets", during 1976 to 2001. Goetzmann, Renneboog and Spaenjers (2011) found a "cointegrating relationships between top incomes and art prices, both for the total 1908-2005 period and since 1945" (Goetzmann, Renneboog and Spaenjers 2011, 20). (Ballesteros 2011) use cointegrating analysis (and Error Correction Model) to tests the efficiency in the Art Market. Recently, Marisa Lerer & Conor McGarrigle (2018, 5) found a "rise of artistic production in response to financial crisis".

2. Data and Methodology

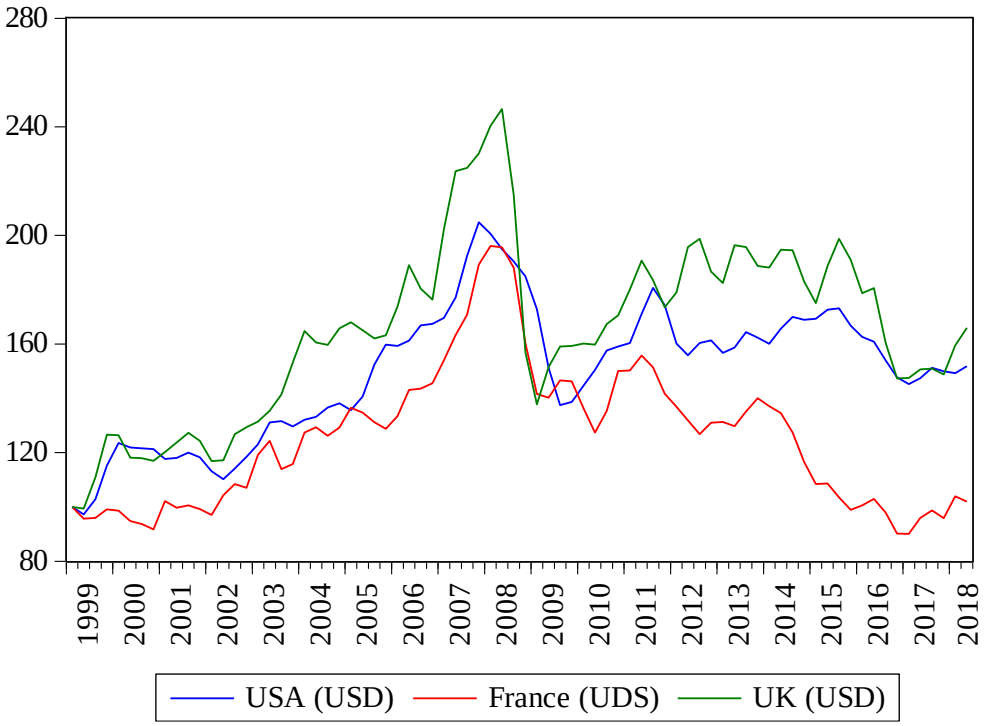
In analysis, we use the Artprice data concerning the Art Price Index for USA, France and United Kingdom. The data are available on http://imgpublic.artprice.com/pdf/agi.xls (accessed on 2018, August 15). These indices are depicted in Figure 1. The data from Artprice.com concerning the art market price index are offered in United States dollar (USD) for United States of America (USA), in euro (EUR) for France and in Great Britain Pound (GBP) for United Kingdom. In our analysis, we used both the unchanged Artprice.com data and the data converted into USD, through using the exchange rates calculated by the European Central Bank (European Central Bank, Statistical Data Warehouse, available at http://sdw.ecb.europa.eu/browse.do?node=bbn71 (accessed 2018, May 6).

Figure 1. Art Price Index for main western Art Markets

a) Art Market Price Index in national currency



b) Art Market Price Index in US dollars



Source: EViews outcomes, relied on:

- Artprice Index (Quarterly data, Base 100 in January 1998) concerning Art market price index in USD for USA, EUR for France and GBP for United Kingdom, data available at http://imgpublic.artprice.com/pdf/agi.xls (accessed 2018, August 23).
- European Central Bank (Statistical Data Warehouse) for exchange rate (EUR/USD and GBP/USD), data available at http://sdw.ecb.europa.eu/browse.do?node=bbn71 (accessed 2018, August 23).

The globalization of the art markets made the main features of the most important national markets (USA, France and United Kingdom) to be similar: strong upward trend until 3rd quarter of 2007 and a sudden fall during the crisis period (2007q4 - 2009q2). From the end of 2009, Art Markets are coming back, regained the upward slope for USA and United Kingdom and attenuated the downward slope, for France.

For all countries, the standard unit root tests [Augmented Dickey-Fuller, Phillips-Perron, Kwiatkowski-Phillips-Schmidt-Shin (KPSS), Elliott-Rothenberg-Stock DF-GLS and Elliott-Rothenberg-Stock Point-Optimal, Ng-Perron] indicate that the price index series for the art market are non-stationary (Annex 1), namely, they are first order integrated, denoted I(1). On the other hand, for all series, breakpoint unit root tests reject the hypothesis of non-stationarity (Annex 2).

3. Cointegration analyses

3.1 Art market price index for US (USD), France (EUR) and United Kingdom (GBP)

To test the cointegration relationships between the art markets indexes it was determined, in the first step, the order of VAR model. By applying the VAR lag order selection criteria, Schwarz information criterion suggested lag = 4 and all the other criteria have selected lag = 7. For lag =3, even

if the residuals are not heteroskedastic, however the model does not mitigate the serial correlation (at lag from 1 to 12). For lag = 7, the VAR Residual Serial Correlation LM Tests does not reject the null hypothesis (there is not the serial correlation), at a lag of at least 12. At the same time, VAR Residual White Heteroskedasticity Tests (levels and squares) does not reject the null hypothesis (there is no heteroskedasticity) at 0.5569 level. Following these, we opted for lag = 7.

If we stated lag intervals = 6 for differenced endogenous in Johansen System Cointegration test specification, the outputs (Annex 3, table A) suggest the possibility of one cointegration relationship, for two group of the assumptions:

a) no deterministic trend in data, intercept (but, no trend) in cointegrating equation, and no intercept, nor trend in VAR part,

b) linear deterministic trend in data, intercept both in cointegrating equation and in VAR part, no trend in cointegrating equation, nor in VAR part of model.

We tested for cointegration in both the groups of specifications.

Model (a): no deterministic trend in data, intercept in cointegrating equation

$$\underset{}{\text{USA}} = \underset{[3.734]}{1.06015}\cdot \text{France} + \underset{[6.898]}{0.82149}\cdot \text{UK} - \underset{[-2.971]}{123.10208}$$

(t-statistics in brackets, below the coefficients). Estimation details:

- ✓ Method: Fully Modified Least Squares (FMOLS),
- ✓ Sample (adjusted): 1998Q2 2018Q2, Included observations: 81 after adjustments
- ✓ Cointegrating equation deterministic: constant
- ✓ Long-run covariance estimate (Pre-whitening with lags = 3 from SIC max-lags = 7, Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

All the coefficients are significant at least 0.01 level. The Wald test does not reject the hypothesis that the coefficients are both equal to 1: the probability associated to F-statistic is 0.3214 [F-statistic value is 1.1518, with df = (2, 78)], and the probability that corresponding to Chi-square statistic is 0.3161 [Chi-square statistic is 2.3036, with df = 2].

Despite these performances, the cointegration tests are not conclusive. Hansen Parameter Instability Test does not reject the null hypothesis, that the series are cointegrated, at 0.2 level. The same, Park's Added Variables Test does not reject the null hypothesis of cointegration at 0.2515 level. Conversely, the residual-based tests are not consistent. The Engle-Granger tau-statistic test does not reject the null hypothesis of no cointegration (unit root in the residuals) at 0.2265 level, but Engle-Granger z-statistic reject this hypothesis (at 0.022 level). Similarly, both tau-statistic and z-statistic Phillips-Ouliaris tests do not reject the null hypothesis of no cointegration (unit root in the residuals) at 0.3197 and 0.3016 significance level. Obviously, the Engle-Granger and Phillips-Ouliaris tests are simply unit root tests applied to the residuals obtained from cointegration equation estimated through OLS. But, a little doubt remains.

Furthermore, in VEC (Vector Error Correction) specification (lag = 7, in short-run dynamics), the cointegrating equation is near to the one described by the previous relationship, but β, the coefficient of cointegration (the speed of adjustment), although negative (-0.0332), however it is not significantly different from zero, at the standard significance level (t-stat = -0.6048).

Model (b): linear deterministic trend in data, intercept and no trend both in cointegrating equation and in VAR part

$$\underset{}{USA} = \underset{[3.565]}{0.87673} \cdot France + \underset{[6.608]}{0.68160} \cdot UK - \underset{[-2.053]}{73.67141}$$

(t-statistics in brackets, below the coefficients).

In addition to the previous model, we have included the trend as additional deterministic regressor. All the coefficients are significant: at least 0.01 level, the first two and at 0.05 level, the last. Both Hansen' Parameter Instability Test and Park's Added Variables Test do not reject the null hypothesis (the series are cointegrated), at a significance level greater than 0.2. The Engle-Granger tau-statistic test does not reject the null hypothesis of no cointegration (unit root in the residuals) at 0.2507 level, but Engle-Granger z-statistic reject this hypothesis (at 0.0257 level). As with the previous model, both tau-statistic and z-statistic Phillips-Ouliaris tests do not reject the null hypothesis of no cointegration (unit root in the residuals) at 0.3197 and 0.3016 significance level.do not reject the hypothesis.

To verify the robustness of the analysis, we built a VEC model with the same hypotheses [linear deterministic trend in data, intercept and no trend both in cointegrating equation and in VAR part (the short-run dynamics)]. The coefficient of cointegration (the speed of adjustment) is negative (-0.02295), but it is not significantly different from zero, at the standard significance level (t-stat = -0.3762). This means that, we reject the hypothesis of cointegration.

3.2 Art market price index in USD for USA, France and the United Kingdom

We have re-calculated the cointegrating model using series of art markets price indexes, where all the series have been computed in USD.

The Johansen tests identified the cointegrating relationships between the series calculated in USD (Annex 3, table B). If lag specification for differenced endogenous is equal to 1, then we select lag > 1 in VEC model.

The maximum of signification for the cointegrating β coefficient (t-stat = -3.631) is reached in model with intercept and trend in cointegrating equation and no trend in VAR(3) specification. The VEC model shown the following long-run equation:

$$\underset{}{USA\$} = \underset{[2.742]}{0.32127} \cdot France\$ + \underset{[2.494]}{0.30966} \cdot UK\$ + \underset{[3.446]}{0.40811} \cdot t + 41.16139$$

Where:

- ✓ in brackets, below the coefficients, we wrote t-statistics,
- ✓ sample (adjusted): 2000q1-2008q2 (74 included observation after adjustments)
- ✓ $ stands for the fact that the art market price index series is recalculated in USD).

The coefficient of cointegration (β – the speed of adjustment) is negative (-0.26916) and it is significantly different from zero (t-stat = -3.6312). The probability of no serial correlation (at lags 1 to 8) is 0.7282 (according to VEC Residual Serial Correlation LM Tests) and VEC Residual Heteroskedasticity Test (Levels and Squares) does not reject the null hypothesis (residuals are not heteroskedastic) at 0.1887 level. Moreover, VEC Residual Normality Tests (Lutkepohl) does not reject the null hypothesis (residuals are multivariate normal) at 0.1887 level

A similar relationship can be obtained through cointegrating regression, by using, as estimating method, the Fully Modified Least Squares (FMOLS).

$$\underset{[2.115]}{\text{USA\$} = 0.30200 \cdot \text{France\$}} + \underset{[2.772]}{0.37481 \cdot \text{UK\$}} + \underset{[2.554]}{0.32990 \cdot t} + \underset{[3.303]}{36.34855}$$

The (small) differences from the previous equation are caused by the number of included observations (77 after adjustments, as against 74 in VEC model) and the method used for estimation (FMOLS vs. OLS). Hansen' Parameter Instability Test does not reject the null hypothesis (the series are cointegrated), at a significance level greater than 0.2. Park's Added Variables Test does not reject the same null hypothesis, at a 0.7921 level. The probabilities associate with the residual-based tests (with null hypothesis of unit root in the residuals, that is the series are not cointegrated) are around of 0.10 or less (0.0005 for Engle-Granger z-statistic). This means that, we do not reject the hypothesis of cointegration.

4. Conclusion

If we look at the entire period from 1998q1 to 2018q2, and the art price indices are estimated in different currencies (USD for USA, Euro for France and GBP for the United Kingdom), then the models and cointegration tests do not provide conclusive evidence for the hypothesis that there was a stable long-run equilibrium relationship between the leading western art markets price indices.

Instead: if the indices are calculated in one and the same currency (in our case, in USD), then there is a stable long-run equilibrium relationship between the art markets price indexes of the main western markets (USA, France, United Kingdom). Moreover, the intercorrelations between art markets are positive as sign and significant from an econometric point of view.

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Annexes

Annex 1: Unit Root Tests for USA, France and United Kingdom Art Price Index, 1998-2018q2

Country	Series in:		Unit root test statistic:								
			ADF	Phillips-Perron	KPSS	DF-GLS	ERS	Ng-Perron			
								MZa	MZt	MSB	MPT
USA	USD 1998-2018q2	Level	-2.334	-2.187	0.731	-0.863	19.614	-1.652	-0.835	0.505	13.592
		1st diff.	-4.244	-3.959	0.202	-3.833	0.402	-48.214	-4.892	0.101	0.556
	USD 1999-2018q2	Level	-1.847	-2.228	0.652	-0.748	18.681	-1.656	-0.832	0.502	13.500
		1st diff.	-4.304	-3.874	0.172	-4.022	0.447	-42.710	-4.613	0.108	0.597
France	EUR 1998-2018q2	Level	-1.311	-1.855	0.341	-1.027	6.827	-2.990	-1.212	0.406	8.176
		1st diff.	-4.550	-5.776	0.340	-2.561	0.077	-17.170	-2.930	0.171	1.427
	USD 1999-2018q2	Level	-1.727	-1.540	0.278	-1.247	5.231	-3.320	-1.282	0.386	7.374
		1st diff.	-5.997	-5.376	0.211	-3.675	0.531	-23.592	-3.340	0.146	1.039
United Kingdom	GBR 1998-2018q2	Level	-2.033	-2.230	1.177	0.709	174.242	0.756	0.875	1.157	86.512
		1st diff.	-5.457	-8.106	0.317	-0.734*)	4.103*)	-1.270*)	-0.784*)	0.618*)	18.906*)
	USD 1999-2018q2	Level	-2.338	-2.391	0.560	-1.201	8.772	-3.641	-1.298	0.356	6.742
		1st diff.	-4.067	-5.156	0.135	-4.098	1.184	-20.986	-3.229	0.154	1.205
Critical value (5%)			-2.900	-2.898	0.463	-1.945	3.060	-8.100	-1.980	0.233	3.170

*) Non-stationary at 5%.

Source: EViews outcomes, relied on:

- ✓ *Artprice Index* (Quarterly data, Base 100 in January 1998) concerning *Art market price index* in USD for USA, EUR for France and GBP for United Kingdom, data available at http://imgpublic.artprice.com/pdf/agi.xls (accessed 2018, August 23).
- ✓ European Central Bank (Statistical Data Warehouse) for exchange rate (EUR/USD and GBP/USD), data available at http://sdw.ecb.europa.eu/browse.do?node=bbn71 (accessed 2018, August 23).

- ✓ Notes:
- ✓ Exogenous: constant;
- ✓ Lag length automatic selection: Schwarz Information Criterion

- ✓ Legend
- ✓ ADF – Augmented Dickey-Fuller test (Null Hypothesis is: time series has a unit root)
- ✓ Phillips-Perron test (Null Hypothesis is: time series has a unit root)
- ✓ DF-GLS – Elliott-Rothenberg-Stock DF-GLS test statistic (Null Hypothesis is: time series has a unit root)
- ✓ ERS – Elliott-Rothenberg-Stock Point-Optimal test statistic (Null Hypothesis is: time series has a unit root)
- ✓ Ng-Perron test statistic (Null Hypothesis is: time series has a unit root)
- ✓ KPSS – Kwiatkowski-Phillips-Schmidt-Shin test statistic (Null Hypothesis: time series is stationary)

Annex 2: Breakpoint Unit Root Tests for USA, France and United Kingdom Art Price Index

Country:	Series in:	t-statistic	Prob.	Break date:	Conclusion
USA	USD: 1998-2018q2	-5.854	< 0.01	2006q3	stationary
	USD: 1999-2018q2	-5.866	< 0.01	2007q1	stationary
France	EUR: 1998-2018q2	-6.634	< 0.01	2007q2	stationary
	USD: 1999-2018q2	-5.790	< 0.01	2007q2	stationary
United Kingdom	GBP: 1998-2018q2	-5.904	< 0.01	2006q3	stationary
	USD: 1999-2018q2	-5.192	0.048	2008q2	stationary

Source: EViews outcomes, relied on:

- ✓ *Artprice Index* (Quarterly data, Base 100 in January 1998) concerning *Art market price index* in USD for USA, EUR for France and GBP for United Kingdom, data available at http://imgpublic.artprice.com/pdf/agi.xls (accessed 2018, August 23).
- ✓ European Central Bank (Statistical Data Warehouse) for exchange rate (EUR/USD and GBP/USD), data available at http://sdw.ecb.europa.eu/browse.do?node=bbn71 (accessed 2018, August 23).

Notes:

- ✓ Null Hypothesis: time series has a unit root;
- ✓ Trend Specification: Trend and intercept;
- ✓ Break Specification: Trend and intercept;
- ✓ Break Type: Innovational outlier;
- ✓ Test critical values: -5.719 for 1% level and -5.175 for 5% level.

Annex 3: Summary of assumptions in Johansen Cointegration Test: Number of Cointegrating Relations by Model

A. Series "Art market price index" in USD for USA, EUR for France and GBP for United Kingdom

Lags interval: 1 to 6

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace statistics	0	1	1	0	0
Max. eigenvalue statistic	0	1	1	0	0

Source: EViews table, *Artprice Index* (Quarterly data, Base 100 in January 1998),

B. Series "Art market price index" in USD for all the countries (USA, France and the United Kingdom)

Lags interval: 1 to 1

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace statistics	1	1	1	1	1
Max. eigenvalue statistic	1	1	1	1	1

Source: EViews outcomes, relied on:

- ✓ *Artprice Index* (Quarterly data, Base 100 in January 1998) concerning *Art market price index* in USD for USA, EUR for France and GBP for United Kingdom, data available at http://imgpublic.artprice.com/pdf/agi.xls (accessed 2018, August 23).
- ✓ European Central Bank (Statistical Data Warehouse) for exchange rate (EUR/USD and GBP/USD), data available at http://sdw.ecb.europa.eu/browse.do?node=bbn71 (accessed 2018, August 23).

Notes:

- ✓ Series: USA, France, UK
- ✓ Sample: 1998 – 2018(q2)
- ✓ Lags interval: 1 to 6 for table A, 1 to 1 for table B.
- ✓ Selected level: 0.05 level*