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THE 1980S PRICE BUBBLE ON (POST) IMPRESSIONISM

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Abstract

The Log Periodic Power Law is a model used to define and measure speculative bubbles. This model has proven useful to track bubbles and even predict crashes of liquid asset classes. Using this methodology coupled with properties of cointegration between stocks and art, the 1980s price bubble on Impressionism and Post-Impressionism is analyzed. It is shown formally that there was a bubble in this market between 1986 and 1989. However, when denominating the art index in JPY rather than in USD, no price bubble behaviour was found at all. This observation suggests that Japanese buyers never felt that they were riding a bubble. Despite popular beliefs, no evidence is found that Japanese buyers viewed art as a speculative vehicle instead of a more classic consumption good that was related to their own cultural heritage.

Keywords: Impressionism, art market, hedonic regression, LPPL, bubble
JEL classification: G1, G17, Z11

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1 Introduction

During the late 1980s, the market for Impressionist art experienced some of the most extreme conditions in its history. On March 31, 1987, Van Gogh' *sunflowers* were lifted by Yasuo Goto from the Yasuda Fire and Marine Insurance Company of Japan for 25 millions at Christie's London. A few months later, waves of records hit the market. Van Gogh's *Irises* were hammered for 30 millions at Sotheby's London. In May 1990, Pierre-Auguste Renoir's *Bal du moulin de la Galette* was acquired by Ryoei Saito for USD 78.1 millions at Christie's New York. By contrast, one and a half year later, the sixth of December 1992, *The Jardin à Auvers*, one of the very last landscapes Vincent Van Gogh painted before his suicide, fetched only FRF 55 million, or 6.5 millions in Paris.
The Nikkei 225, on the other hand, followed a similar path. In the afternoon of the 29th of December 1989, this equity index was at its all-time high of 38'915.87 after a massive 106% rise in three years. Not even three years later, on Tuesday the eighteenth of August 1992, five months prior to the *The Jardin à Auvers*' sale, the same index dropped to a mere 14'309.41, a bottom not seen since March 1986.

At first sight, there seems to be a coincidence in timing between the rise and fall of painting prices, especially on French painters (see for instance de la Barre et al. (1993) [5]) and the development of bubble-like behaviour in Japanese stocks. Singer and Lynch (1997) [29] wrote about *Japanese speculators in the Impressionist market*. Roehner and Sornette (1999) [26] also showed evidences of speculation in the stamp market in the 1980s, with a strong outperformance of XIXth century stamps and Van Gogh stamps.
Using a hedonic regression methodology, Wieand et al. (1998) [37] suggested that *the combination of high Japanese security prices and low yen cost of art made Western art an attractive asset to Japanese investors*. Additionally, Hiraki et al. (2009) [12] have highlighted comovements between Japanese stocks, land index and art indices during the 1980s.
They conclude that, amongst all genres and styles, Impressionism was aggressively bid, as *[Japanese buyers] had a much stronger preference to well-known French Impressionist and Post-Impressionist style paintings* (Hiraki et al., 2009). The same authors find also that, amongst all genres, it is French Impressionism that is most correlated with Nikkei, whereas Dutch Old Masters for instance are less correlated.

This paper aims at further investigating Impressionist art prices behaviour during this period, as important questions are still pending. We set five goals for this paper:
Firstly, we want to formally challenge the common belief that a bubble took place in the

market for Impressionist and Post-Impressionist art at the end of the 1980s. Identifying bubble behaviour in the art market is of great relevance in order to better understand its price dynamics. This partially answers the question whether art can be seen as a speculative rather than a common consumption or investment good.
Our second objective is to estimate as precisely as possible the timing of this phenomenon. In what period exactly did prices start accelerating, and, when did this acceleration stop, resulting in a change of regime, a bubble deflation or an outright crash?
Thirdly, we want to describe price dynamics of other art movements during this period. We build indices for Modern Art (that can be seen as historically close to Post-Impressionism) and Old Masters (that can be seen as historically less related to Impressionism and Post-Impressionism).
Fourth, we want to compare the Western (European and American) perspective with the Japanese point of view by taking into account currency effect.
Finally, an explanation is put forward on why Impressionist art attracted so much the Japanese collectors.

To investigate these questions, a rigorous framework is needed that allows one to define and characterize a speculative bubble. We exploit recent developments in bubble modelling made by Jiang et al. (2010) [16] and references.
In order to study art prices, we construct a new hedonic index on Impressionist and Post-Impressionist drawings. Whereas many art indices exist in the literature, only a few seem to exclusively cover sales of Impressionist art during the 1980s. A first example of such indices is found in de la Barre et al. (1993), who designed an OLS-based XIXth century French painters index covering 1980 to 1991. A second example of such index is found in Hiraki et al. (2009) who used an index that, *for each artist, is constructed roughly as the average prices of his or her paintings on a monthly basis, and after some seasonality adjustment, the index corresponding to a portfolio of particular artists is calculated.*
However, none of these indices satisfy our needs. Indeed we want an index based on the drawings market, as this market was not only played by the upper-class, like the Impressionist painting market, but also by Japanese, American and European middle-class. Furthermore, as we use the index as observed series, we need our estimates to be as precise as possible. We rely on Hodgson and Vorkink' (2004) semi-parametric estimation to build the index. This class of indices have been developed to achieve greater precision in situations where residuals of hedonic regressions are not normally distributed, a classical issue when designing art indices.

The remainder of the paper is organised as follows. In section 2, the methodology is explained on how the index is built. The third section elaborates on the time series analysis

tools that are used to distract all relevant information from the newly constructed art index. In section 4 the results of this analysis are presented. Section 5 offers an explanation to price moves in the art markets and what role Japanese collectors may have played. The last section closes this paper with our final conclusions.

2 The construction of a new index on Impressionist and Post-Impressionist art

2.1 The dataset

This study is based on three datasets. The first one consists of sales of works on paper from artists belonging to Impressionism and Post-Impressionism art movements. We confined our analysis to 3862 artworks from thirteen artists, born between 1820 and 1880, and cited in Galenson and Weinberg (2001) [6]: Pissarro, Manet, Degas, Cezanne, Monet, Redon, Renoir, Gauguin, Van Gogh, Seurat, Toulouse-Lautrec, Bonnard, and Vlaminck. The second dataset is made of 2563 sales from 39 Old Masters of Dutch, French and Italian origin cited in Ginsburgh and Schwed (1992) [9]. The third dataset consists in 2650 artworks made by 9 different artists who can be seen as painters of Modern Art (Andre Derain, Fernand Leger, Georges Braque, Jean Arp, Joan Miro, Juan Gris, Marc Chagall, Pablo Picasso and Robert Delaunay).
We choose to only include sales of drawings, studies and sketches, as supply in this segment of the art market is larger than in the market for paintings. Furthermore, the market for works on canvas is reputed much more expensive and concerns mainly high net worth individuals (see Goetzmann et al., 2011 [10]). We are more interested in behavioural pattern of the broader market for art.
Our database has been built using sales catalogues and results files. All sales were observed between January 1975 and December 1994. Prices are expressed in USD and are deflated using the 1995 OECD price index. We grossly estimate buyer's transaction fees using Christie's and Sotheby's fees' policy: +25% for works below 50,000 USD and +20% otherwise.
As we want to focus on the broad art market, and not on very expensive art that may bias the index, we trim the 5% most expensive artworks, on semi-annual basis[1]. After eliminat-

[1]Indices are less robust and more volatile when no trimming is made, but conclusions stay the same.

ing further sales lacking information (size of the work, title, etc.) the first, second and third dataset eventually consists of 3463, 2410 and 2382 sales respectively.
Financial data are imported from Datastream and consists of 5218 daily observations of closing price of the Nikkei 225 and the daily JPY/USD exchange rate, between the first of January, 1975 and the 30th of December, 1994.

2.2 Methodology of Hedonic Index construction

It is the purpose to derive indices that show the progression of the market over time. Indices are based on a hedonic regression methodology, as opposed to a repeat-sales methodology (see a detailed comparison in Ginsburgh et al., 2006 [8]). The basic principle in this approach is the regression of the logged prices with respect to specific characteristics (size, medium, period of the sale, etc.) of the art pieces so as to obtain a marginal "price" for each characteristic.

$$p_i = \sum_{t=1}^{T} \gamma_t d_{i,t} + \sum_{k=1}^{K} \alpha_k v_{i,k} + u_i, i = 1, ..., n. \tag{1}$$

In which p_i is the logged price of sale i, $d_{i,t}$ is a dummy variable taking the value 1 if the work of art i was sold in period t, and 0 otherwise. There are T = 39 periods, as one of the semesters of the series is used as benchmark. The K variables $v_{i,k}$ reflect other specific characteristics of the piece of art i. For instance, for the Impressionist/Post Impressionist art dataset, these include: the *height* and *surface*, the *lot* number, twelve dummies related to the artists (Pissarro as a benchmark), six dummies whose values depend on the *auction houses* (Sotheby's, Christie's, Koller, Blache, Ader Picard and Tajan, Phillips, Bonhams), one dummy taking the value 1 if the sales' session is devoted to a specific *collection* or not, six dummies for the *weekday* the sale occurs (as some (un)important sales may be more likely to happen certain days), three dummies for the *city* where the sale occurs (New York, London and Zurich), one dummy taking the value 1 if the drawing is a *study*, 0 otherwise, and fourteen dummies corresponding to different *subjects* that are not mutually exclusive: landscape, peasants, animals, portrait, people, still life, urban scenes, family of the artist, self-portrait, dancers, bath scenes, women, nude, religious scenes. The number of objects in the analysis (n) totals 3463.

After eliminating variables that are not significant at a 5% level in a standard ordinary least squares regression, 31 variables (in addition to the 39 semiannual dummies) are restrained. This linear model results in an R^2 of nearly 60% for Impressionism and Post-Impressionism. The same methodology yields an R^2 of 40% for Old Masters and more than 67% for Modern Art.

As we want to obtain as much precision as possible in the final estimation of the parameters we follow Hodgson and Vorkink (2004) [13] and implement the modified Bickel's (1982) [2] adaptive estimator to gain more efficiency. Note that a valid application of this method requires symmetry of the residuals, which is verified in our case.

The semiparametric estimator is built as follow:

Let us consider $X_i' = (d_{i1}, ..., d_{i,t}, v_{i,1}, ..., v_{i,K})$ and $\beta = (\gamma_1, ..., \gamma_T, \alpha_1, ..., \alpha_K)$

Let $\hat{\beta}$ be the estimator of β, based on ordinary least squares:

$$\hat{\beta} = (X'X)^{-1}(X'p). \tag{2}$$

Let $\hat{\epsilon} = p - X\hat{\beta}$ be the vector of residuals. Let us define K(.), a gaussian kernel: $(K(\lambda) = -\lambda\frac{e^{0.5\lambda^2}}{\sqrt{2\pi}})$.

$$\widehat{f(\epsilon_i)} = \frac{1}{2(n-1)}\sum_{i\neq j}^{n}(K(\frac{\hat{\epsilon_i}+\hat{\epsilon_j}}{h}) + K(\frac{\hat{\epsilon_i}-\hat{\epsilon_j}}{h})). \tag{3}$$

$$\widehat{f'(\epsilon_i)} = \frac{1}{2h(n-1)}\sum_{i\neq j}^{n}(K'(\frac{\hat{\epsilon_i}+\hat{\epsilon_j}}{h}) + K'(\frac{\hat{\epsilon_i}-\hat{\epsilon_j}}{h})), \tag{4}$$

where h is a bandwidth obtained using Silverman's rule of thumb [28] . The score function is computed using a trimming parameter $(t_1 = 2.5, t_2 = e^{2.5^2/2}, t3 = 2.5)$ following Hsieh and Manski (1987) [14].

$$\hat{\psi}_i(\hat{\epsilon_i}) = \frac{\hat{f'(\epsilon_i)}}{\hat{f(\epsilon_i)}} \text{ if } \mid \epsilon_i \mid < t_1 \text{ and } f(\epsilon_i) > t_2 \text{ and } f'(\epsilon_i) < t_3. \tag{5}$$

$$\hat{\psi}_i(\hat{\epsilon_i}) = 0 \text{ otherwise.} \tag{6}$$

The sample score vector is then estimated as follows:

$$\hat{S} = \frac{\sum_{i=1}^{n} X_i\hat{\psi}_i(\hat{\epsilon_i})}{n}. \tag{7}$$

Similarly to Hodgson and Vorkink (2004), the information matrix is approximated:

$$\hat{I} = \frac{\sum_{i=1}^{n}(\hat{\psi}_i(\hat{\epsilon_i}))^2}{n^2}\sum_{i=1}^{n} X_iX_i'. \tag{8}$$

According to Bickel(1982):

$$\tilde{\beta} = \hat{\beta} + \hat{I}^{-1}\hat{S}. \tag{9}$$

$$\sqrt{\tilde{\beta} - \beta} \rightarrow N(0, I^{-1}). \tag{10}$$

White's (1980) [36] consistent estimator of variance is used to obtain robust estimators of $\tilde{\beta}$'s variance.
Finally, the index is built. The semi-annual Impressionist Works On Paper index is further referred to as *IWOP*. The Modern Art Works on Paper index is referred to as *MAWOP* and the Old Master Drawings index is referred to as *OMD*. The first semester of 1975 is considered as the base of the index, whose value is arbitrarily put to 100.

$$IWOP_t = 100e^{\tilde{\gamma}_t - \tilde{\gamma}_1}, \tag{11}$$

where $t = 1, ..., T$.

The *OMD* (Old Master Drawings) index and *MAWOP* (Modern Art Work On Paper) index are built in a similar fashion.
Tables 3, 4 and 5 in appendix summarize results from these hedonic regressions.

3 Time series analysis

3.1 Overview

First we devote our analysis to the IWOP index. As the index is based on the coefficients of the 39 time dummies presented in equation 1, our semi-annual index is only made of 39 plus 1 observations. The LPPL methodology requires a fit of 7 parameters. Applying this methodology directly to the 40 observations may lead to overfitting [2]. To deal with this problem, an innovative approach is required. This starts with the observation of cointegration between the IWOP index and Japanese stocks (Nikkei). By exploiting this relationship to simulate synthetic art indices using a monte carlo simulation, an LPPL can be fitted

[2]Note that though results are less precise, conclusions stay unchanged when applying directly LPPL on the 40 observations.

on each of these simulations in order to obtain the needed estimates and their confidence intervals.

3.2 Methodology

3.2.1 LPPL

Let $f(t)$ be a times series. The Log Periodic Power Law is :

$$f(t) = A + B(t_c - t)^m + C(t_c - t)^m Cos(\omega \log(t_c - t) + \phi). \tag{12}$$

$$\lim_{t \to t_c} f(t) = \infty. \tag{13}$$

In this equation A is a constant term, $B(t_c - t)^m$ models a super-exponential acceleration where t_c is a critical time, and $C(t_c - t)^m Cos(\omega \log(t_c - t) + \phi)$ introduces a first order log-periodic oscillation (Sornette, 1998 [31], Jian et al., 2010). Following Jiang et al., 2010, $f(t)$ follows a bubble-type behaviour if $B < 0$, $m \in [0, 1]$ and $C \neq 0$. The critical time, t_c, introduces a singularity in the equation. It is the point where the price series diverges towards infinity. In its current form, the model does not give any solution beyond this critical time. However, it suggests a change of regime beyond t_c that may lead to a bubble deflation or an outright crash. As a consequence, all conclusions drawn in this paper will relate to this specific definition of a bubble.

3.2.2 Cointegration

Under the assumption that the IWOP and the Nikkei are cointegrating time series, the critical time t_c should be identical for both of them, independent of error terms. Indeed, if the IWOP and the Nikkei are cointegrating time series, they will, by definition, follow this relationship:

$$Nikkei_t = c + \mu \times IWOP_t + w_t, t = 0, ..., T, \tag{14}$$

where w_t is a stationary process. On the other hand, under the assumption that the Nikkei follows an LPPL price process:

$$Nikkei_t = f(t) + \xi_t, \tag{15}$$

where $f(t)$ is the LPPL function and ξ_t is an error term.
By combining (14) and (15):

$$f(t) + \xi_t = c + \mu IWOP_t + w_t. \tag{16}$$

(13) and (16)

$$\lim_{t \to t_c} f(t) = \lim_{t \to t_c} (c + \mu IWOP_t - \xi_t + w_t) = \infty. \tag{17}$$

t_c is found by estimating LPPL function on the Nikkei.

3.2.3 Monte Carlo

In practise, c, μ and w_t are estimated using ordinary least squares.

$$\mu \sim N(\hat{\mu}, \hat{\sigma_\mu^2}). \tag{18}$$

$$c \sim N(\hat{c}, \hat{\sigma_c^2}). \tag{19}$$

Let us further assume:

$$w \sim N(0, \hat{\sigma^2}_w). \tag{20}$$

By definition of OLS estimators:

$$c = \bar{Nikkei_t} - \mu \bar{IWOP}, \tag{21}$$

where

$$\bar{Nikkei} = \frac{\sum_{t=0}^{T} Nikkei_t}{T+1}, \tag{22}$$

and

$$\bar{IWOP} = \frac{\sum_{t=0}^{T} IWOP}{T+1}. \tag{23}$$

It is hence possible to simulate series for the IWOP, from daily Nikkei values, based on (14).

$$IWOP^*_{\tau,z} = c^*_{\tau,z} + \mu^*_{\tau,z} Nikkei_\tau + w^*_{\tau,z},\ \tau = 1, ..., t_c,\ z = 1, ..., Z, \tag{24}$$

where μ^* and w^* are randomly selected values according to (18) and (20) , and c^* is the corresponding value for c, according to (21). Z is the total number of simulations.
For each simulated series, we estimate LPPL parameters by non linear least squares. We then obtain as many estimations of LPPL coefficients as simulated series.
As the $IWOP^*$ series have been simulated, it must be tested whether the coefficients resulting from non linear estimation are compliant with the definition of a bubble. If yes, then the null hypothesis that no bubble took place in the art market can be rejected.

4 Empirical results

4.1 The bubble on Nikkei

The starting time and the critical times for the Nikkei bubble are found using Bastiaensen et al.'s (2009) [1] methodology: one endpoint is fixed while the other one varies. As explained in the previous section, each fit process produces a different set of parameters estimated by non linear least squares. By selecting solutions with the smallest MSE and that match the observed peak on equity, one gets a meaningful set of coefficients. Figure 1 highlights some

of these possible solutions. Among them, one suggestion seems to better match observed data: a fit beginning in summer 1986 and ending in December 1989.

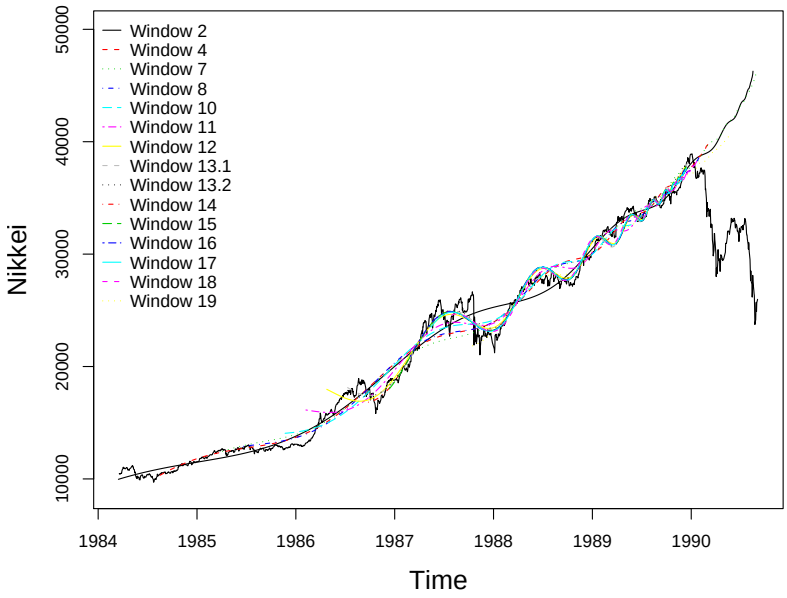

Figure 1: Selected LPPL fits on Nikkei

4.2 The bubble on Impressionist and Post-Impressionist art prices

Figure 2 compares the IWOP, obtained from Hodgson and Vorkink, 2004's methodology and the Nikkei. Worthington and Higgs (2001) [38] have already highlighted the presence of cointegration between art and equities. We perform a Phillips-Ouliaris (1990) [24] cointegration test and observe that the IWOP is significantly cointegrated with the Nikkei, at a confidence level of 5%. At the contrary, IWOP is not significantly cointegrated with S&P 500 at a level of 15%, what confirms results from Hiraki et al. (2009).

We generate the expected time series of art prices, based on the cointegration between Nikkei and IWOP. We use these series to first investigate several possibilities for the critical time and the starting point of a would-be bubble on art. As the IWOP index and

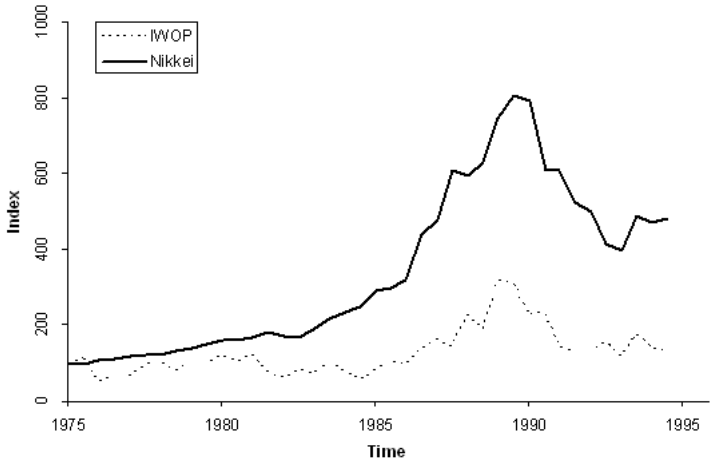

Figure 2: Iwop and Nikkei rescaled to 100 in 1975

Japanese equities are strongly cointegrated, we use the solutions found for Nikkei as prime possibilities. Figure 3 illustrates the fits for these options.

We select the two solutions that yield the smallest Mean Squared Error on the one hand and match the observed peak of December 1989 /January 1990 on the Nikkei on the other hand:

- From June 1986 to December 1989.
- From July 1987 to January 1990.

However, we cannot directly conclude that a bubble did exist on Impressionist and Post-Impressionist art prices, as we need to take into account the noise linked to our estimation of daily art prices. In order to cope with this issue, we simulate 10'000 series. Each series suffer from noise as described in equation (24). LPPL parameters are estimated and recorded for all series.
For both possibilities, key parameters stay in line with Jiang et al., 2010's definition of a bubble[3] in more than 95% of the simulations, suggesting that a bubble did occur in the market for XIXth century art.

[3] $B < 0$, $m \in [0, 1]$ and $C \neq 0$

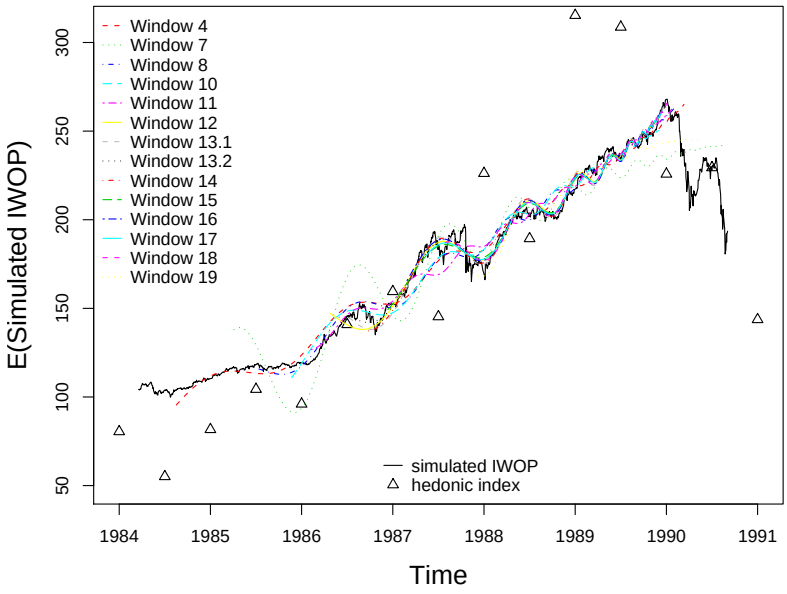

Figure 3: Selected LPPL fits on IWOP*

4.3 Market behavior for Old Masters and Modern art

Figure 4 plots the three art indices (OMD, MAWOP and IWOP) along the Nikkei 225. Interestingly, for the MAWOP and OMD, the Phillips-Ouliaris (1990) test fails to reject the null hypothesis of no-cointegration with Nikkei. Nevertheless, Figure 4 seems to present a peak in prices right after 1990, both for the Old Master Drawings index and Modern Art Works On Papers. Indeed, we reject the null hypothesis of no-cointegration for IWOP against MAWOP when taking a 6 months lag into account, and we reject the null hypothesus of no-cointegration for MAWOP against OMD, also with a 6 months lag into account. In other words, the IWOP is directly cointegrated with Nikkei, whereas MAWOP is only cointegrated with IWOP with a lag, and OMD is cointegrated with MAWOP with yet another lag. This suggests that IWOP and Nikkei were leading a bubble, whereas OMD and MAWOP were following it. Because we do not directly observe cointegration of OMD and MAWOP with Nikkei, we cannot however use the same methodology to affirm or infirm that a bubble took place in the market for Old Masters or the one for Modern Art. We can however affirm there was a bullish market prior to 1990, followed by a significant drop in

prices.

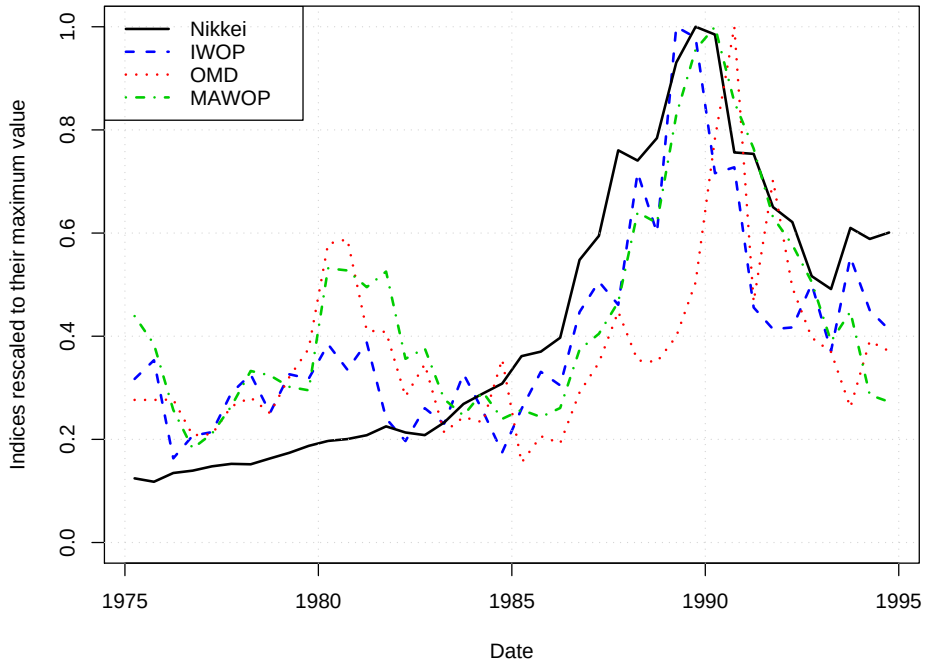

Figure 4: IWOP (USD), MAWOP (USD), OMD (USD) and Nikkei (JPY), rescaled to 1 in their maximum value

5 Explanation to swings in art prices

Results of previous sections show that a speculative bubble took place in the market for impressionist art and that the timing of this bubble lies between June 1986 and January 1990. However, three important questions still need to be addressed:
- Why a lagged cointegration is observed between (Post) Impressionism and other art movements ?
- Did Japanese really present a speculative behaviour on art prices ?
- Why did Japanese buy more specifically Impressionist art during the 1980s?

5.1 Why a lagged cointegration is observed between (Post) Impressionism and other art movements ?

A first explanation to the lagged cointegration would be linked to the timing of the sales, as important auctions are typically spaced of 6 months from one another. However, it is known that impressionism and modern art were presented in the same week, sometimes in the same sale. The same is true for Old Masters. This phenomenon comes from the fact that works on paper were frequently gathered by auction houses in special sales devoted to drawings. As a consequence, this first possibility to explain a lagged cointegration of prices seems unconvincing.
A second explanation would be that our initial failing to reject the null hypothesis of no-cointegration with Nikkei is due to a type II error. In this case, we would fail to spot that the three segments could have acted as one. Nevertheless, as we observe the lagged relationship on two different samples (MAWOP and OMD), this idea fades.
Finally, a possibility is that Impressionist works were setting the pulse of the global art market. In other words, Impressionism was, at the time, the leading engine of global art prices. The strong cointegration between IWOP and Nikkei, as well as many other evidences (see for instance Hiraki et al, 2009 or de la Barre et al., 1994) suggest that Japanese investors may have directly influenced the Impressionist art market. From our results, we can conclude that other movements, either closely related (like Modern Art) or not (like Old Masters), did suffer from lagged contagion.

5.2 Did Japanese present a speculative behaviour on art prices?

It was concluded in the previous section that a bubble occurred in the market for (Post) Impressionist art. As the IWOP index is denominated in USD this conclusion merely counts for what could be referred to as a Western perspective. Compelling evidence shows that this art bubble was strongly linked to a bubble on Japanese equities at the time. A common explanation for this phenomenon (see for instance Hiraki et al., 2009) is that Japanese collectors, enriched by a booming equity market, fuelled the ever increasing, unstable pressure on art prices in Western countries.
However, to our knowledge, few studies have investigated the Japanese point of view of this bubble. A simple, yet powerful tool to look at the market through Japanese eyes, is to design the IWOP in Japanese yen rather than in US dollars.
Figure 5 shows how the exchange rate evolved between 1975 until 1995. Though this mar-

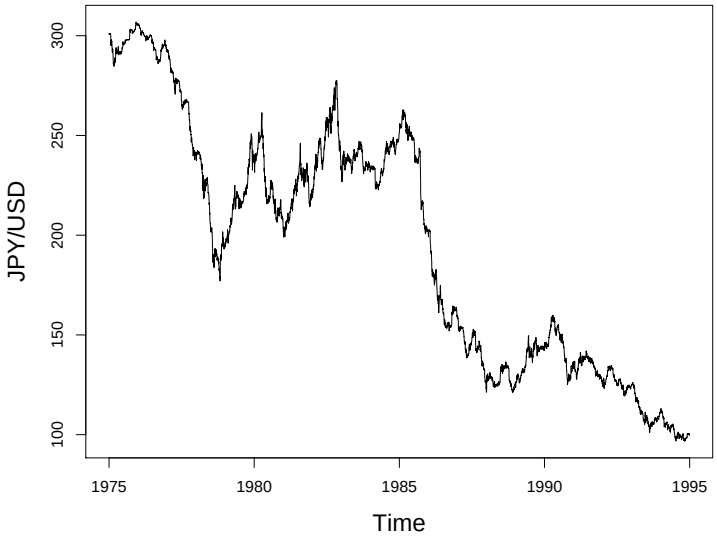

Figure 5: Foreign exchange: JPY to USD

ket did not encounter a bubble type behaviour, it trended in favour of the Japanese yen, from roughly 300 JPY/USD in 1975, to 100 JPY/USD in 1995.
In this context, figure 6 shows that art prices in Japanese currency were not especially high in the period ranging from 1986 to 1990. From its lowest level in 1984, to its peak in 1989, Impressionist and Post-Impressionist art rallied +231% for the yen owner. Though impressive, this was a rather modest performance compared to the +472% American investors encountered during the same period.
Furthermore, art prices in real terms were more than three times as expensive in 1989 than they were in 1975 for USD owners. On the other hand, JPY owners felt a rather small 50% increase in art prices over the whole 1975-1989 period.

An explanation consistent with the observation of a bubble from a Western perspective is found in the works of Smith et al. (1988) [30]: irrational behaviour need not exist for a bubble to happen. Lei et al. (2001) [21] summarize this concept: *a rational trader might make a purchase at a price greater than the fundamental value, believing that he will be able to realize a capital gain by reselling at an even higher price, either to an irrational trader, or to a trader who plans on reselling*. In other words, bubbles can occur when market participants are rational, but observe the presence of irrational actors. As showed

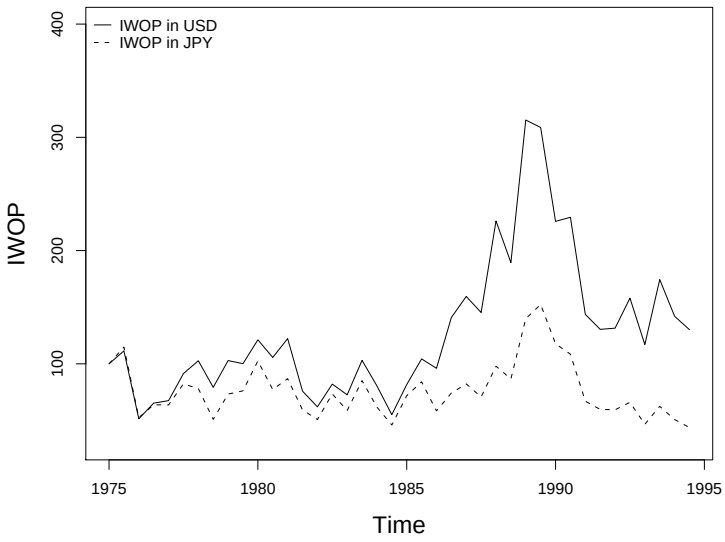

Figure 6: Comparison of the IWOP in USD and the IWOP in JPY

previously, for Western collectors, Japanese were riding a bubble. Indeed, from a USD denominated point of view, Japanese collectors acted in an irrational fashion as demonstrated by the creation of a LPPL bubble type. Nevertheless, Japanese themselves never felt they were riding a bubble as the price level at which they were buying was not historically high, once the USD/JPY exchange rate is taken into account.
All actors may have been rational: Japanese collectors behaved rationally by consuming art they like at reasonable JPY levels, whereas Western investors bought art at high USD prices, hoping to resell to the "irrational" Japanese they truly observe. In Lei et al.'s words, the situation in global art markets, end of the 1980s saw *the existence of speculative opportunities* (see Blanchard (1979) [3] or Brooks and Katsaris (2003) [4] or a formal description of bubble creation when rational speculative opportunities occur).

5.3 Why did Japanese buy more specifically Impressionist art during the 1980s?

It is well known that discovery or re-discovery of art movements by scholars and museums can lead to soaring prices (de Limburg-Stirum and Ginsburgh, 1995 [7]). This hypothesis, however, seems improbable in the case of the Impressionism and Post-Impressionism boom of the 1980s, as these movements were already established and universally recognised for almost a century. Indeed, the term *Impressionist* is derived from Claude Monet's work *Impression, soleil levant*, and was originally invented in 1874 by an art critic to satirise Monet's art. The artist subsequently adopted the word to describe the entire movement. *Post-Impressionism* was first coined by art critic and artist Roger Fry to title an exhibition at the Grafton Galleries in London in 1910. Nathanson (1985) [23] has highlighted that Fry invented the term to group what are nowadays known as different movements, ranging from Modernism to Proto-Cubism. As movements, Impressionism and Post-Impressionism already had international visibility in the first part of the XXth century: in addition to the Grafton Galleries' exhibition, London played a role in promoting French and British Impressionism with exhibitions as early as 1883 (Rewald, Pissarro and Pissarro, 1949) [25]. In 1918, National Gallery's director Sir Charles Holmes spent 20'000 on post Impressionists paintings, including Degas and Gauguin (Munro, 2003 [22]). Of course, France was a leader in promoting French Impressionism and Post-Impressionism. In 1922, the Toulouse-Lautrec museum opened in the city of Albi to host Lautrec's works as well as Bonnard's, Serusier's, Valadon's and Vuillard's (Julien, 1952 [17]).

In 1929, the largest version of the *Bal du moulin de la Galette* was hung in the Musée du Louvre. The piece was previously exhibited in the Musée du Luxembourg. Such a transfer was, under the French system, conditional to the fact that " [the artist's] *glory had been confirmed by universal opinion"* (Laclotte et al., 1986 [20]).

The Museum of Modern Art in New York was established in 1929 and displayed the same year an exhibition devoted to Cezanne, Van Gogh, Gauguin and Seurat. In 1935, this museum organised an exhibition entirely devoted to Vincent Van Gogh (Goodyear, 1943 [11]). In 1937, the Palais de Tokyo in Paris, built for the International Exhibition, hosted Neo-Impressionists and Pont-Aven school paintings.

The former USSR also had a marked interest in the genre as at least 74 Impressionist and Post-Impressionist master pieces were seized in Germany by Soviet authorities after the Second World War, to augment the Hermitage's collection (Kostenevich, 1995 [19]).

In 1959, the National Museum of Western Art opened in Tokyo to exhibit Western paintings, including works of Manet, Renoir, Monet, Van Gogh, Gauguin and Moreau, previously held by the famous Japanese collector Matsukata Kojiro (National Museum of West-

ern Art, 1960 [33]). Hence, as a matter of fact, Impressionism and Post-Impressionism cannot be considered as being "discovered" in the 1970s or 1980s. It is more likely that the roots of the bubble may be found in the historical links between Impressionism and Japan. It is indeed well documented that Western art was influenced by Japanese art precisely during the second part of the nineteenth century, when Europe (and more particularly France) was subject to "Japonisme". Watanabe(1984) [34] has highlighted that *after 1867*[4]*, Japanese prints became widely available in the West* and that *the cult of Japanese art is a distinct characteristic of the 1870ies and 1880ies in the West, particularly in France and in England*. As Schuster(1974) [27] explains: *Degas, Gauguin, Manet, Matisse, Monet, Toulouse-Lautrec, Van Gogh, Baudelaire, Flaubert, Zola: all were enthusiastic about the new Japanese way of painting - so different from techniques known in Europe*. For Van Gogh, Japan is an utopia (Kodera(1984) [18]) that he tries to figure out in his paintings. Cezanne may have similar links to Japan (Inaga, 1988 [15], Tanaka, 2001 [32]). According to Weisberg(1975) [35] Manet and Degas were both influenced by Japanese prints and Japonisme. An exhibition held in 1988, called "Le Japonisme", took place at the Galeries Nationales du Grand Palais in Paris and the Museum of Western Art in Tokyo. The museums exhibited works of Cezanne (of which *La Montagne Sainte-Victoire*), Degas, Gauguin, Manet, Monet, Pissarro, Renoir, Toulouse-Lautrec and Van Gogh.

Impressionism and Post-Impressionism may be seen as the first signs of tangible Japanese influence on modern European culture in a post-Edo period. The very same influence, not only on art, but also on finance, was at its highest in the 1980s, as the Japanese economy was taking over the world. In this context, for a Japanese to buy late XIXth century art in the eighties was not simply obtaining a European painting, it was also acquiring part of Japanese history: the early international Japanese influence in the modern world.

6 Conclusion

This paper investigates the bubble-like behaviour in Impressionist art and Japanese stocks at the end of the 1980s. A common explanation of high art prices at the end of the eighties is the Japanese influence on international art markets, more precisely on Impressionist and Post-Impressionist art. We suggest that Impressionist and Post-Impressionist art were no arbitrary choice for Japanese collectors: these movements stand for one of the greatest examples of Japanese influence on European art. In a sense, Japanese collectors were simply

[4]the end of the Edo period

buying part of their cultural heritage.
However, to formally investigate the assumption that a speculative bubble took place in Impressionist art, a semi-parametric adaptive estimation is performed on Impressionist works on paper data to obtain a semi-annual USD index between 1975 and 1995. As it is imprecise to calibrate a Log Periodic Power Law (LPPL) on only 40 data, we exploit an observed cointegration between Nikkei and Impressionist art prices to simulate series.
From our Monte-Carlo simulation, we derive sets of LPPL parameters. All of them comply (at a 95% confidence level) with Jiang et al.'s definition of a bubble.
As a consequence, our first result shows that an unstable acceleration of prices took place in the market for Impressionist works on paper, at the end of the 1980s. Our results also suggest a price contagion to other markets, such as Modern Art (a movement closely related to Post-Impressionist art), or even Old Masters. This confirms previous results (de la Barre et al, 1996 [5]) that global art markets did experience considerable growth prior to 1990. The existence of a lagged cointegration between Impressionism and these art movements suggests that global art prices were more or less following trends set by Japanese collectors in Impressionist and Post-Impressionist art.
A second important result is the timing of the bubble: we identify several possibilities, but favour two scenarios: from June 1986 to December 1989, and/or from July 1987 to January 1990.

By contrast, by designing the same index in Japanese yen rather than American dollar, we show that, from a Japanese point of view, there is no evidence at all that a bubble occurred. An important conclusion of this last finding is that Japanese buyers never felt they were riding a "bubble", they were merely surfing a bullish art market. Despite popular belief, this finding implies that we have no evidence that Japanese buyers perceived Impressionist art as speculative vehicle instead of sa consumption good.

Nevertheless, Westerners did experience a bubble. Some blamed the Japanese for it. Actually, what the West was experiencing was the combination of a bullish art market led by enriched Japanese on the one hand and the strength of the yen on the other hand. It is this very combination that turned out to be the perfect storm for European and American collectors. This combination was so strong and so unstable that it had to collide at one point, as predicted by LPPL. History tells that it is the bullish art trend that came abruptly to an end, whereas the JPY/USD did not stop strengthening.
Another consequence of this duality is that, depending on the point of view (Western or Japanese) one may, or may not, consider that a bubble took place. This observation opens paths for further investigation: What role foreign exchange, or rates market can play on the creation of a bubble on real assets? How swings in currencies can lead to important

transfers of cultural goods at international level? How to design a new model explaining the creation of bubbles created by combined effects of different markets?

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Appendix

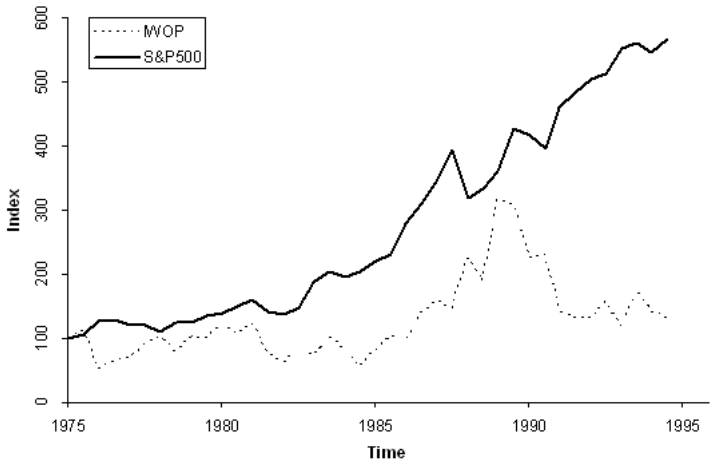

Figure 7: Iwop and S&P500 rescaled to 100 in 1975

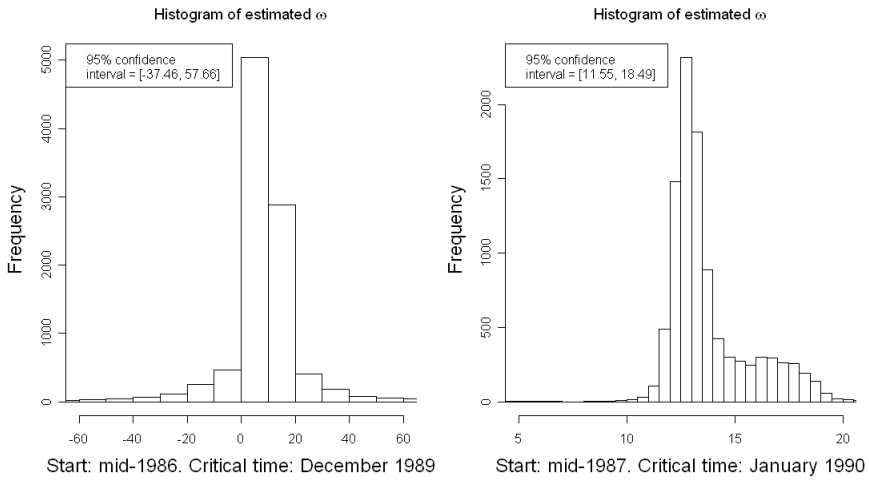

Figure 8: Histogram of $\hat{\omega}^*$

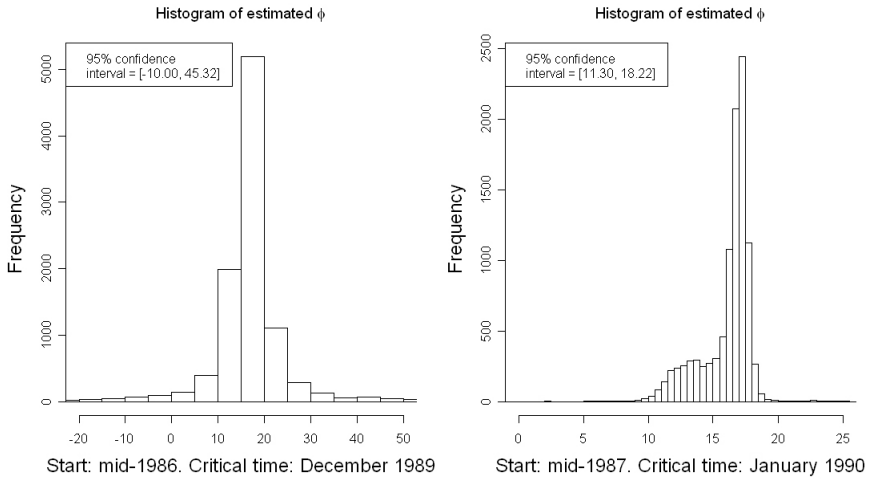

Figure 9: Histogram of $\hat{\phi}^*$

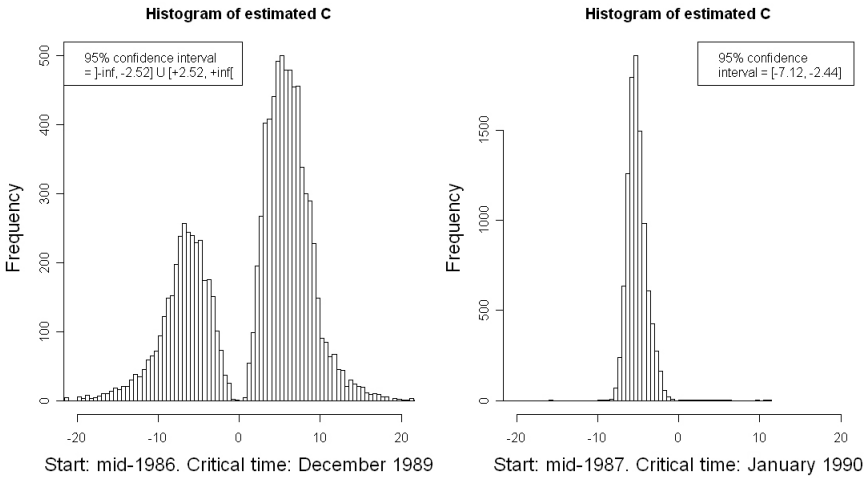

Figure 10: Histogram of $\hat{C}^*$

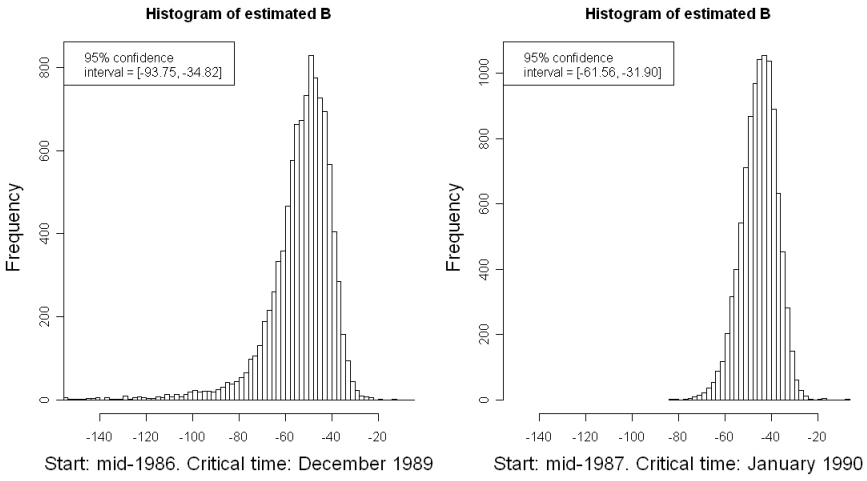

Figure 11: Histogram of $\hat{B}^*$

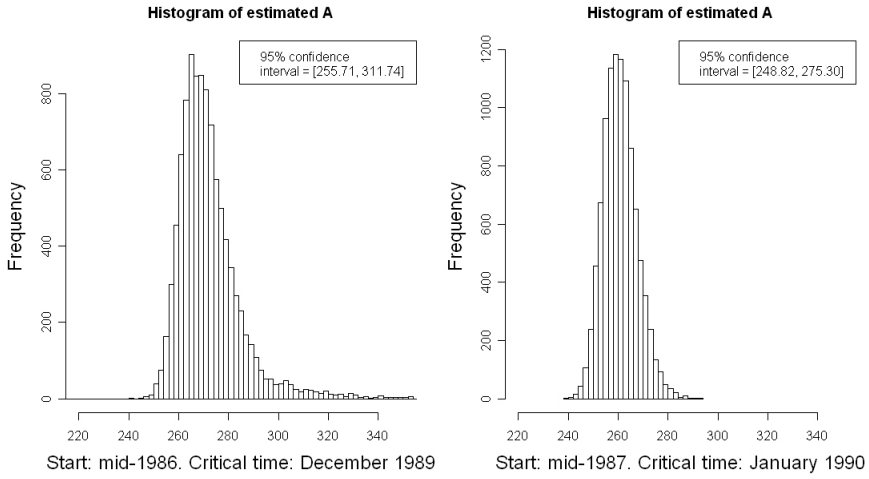

Figure 12: Histogram of $\hat{A}^*$

	IWOP		MAWOP		OMD	
	Amount of pieces	Volume (USD)	Amount of pieces	Volume (USD)	Amount of pieces	Volume (USD)
S1.1975	20	208,232	20	273,243	7	8,928
S2.1975	49	481,448	29	315,647	40	55,236
S1.1976	132	377,291	63	676,091	62	101,857
S2.1976	50	204,089	22	118,712	41	53,269
S1.1977	81	379,474	49	454,212	80	121,684
S2.1977	42	407,487	40	465,583	63	144,532
S1.1978	90	2,352,968	53	878,717	39	123,863
S2.1978	38	165,265	33	379,790	48	110,817
S1.1979	91	1,308,812	54	667,809	57	178,329
S2.1979	89	1,440,889	54	841,579	69	203,207
S1.1980	74	1,212,729	51	645,719	46	118,751
S2.1980	75	820,987	51	1,061,581	131	418,751
S1.1981	111	1,331,296	58	1,250,972	58	207,803
S2.1981	53	310,884	50	1,574,859	50	160,945
S1.1982	61	460,616	64	1,251,675	65	155,652
S2.1982	49	658,769	38	547,762	64	196,567
S1.1983	121	1,529,979	63	1,153,559	60	135,754
S2.1983	96	925,831	48	997,662	62	187,958
S1.1984	69	807,634	72	1,520,943	37	139,186
S2.1984	64	437,862	46	1,054,241	118	1,678,016
S1.1985	107	1,157,654	76	1,976,736	61	144,180
S2.1985	65	1,787,884	32	884,667	60	167,460
S1.1986	100	1,738,960	76	1,759,084	76	286,941
S2.1986	80	4,322,849	77	3,370,809	49	285,953
S1.1987	116	4,425,521	108	5,416,072	61	525,880
S2.1987	128	6,917,476	68	3,443,936	92	1,790,164
S1.1988	124	8,620,164	93	8,932,129	39	272,411
S2.1988	114	4,789,777	73	6,942,076	60	402,599
S1.1989	179	13,923,224	114	12,700,459	38	288,818
S2.1989	131	11,073,430	87	8,980,418	67	570,868
S1.1990	193	6,809,236	101	9,124,550	71	1,721,729
S2.1990	89	5,118,064	44	2,817,718	54	1,164,225
S1.1991	78	2,127,495	55	4,039,207	42	402,948
S2.1991	53	1,735,649	46	2,571,990	99	1,529,744
S1.1992	61	2,007,688	63	4,083,818	44	369,184
S2.1992	61	1,783,540	50	3,191,454	75	515,662
S1.1993	83	2,690,097	59	3,845,099	50	388,634
S2.1993	69	2,962,844	67	7,018,055	58	300,017
S1.1994	96	2,555,558	69	4,368,277	71	992,542
S2.1994	81	2,008,597	66	3,928,271	46	417,484
TOTAL	3,463	104,378,249	2,382	115,525,181	2,410	17,038,548

Table 1: Descriptive statistics per semester

	Artist	Amount of pieces	Turnover (USD)		Artist	Amount of pieces	Turnover (USD)
IWOP				OMD			
	Bonnard	426	3,759,075		Bandinelli	37	687,482
	Cezanne	143	8,986,431		Battista Franco	1	4,627
	Degat	585	27,354,785		Bloemaert	1	849
	Gauguin	167	4,788,563		Bol	38	393,506
	Manet	42	2,039,281		Bramer	38	36,483
	Monet	38	2,420,699		Bril	57	270,440
	Pissarro	634	9,091,534		Callot	30	642,240
	Redon	138	9,001,142		Cambiaso	179	640,561
	Renoir	230	11,247,239		Carracci	36	927,768
	Seurat	63	5,824,102		Castiglione	24	319,381
	Toulouse-Lautrec	308	3,054,858		da Cortona	37	612,776
	Van Gogh	61	6,747,444		de Bisschop	64	210,776
	Vlaminck	628	10,063,096		de Gheyn the Younger	20	327,791
	Total	3,463	104,378,249		della Bella	127	384,382
					Dusart	4	11,885
MAWOP					Franceschini	105	238,549
	Arp	22	744,623		Giordano	66	203,390
	Braque	37	899,860		Guercino	240	2,530,302
	Chagall	354	37,060,618		Jordaens	40	427,769
	Delaunay	13	864,598		Kappes	1	1,081
	Derain	365	1,164,245		Lafage	38	72,588
	Gris	4	149,384		Maratta	69	370,107
	Leger	564	20,071,122		Palma il Giovane	125	411,916
	Miro	314	17,315,382		Passeri	34	120,164
	Picasso	709	37,255,349		Pier Francesco Mola	60	445,170
	Total	2,382	115,525,181		Piola	1	723
					Romano	56	528,890
					Rosa	109	674,262
					Rubens	73	1,166,010
					Saftleven (C.)	41	205,669
					Saftleven (H.)	123	488,871
					Tintoretto	17	164,148
					van der Ulft	73	202,721
					van Dyck	46	131,396
					van Goyen	202	1,301,342
					van Ostade	24	102,774
					Waterloo	81	407,872
					Zuccaro (F.)	70	744,759
					Zuccaro (T.)	23	627,128
					Total	2,410	17,038,548

Table 2: Descriptive statistics per artist

Variable	Coefficient	White'SD
Intercept	8.91 ***	0.10
Ader	0.27 ***	0.07
Bath scenes	0.33 ***	0.12
Bonhams	-0.7 ***	0.20
Bonnard	-0.41 ***	0.07
Cezanne	1.46 ***	0.09
Christie's	-0.13 ***	0.05
Dancer	0.4 ***	0.09
Degas	0.83 ***	0.08
Gauguin	0.86 ***	0.10
Height	0.03 ***	0.002
Koller	1.59 ***	0.21
Landscape	0.19 ***	0.05
Lautrec	0.14 **	0.06
London	0.58 ***	0.05
Lot	-0.00007 **	0.00003
Manet	1.2 ***	0.21
Monet	1.24 ***	0.20
New York	0.68 ***	0.05
Nude	-0.13 *	0.07
People	-0.34 ***	0.05
Phillips	-0.51 ***	0.12
Redon	1.25 ***	0.10
Renoir	0.85 ***	0.08
Saturday	0.45 ***	0.10
Scenes with women	0.29 ***	0.07
Seurat	1.53 ***	0.18
Study	-0.46 ***	0.05
Tuesday	0.24 ***	0.06
Van Gogh	2.21 ***	0.10
Vlaminck	0.32 ***	0.06
Wednesday	0.14 ***	0.04

Table 3: Parameters estimates and White's SD of variables' coefficients for IWOP, R^2=58% (*** 1%; ** 5%; * 10% significativity level)

Variable	Coefficient	White'SD
Intercept	7.51 ***	0.04
Christie's	0.24 ***	0.01
Dead	-0.13 ***	0.01
Fernand Leger	2.22 ***	0.003
Georges Braque	2.18 ***	0.02
Jean Arp	1.51 ***	0.04
Joan Miro	2.41 ***	0.01
Juan Gris	1.9 ***	0.20
Lot	0.00006 ***	0.000000001
Marc Chagall	3.28 ***	0.01
New York	0.26 ***	0.01
Pablo Picasso	2.55 ***	0.00
Paris	0.15 ***	0.004
Robert Delaunay	2.4 ***	0.06
Sotheby's	0.33 ***	0.01
Width	0.04 ***	0.00001

Table 4: Parameters estimates and White's SD of variables' coefficients for MAWOP, R^2=67% (*** 1%; ** 5%; * 10% significativity level)

Variable	Coefficient	White'SD
Intercept	9.17 ***	0.27
Annibale Carracci	0.92 ***	0.09
Attribution	-0.69 **	0.01
Birth	-0.06 ***	0.0005
Carlo Maratta	0.79 ***	0.05
Christie's	0.61 ***	0.005
Finarte	0.2	0.16
Flemish	0.45 ***	0.01
Giovanni Benedetto Castiglione	0.96 ***	0.05
Giuseppe Passeri	0.69 ***	0.09
Guercino	0.73 ***	0.05
Height	-0.005 ***	0.000001
Jacob de Gheyn the Younger	0.81 **	0.09
Jacob Jordaens	0.53 ***	0.04
Jacques Callot	0.5 ***	0.06
Leonard Bramer	-0.88 ***	0.04
London	-0.14 ***	0.003
Luca Giordano	0.68 ***	0.07
Paris	0.31 ***	0.01
Pier Francesco Mola	0.85 ***	0.04
Pietro da Cortona	0.79 ***	0.05
Salvator Rosa	0.88 ***	0.03
Sir Peter Paul Rubens	0.32 ***	0.05
Sotheby's	0.66 ***	0.004
Study	-0.12 ***	0.003
Width	-0.01 ***	0.000001

Table 5: Parameters estimates and White's SD of variables' coefficients for OMD, R^2=40% (*** 1%; ** 5%; * 10% significativity level)

Window	Start	End	m	ω	ϕ	A	B	C	SSE/n
2	17/03/1984	17/08/1990	1.23	8.01	10.27	246.75	- 17.16	3.73	160.85
4	18/08/1984	12/03/1990	0.86	18.11	- 1.57	265.12	- 39.46	- 2.34	47.61
7	7/04/1985	2/09/1990	1.49	22.32	15.80	242.00	- 11.59	- 3.25	255.41
8	22/06/1985	29/01/1990	0.88	19.14	1.10	262.50	- 39.31	2.85	46.38
10	23/11/1986	30/11/1989	1.02	16.22	17.46	250.29	- 31.92	2.82	48.36
11	8/02/1986	22/01/1990	0.86	29.09	4.48	262.47	- 40.09	- 1.51	53.20
12	26/04/1986	8/12/1989	0.77	12.46	20.28	259.55	- 43.13	6.59	26.05
13.1	12/07/1986	24/12/1989	0.72	13.25	13.16	264.54	- 46.82	8.09	26.70
13.2	12/07/1986	2/12/1989	0.73	12.66	1.47	260.36	- 44.93	6.73	21.42
14	26/09/1986	13/12/1989	0.75	12.75	13.71	261.30	- 44.56	7.58	22.11
15	12/12/1987	12/12/1989	0.74	12.70	10.62	261.53	- 45.03	- 5.61	20.75
16	27/02/1987	11/12/1989	0.72	12.63	20.10	261.77	- 45.47	7.09	22.16
17	15/05/1987	15/12/1989	0.74	12.88	4.19	261.98	- 45.16	- 6.17	21.99
18	31/07/1987	5/01/1990	0.73	13.98	12.61	266.91	- 48.13	6.41	20.79
19	16/10/1987	20/05/1990	1.92	17.81	57.29	245.46	- 12.45	2.46	110.89

Table 6: LPPL parameters for several fits for expected simulated IWOP

Start	End	m	ω	ϕ	A	B	C	SSE/n
17/03/1984	17/08/1990	0.64	7.77	0.85	46,289.19	- 11,637.78	- 598.16	982,473
18/08/1984	12/03/1990	0.76	10.15	- 1.43	40,288.46	- 8,549.73	- 452.80	1,132,950
7/04/1985	2/09/1990	0.67	12.92	- 0.29	46,700.58	- 11,466.31	- 377.99	1,446,651
22/06/1985	29/01/1990	0.81	10.13	- 0.98	38,592.79	- 7,593.49	- 474.50	1,291,966
23/11/1986	30/11/1989	0.85	9.55	0.58	36,747.75	- 6,768.08	- 545.71	1,314,529
8/02/1986	22/01/1990	0.79	11.72	1.27	38,351.16	- 7,561.00	661.27	1,156,888
26/04/1986	8/12/1989	0.73	12.44	1.45	37,826.94	- 7,906.18	974.87	721,102
12/07/1986	24/12/1989	0.69	13.27	0.61	38,600.08	- 8,470.20	1,088.28	611,003
12/07/1986	2/12/1989	0.70	12.59	1.55	37,945.93	- 8,175.03	1,087.42	631,792
26/09/1986	13/12/1989	0.73	12.75	1.14	37,905.26	- 7,904.11	1,091.75	600,539
12/12/1987	12/12/1989	0.74	12.71	1.18	37,797.89	- 7,796.49	1,098.68	620,598
27/02/1987	11/12/1989	0.75	12.64	1.24	37,708.79	- 7,719.06	1,106.21	651,379
15/05/1987	15/12/1989	0.77	12.91	1.04	37,693.90	- 7,619.50	1,081.39	675,575
31/07/1987	5/01/1990	0.82	13.95	0.07	37,892.22	- 7,420.46	995.80	629,360
16/10/1987	20/05/1990	0.89	13.15	0.62	40,522.00	- 7,586.20	- 511.66	406,731

Table 7: LPPL parameters for several fits for Nikkei

	IWOP (USD)	IWOP (JPY)
1/03/1975	100.00	100.00
1/09/1975	111.44	114.81
1/03/1976	51.46	52.50
1/09/1976	65.29	63.84
1/03/1977	67.51	63.72
1/09/1977	91.41	82.29
1/03/1978	102.75	78.13
1/09/1978	79.26	51.03
1/03/1979	102.87	73.29
1/09/1979	100.17	76.18
1/03/1980	121.21	102.57
1/09/1980	105.65	77.30
1/03/1981	122.29	86.93
1/09/1981	75.88	59.36
1/03/1982	62.02	50.80
1/09/1982	82.11	73.43
1/03/1983	72.64	58.82
1/09/1983	103.10	85.17
1/03/1984	80.48	61.77
1/09/1984	55.12	46.00
1/03/1985	81.67	71.84
1/09/1985	104.36	84.15
1/03/1986	96.04	58.46
1/09/1986	140.89	74.22
1/03/1987	159.51	82.29
1/09/1987	145.32	70.75
1/03/1988	226.17	97.94
1/09/1988	189.37	86.66
1/03/1989	315.31	139.90
1/09/1989	308.69	152.41
1/03/1990	225.78	117.72
1/09/1990	229.41	108.50
1/03/1991	143.69	67.05
1/09/1991	130.45	59.76
1/03/1992	131.49	59.41
1/09/1992	158.02	66.01
1/03/1993	117.04	46.61
1/09/1993	174.42	62.50
1/03/1994	142.01	50.81
1/09/1994	130.13	43.76

Table 8: Values of the Impressionist Works on Paper Index in USD and in yen