Long-term comovements in international markets for paintings†

by

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Abstract

We study steady-state relationships between prices for paintings obtained by three groups of painters (Impressionist Modern and Contemporary European Masters, Other minor European painters, Contemporary US painters) at public auctions in New York, London and Paris between 1962 and 1991. The analysis is carried out by estimating vector autoregressive models, using the recent techniques developed by Johansen. The results show that the various markets move closely together, and are, even in New York, led by what happens to the group of European Great Masters, whose prices are not influenced by other prices. We also examine the relation between art and stock markets; we find that there is no long-run relation between these two assets, though in the short-run, financial markets do influence art markets.

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1. Introduction

We are interested in price comovements obtained by three groups of painters between 1962 and 1991: Impressionist Modern and Contemporary European Masters (GM for short), Other minor European painters (OP), Contemporary US painters (US). We analyze price movements in the three countries where the most important public auctions are held: the United States (New York), the United Kingdom (London) and France (Paris and Versailles). The analysis is carried out by estimating vector autoregressive models, using the recent techniques developed by Johansen (1988, 1991) and Johansen and Juselius (1990, 1992). These methods make it possible to isolate steady-state relations (if any) from short-run behaviour.

The results we have obtained show that the various markets move closely together, but are, even in New York, led by what happens to the group of European Great Masters, whose prices are weakly exogenous. We also examine the relation between art markets and stock markets in New York, London, Tokyo and Paris; we find that there is no long-run relation between these markets, though in the short-run, financial markets do influence the the prices of collectibles.

The paper is organized as follows. In Section 2, we describe the basic ideas embodied in vector autoregressive models as well as the main tests which can be carried out in order to simplify the autoregressive representation and to allow for some intuitive economic interpretation. Section 3 goes into some details concerning the construction of the price indices for paintings that are analyzed in this paper; the methodology is borrowed from ideas developed in hedonic regression. Section 4 describes the main results obtained from the estimation of vector autoregressive models. Some conclusions and extensions are suggested in Section 5.

2. Methodology

We consider the following relations between two endogenous variables $y_{1,t}$ and $y_{2,t}$; we assume that $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$ is stationary and write the two-equation model as:

(2.1a) $$\Delta y_{1,t} = \alpha_1(\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \gamma_{11}\Delta y_{1,t-1} + \gamma_{12}\Delta y_{2,t-1} + \delta_1 + \eta_{1,t}$$

(2.1b) $$\Delta y_{2,t} = \alpha_2(\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \gamma_{21}\Delta y_{1,t-1} + \gamma_{22}\Delta y_{2,t-1} + \delta_2 + \eta_{2,t},$$

where the α_i's, β_i's, γ_{ji}'s and δ's are parameters and the $\eta_{i,t}$'s are white noise error terms. Equation (2.1a) say, consists of two parts: (a) a long-run component relating y_1 and y_2, represented by:

(2.2a) $$\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1} = \varepsilon_{t-1}$$

and (b) short-run dynamics consisting of:

(2.2b) $$\Delta y_{1,t} = \alpha_1 \varepsilon_{t-1} + \gamma_{11} \Delta y_{1,t-1} + \gamma_{12} \Delta y_{2,t-1} + \eta_{1,t}.$$ [1]

If the deviations ε_{t-1} from the long-run equilibrium defined in (2.2a) are stationary, then there exists a long-run steady-state relationship $\beta_1 y_1 + \beta_2 y_2 = 0$ between the two endogenous variables, which can be seen to "move together." Moreover, if α_1 is negative, then an error correction mechanism is at work: indeed, if $\varepsilon_{t-1} > 0$, $y_{1,t-1}$ can be thought to exceed its steady-state value in t-1, imposing a downward correction of $y_{1,t}$ at time t. This is the essence of vector autoregression estimation methods. A detailed analysis is obviously beyond the scope of this paper, and we merely discuss some details that are useful for the understanding of our results.

First, as can be seen from equation (2.1), one may adopt a different normalization, for example $\beta_1 = 1$; then the long-run steady-state equation becomes $y_1 = -\beta_2' y_2$, with $\beta_2' = \beta_2/\beta_1$.

Second, the number of endogenous variables (and equations) can be larger than two (r in general); if there are, say three, the long-run relationhip becomes:

(2.3) $$\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1} + \beta_3 y_{3,t-1} = \varepsilon_{t-1},$$

and this permits testing hypotheses as to which variables have a significant influence in the relationship. One may for instance test the null hypothesis H_0: $\beta_3 = 0$; if H_0 cannot be rejected, the relationship can be simplified and written as in (2.2a). This is a test on the *exclusion of long-run variables*, but other tests are possible, for example H_0: $\beta_1 = \beta_2$.

Third, it can be shown that there may exist at most r-1 cointegration vectors (long-run relationships) between the r variables of the model; the procedures developed by

[1] Note that the intecept parameters δ_1 can be interpreted either as part of the long-run relationhip (2.2a), which is then written $\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1} + \delta_1/\alpha_1 = 0$, as a drift in the short-run relation (2.2b) or as a combination of both.

Johansen (1988, 1991) and Johansen and Juselius (1990, 1992) will make it possible to test *how many such relations* are "significant" between the r variables.

Fourth, in the model (2.1), one may also test hypotheses such as H_0: $\alpha_2 = 0$. If this hypothesis cannot be rejected, then the model simplifies to:

(2.4a) $$\Delta y_{1,t} = \alpha_1(\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \gamma_{11}\Delta y_{1,t-1} + \gamma_{12}\Delta y_{2,t-1} + \delta_1 + \eta_{1,t}$$

(2.4b) $$\Delta y_{2,t} = \qquad + \gamma_{21}\Delta y_{1,t-1} + \gamma_{22}\Delta y_{2,t-1} + \delta_2 + \eta_{2,t},$$

and one concludes that y_2 does not respond to deviations from the long-run behaviour of the system; y_2 is then said to be weakly exogenous for the parameters α_1, β_1, β_2. If moreover, the γ_{21} coefficient in (2.4b) is not significantly different from zero, y_1 does not Granger-cause y_2: it is influenced neither by the long-run nor by the short-run of y_1.

Finally, in both relations (2.1a) and (2.1b), we have included two-period lagged variables only, but clearly, (2.1a) could for example more generally be written as:

(2.5) $$\Delta y_{1,t} = \alpha_1(\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \Sigma_k\Sigma_i\gamma_{1i}\Delta y_{i,t-k} + \delta_1 + \eta_{1,t},$$

with $k = 1, 2, ..., \tau$.

In economic modelling, there is usually a theory behind the long-run relation; in consumption analysis for example, one may assume that a constant proportion of income (y_2) is spent on consumption (y_1), while the autoregressive representation tries to capture short-run fluctuations; $-\beta_2/\beta_1$ represents then the steady-state income elasticity, α_1 measures the speed at which deviations from this steady-state relation are corrected, while the γ's take into account some ad hoc short-run dynamics.

In the cases considered in this paper, there is hardly any theoretical underpinning for the long-run relation; the coefficient $-\beta_2/\beta_1$ can be interpreted as the elasticity of y_1 w.r.t. y_2; if, for two price indices y_1 and y_2, this coefficient is close to unity, we may conclude that, in the long-run, prices move together and at rates that are not significantly different. The other coefficients (α's and γ's) are interpretable in the same way as above.

The estimation method used in the paper is due to Johansen (1988, 1991) and Johansen and Juselius (1990, 1992). The number of long-run relationships ((2.2a) or (2.3)) is tested via the so-called maximal eigenvalue and trace tests, for which distributions have been tabulated. The other tests (exculsion of long-run variables or weak exogeneity) are based on usual likelihood ratios tests which have χ^2-distributions, under the null hypothesis.

3. The data

3.1 Principles of construction of the indices

The return indices used in our calculations have been computed through hedonic regressions, as suggested in Chanel et al. (1992); one estimates the following equation:

$$p_{it} = \sum_{k=1}^{m} \alpha_k x_{ik} + c(t) + \xi_{it}, \tag{3.1}$$

where p_{it} is the (logarithm of the) price of a collectible i sold at time t, x_{ik} is a time-invariant idiosyncratic attribute of i; c(t) is a market-wide price effect and ξ_{it} is an error term. Model (3.1) can be given a convenient interpretation if one isolates in the right-hand side the time effect and the random error. The left hand-side can then be thought of as representing the price of a work i sold in t, freed from the implicit prices of its characteristics; this "characteristic-free price" is assumed to include the effect of time and a random error only; by averaging the characteristic-free prices of all works i sold in t, one obtains the average price of a "standardized" work at time t.

Different specifications of c(t) can be considered. We have set:

$$c(t) = \sum_{t=\tau_0}^{\tau_T} \gamma_t z_t, \tag{3.2}$$

where $[\tau_0,\tau_T]$ is the time interval over which observations are available; z_t is a dummy variable which takes the value one if the work is sold in period $t \in [\tau_0,\tau_T]$, and zero otherwise; the γ_t's are parameters to be estimated. The sequence $\gamma_{\tau_0}, ..., \gamma_{\tau_T}$ is used to construct the price or value index.

Most of the work carried out in order to compute returns on art uses repeat sales regressions (i.e. regressions based on observations of collectibles sold at least twice) rather than hedonic regressions. The pros and cons of both methods are discussed in Chanel et al. (1992) and Ginsburgh (1994).[2] Here, we merely note that it would be

[2] See also Goetzmann (1990, 1993).

difficult to construct yearly (or half-yearly) indices using repeat sales only, since the number of resales for which prices are observable is quite limited.

3.2 Original data available

The data used to calculate value indices come from Mayer's (1963-1992) compendia "Annuaire des Ventes." These yearbooks of public auctions are available since 1963 (sales of 1962); we thus cover the years 1962 to 1991. Three databases were compiled. Two of them concern European painters born after 1830, thus excluding Old Masters; the third one is devoted to 20th century American painters

The first contains some 25,000 sales of 82 well-known Impressionist, Modern and Contemporary European painters, selected in a fairly subjective way: we chose painters who lived (or at least spent part of their lifetime) in Paris, were frequently sold in public auctions (Dufy, Marquet, Van Dongen) and/or are well known (Cézanne, Gauguin, Seurat). For each of them, all sales collected by Mayer during the period 1962-1991 are included. We refer to those painters as 'Great Masters'.

This database includes well-known painters only and can hardly be thought of as representing European painters in general. Therefore, we constructed a second database of European painters ('Other Painters'), as follows. For each year (1962 to 1991), we draw 82 random numbers (within the set corresponding to the pages in each volume of Mayer's compendia). The first painter appearing on each such randomly chosen page is selected and all his paintings sold during that year are included. The database contains over 6,000 sales, and hence approximately 200 paintings per year. A notable difference between the two databases is that each Great Master is followed over the 30 years time-span, while Other painters are not (except by chance).[3]

The third database, compiled by Demortier (1992) is concerned with the works of 139 American painters who were born after 1900 and/or died after 1965. This includes painters belonging to all "contemporary" currents,[4] and makes for over 6,000 paintings sold between 1962 and 1991.

In Mayer's compendia, each sale is decribed by a certain number of characteristics (see below) and by a sale number, corresponding to a specific auction describing the

[3] See de la Barre et al. (1994) for more details.
[4] The following movements are represented: action painting, hard edge, minimal art, colorfield, hyperrealism and realism, pop art, bad painting, neo-geo, symbolism, naturalism, conceptual art, abstract expressionism, and precursors.

location and the date of sale. It is therefore possible to construct monthly or quarterly indices. There are two reasons for having chosen to work with half-yearly indices. First, to compute monthly indices, more sales would be needed[5] in order to obtain reliable indices and second, there are almost no auctions in July, August and September; this reason also makes it clear why it would make little sense to construct quarterly indices.[6]

Though like financial markets, the art market is international (a Japanese collector can easily buy in London, Paris or New York), we consider three different geographical markets: the United States, the United Kingdom and France. Prices in the US and the UK are computed from all auctions at Christie's and Sotheby's New York[7] and London respectively; for France, all auctions collected by Mayer are included.

The characteristics we use to describe each work are limited by the fact that, beside the name of the artist and of the painting, the yearbooks give only a very rough description of the painting: the size of the work (height and width), the year in which it was painted (though not in all cases), the medium used, the place of the sale (saleroom, country) and the time of sale. Such a simple description is thus hardly comprehensive enough to explain the price differences between artists and one is necessarily led to include some measure of the repute of the painter. To represent reputation, Anderson (1974) uses an "estimated price" for each artist. We chose to work with dummy variables for artists (or nationalities).[8]

3.3 Indices constructed

The model we shall be using combines (3.1) and (3.2) and is estimated on the full sample of sales and resales. The x_{ki} variables describing characteristics are the following: dimensions (3 variables: height, width and surface); dummy variables for painters (82 for 'Great Masters', 139 for American painters) or for nationalities (25 for 'Other painters'); dummy variables for type of painting and/or medium (2 for 'Great Masters': painting or collage, 4 for 'Other painters': canvas, wood, cardboard, other; 15 for American painters[9]);

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[5] For the 'Other painters' database, there are 6,000 observations over 30 years, i.e. an average of 17 observations per month or 50 per quarter; these are numbers which we thought of being too small to construct indices with higher than half-yearly frequency.

[6] We also mention that the year is divided into two "semesters" of unequal lenght: a seven months period (January-July) and a five months period (August-December); these are the two "seasons" usually taken into consideration by salerooms also, since, for calendar reasons, the last important sales before the summer holidays may take place either end of June or beginning of July: they should both be considered as belonging to the same "season."

[7] In New York, Parke Bernett until it was bought by Sotheby's.

[8] See Grampp (1989) for a justification of the idea that the name of the painter is part of the aesthetic value of a painting.

[9] There is an unfortunate asymmetry in the treatment of media in the databases.

60 dummy variables z_t describing the dependence of prices over the sixty half-years 1962-1991.[10]

Such regressions were thus run for Great Masters in New York, London and France (3 indices), Other (European) painters in London and France (2 indices) and American painters in New York (1 index). European painters other than Great Masters hardly sell in the United States, while American painters seldom appear at auctions in Europe. The various indices are reproduced in Figures 1 and 2.[11]

3.4 Overall quality of the regression results

It may be interesting to illustrate the results with three regressions run on the full samples, including all salerooms. We use the specification given in equations (3.1)-(3.2), with annual instead of half-yearly dummies and with 17 additional dummies for salerooms. As can be seen from Table 1, the fit is excellent for Great Masters and American painters (there are of course painter dummies included) and satisfactory for Other painters. Dimensions pick the right sign: prices increase with height and width, though there is a limit, since surface picks a negative sign. Canvas (chosen as reference) is the most expensive medium and it is worth noting that collages are cheaper.

Individual painters and nationalities (in the case of Other painters, who change from year to year) add very significantly to the explained variance; since individual standard deviations are not very informative, we tested the hypothesis that all coefficients (either for individual painters in the Great Masters sample or nationalities in the Other Painters sample) were equal. In both cases, this hypothesis is strongly rejected.[12] The same conclusion holds for salerooms, showing that prices for "homogenized" paintings can be very different across salerooms.[13]

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10 It is worth noting that these indices are not chronological series in the usual sense, since they are derived from a regression in which prices of sales in t may have some influence on the price index in t-1. Therefore, it may be cleaner to compute indices using pairs of adjacent years; this would produce an average price for each year t+1, with t as base year; these numbers are then simply chained to compute a price index over the whole period. We have done this, and the outcome is almost the same as the one onbtained from a unique regression. See de la Barre et al. (1994). Recursive regression is another alternative that would avoid "the dependence of the past on the future."

11 Prices are expressed in US$, £ or FF for sales in New York, London and France respectively. In some cases (i.e. when we deal with sales for Great Masters in New York, London and France), all value indices are expressed in US$. We did not correct these data for inflation: since we have no information on who buys the paintings, it is not clear which inflation rate should be used to deflate the data. Moreover, it is obvious from Figures 1 and 2, that deflating the series would leave the conclusions unchanged.

12 This has not been done for US painters, but there is no doubt that the result would be identical.

13 For more details, see de la Barre et al. (1994) and Ginsburgh (1994) for paintings and Pesando (1993) for prints.

Figure 1
Prices in New York, London and Paris
(national currencies, indices in logarithms)

Figure 2
Prices for Great Masters and Other painters
(in US $, indices in logarithms)

Table 1
Results of the hedonic regressions for painters (in FF)
$(p_{it} = \Sigma_k \alpha_k x_{ki} + \Sigma_t \gamma_t z_t + \varepsilon_{it})$

	Eur. Great Masters		Other Eur. painters		US painters	
	Coeff.	St. dev	Coeff.	St. dev.	Coeff.	St. dev
Height	.0111	.0002	.0080	.0010	.0090	.0002
Width	.0077	.0002	.0050	.0010	.0081	.0003
Surface (x 1,000)	-.1898	.0053	-.2400	.0080	-.0269	.0013
Canvas	.0000	-	.0000	-	.0000	-
Collage	-.5306	.0928	-.1830	.0840	-.2690	.0721
Wood panel	-	-	-.0790	.0550	-.2799	.0545
Cardboard	-	-	-.1300	.0710	-.2168	.0399
Oil	-	-	-	-	.0000	-
Oil +	-	-	-	-	.1132	.0460
Individual painters	82 var.	471.6*	-	-	139	n.a.
Nationalities	-	-	24 var.	9.2*	-	-
Salerooms	17 var.	87.7*	17 var.	76.7*	17 var.	n.a.
Time	31 var.		30 var.		30 var.	
R^2	.81		.48		.81	
Nb. of observations	24,540		6,410		6,224	

* F-values resulting from testing the null-hypothesis that all coefficients are equal to zero.
Sources: de la Barre et al. (1994) and Demortier (1992).

4. Price cointegration

The analysis which follows is in three parts: we first consider each location separately (New York, London and Paris) and examine whether the two (or three) groups of painters are cointegrated, in the sense that if one series is affected by an exogenous shock, then the other(s) is (are) affected also, so that in the long-run, the series cannot diverge. We then analyze whether prices in the three locations are interrelated. Finally, we examine whether art markets are linked to stock markets.[14]

[14] Before turning to these analyses, we checked whether all time series used where I(1). The ADF tests, which are not reported here, show that all series (including the stock exchange series used) have a unit root in their levels, but are stationary after differencing once.

4.1 Cointegration between painters by location

Our first analysis concerns the possibility that the groups of painters are cointegrated in each location. The analyses are summarized in Table 2. The models estimated in all three cases are thus:

$$\Delta y_{1,t} = \alpha_1(\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \Sigma_k \Sigma_i \gamma_{1i} \Delta y_{i,t-k} + \delta_1 + \eta_{1,t}$$

$$\Delta y_{2,t} = \alpha_2(\beta_1 y_{1,t-1} + \beta_2 y_{2,t-1}) + \Sigma_k \Sigma_i \gamma_{2i} \Delta y_{i,t-k} + \delta_2 + \eta_{2,t},$$

where k, the number of lags for short-run effects is equal to 2, 3 or 4 (i.e. 2, 3 or 4 half-years) and β_1 is normalized to unity. The first relation concerns 'Other painters' (in London and Paris) or 'US painters' (in New York), while the second one concerns 'Great Masters'; the subscripts should be interpreted accordingly (1 refers to Other or US painters, 2 to Great Masters). The conclusions which can be drawn are surprisingly similar:

(a) the different specifications for the number of lags (k = 2, 3 or 4) lead to almost identical results and the Jarque-Bera test shows that normality of the residuals cannot be rejected at the 5% probability level; results are thus robust with respect to the number of lags chosen;
(b) both the λ_{max} and the Trace tests indicate that both series are cointegrated;
(c) the unrestricted β_2 coefficients in the long-run relation are close to unity;
(d) error correction mechanisms are at work; the α_1 coefficients are all negative, and quite large (between -.60 and -.80), while most of the α_2 coefficients are positive (recall that β_2 is negative); errors are corrected somewhat more rapidly in Paris than in London and New York;
(e) the hypothesis H_0: $\alpha_2 = 0$ cannot be rejected, as shown by the χ^2-values; this implies that both in London and in Paris, 'Other painters' follow 'Great Masters'; similarly, but somewhat more surprisingly, in New York, 'Great Maters' prices "lead" 'US painters' prices;
(f) the joint hypotheses H_0: $\alpha_2 = 0$ and $\beta_2 = -1$ cannot be rejected either.

Table 2 Cointegration analysis
New York, London and Paris

		New York (US and GM)			London (OP and GM)			Paris (OP and GM)		
Lags		k=2	k=3	k=4	k=2	k=3	k=4	k=2	k=3	k=4
Testing for the number of cointegrating vectors†										
λ_{max}	$r \le 1$	.8	2.6	.8	.4	.7	1.0	.3	.7	1.1
	$r = 0$	19.4	10.3	13.2	16.7	12.9	12.3	21.3	16.7	23.3
Trace	$r \le 1$	.8	2.6	.8	.4	.7	1.0	.3	.7	1.1
	$r = 0$	20.1	12.9	14.0	20.1	13.5	13.3	21.5	17.5	24.4
Parameter values (one cointegrating vector)										
β_1		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
β_2		-.92	-.96	-.96	-.96	-.99	-1.03	-.88	-.86	-.89
α_1		-.60	-.47	-.64	-.62	-.57	-.60	-.72	-.79	-1.01
α_2		.22	.14	.11	.10	.09	.11	.06	-.04	-.05
Hypothesis testing H_0: $\alpha_2 = 0$										
χ^2-value (1 d.f.)		2.86	.80	.55	3.56	0.19	2.26	0.42	0.14	0.18
β_1		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
β_2		-.90	-.93	-.95	-.93	-.96	-.99	-.88	-.86	-.89
α_1		-.70	-.58	-.71	-.63	-.60	-.64	-.75	-.78	-.99
α_2		.00	.00	.00	.00	.00	.00	.00	.00	.00
Hypothesis testing H_0: $\alpha_2 = 0$ and $\beta_2 = -1$										
χ^2-value (2 d.f.)		5.84	1.77	1.13	4.06	0.18	2.28	4.67	5.10	5.52
β_1		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
β_2		-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
α_1		-.61	-.52	-.66	-.61	-.58	-.64	-.62	-.60	-.80
α_2		.00	.00	.00	.00	.00	.00	.00	.00	.00
Jarque-Bera normality tests (χ^2 with 2 d.f.)										
Relation 1		3.59	1.79	.29	.90	1.74	2.38	2.16	3.54	.67
Relation 2		.36	6.12	1.85	.67	.31	.10	4.27	4.31	5.14

† At the 5% probability level, the tabulated values are 8.1 and 14.6 for the λ_{max} test and 8.1 and 17.8 for the trace test.

One may thus conclude that prices for 'Great Masters' and 'US painters' in New York, as well as for 'Great Masters' and 'Other Painters' in London and Paris do not diverge in the long run; temporary deviations are corrected: prices for US and Other painters adjust to prices of Great Masters.

4.2 Cointegration between locations

Here, we are interested in the relations between prices for 'Great Masters' in New York, London and Paris and by 'Other European painters' in London and Paris. The results are given in Table 3. For GM, relations (and subscripts) 1, 2 and 3 refer to New York, London and Paris respectively; for OP, 1 and 2 concern London and Paris. The results can be summarized as follows.

(a) for 'Great Masters', there is a unique cointegrating relation between the three locations and the joint hypothesis that prices in New York and Paris are weakly exogenous cannot be rejected, while London reacts to New York and Paris and quite rapidly so (α_2 = -0.70);
(b) in the case of 'Other painters', the two markets are obviously linked and some arbitrage is at play: trends in London and Paris are strongly similar, and in both cases, error correction mechanisms are present; the French market, however, reacts somewhat more rapidly to disequilibria than London.

4.3 The influence of stock exchange movements [15]

The relations between art markets and individual stock markets (Tokyo, New York, London and Paris, the third variable in the various relations) are summarized in Tables 4 and 5. The conclusions are as follows.[16]

(a) like above, in all but one case, there exists only one cointegrating long-run relation between art and each stock market individually;
(b) stock markets appear to be without influence in the long-run relationships (H_0: $\beta_3 = 0$ cannot be rejected); there is one exception for the New York stock exchange in London;

[15] See Chanel (1995) for a similar approach and similar results.
[16] We give the results for the case k = 4 only.

Table 3 Cointegration analysis
Great Master and Other painters

		Great Masters (New York, London, Paris)			Other painters (London, Paris)		
Lags		k=2	k=3	k=4	k=2	k=3	k=4
Testing for the number of cointegrating vectors[†]							
λ_{max}	$r \leq 2$	.8	1.1	1.2			
	$r \leq 1$	6.8	7.4	9.0	1.3	1.6	1.0
	$r = 0$	24.2	20.3	17.0	28.3	15.9	9.3
Trace	$r \leq 2$	.8	1.1	1.2			
	$r \leq 1$	7.6	8.5	10.3	1.3	1.6	1.0
	$r = 0$	31.8	28.9	27.3	29.7	17.5	10.3
Parameter values (one cointegrating vector)							
β_1		.26	.52	.63	1.00	1.00	1.00
β_2		1.00	1.00	1.00	-1.07	-1.05	-1.06
β_3		-1.13	-1.36	-1.47			
α_1		-.12	-.29	-.11	-.45	-.48	-.40
α_2		-.57	-.58	-.43	.48	.30	.24
α_3		.32	.13	.41			
Hypothesis testing (for GM only: H_0: $\alpha_1 = \alpha_3 = 0$)							
χ^2-value (2 d.f.)		4.42	4.09	4.18			
β_1		.09	.23	.19			
β_2		1.00	1.00	1.00			
β_3		-.97	-1.09	-1.04			
α_1		.00	.00	.00			
α_2		-.72	-.69	-.72			
α_3		.00	.00	.00			
Hypothesis testing ((for GM: H_0: $\alpha_1 = \alpha_3 = 0$, $\beta_3 = -\beta_2$; for OP: $\beta_2 = -\beta_1$)							
χ^2-value*		4.95	4.31	4.22	0.76	0.24	0.23
β_1		.12	.13	.14	1.00	1.00	1.00
β_2		1.00	1.00	1.00	-1.00	-1.00	-1.00
β_3		-1.00	-1.00	-1.00			
α_1		.00	.00	.00	-.47	-.50	-.42
α_2		-.71	-.71	-.73	.46	.27	.21
α_3		.00	.00	.00			
Jarque-Bera normality tests (χ^2 with 2 d.f.)							
Relation 1		.18	.31	.79	.36	.37	.38
Relation 2		2.72	.97	.16	4.54	4.80	4.65
Relation 3		1.14	.75	.11			

(c) stock markets are not influenced by deviations from long-run disequilibria on the art market; the French stock market is an exception in this respect;
(d) given (a), (b) above, the long-run results are very close to those obtained in section 4.1;
(e) as can be seen from Table 5, stock markets (especially Tokyo) have a short-run impact on paintings by Great Masters.[17] The Paris stock exchange has an impact on 'Other painters' only.

5. Conclusions

The results obtained are somewhat unexpected,[18] since they support the hypothesis that, in the long run, all three markets move together: the returns for important European painters, minor European painters and American contemporary painters are roughly similar.[19] It is as if the price obtained for the first time at an auction[20] defined the value of a painting, which subsequently, would merely follow a general price trend. A portfolio of Van Gogh's would do as well as a portfolio of Ginsburgh's, if these appeared more or less regularly at auctions; there is however little doubt that if Ginsburgh owned a Van Gogh, he would enjoy more utility than would Van Gogh from a Ginsburgh.

Short-run fluctuations in stock markets, and especially Tokyo have an impact on art markets, but given the relative dimensions of the two markets, it comes as no surprise that there is no effect in the other direction. The finding that stock markets have no long-term impact is however less evident.

[17] However, here a more careful analysis would be needed; in particular, the number of lags should be varied in order to have a clearer picture of the short run behaviour. This is beyond the scope of our paper and is treated in Chanel (1995).
[18] One could of course think that if transactions were made for financial reasons only, arbitrage would eventually have to equalize price movements; it is however quite clear that buyers are not the same on the three markets and that (hopefully) some transactions are motivated by artistic incentives.
[19] More precisely, $\Delta \log y_{1t} = \Delta \log y_{2t} + \varepsilon_t$.
[20] Obviously, not all painters are "known" enough to be sold at auctions; auctions already play the role of a filter.

Table 4 Cointegration analysis
Paintings and stocks (k = 4)

		New York*		London**			Paris***		
Stock exchange		NYork	Tokyo	NYork	Tokyo	London	NYork	Tokyo	Paris
Testing for the number of cointegrating vectors†									
λmax	r≤2	2.9	.2	6.1	.6	.3	7.6	.3	.0
	r≤1	5.4	11.7	8.5	9.3	6.5	10.1	10.1	7.1
	r=0	18.5	15.0	13.9	14.7	13.9	25.3	25.3	39.0
Trace	r≤2	2.9	.2	6.1	.6	.3	7.6	.3	.0
	r≤1	8.4	11.9	14.6	9.8	6.8	17.8	10.4	7.2
	r=0	26.9	26.9	28.4	24.5	20.7	43.1	35.7	46.2
Hypothesis testing (H_0: α_3=0) (weak exogeneity of stock exchange)									
χ^2-value		.13	2.93	.11	3.50	.38	.05	3.54	13.21
Significance		(.72)	(.09)	(.74)	(.06)	(.54)	(.82)	(.06)	(.00)
Parameter values (one cointegrating vector)									
β_1		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
β_2		-1.26	-1.17	-3.91	-.60	-1.76	-1.08	-1.03	-.98
β_3		.60	.22	4.74	-.34	.94	.60	.12	.05
α_1		-.49	-.25	-.03	-.65	-.34	-1.00	-1.06	-1.04
α_2		.32	.29	.07	.11	.14	-.22	.03	.00
α_3		.00	.00	.00	.00	.00	.00	.00	-.31
Hypothesis testing (H_0: β_3 = 0)									
χ^2-value		3.71	.26	5.57	.43	1.99	2.54	.33	.04
Significance		(.05)	(.61)	(.02)	(.51)	(.16)	(.11)	(.57)	(.84)
β_1		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
β_2		-1.02	-.94	-3.91	-.90	-1.12	-.83	-.90	-.95
β_3		.00	.00	4.74	.00	.00	.00	.00	.00
α_1		-.52	-.36	.03	-.42	-.47	-.88	-1.05	-1.08
α_2		.19	.28	.07	.12	.11	-.31	-.00	-.05
α_3		.00	.00	.00	.00	.00	.00	.00	-.31
Short-run effects (see Table 5)									
Jarque-Bera normality tests (χ^2 with 2 d.f.)									
Relation 1		.77	.21	.33	.73	4.38	1.46	1.15	1.62
Relation 2		3.26	1.75	1.32	3.19	1.83	.52	1.94	.45

* Subscripts refer to US painter, Great Masters and the NY or the Tokyo stock exchange.
** Subscripts refer to Other painters, Great Masters and the NY, the Tokyo or the London stock exchange.
*** Subscripts refer to Other painters, Great Masters and the NY, the Tokyo or the Paris stock exchange.
†The tabulated values for testing the number of roots are 8.1, 14.6 and 21.3 at the 5% probability level.

Table 5 Cointegration analysis
Paintings and stocks (k = 4)
Short-run effect

	New York		**London**			**Paris**		
Stock exchange	NYork	Tokyo	NYork*	Tokyo**	London	NYork	Tokyo	Paris
Short run impact of Stock exchange on Other painters								
$\Delta Stock_0$	-	-	-	-	-	.80 (.53)	-	-
$\Delta Stock_{-1}$	-	-	-	-	-	-	-	-
$\Delta Stock_{-2}$	-	-	-2.00 (.87)	-	-	-	-	-.60 (.33)
$\Delta Stock_{-3}$	-	-	-	-	-	-	-	-
Short run impact of Stock exchange on US painters								
$\Delta Stock_0$	-	-	-	-	-	-	-	-
$\Delta Stock_{-1}$	-	-	-	-	-	-	-	-
$\Delta Stock_{-2}$	-	-	-	-	-	-	-	-
$\Delta Stock_{-3}$	-	1.60 (.48)	-	-	-	-	-	-
Short run impact of Stock exchange on Great Masters								
$\Delta Stock_0$	.83 (.32)	.73 (.25)	-	.57 (.25)	-	.41 (.34)	.69 (.27)	-
$\Delta Stock_{-1}$	.43 (.33)	.86 (.28)	-	.93 (.24)	.35 (.18)	.58 (.32)	.52 (.29)	-
$\Delta Stock_{-2}$	-	-	-	-	.22 (.18)	.62 (.32)	.60 (.30)	-
$\Delta Stock_{-3}$	-	-	-	-	-	-	-	-

Standard deviations are between brackets under the coefficients.
*A dummy equal to 1 in 1986-2 has been introduced, in order to have normally distributed residuals.
**A dummy equal to 1 in 1969-1 and another dummy equal to 1 in 1986-2 has been introduced in order to have normally distributed residuals.

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