SALIENT FEATURES OF DEPENDENCE IN DAILY US STOCK MARKET INDICES

LUIS A. GIL-ALANA
JUNCAL CUÑADO
FERNANDO PÉREZ DE GRACIA

FUNDACIÓN DE LAS CAJAS DE AHORROS
DOCUMENTO DE TRABAJO
Nº 356/2007

De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

SALIENT FEATURES OF DEPENDENCE IN DAILY US STOCK MARKET INDICES*

Luis A. Gil-Alana, University of Navarra, Pamplona, Spain

Juncal Cuñado, University of Navarra, Pamplona, Spain

Fernando Perez de Gracia, University of Navarra, Pamplona, Spain

ABSTRACT

This paper deals with the analysis of dependence in the US stock market. We focus first on the log-values of the Dow Jones Industrial Average, Standard and Poors 500 and Nasdaq indices, daily from February, 1971 to February, 2007. The volatility processes are also examined based on the squared and absolute values of the returns series. Finally, the "day of the week" effect is also investigated by looking at the orders of integration for each day of the week. A new modelling approach to describe the dependence in this context is also presented. The results suggests that there are very similar patterns for the Dow Jones Industrial Average, Standard and Poors 500. Further, the lowest degrees of dependence are observed on Mondays and Tuesdays.

Keywords: Long range dependence; Volatility; US stock market; Day of week effect.

JEL Classification: C22; G14; G15.

Corresponding author: Fernando Perez de Gracia
University of Navarra
Faculty of Economics
Edificio Biblioteca, Entrada Este
E-31080 Pamplona, SPAIN

Phone: 00 34 948 425 625
Fax: 00 34 948 425 626
Email: fgracia@unav.es

* Juncal Cunado and Luis A. Gil-Alana gratefully acknowledge financial support from the Spanish Ministry of Science and Technology (SEJ2005-07657/ECON). Fernando Perez de Gracia acknowledges research support from the Spanish Ministry of Science and Technology and FEDER through grant SEJ2005-06302/ECON and from the Plan Especial de Investigacion de la Universidad de Navarra.

1. Introduction

There is ample financial literature devoted to analyze, model and forecast the behavior of stock markets. The finance theory suggests many stylized facts in daily stock prices. Thus, for example, mean reversion in stock market prices have been examined in many papers (e.g., Fama and French, 1988; Poterba and Summers, 1988; Lo and MacKinlay, 1988; Kim et al., 1991; Richardson, 1993; Harvey, 1995; Balvers et al., 2000; Chaudhuri and Wu, 2003 and Gropp, 2004 among many others). However, the empirical evidence on mean reversion in stock market prices is still inconclusive. For example, the seminal papers by Fama and French (1988) and Poterba and Summers (1988) documented the mean reversion in the US stock prices, while other authors such as Lo and MacKinlay (1988) presented evidence against mean reversion using weekly US data. Second, the volatility in the stock returns presents an autocorrelation function that decays slowly. Bollerslev and Wright (2000) and Ding et al. (1993) among others found that absolute and squared returns present mean reversion. Third, daily stock prices usually tend to present day of the week effect.[1] The day of the week effect is a relevant stock market anomaly which is extensively documented in the financial literature (see, for example, the initial evidence for the US case in Osborne, 1962; Cross, 1973; French, 1980 and Gibbons and Hess, 1981). This anomaly in the stock market has been recently observed in many other countries (e.g., Gultekin and Gultekin, 1983; Jaffe and Westerfield, 1985; Solnik and Bousquet, 1990; Dubois and Louvet, 1996; and Brooks and Persand 2001 among others).

In this paper we focus on these stylized facts using long range dependence. Initially, we examine the long range dependence in three daily US stock market indices; then the volatility processes are also examined from a long memory viewpoint. Finally,

[1] Other some calendar anomalies are the January effect and the turn of the month effect among others.

the "day of the week" effect is investigated, proposing a fractional model where the long run dynamics depends exclusively on the day of the week. Long range dependence has been also extensively examined in stock markets (e.g., Lo, 1991; Granger and Ding, 1995a,b; Ding et al., 1993; Baillie et al., 1996; Lobato and Savin, 1998; Sibbertsen, 2004 and recently, Christodoulou-Volos and Siokis, 2006).[2] Most of the empirical evidence using long range dependence is also inconclusive. Thus, some authors find little or no evidence of long memory in stock markets (e.g., Hiemstra and Jones, 1997, and the references therein). On the other hand, Crato (1994), Barkoulas and Baum (1996), Barkoulas et al. (2000), Sadique and Silvapulle (2001), Henry (2002), and Tolvi (2003) among others, find evidence of long memory in monthly, weekly, and daily stock market returns.

The structure of the paper is as follows. Section 2 briefly describes the statistical models employed in the paper. Section 3 describes the data; In Section 4 we present the main results of the paper, while Section 5 contains some concluding comments and extensions.

2. The statistical models

The statistical models employed across this paper are all based on different versions of fractionally integrated models. This allows a greater degree of flexibility than the standard approaches based on stationarity I(0) or nonstationarity I(1) since the number of differences required to get I(0) series may non-necessarily be an integer number but a real value.

[2] For example, Lobato and Savin (1998) and Sibbertsen (2004) found long range dependence in volatilities while Christodoulou-Volos and Siokis (2006) using daily data for 34 countries found evidence long memory in returns. We extend previous studies by including both long range dependence in stcok returns and volatility in three US stock market indices.

Following the work of Granger (1980), Granger and Joyeaux (1980), and Hosking (1981), a rapidly growing body of literature has emerged on fractionally integrated ARFIMA processes. Robinson (1994a, 2003), Beran (1994), and Baillie (1996) present excellent surveys of the literature. A process x_t is integrated of order d if,

$$(1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots, \qquad (1)$$

with $x_t = 0$, $t \leq 0$, where u_t is an I(0) process, defined as a covariance stationary process with spectral density function that is positive and finite, and L is the backward shift operator. In the event that d is not an integer, the series x_t requires fractional differencing in order to obtain a stationary (possibly) ARMA series. ARIMA(p,d,q) models in which d is a positive integer are special cases of the general process in (1). If $d > 0$ in (1), x_t is said to be long memory, so-named because of the strong association between observations widely separated in time.

For stock indices, the evidence in favor of long memory may be due to the effect of aggregation. In fact, aggregation is one of the main sources of long memory. The key idea is that aggregation of independent weakly dependent series can produce a strong dependent series. Robinson (1978) and Granger (1980) show that fractional integration can arise as a result of aggregation when: a) data are aggregated across heterogeneous autoregressive (AR) processes, and b) data involving heterogeneous dynamic relationships at the individual level are then aggregated to form the time series. Moreover, the existence of long memory in financial asset returns suggests that new theoretical models based on nonlinear pricing models should be elaborated. Mandelbrot (1971) notes that in the presence of long memory, martingale models of asset prices cannot be obtained from arbitrage. In addition, statistical inference concerning asset pricing models based on standard testing procedures may not be appropriate in the context of long memory processes. (See, e.g., Yajima, 1985, and Barkoulas et al., 2000).

Throughout this paper we focus on Robinson's (1994b) parametric approach, which does not require preliminary differencing; it allows us to test any real value d in (1) encompassing stationary and nonstationary hypotheses. We use the following model:

$$y_t \;=\; \beta' z_t \;+\; x_t, \qquad (2)$$

where y_t is the time series we observe, β is a (kx1) vector of unknown parameters; z_t is a (kx1) vector of deterministic components, and x_t is given by (1), testing the null hypothesis:

$$H_o : \; d \;=\; d_o, \qquad (3)$$

for any real value d_o. Thus, the null hypothesized model is:

$$y_t \;=\; \beta' z_t \;+\; x_t; \qquad (1-L)^{d_o} x_t \;=\; u_t, \qquad t \;=\; 1, 2, \ldots.$$

Another advantage of this approach is that the limit distribution is standard normal, and this limit behaviour holds independently of the deterministic regressors used in z_t and the type of weak dependence allowed for the I(0) disturbance term u_t. In the final part of the article, equation (1) will be replaced by:

$$(1 - L^5)^d \, y_t = \; u_t, \;\; t = 1, 2, \ldots, \qquad (4)$$

to take into account the "day of the week" long memory effects. The functional forms of the test statistics employed in the paper are described in the Appendix.

3. Data description

We used daily data for the Dow Jones Industrial Average (DJIA), Standard and Poors 500 (S&P) and Nasdaq indices from February 5, 1971 to February 7, 2007 yielding 9,395 observations. All data are obtained from the Bloomberg web site (http://www.bloomberg.com) and they are all in natural logs.

[Insert Figure 1 and Table 1 about here]

Figure 1 displays the plots of the three US stock markets time series indices: DJIA, S&P and Nasdaq. Apparently the three time series display a very similar shape over the sample period and show a clear upward trend.

Summary statistics on the three US stock markets indices (in logs) and their corresponding returns are shown in Table 1. The Nasdaq index presents the highest volatility over the sample period, while S&P and the DJIA are more stable markets. When we analyze the log stock market prices in first differences (i.e., returns), all series present a similar mean and volatility behavior across the sample period. The skewness and kurtosis coefficients reveal departures from normality in the data, confirmed by the Jarque-Bera statistic.[3]

4. Salient features of dependence in US stock market indices

This section is divided into various sub-sections. In the first one we examine the degree of dependence of the three series by estimating their orders of integration. Here we employ Robinson's (1994b) parametric approach along with an estimate of d based on the Whittle function. The second sub-section is devoted to the volatility processes, and the same procedures as in the previous sub-section are applied here to the squared and absolute values of the returns, which are used as proxies for the volatility. The third sub-section deals with the "day of the week" effect.

4.1 Initial results on dependence

[3] Robinson's methods employed in this article are robust agains non-Gaussian disturbances.

Table 2 summarizes the results of Robinson's (1994b) parametric approach in (1) and (2) for the three log-series, assuming that u_t in (1) is white noise; since we must also specify the deterministic components of z_t in (2), we consider the three standard cases, i.e., no deterministic terms (i.e., $z_t = 0$), an intercept ($z_t \equiv 1$), and an intercept and a linear time trend ($z_t = (1, t)^T$). Table 2 shows the test results; the numbers in bold are the maximum likelihood estimates of *d* obtained with the Whittle function. Table 2 also shows the 95% confidence bands for the non-rejection values of d_o using Robinson's (1994b) parametric approach.[4]

[Insert Table 2 about here]

The first thing we observe in Table 2 is that the estimated values of d are slightly above 1 in the three series and this happens for the three types of models employed, being higher for the Nasdaq than for the other two indices. Moreover, the confidence intervals for the non-rejection values of d_o include the unit root (and also some values of d below 1) in all cases with the exception of the Nasdaq with an intercept and/or a linear trend. The fact that d is found to be in most cases equal to or higher than 1 suggests that the markets are efficient according to this simple specification. However, these significant results might be due in large part to the un-accounted-for I(0) autocorrelation in u_t. Thus, we also obtained results using autoregressions for the disturbance term. Table 3 displays the results of Robinson's (1994b) statistic assuming that u_t in (1) is AR(1), and we take d_o-values in (3) equal to 0, 0.10, …, 1.40 and 1.50. The limit distribution of the test statistic is unaffected by the inclusion of (weakly) autocorrelated terms, and thus it is still standard N(0,1). A significant feature of these results is that the

[4] Here, we test H_o (3) in model given by (1) and (2), using d_o-values from 0 to 2 in 0.001 increments.

value of the test statistic does not monotonically decrease with d_o. Such monotonicity is a characteristic that should be expected in these results given correct specification and adequate sample size since the test statistic is one-sided. Thus, for example, if H_o (3) is rejected with $d_o = 0.10$ against the alternative $d > 0.10$, the test statistic is significantly positive and above the critical value, and a more significant result in this direction should be expected when $d_o = 0$ is tested.

[Insert Tables 3 and 4 about here]

We observe in Table 3 that monotonicity is not satisfied if d is small for any model and any series. This lack of monotonicity may be explained in terms of model specification as is argued for example in Gil-Alana and Robinson (1997), though it may also be a consequence of the competition between the fractional differencing parameter and the AR coefficient in describing the nonstationarity. Thus, we observe that if $d = 0$, H_o cannot be rejected in most of the cases, and, though not reported, the AR coefficients were then very close to 1 in all cases. We finally observe that only if $d > 1$ (in case of no deterministic terms) or if $d > 0.60$ (with an intercept and/or a time trend) is monotonicity satisfied. Table 4 displays the Whittle estimates of d and the 95% confidence bands for those regions of d where monotonicity is achieved. Here, we observe that if no deterministic terms are included, the unit root null hypothesis is rejected for the three series in favour of higher orders of integration; however, if an intercept and/or a linear trend are included, the values of d are strictly smaller than 1 for the DJIA and the S&P, implying a small degree of mean reversion for these two series. On the other hand, for the Nasdaq, d is strictly above 1 in all cases.[5]

[5] Higher AR orders were also employed and the results were completely in line with those reported here.

The following two figures display the estimates of d using samples of one complete year of observations. In doing so we want to investigate if the order of integration of the series has changed across the years. Figure 2 refers to the case of white noise disturbances while Figure 3 corresponds to the AR(1) case.

[Insert Figures 2 and 3 about here]

Starting with the white noise case we observe that for the DJIA and the S&P, the values decrease slowly across the sample from values above 1 at the beginning of the sample to values below 1 at the end of the sample. For the Nasdaq, the decrease is more pronounced. In fact, for the first half of the sample, the values are strictly above 1 and only for the last ten years there are estimates below unity. A similar pattern is observed if AR(1) disturbances are considered, though here the confidence bands include the unit root in all cases, also for the values corresponding to the Nasdaq index. In general, a slight reduction is observed in the orders of integration of the series across the sample, in some cases, below unity, implying that the market is becoming more inefficient as time goes by, especially for the DJIA and the S&P indices.

4.2 Long memory in the volatility series

We use two alternative measures of volatility: absolute returns and squared returns which have been already used in the financial literature. Absolute returns were employed by Ding et al. (1993), Granger and Ding (1996), Bollerslev and Wright (2000), Gil-Alana (2005), Cavalcante and Assaf (2004), Sibbertsen (2004) and Cotter (2005), whereas squared returns were used in Lobato and Savin (1998), Gil-Alana (2003), Cavalcante and Assaf (2004) and Cotter (2005).

Table 5 displays the confidence bands and the Whittle estimates of d for the absolute and squared returns of the three indices, assuming that the disturbances are white noise. The first thing we observe here is that the values are robust to the three cases of no regressors, an intercept and an intercept with a linear trend. In all cases the confidence bands are constrained in the interval (0, 0.5) implying stationary long memory volatility processes. For the DJIA and the S&P, the values are higher with the absolute returns, while the opposite happens for the Nasdaq index. Thus, for the squared returns, d is around 0.111 for the DJIA; it is 0.126 for the S&P, and is around 0.218 for the Nasdaq. For the absolute values, the corresponding values are around 0.164, 0.166 and 0.210 respectively for the three indices.

[Insert Table 5, Figure 4 and Table 6 about here]

In Figure 4 we display the estimates (and confidence intervals) using samples of 1-year observations and we observe that the behaviour of the estimates are relatively stable across the sample for the three series and the two proxies. In Table 6 we report the average values of d in the volatility processes across years. We note that d is constrained between 0.035 and 0.150 for the DJIA, it is between 0.060 and 0.195 for the S&P, and is between 0.045 and 0.175 for the Nasdaq. Thus, in all cases d is above 0 implying long memory volatility.

4.3 "Day of the week" effect

The day of the week effect is a relevant stock market anomaly which is extensively documented in the financial literature (see, for example, the initial evidence of Osborne, 1962; Cross, 1973; French, 1980 and Gibbons and Hess, 1981). This anomaly in the stock market has also been observed in many countries (for example, Jaffe and Westerfield, 1985 for Canada, Australia, Japan and the UK; Solnik and Bousquet, 1990 for the case of France; and Brooks and Persand, 2001 for South Korea, Malaysia, the Philippines, Taiwan and Thailand).

Tables 7 and 8 refer to the same procedures as before, splitting the data by the day of week. Starting with the white noise case (Table 7) we see that for the DJIA and S&P, the estimated d is smaller than 1 for the five days of the week, and, moreover, for Mondays and Tuesdays, the unit root null is rejected in favour of smaller orders of integration. Thus, we obtain evidence of mean reversion of these two days of the week. On the other hand, the Nasdaq index shows strong evidence of no mean-reversion, with values of d strictly above 1 for all days of the week.

[Insert Tables 7 and 8 about here]

Allowing AR(1) disturbances the values are higher in all cases and evidence of $d < 1$ is only obtained for the DJIA index on Mondays. The estimates are also smaller than 1 for Tuesdays and Wednesdays on the Dow Jones, and for Mondays and Tuesdays in the S&P. Similarly to the white noise case, evidence of $d > 1$ is obtained for the Nasdaq across all days. In any case, even for the Nasdaq index, smaller orders of integration are obtained on Mondays and Tuesdays compared with the other days of the week.

The results presented in this subsection indicate that the degree of persistence is different depending on the day of the week, observing lower orders of integration on Mondays and Tuesdays in all series. In what follows, we consider a model where the long memory dynamic effects are supposed to be dependent on the day of the week, while other short run dynamics are described through the I(0) structure of the disturbance term. In particular, we suppose that the data follow a model of form:

$$y_t \;=\; \beta' z_t \;+\; x_t, \qquad t = 1, 2, \ldots, \qquad (5)$$

$$(1 - L^5)^d \, x_t = u_t, \qquad t = 1, 2, \ldots, \qquad (6)$$

$$u_t \;=\; \rho u_{t-1} \;+\; \varepsilon_t, \qquad t = 1, 2, \ldots, \qquad (7)$$

where z_t in (5) again adopts the three models of no deterministic terms, an intercept, and an intercept with a linear time trend. This model implies that the present value of the series (y_t) depends in the long run on its value five periods before (y_{t-5}), and on all past observations which are backwards multiples of 5, i.e., y_{t-10}, y_{t-15}, ….[6] Here, we employ another version of Robinson's (1994b) parametric approach, and the functional form of the test statistic (which is also asymptotically N(0,1)-distributed) is presented in the Appendix. This type of model is relevant in the context of daily financial data, where the value of an asset on a given day of the week may be strongly influenced by its value on the same day of the previous week. There is in fact an extensive literature documenting the presence of calendar anomalies (such as the weekend effect, the day of the week effect, and the January effect) in financial series, both in the US and in other developed markets, dating back to Osborne (1962). Negative Monday returns were found, *inter alia*, by Cross (1973), French (1980), and Gibbons and Hess (1981), the former two analysing the S&P index, the latter the DJIA. Similar findings have been reported for other US financial markets, such as the futures, bond and Treasury Bill markets (e.g., Cornell, 1985; Dyl and Maberly, 1986), foreign exchange markets (Hsieh, 1988), and for Australian, Canadian, Japanese and UK financial markets (e.g., Jaffe and Westerfield, 1985; Jaffe et al., 1989 and Agrawal and Tandon, 1994). Effects on stock market volatility have also been documented (Kiymaz and Berument, 2003).

Various explanations have been offered for the observed patterns. Some focus on delays between trading and settlement in stocks (Gibbons and Hess, 1981): buying on Fridays creates a two day interest free loan until settlement; hence, there are higher transaction volumes on Fridays, resulting in higher prices, which decline over the weekend as this incentive disappears. Others emphasise a shift in the broker investor balance in buying-selling decisions which occurs during weekends, when investors have more time to study the market themselves (rather than rely on brokers); this typically results in net sales on Mondays, when liquidity is low in the absence of institutional trading (Miller, 1988). It has also been suggested that the Monday effect largely reflects the fact that, when daily returns are calculated, the clustering of dividend payments around Mondays is normally ignored; alternatively, it could be a consequence of positive news typically being released during the week, and negative ones over the weekend (Fortune, 1998). Additional factors which could be relevant are serial correlation, with Monday prices being affected by Friday ones, and a negative stock performance on Fridays being given more weight (Abraham and Ikenberry, 1994); measurement errors (Keim and Stambaugh, 1984); size (Fama and French, 1992); volume (Lakonishok and Maberly, 1990).

Initially, we suppose that there are no short run components (i.e., $\rho = 0$ in (7)) and therefore all the dynamic behaviour of the series is described through the fractional differencing polynomial in (6). The results are displayed in Tables 9 and 10.

[Insert Tables 9 and 10 about here]

---

[6] Note that for the three indices, if there was no value for a given day, the arithmetic mean using the previous and the following observation was computed.

Table 9 displays the values of the test statistic, testing again H_o (3) now in the model given by (5) and (6) for d_o-values from 0 to 1.50 with 0.10 increments. The first thing we observe in this table is that the value of the test statistic monotonically decreases with d in all cases across the three models presented. It is also observed that the only non-rejection value reported in the table takes place at d = 1 for the Nasdaq index in the case of no deterministic terms. However, other non-rejections may occur at values of d in the intervals across the points. Thus, it seems that some non-rejections could take place at values of d between 0.9 and 1 for the DJIA and S&P, and at values constrained between 1 and 1.1 for the Nasdaq index.[7] Note that these are the values where the test statistic changes its sign and thus we can find values within the N(0,1) confidence interval. Table 10 reports the 95% confidence band of non-rejection values along with the Whittle estimate of d. It is observed that d is below 1 for the DJIA and S&P, while it is slightly above 1 for the Nasdaq index.

[Insert Tables 11 – 13 about here]

Table 11 is similar to Table 9 but imposing an AR(1) structure for the disturbance term. Here we observe that the null hypothesis is rejected in all cases except when d = 0, implying that a simple AR(1) model could be an adequate specification for the series. However, though not reported, the AR coefficient was in these cases extremely close to 1, implying once more that the fractional differencing polynomial is competing with the AR parameter in describing the long run effect. Note that the polynomial $(1-L^5)$ can be decomposing into $(1-L)(1+L^2+L^3+L^4)$ implying then the existence of a unit root at the long run or zero frequency, which may compete with the

[7] The day of the week effect may not be the same across markets. For example, Wang et al. (1997) and Chang et al. (2004), show that the weekend effect was more intense in the Nasdaq than in other US stock

AR coefficient if this is close to 1. Thus, we also employ an alternative to the AR model, which is based on Bloomfield (1973) exponential spectral model. This is a non-parametric approach of modelling the I(0) disturbances, where the spectral density function is given by:

$$f(\lambda;\tau) \;=\; \frac{\sigma^2}{2\pi}\,\exp\left(2\sum_{r=1}^{m}\tau_r\cos(\lambda r)\right), \qquad (8)$$

where m is the number of parameters required to describe the short run dynamics of the series. Bloomfield (1973) showed that the logarithm of an estimated spectral density function is often found to be a fairly well-behaved function and can thus be approximated by a truncated Fourier series. He showed that the spectral density of an ARMA process can be well approximated by (8). Moreover, this model is stationary across all values of τ, and the model accommodates extremely well in the context of Robinson's (1994b) tests. The results using the model of Bloomfield (1973) (with m = 1) are displayed in Tables 12 and 13. Higher orders for m were also tried and the results were practically the same in terms of the non-rejection values of d. First, we observe that monotonicity is again achieved in all cases and the non-rejections take place at values of d constrained between 0.70 and 0.80 for the DJIA and S&P, and between 0.80 and 0.90 for the Nasdaq. The estimated values of d are higher in case of a linear time trend and in all cases d is between 0.74 and 0.81, implying long memory and mean reversion for the "day of the week" effect.

Next we wonder which may be the best model specifications in the context of "day of the week" effects, and use likelihood criteria along with t-tests to determine the best models. It is obtained that the best specification for the DJIA is the following:

---

market indices.

$$y_t = 6.72541 - 0.00082t + x_t; \quad (1 - L^5)^{0.790} x_t = u_t; \quad u_t \approx Bloomfield\,(\tau = 1.059)$$
$$\quad (463.64) \quad (-51.75)$$

with the t-values in parenthesis. For the S&P the selected model is:

$$y_t = 4.52984 - 0.00054t + x_t; \quad (1 - L^5)^{0.779} x_t = u_t; \quad u_t \approx Bloomfield\,(\tau = 1.052),$$
$$\quad (347.80) \quad (-41.51)$$

and finally, for the Nasdaq index,

$$y_t = 4.57865 - 0.00054t + x_t; \quad (1 - L^5)^{0.805} x_t = u_t; \quad u_t \approx Bloomfield\,(\tau = 1.109).$$
$$\quad (303.72) \quad (-30.30)$$

Thus, once more we obtain a higher degree of persistence for the Nasdaq than for the other two indices.

5. Conclusions

This paper deals with the analysis of the dependence in the US stock market by means of investigating the orders of integration of the DJIA, the S&P and the Nasdaq indices over the period February 5, 1971 to February 7, 2007. The volatility processes are also examined by looking at the degrees of integration of the absolute and squared returns, which are used as proxies for the volatility. In the final part of the paper we have examined the "day of the week" effect, first by looking at the orders of integration separately for each day of the week. A new modelling approach, based on long run dependence for the week-day effect is also considered.

The results can be summarized as follows: first, we observe very similar patterns for the DJIA and the S&P indices compared with the Nasdaq index. The Nasdaq index only includes technology stocks whereas the DJIA and the S&P indices include stocks from the industrial sector and other sectors and thus are usually good indicators of the stock market as a whole. Thus, the similarities observed in these two indices may also be translated to their degrees of persistence. Starting with the original log-series, we observe that if all the dependence is captured through the fractional differencing polynomial, the order of integration is slightly above 1, and the unit root cannot be rejected for the DJIA and the S&P. However, allowing weak dependence (AR and Bloomfield) the orders of integration are strictly smaller than 1 (and thus showing mean reversion) for these two indices, while it is strictly above 1 for the Nasdaq. In general, we observe a slight decrease in the degree of dependence across the years in the sample. With respect to the volatility processes, there is strong evidence of some degree of stationary long memory ($0 < d < 0.5$) for the two proxies in the three series, being once more higher in the case of the Nasdaq index. The long range dependence in volatility are also found in Ding et al. (1993), Lobato and Savin (1998) and Sibbertsen (2004). If we separate the data by the day of the week, the lowest degrees of dependence are observed on Mondays and Tuesdays. Modeling the "day of the week" effect by means of a long memory model, mean reversion is obtained in practically all cases, with higher values obtained again for the Nasdaq index. Thus, the Nasdaq seems to the closest market to efficiency while the DJIA and S&P500 seem to present a small degree of mean reversion.

Appendix

Assuming that y_t is described by equation (2), the regression errors, x_t adopt the form:

$$\rho(L;\theta)\, x_t = u_t, \quad t = 1, 2, ..., \qquad \text{(A1)}$$

where ρ is a scalar function that depends on L and the unknown parameter θ that will adopt different forms as shown below, and u_t is I(0). The function ρ is specified in such a way that all its roots should be on the unit circle in the complex plane, and therefore it includes polynomials of the form $(1-L^k)^{d+\theta}$, where k is an integer and d may be a real value. Thus, in what follows, we assume that

$$\rho(L;\theta) = (1 - L^k)^{d+\theta}. \qquad \text{(A2)}$$

Robinson (1994b) proposed a Lagrange Multiplier (LM) test of the null hypothesis:

$$H_o : \theta = 0,. \qquad \text{(A3)}$$

in a model given by (2) and (A1 – A2). Based on H_o given by (A3), the estimated β and residuals are:

$$\hat{u}_t = (1 - L^k)^{d_o} y_t - \hat{\beta}' w_t,$$

$$w_t = (1 - L^k)^{d_o} z_t; \quad \hat{\beta} = \left(\sum_{t=1}^{T} w_t w_t' \right)^{-1} \sum_{t=1}^{T} w_t (1 - L^k)^{d_o} y_t.$$

The functional form of the test statistic is then given by:

$$\hat{r} = \frac{T^{1/2}}{\hat{\sigma}^2} \hat{A}^{-1/2} \hat{a} \qquad \text{(A4)}$$

where T is the sample size, and

$$\hat{A} = \frac{2}{T} \left(\sum_{j=1}^{*} \psi(\lambda_j)^2 - \sum_{j=1}^{*} \psi(\lambda_j) \hat{\varepsilon}(\lambda_j)' \times \left(\sum_{j=1}^{*} \hat{\varepsilon}(\lambda_j) \hat{\varepsilon}(\lambda_j)' \right)^{-1} \times \sum_{j=1}^{*} \hat{\varepsilon}(\lambda_j) \psi(\lambda_j) \right)$$

$$\hat{a} = \frac{-2\pi}{T} \sum_{j=1}^{*} \psi(\lambda_j)\, g(\lambda_j;\hat{\tau})^{-1} I(\lambda_j); \qquad \hat{\sigma}^2 = \sigma^2(\hat{\tau}) = \frac{2\pi}{T} \sum_{j=1}^{T-1} g(\lambda_j;\hat{\tau})^{-1} I(\lambda_j);$$

$$\hat{\varepsilon}(\lambda_j) = \frac{\partial}{\partial \tau} \log g(\lambda_j; \hat{\tau}); \qquad \lambda_j = \frac{2\pi\, j}{T}; \qquad \hat{\tau} \ = \ \arg\min_{\tau \in T^*} \sigma^2(\tau),$$

and the sums over * in the above expressions are over $\lambda \in M$ where $M = \{\lambda: -\pi < \lambda < \pi, \lambda \notin (\rho_l - \lambda_1, \rho_l + \lambda_1), l = 1, 2, \ldots, s\}$ such that ρ_l, $l = 1, 2, \ldots, s < \infty$ are the distinct poles of $\psi(\lambda)$ on $(-\pi, \pi]$. Also,

$$\psi(\lambda_j) = \mathrm{Re}\left[\log \left(\frac{\partial}{\partial \theta} \log \rho(e^{i\lambda_j}; \theta) \right) \right]_{\theta = 0}, \qquad \text{(A5)}$$

and $I(\lambda_j)$ is the periodogram of u_t evaluated under the null. The function g above is a known function coming from the spectral density of u_t,

$$f(\lambda; \sigma^2; \tau) \ = \ \frac{\sigma^2}{2\pi} g(\lambda; \tau), \qquad -\pi \ < \ \lambda \ \le \ \pi.$$

Note that these tests are purely parametric, and, therefore, they require specific modelling assumptions about the short memory specification of u_t. Thus, if u_t is a white noise, then $g \equiv 1$, (and thus, $\hat{\varepsilon}(\lambda_j) = 0$), and if it is an AR process of the form $\phi(L)u_t = \varepsilon_t$, $g = |\phi(e^{i\lambda})|^{-2}$, with $\sigma^2 = V(\varepsilon_t)$, so that the AR coefficients are a function of τ.

Based on H_o (A3), Robinson (1994b) showed that under certain very mild regularity conditions:

$$\hat{r} \ \to_d \ N(0,1) \quad as \quad T \to \infty.$$

Hence, we are in a classical large sample-testing situation: an approximate one-sided $100\alpha\%$ level test of H_o (A4) against the alternative: H_a: $d > d_o$ ($d < d_o$) will be given by the rule: "Reject H_o if $\hat{r} > z_\alpha$ ($\hat{r} < - z_\alpha$)", where the probability that a standard normal variate exceeds z_α is α.

Note that given the functional form of ρ in (A2),

$$\psi(\lambda_j) = \mathrm{Re}\left[\left(\frac{\partial}{\partial\theta}\log\rho(e^{i\lambda_j};\theta)\right)\right]_{\theta=0} = \mathrm{Re}\left[\frac{\partial}{\partial\theta}(d+\theta)\log(1-e^{i\lambda_j k})\right] =$$

$$\mathrm{Re}\left[\log(1-e^{i\lambda_j k})\right] = \mathrm{Re}\left[\log(1-\cos\lambda k - i\sin\lambda k\right] = \log\left|(1-\cos\lambda k - i\sin\lambda\right| =$$

$$\log(2-2\cos\lambda k)^{0.5}.$$

In some simple cases, the above formula simplifies. Thus, for example, if k = 1, which is the form employed in Sections 4.1 and 4.2,

$$\psi(\lambda_j) = \log\left|2\sin\frac{\lambda_j}{2}\right|.$$

If k = 2, and noting that $(1 - e^{i2\lambda}) = (1 - e^{i\lambda})(1 - e^{-i\lambda})$,

$$\psi(\lambda_j) = \log\left|2\sin\frac{\lambda_j}{2}\right| + \log\left(2\cos\frac{\lambda_j}{2}\right)$$

and similarly, if k = 4,

$$\psi(\lambda_j) = \log\left|2\sin\frac{\lambda_j}{2}\right| + \log\left(2\cos\frac{\lambda_j}{2}\right) + \log\left|2\cos\lambda_j\right|.$$

A common feature of all these expressions is that they have a finite number (k) of poles across the spectrum, but they are all squared integrable.

References

Abraham, A., Ikenberry, D., 1994, The individual investor and the weekend effect, Journal of Financial and Quantitative Analysis 29, 263-277.

Agrawal, A., Tandon, K., 1994, Anomalies or illusions? Evidence from stock markets in eighteen countries, Journal of International Money and Finance 13, 83-106.

Baillie, R.T., 1996, Long memory processes and fractional integration in Econometrics, Journal of Econometrics 73, 5-59.

Baillie, R., Bollerslev, T., Mikkelsen, H., 1996, Fractionally integrated generalized autoregressive conditional heteroskedasticity, Journal of Econometrics 74, 3-30.

Balvers, R., Wu, Y., Gilliland, E., 2000, Mean reversion across national stock markets and parametric contrarian investment strategies, Journal of Finance 55, 745-772.

Barkoulas, J.T., Baum, C.F., 1996, Long term dependence in stock returns, Economics Letters 53, 253-259.

Barkoulas, J.T., Baum, C.F., Travlos, N., 2000, Long memory in the Greek stock market, Applied Financial Economics 10, 177-184.

Beran, J., 1994, Statistics for long memory processes, Chapman and Hall, New York.

Bloomfield, P., 1973, An exponential model in the spectrum of a scalar time series, Biometrika 60, 217-226.

Bollerslev, T., Wright, J.H., 2000, High frecuency data, frequecy domain inference and volatility forecasting, Review of Economics and Statistics 83, 596-602.

Brooks, C., Persand, G., 2001, Seasonality in Southeast Asian stock markets: Some new evidence on day –of –the week effects, Applied Economics Letters 8, 155 - 8.

Cavalcante, J., Assaf, A., 2004, Long range dependence in the returns and volatility of the Brazilian stock market, European Review of Economics and Finance 3, 5-22.

Chang, S., Leung, W., Wang, K., 2004, The impact of institutional investors on the Monday seasonal, Journal of Business 7, 967-986.

Chaudhuri, K., Wu, Y., 2003, Random walk versus breaking trend in stock prices: Evidence from emerging markets, Journal of Banking and Finance 27, 2003.

Christodoulou-Volos, C., Siokis, F., 2006, Long range dependence in stock market returns, Applied Financial Economics 16, 1331-1338.

Cornell, B., 1985, The weekly patterns in stock returns cash versus futures: A note, Journal of Finance 40, 583-588.

Cotter, J., 2005, Uncovering long memory in high frequency UK futures, European Journal of Finance 11, 325-337.

Crato, N., 1994, Some international evidence regarding the stochastic behaviour of stock returns, Applied Financial Economics 4, 33-39.

Cross, F., 1973, The behavior of stock prices on Fridays and Mondays, Financial Analyst Journal 29, 67-69.

Ding, Z., Granger, C.W.J., Engle, R.F., 1993, A long memory property of stock markets and a new model, Journal of Empirical Finance 1, 83-106.

Dyl, E., Maberly, E.D., 1986, The anomaly that isn't there: A comment on Friday the thirteenth, Journal of Finance 43, 1285-1286.

Dubois, M., Louvet, P., 1996, The day of the week effect: The international evidence, Journal of Banking and Finance 20, 1463-1484.

Fama, E.F., French, K.R., 1988, Permanent and transitory components of stock prices, Journal of Political Economy 96, 246-273.

Fama, E.F., French, K.R., 1992, The cross section of expected stock returns, Journal of Finance 47, 427-465.

Fortune, P., 1998, Weekends can be rough: Revisiting the weekend effect in stock prices, Working Paper no. 98-6, Federal Reserve Bank of Boston.

French, K., 1980, Stock returns and the weekend effect, Journal of Financial Economics 8, 55-69.

Gibbons, M., Hess, P., 1981, Day of the week effects and asset returns, Journal of Business 54, 579-596.

Gil-Alana, L.A., 2003, Fractional integration in the volatility of asset returns, European Review of Economics and Finance 2, 41-52.

Gil-Alana, L.A., 2005, Long memory in daily absolute and squared returns in the Spanish stock market, Advances in Investment Analysis and Portfolio Management 1, 198-217.

Gil-Alana, L.A., Robinson, P.M., 1997, Testing of unit roots and other nonstationary hypotheses in macroeconomic time series, Journal of Econometrics 80, 241-268.

Granger, C.W.J., 1980, Long memory relationships and the aggregation of dynamic models, Journal of Econometrics 14, 227-238.

Granger, C.W.J., Ding, Z., 1995a, Some properties of absolute returns. An alternative measure of risk, Annales d'Economie et de Statistique 40, 67-91.

Granger, C.W.J., Ding, Z., 1995b, Stylized facts on the temporal and distributional properties of daily data from speculative markets, Working Paper, UCSD.

Granger, C.W.J., Ding, Z., 1996, Varieties of long memory models, Journal of Econometrics 73, 61-78.

Granger, C.W.J., Joyeux, R., 1980, An introduction to long memory time series and fractionally differencing, Journal of Time Series Analysis 1, 15-29.

Gropp, J., 2004, Mean reversion of industry stock returns in the U.S., 1926–1998, Journal of Empirical Finance 11, 537-551.

Gultekin, M.N., Gultekin, N.B., 1983, Stock market seasonality: International evidence, Journal of Financial Economics 17, 469-482.

Harvey, C.R., 1995, Predictable risk and returns in emerging markets, Review of Financial Studies 8, 773-816.

Henry, O.T., 2002, Long memory in stock returns: Some international evidence, Applied Financial Economics 12, 725-729.

Hiemstra, C., Jones J.D., 1997, Another look at long memory in common stock returns, Journal of Empirical Finance 29, 373-401.

Hosking, J.R.M., 1981, Modelling persistence in hydrological time series using fractional differencing, Water Resources Research 20, 1898-1908.

Hsieh, D.A., 1988, The statistical properties of daily foreign exchange markets: 1974-1983, Journal of International Economics 24, 129-145.

Jaffe, J.F., Westerfield, R., 1985, The week-end effect in common stock returns. The international evidence, Journal of Finance 40, 433-454.

Jaffe, J.F., Westerfield, R., Ma, C., 1989, A twist on the Monday effect in stock prices: Evidence from the US and foreign stock markets, Journal of Banking and Finance 13, 641-650.

Keim, D.B., Stambaugh, F., 1984, A further investigation of weekend effects in stock returns, Journal of Finance 39, 819-840

Kim, M.J., Nelson, C.R., Startz, R., 1991, Mean reversion of stock prices: A reappraisal of the empirical evidence, Review of Economic Studies 58, 5151–5280.

Kiymaz, H., Berument, H., 2003, The day of the week effect on stock market volatility and volume: International evidence, Review of Financial Economics 12, 363-380.

Lakonishok, J., Maberly, E., 1990, The weekend effect: Trading patterns of individual and institutional investors, Journal of Finance 45, 231-244.

Lo, A.W., 1991, Long-term memory in stock prices, Econometrica 59, 1279-1313.

Lo, A.W., MacKinley, A.C., 1988, Stock market prices do not follow a random walk: Evidence from a simple specification test, Review of Financial Studies 1, 41-66.

Lobato, I.N., Savin, N.E., 1998, Real and spurious long memory properties of stock market data, Journal of Business and Economic Statistics 16, 261-268.

Mandelbrot, B.B., 1971, When can price be arbitraged efficiently? A limit to the validity of the random walk and martingale models, Review of Economics and Statistics 53, 225-236.

Miller, E., 1988, Why a weekend effect?, Journal of Portfolio Management 14, 42-48.

Osborne, M.F.M., 1962, Periodic structure in the Brownian motion of the stock market, Operations Research 10, 345-379.

Poterba, J.M., Summers, L.H., 1988, Mean reversion in stock prices: Evidence and implications, Journal of Financial Economics 22, 27-59.

Richardson, M., 1993, Temporary components of stock prices: A skeptic´s view, Journal of Business and Economic Statistics 11, 199-207.

Robinson, P.M., 1978, Statistical inference for a random coefficient autoregressive model, Scandinavian Journal of Statistics 5, 163-168.

Robinson, P.M., 1994a, Time series with strong dependence, Invited Paper 1990 World Congress of the Econometric Society, Advances in Econometrics: Sixth World Congress, Volume 1 (C.A. Sims, ed.) Cambridge University Press, 47-96.

Robinson, P.M., 1994b, Efficient tests of nonstationary hypotheses, Journal of the American Statistical Association 89, 1420-1437.

Robinson, P. M., 2003, Long memory time series, Time series with long memory, (P.M. Robinson, ed.), Oxford University Press, Oxford, 1-48.

Sadique, S., Silvapulle, P., 2001, Long memory in stock market returns: International evidence, International Journal of Finance and Economics 1, 59-68

Sibbertsen, P., 2004, Long memory in volatilities of German stock returns, Empirical Economics 29, 477-488.

Solnik, B., Bousquet, L., 1990, Day of the week effect on the Paris Bourse, Journal of Banking and Finance 14, 461-469.

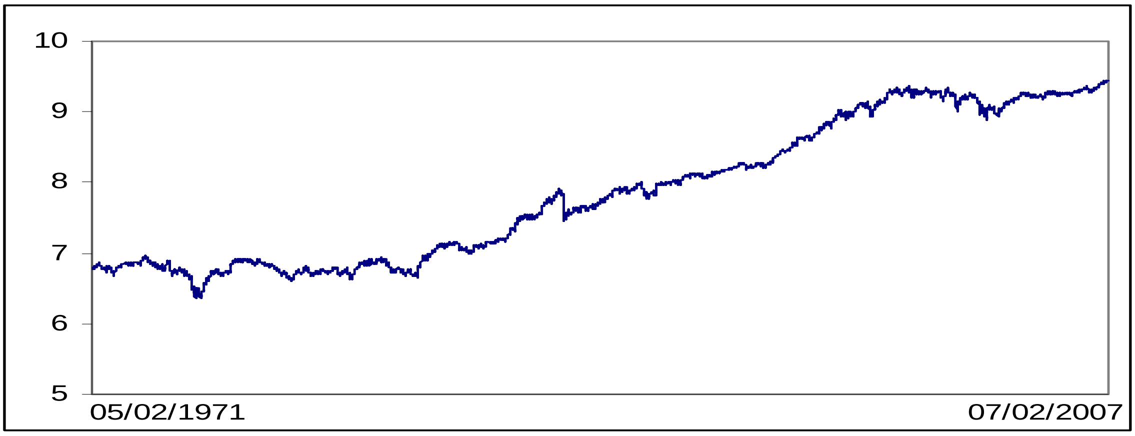
Tolvi, J., 2003, Long memory model in a small economy, Economics Bulletin 7, 1-13.

Yajima, Y., 1985, Estimation of long memory time series models, Australian Journal of Statistics 27, 303-320.

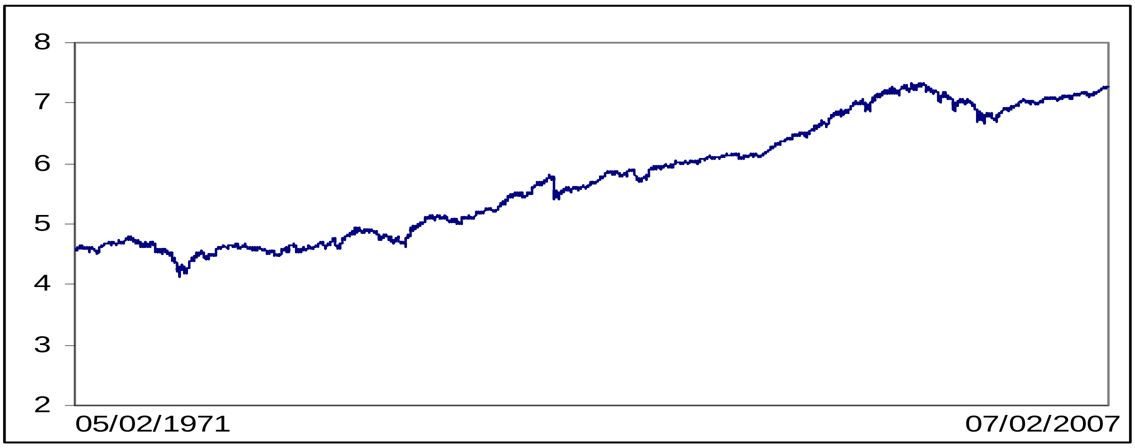
Wang, K., Li, Y., Erickson, J., 1997, A new look at the Monday effect, Journal of Finance 52, 2171-2186.

Figure 1: Original time series (in logarithm form)

DJIA Index



S&P Index



Nasdaq Index

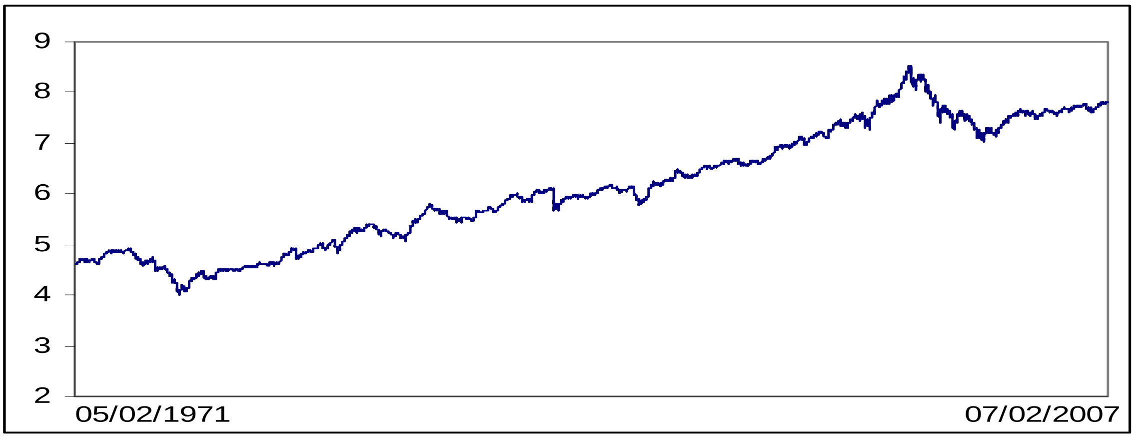


Table 1: Summary statistics on US stock market indices

	M	SD	Skew	Kurtosis	Jarque-Bera
Original series					
DJIA	7.8566	0.9885	0.24	1.51	958
S&P	5.7481	0.9807	0.16	1.54	864
NASDAQ	6.1176	1.1697	0.10	1.75	623
First differences (returns)					
DJIA	0.000284	0.0100	-1.83	53	98480
S&P	0.000288	0.0098	-1.43	38.9	510419
NASDAQ	0.00034	0.0116	-0.31	14.3	50144

Table 2: Estimates of d based on white noise disturbances

Series	No regressors (NR)	An intercept (I)	A linear trend (LT)
DJIA	1.001 [0.988, 1.014]	1.010 [0.996, 1.025]	1.010 [0.996, 1.024]
S&P	1.001 [0.989, 1.015]	1.014 [1.000, 1.029]	1.014 [1.000, 1.029]
NASDAQ	1.006 [0.993, 1.019]	1.067 [1.054, 1.081]	1.067 [1.054, 1.081]

The values in brackets refers to the 95% confidence intervals.

Table 3: Values of the test statistic (Robinson, 1994b) with AR(1) disturbances

d	DJIA			S&P			NASDAQ		
	NR	I	LT	NR	I	LT	NR	I	LT
0.00	-0.475	-0.474	-0.618	-0.315	-0.315	0.625	0.387	0.387	6.371
0.10	-17.675	-17.676	-16.708	-17.618	-17.631	-16.180	-15.317	-15.407	-15.234
0.20	-21.599	-21.152	-21.903	-21.599	-21.618	-21.749	-21.264	-21.255	-21.221
0.30	-26.123	-26.342	-27.421	-26.750	-26.993	-27.458	-26.697	-26.819	-26.897
0.40	-32.936	-33.935	-33.964	-33.769	-35.092	-33.565	-33.849	-34.724	-32.435
0.50	-42.787	-48.140	-33.910	-44.097	-48.012	-28.395	-44.368	-44.128	-27.176
0.60	-57.736	-11.500	29.698	-59.963	13.003	46.215	-60.808	5.380	24.514
0.70	-78.094	35.333	69.657	-83.578	37.456	58.182	-85.318	41.293	52.186
0.80	-104.51	19.552	28.490	-105.39	18.191	22.911	-100.07	27.285	29.951
0.90	-93.079	4.999	6.334	-63.853	4.847	5.489	-53.363	12.530	12.899
1.00	-1.491	-3.584	-3.584	-1.681	-3.494	-3.494	-2.533	1.989	1.989
1.10	19.673	-9.284	-9.280	15.125	-9,135	-9.139	12.739	-5.476	-5.476
1.20	12.173	-13.618	-13.612	10.895	-13.377	-13.370	9.214	-10.964	-10.959
1.30	4.534	-17.049	-17.052	3.511	-16.733	-16.733	2.969	-15.130	-15.130
1.40	-1.803	-19.865	-19.844	-2.466	-19.491	-19.482	-2.789	-18.407	-18.401
1.50	-7.036	-22.225	-22.201	-7.506	-21.820	-21.811	-7.720	-21.071	-21.064

In bold, significant statistics at the 5% level. NR = No deterministic terms; I = Intercept. LT = Linear trend.

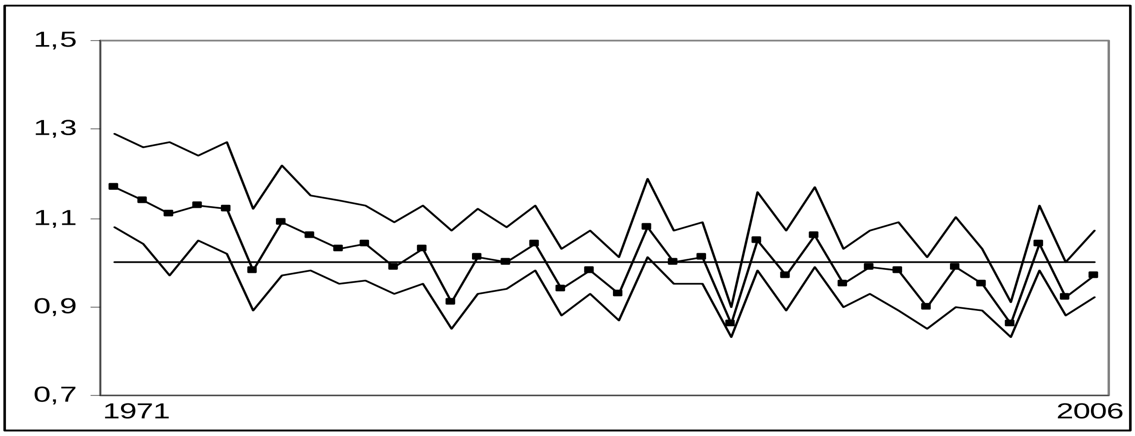
Table 4: Estimates of d based on AR(1) disturbances

Series	No regressors (NR)	An intercept (I)	A linear trend (LT)
DJIA	1.370 [1.344, 1.397]	0.953 [0.935, 0.973]	0.957 [0.940, 0.975]
S&P	1.357 [1.330, 1.385]	0.953 [0.934, 0.974]	0.957 [0.940, 0.975]
NASDAQ	1.350 [1.322, 1.378]	1.024 [1.004, 1.044]	1.024 [1.004, 1.044]

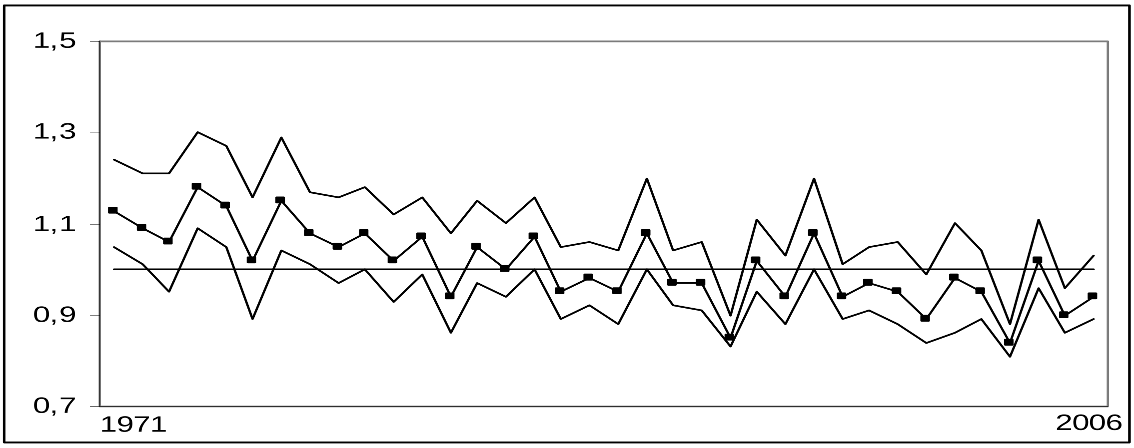
The values in brackets refers to the 95% confidence intervals.

Figure 2: Estimates of d based on 1-year samples with white noise disturbances

DJIA Index



S&P Index



Nasdaq Index

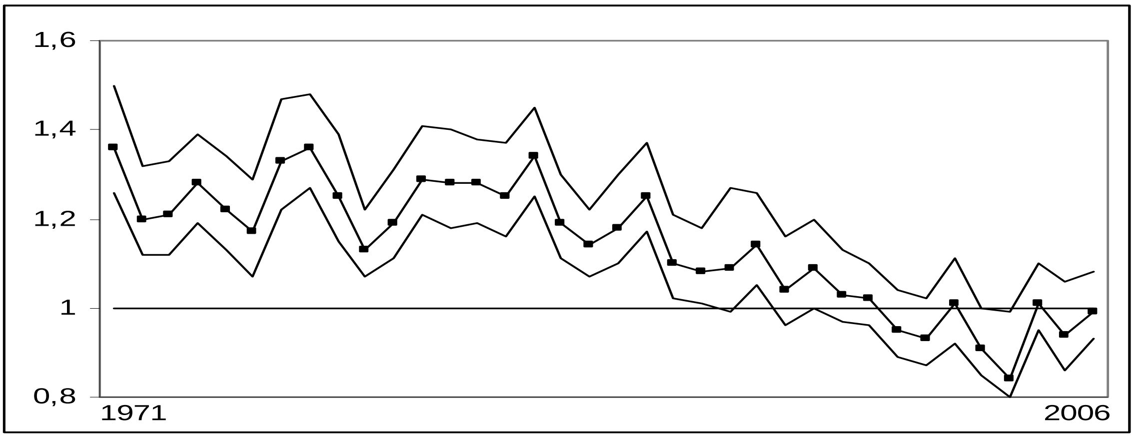
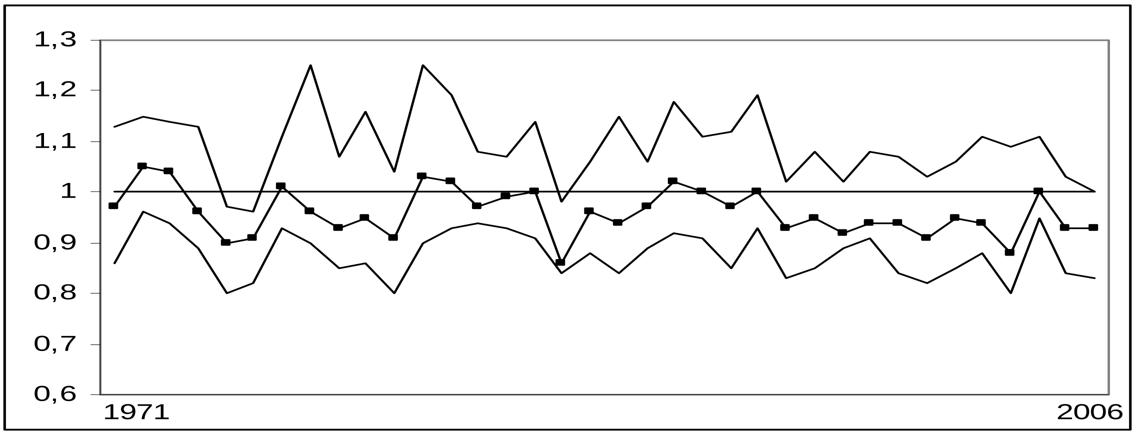
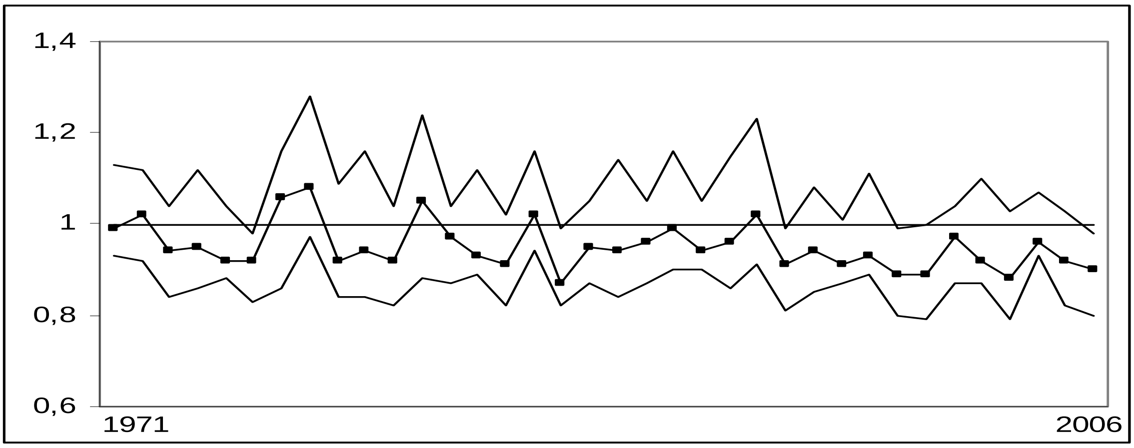


Figure 3: Estimates of d based on 1-year samples with AR(1) disturbances

DJIA Index



S&P Index



Nasdaq Index

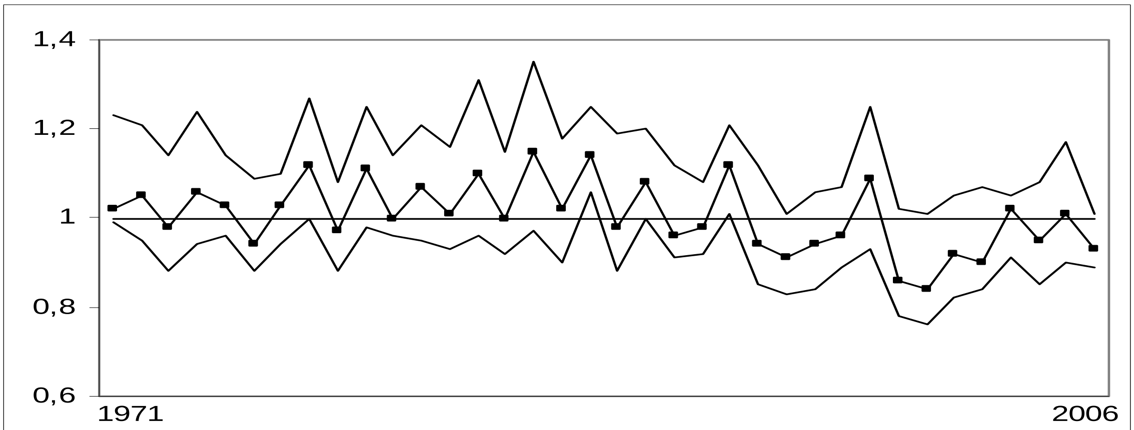


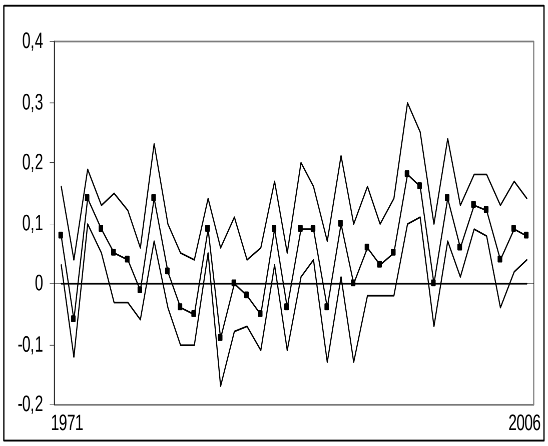
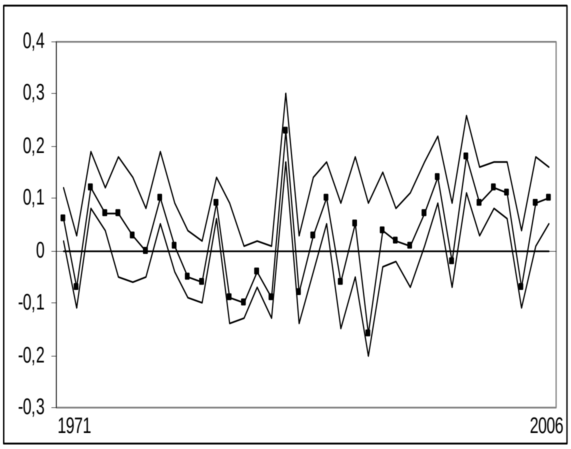
Table 5: Estimates of d for the volatility processes based on white noise disturbances

a) Squared returns			
Series	No regressors (NR)	An intercept (I)	A linear trend (LT)
DJIA	0.111 [0.100, 0.123]	0.111 [0.100, 0.213]	0.111 [0.100, 0.123]
S&P 500	0.126 [0.115, 0.138]	0.126 [0.115, 0.138]	0.126 [0.115, 0.138]
NASDAQ	0.218 [0.209, 0.227]	0.218 [0.209, 0.227]	0.216 [0.207, 0.226]
a) Absolute returns			
Series	No regressors (NR)	An intercept (I)	A linear trend (LT)
DJIA	0.164 [0.156, 0.173]	0.164 [0.156, 0.173]	0.161 [0.153, 0.169]
S&P	0.168 [0.160, 0.176]	0.168 [0.160, 0.176]	0.166 [0.158, 0.174]
NASDAQ	0.210 [0.203, 0.217]	0.210 [0.203, 0.217]	0.208 [0.201, 0.215]

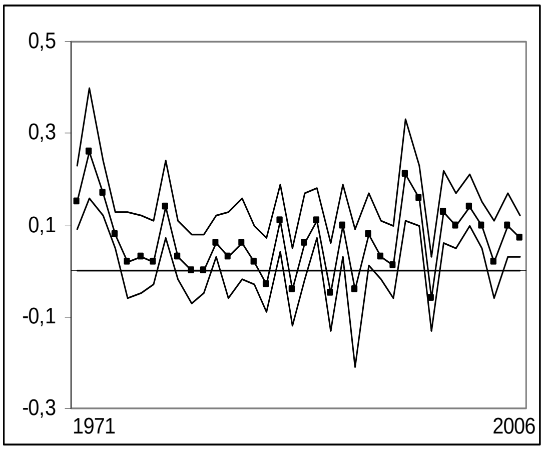
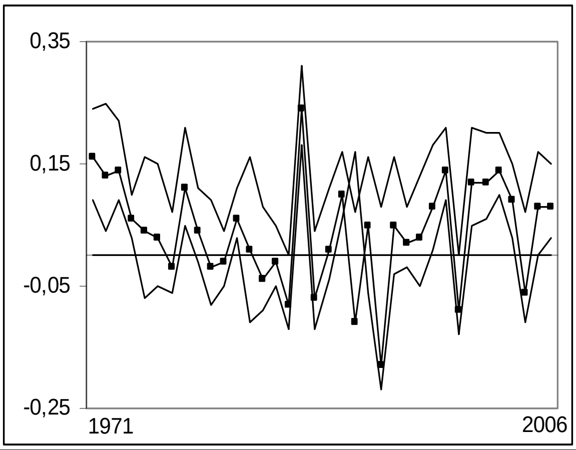
The values in brackets refers to the 95% confidence intervals.

Fig. 4: Estimates of d in volatility based on 1-year samples with white noise disturbances

DJIA Index

Squared returns	Absolute returns
	

S&P Index

Squared returns	Absolute returns
	

Nasdaq Index

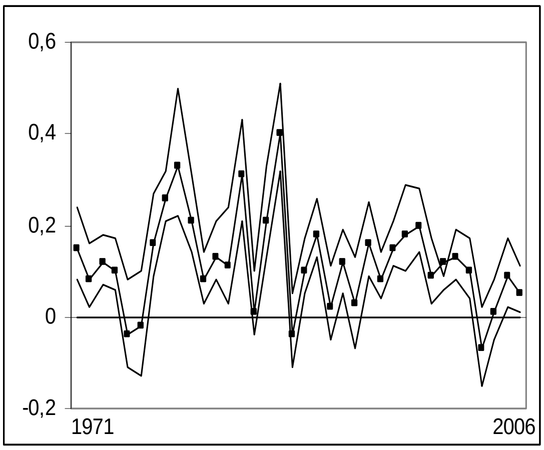
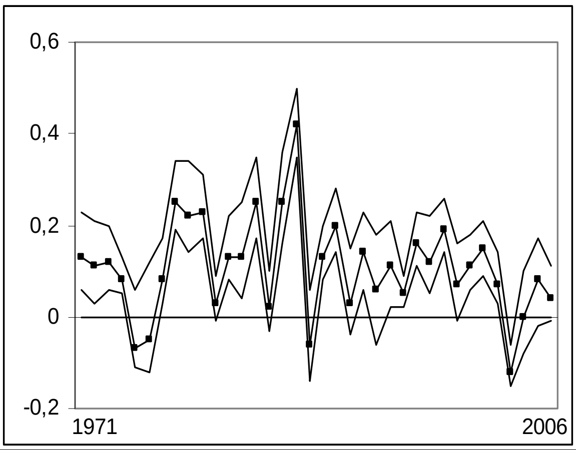
Squared returns	Absolute returns
	

Table 6: Average values of d in the volatility processes across years

Series	Squared returns	Absolute returns
DJIA	[0.035 (0.057) 0.150]	[0.035 (0.080) 0.140]
S&P	[0.060 (0.110) 0.175]	[0.060 (0.120) 0.195]
NASDAQ	[0.045 (0.100) 0.175]	[0.025 (0.085) 0.170]

Table 7: Estimates of d for each day of the week based on white noise disturbances

	Monday	Tuesday	Wednesday	Thursday	Friday
DJIA	0.939 [0.915, 0.967]	0.959 [0.934, 0.987]	0.991 [0.964, 1.022]	0.991 [0.964, 1.021]	0.978 [0.953, 1.007]
S&P	0.940 [0.915, 0.966]	0.954 [0.930, 0.982]	0.983 [0.957, 1.013]	0.987 [0.960, 1.016]	0.981 [0.956, 1.010]
NASDAQ	1.033 [1.007, 1.063]	1.046 [1.018, 1.076]	1.065 [1.037, 1.096]	1.079 [1.050, 1.111]	1.083 [1.054, 1.115]

Table 8: Estimates of d for each day of the week based on AR(1) disturbances

	Monday	Tuesday	Wednesday	Thursday	Friday
DJIA	0.955 [0.918, 0.998]	0.979 [0.938, 1.025]	0.989 [0.945, 1.040]	1.000 [0.956, 1.053]	1.022 [0.976, 1.076]
S&P	0.967 [0.930, 1.009]	0.988 [0.949, 1.033]	1.000 [0.958, 1.050]	1.003 [0.961, 1.054]	1.022 [0.978, 1.074]
NASDAQ	1.080 [1.033, 1.133]	1.067 [1.020, 1.118]	1.084 [1.034, 1.140]	1.100 [1.044, 1.158]	1.079 [1.027, 1.137]

Table 9: Values of the test statistic for the "day of the week" with white noise disturbances

d	DJIA			S&P			NASDAQ		
	NR	I	LT	NR	I	LT	NR	I	LT
0.00	409.32	409.32	333.80	409.22	419.21	325.87	406.34	406.34	307.85
0.10	386.74	386.78	322.49	408.95	409.73	322.77	404.26	404.03	312.56
0.20	281.78	283.39	314.65	302.55	305.73	318.31	307.64	310.09	303.34
0.30	244.11	242.61	309.70	237.44	239.99	304.47	232.85	237.11	291.76
0.40	206.06	200.00	304.64	197.74	195.86	297.38	193.58	194.91	283.30
0.50	159.82	151.29	301.89	154.24	153.13	285.49	152.71	159.75	265.07
0.60	111.31	112.56	256.46	108.51	120.46	225.46	108.99	135.10	205.37
0.70	68.81	75.58	142.87	67.74	77.47	118.93	69.09	96.31	120.44
0.80	36.73	35.56	51.02	36.44	35.83	44.65	37.81	55.48	60.42
0.90	14.61	10.71	12.52	14.55	10.60	11.61	15.63	26.83	27.40
1.00	-0.23	-3.93	-3.93	-0.22	-4.29	-4.29	**0.52**	7.87	7.86
1.10	-10.33	-13.31	-13.36	-10.32	-13.79	-13.82	-9.81	-4.94	-4.95
1.20	-17.43	-19.82	-19.83	-17.43	-20.32	-20.32	-17.09	-13.88	-13.88
1.30	-22.63	-24.60	-24.59	-22.62	-25.06	-25.06	-22.39	-20.32	-20.31
1.40	-26.56	-28.23	-28.23	-26.55	-28.64	-28.64	-26.39	-25.08	-25.08
1.50	-29.63	-31.07	-31.07	-29.61	-31.43	-31.43	-29.50	-28.70	-28.70

Table 10: Estimates of d for the "day of the week" based on white noise disturbances

Series	No regressors (NR)	An intercept (I)	A linear trend (LT)
DJIA	0.998 [0.985, 1.011]	0.968 [0.955, 0.982]	0.969 [0.958, 0.983]
S&P	0.998 [0.985, 1.011]	0.965 [0.957, 0.978]	0.967 [0.953, 0.979]
NASDAQ	1.004 [0.992, 1.018]	1.057 [1.048, 1.072]	1.058 [1.044, 1.070]

The values in brackets refers to the 95% confidence intervals.

Table 11: Values of the test statistic for the "day of the week" with AR(1) disturbances

d	DJIA			S&P			NASDAQ		
	NR	I	LT	NR	I	LT	NR	I	LT
0.00	**-0.40**	**-0.41**	**-0.38**	**-0.39**	**-0.39**	**-0.35**	**-0.42**	**-0.42**	**-0.37**
0.10	-7.68	-7.68	-8.16	-7.08	-7.09	-8.24	-6.90	-8.92	-8.38
0.20	-16.54	-16.52	-15.92	-16.20	-16.17	-16.02	-16.12	-16.09	-16.18
0.30	-22.94	-22.93	-22.12	-22.89	-22.86	-22.18	-22.94	-22.91	-22.34
0.40	-27.61	-27.63	-26.71	-27.62	-27.60	-26.68	-27.68	-27.65	-26.82
0.50	-31.25	-31.11	-29.47	-31.22	-30.79	-28.97	-31.25	-30.75	-29.23
0.60	-34.03	-29.53	-28.56	-33.94	-30.42	-27.59	-33.93	-30.77	-28.99
0.70	-36.02	-31.28	-26.98	-35.90	-31.11	-27.40	-35.87	-30.13	-29.36
0.80	-37.45	-33.72	-30.32	-37.31	-31.31	-30.76	-37.26	-31.64	-31.42
0.90	-38.52	-34.44	-33.57	-38.38	-33.79	-33.71	-38.33	-33.61	-33.58
1.00	-39.38	-36.65	-35.70	-39.25	-35.80	-35.80	-39.21	-35.45	-35.45
1.10	-40.12	-38.01	-37.30	-40.01	-37.42	-37.42	-39.97	-37.07	-37.07
1.20	-40.78	-38.63	-38.63	-40.69	-38.88	-38.75	-40.66	-38.46	-38.46
1.30	-41.39	-39.75	-39.75	-41.32	-39.87	-39.87	-41.29	-39.64	-39.64
1.40	-41.95	-40.72	-40.72	-41.89	-40.07	-40.83	-41.88	-40.65	-40.65
1.50	-42.48	-42.99	-41.55	-42.43	-41.66	-41.66	-42.42	-41.53	-41.53

Table 12: Values of the test statistic for the "day of the week" with Bloomfield disturbances

d	DJIA			S&P			NASDAQ		
	NR	I	LT	NR	I	LT	NR	I	LT
0.00	184.28	184.28	147.48	185.22	185.22	143.18	187.11	187.11	137.94
0.10	166.82	166.90	146.37	181.52	180.20	143.83	179.29	180.98	135.72
0.20	115.62	115.93	135.92	125.88	125.48	133.02	126.87	129.33	124.68
0.30	93.34	92.54	122.95	89.92	92.15	121.82	89.13	89.38	115.29
0.40	72.16	69.84	116.79	68.56	66.97	113.52	67.70	66.65	108.69
0.50	48.26	44.75	113.22	45.97	45.39	104.87	46.37	48.87	97.51
0.60	26.41	25.96	87.95	24.83	29.63	74.88	24.70	35.42	65.70
0.70	7.40	9.20	36.66	6.90	9.68	27.15	7.14	17.10	27.38
0.80	-6.80	-8.38	-2.29	-6.88	-8.07	-4.84	-6.62	-0.93	1.29
0.90	-16.78	-18.69	-17.94	-16.75	-18.96	-18.54	-16.58	-12.96	-12.72
1.00	-23.50	-25.16	-25.17	-23.45	-25.45	-25.45	-23.07	-21.16	-21.16
1.10	-27.98	-29.50	-29.51	-27.94	-29.59	-29.60	-27.92	-26.75	-26.75
1.20	-31.34	-32.52	-32,52	-31.30	-32.79	-32.79	-31.32	-30.80.	-30.79
1.30	-33.95	-34.90	-34.90	-33.92	-35.02	-35.02	-33.81	-33.62	-33.69
1.40	-35.83	-36.74	-36.74	-35.80	-36.85	-36.85	-35.84	-35.84	-35.84
1.50	-37.43	-38.21	-38.21	-37.40	-38.30	-38.30	-37.45	-37.63	-37.63

Table 13: Estimates of d for the "day of the week" based on Bloomfield disturbances

Series	No regressors (NR)	An intercept (I)	A linear trend (LT)
DJIA	0.747 [0.734, 0.753]	0.750 [0.738, 0.758]	0.790 [0.782, 0.796]
S&P	0.748 [0.736, 0.754]	0.748 [0.742, 0.756]	0.779 [0.773, 0.783]
NASDAQ	0.748 [0.738, 0.761]	0.796 [0.787, 0.804]	0.805 [0.797, 0.817]

The values in brackets refers to the 95% confidence intervals.

FUNDACIÓN DE LAS CAJAS DE AHORROS

DOCUMENTOS DE TRABAJO

Últimos números publicados

159/2000 Participación privada en la construcción y explotación de carreteras de peaje
Ginés de Rus, Manuel Romero y Lourdes Trujillo

160/2000 Errores y posibles soluciones en la aplicación del *Value at Risk*
Mariano González Sánchez

161/2000 Tax neutrality on saving assets. The spahish case before and after the tax reform
Cristina Ruza y de Paz-Curbera

162/2000 Private rates of return to human capital in Spain: new evidence
F. Barceinas, J. Oliver-Alonso, J.L. Raymond y J.L. Roig-Sabaté

163/2000 El control interno del riesgo. Una propuesta de sistema de límites riesgo neutral
Mariano González Sánchez

164/2001 La evolución de las políticas de gasto de las Administraciones Públicas en los años 90
Alfonso Utrilla de la Hoz y Carmen Pérez Esparrells

165/2001 Bank cost efficiency and output specification
Emili Tortosa-Ausina

166/2001 Recent trends in Spanish income distribution: A robust picture of falling income inequality
Josep Oliver-Alonso, Xavier Ramos y José Luis Raymond-Bara

167/2001 Efectos redistributivos y sobre el bienestar social del tratamiento de las cargas familiares en el nuevo IRPF
Nuria Badenes Plá, Julio López Laborda, Jorge Onrubia Fernández

168/2001 The Effects of Bank Debt on Financial Structure of Small and Medium Firms in some European Countries
Mónica Melle-Hernández

169/2001 La política de cohesión de la UE ampliada: la perspectiva de España
Ismael Sanz Labrador

170/2002 Riesgo de liquidez de Mercado
Mariano González Sánchez

171/2002 Los costes de administración para el afiliado en los sistemas de pensiones basados en cuentas de capitalización individual: medida y comparación internacional.
José Enrique Devesa Carpio, Rosa Rodríguez Barrera, Carlos Vidal Meliá

172/2002 La encuesta continua de presupuestos familiares (1985-1996): descripción, representatividad y propuestas de metodología para la explotación de la información de los ingresos y el gasto.
Llorenc Pou, Joaquín Alegre

173/2002 Modelos paramétricos y no paramétricos en problemas de concesión de tarjetas de credito.
Rosa Puertas, María Bonilla, Ignacio Olmeda

174/2002 Mercado único, comercio intra-industrial y costes de ajuste en las manufacturas españolas.
José Vicente Blanes Cristóbal

175/2003 La Administración tributaria en España. Un análisis de la gestión a través de los ingresos y de los gastos.
Juan de Dios Jiménez Aguilera, Pedro Enrique Barrilao González

176/2003 The Falling Share of Cash Payments in Spain.
Santiago Carbó Valverde, Rafael López del Paso, David B. Humphrey
Publicado en "Moneda y Crédito" nº 217, pags. 167-189.

177/2003 Effects of ATMs and Electronic Payments on Banking Costs: The Spanish Case.
Santiago Carbó Valverde, Rafael López del Paso, David B. Humphrey

178/2003 Factors explaining the interest margin in the banking sectors of the European Union.
Joaquín Maudos y Juan Fernández Guevara

179/2003 Los planes de stock options para directivos y consejeros y su valoración por el mercado de valores en España.
Mónica Melle Hernández

180/2003 Ownership and Performance in Europe and US Banking – A comparison of Commercial, Co-operative & Savings Banks.
Yener Altunbas, Santiago Carbó y Phil Molyneux

181/2003 The Euro effect on the integration of the European stock markets.
Mónica Melle Hernández

182/2004 In search of complementarity in the innovation strategy: international R&D and external knowledge acquisition.
Bruno Cassiman, Reinhilde Veugelers

183/2004 Fijación de precios en el sector público: una aplicación para el servicio municipal de suministro de agua.
Mª Ángeles García Valiñas

184/2004 Estimación de la economía sumergida es España: un modelo estructural de variables latentes.
Ángel Alañón Pardo, Miguel Gómez de Antonio

185/2004 Causas políticas y consecuencias sociales de la corrupción.
Joan Oriol Prats Cabrera

186/2004 Loan bankers' decisions and sensitivity to the audit report using the belief revision model.
Andrés Guiral Contreras and José A. Gonzalo Angulo

187/2004 El modelo de Black, Derman y Toy en la práctica. Aplicación al mercado español.
Marta Tolentino García-Abadillo y Antonio Díaz Pérez

188/2004 Does market competition make banks perform well?.
Mónica Melle

189/2004 Efficiency differences among banks: external, technical, internal, and managerial
Santiago Carbó Valverde, David B. Humphrey y Rafael López del Paso

190/2004 Una aproximación al análisis de los costes de la esquizofrenia en españa: los modelos jerárquicos bayesianos
F. J. Vázquez-Polo, M. A. Negrín, J. M. Cavasés, E. Sánchez y grupo RIRAG

191/2004 Environmental proactivity and business performance: an empirical analysis
Javier González-Benito y Óscar González-Benito

192/2004 Economic risk to beneficiaries in notional defined contribution accounts (NDCs)
Carlos Vidal-Meliá, Inmaculada Domínguez-Fabian y José Enrique Devesa-Carpio

193/2004 Sources of efficiency gains in port reform: non parametric malmquist decomposition tfp index for Mexico
Antonio Estache, Beatriz Tovar de la Fé y Lourdes Trujillo

194/2004 Persistencia de resultados en los fondos de inversión españoles
Alfredo Ciriaco Fernández y Rafael Santamaría Aquilué

195/2005 El modelo de revisión de creencias como aproximación psicológica a la formación del juicio del auditor sobre la gestión continuada
Andrés Guiral Contreras y Francisco Esteso Sánchez

196/2005 La nueva financiación sanitaria en España: descentralización y prospectiva
David Cantarero Prieto

197/2005 A cointegration analysis of the Long-Run supply response of Spanish agriculture to the common agricultural policy
José A. Mendez, Ricardo Mora y Carlos San Juan

198/2005 ¿Refleja la estructura temporal de los tipos de interés del mercado español preferencia por la liquidez?
Magdalena Massot Perelló y Juan M. Nave

199/2005 Análisis de impacto de los Fondos Estructurales Europeos recibidos por una economía regional: Un enfoque a través de Matrices de Contabilidad Social
M. Carmen Lima y M. Alejandro Cardenete

200/2005 Does the development of non-cash payments affect monetary policy transmission?
Santiago Carbó Valverde y Rafael López del Paso

201/2005 Firm and time varying technical and allocative efficiency: an application for port cargo handling firms
Ana Rodríguez-Álvarez, Beatriz Tovar de la Fe y Lourdes Trujillo

202/2005 Contractual complexity in strategic alliances
Jeffrey J. Reuer y Africa Ariño

203/2005 Factores determinantes de la evolución del empleo en las empresas adquiridas por opa
Nuria Alcalde Fradejas y Inés Pérez-Soba Aguilar

204/2005 Nonlinear Forecasting in Economics: a comparison between Comprehension Approach versus Learning Approach. An Application to Spanish Time Series
Elena Olmedo, Juan M. Valderas, Ricardo Gimeno and Lorenzo Escot

205/2005 Precio de la tierra con presión urbana: un modelo para España
Esther Decimavilla, Carlos San Juan y Stefan Sperlich

206/2005 Interregional migration in Spain: a semiparametric analysis
Adolfo Maza y José Villaverde

207/2005 Productivity growth in European banking
Carmen Murillo-Melchor, José Manuel Pastor y Emili Tortosa-Ausina

208/2005 Explaining Bank Cost Efficiency in Europe: Environmental and Productivity Influences.
Santiago Carbó Valverde, David B. Humphrey y Rafael López del Paso

209/2005 La elasticidad de sustitución intertemporal con preferencias no separables intratemporalmente: los casos de Alemania, España y Francia.
Elena Márquez de la Cruz, Ana R. Martínez Cañete y Inés Pérez-Soba Aguilar

210/2005 Contribución de los efectos tamaño, book-to-market y momentum a la valoración de activos: el caso español.
Begoña Font-Belaire y Alfredo Juan Grau-Grau

211/2005 Permanent income, convergence and inequality among countries
José M. Pastor and Lorenzo Serrano

212/2005 The Latin Model of Welfare: Do 'Insertion Contracts' Reduce Long-Term Dependence?
Luis Ayala and Magdalena Rodríguez

213/2005 The effect of geographic expansion on the productivity of Spanish savings banks
Manuel Illueca, José M. Pastor and Emili Tortosa-Ausina

214/2005 Dynamic network interconnection under consumer switching costs
Ángel Luis López Rodríguez

215/2005 La influencia del entorno socioeconómico en la realización de estudios universitarios: una aproximación al caso español en la década de los noventa
Marta Rahona López

216/2005 The valuation of spanish ipos: efficiency analysis
Susana Álvarez Otero

217/2005 On the generation of a regular multi-input multi-output technology using parametric output distance functions
Sergio Perelman and Daniel Santin

218/2005 La gobernanza de los procesos parlamentarios: la organización industrial del congreso de los diputados en España
Gonzalo Caballero Miguez

219/2005 Determinants of bank market structure: Efficiency and political economy variables
Francisco González

220/2005 Agresividad de las órdenes introducidas en el mercado español: estrategias, determinantes y medidas de performance
David Abad Díaz

221/2005 Tendencia post-anuncio de resultados contables: evidencia para el mercado español
Carlos Forner Rodríguez, Joaquín Marhuenda Fructuoso y Sonia Sanabria García

222/2005 Human capital accumulation and geography: empirical evidence in the European Union
Jesús López-Rodríguez, J. Andrés Faíña y Jose Lopez Rodríguez

223/2005 Auditors' Forecasting in Going Concern Decisions: Framing, Confidence and Information Processing
Waymond Rodgers and Andrés Guiral

224/2005 The effect of Structural Fund spending on the Galician region: an assessment of the 1994-1999 and 2000-2006 Galician CSFs
José Ramón Cancelo de la Torre, J. Andrés Faíña and Jesús López-Rodríguez

225/2005 The effects of ownership structure and board composition on the audit committee activity: Spanish evidence
Carlos Fernández Méndez and Rubén Arrondo García

226/2005 Cross-country determinants of bank income smoothing by managing loan loss provisions
Ana Rosa Fonseca and Francisco González

227/2005 Incumplimiento fiscal en el irpf (1993-2000): un análisis de sus factores determinantes
Alejandro Estellér Moré

228/2005 Region versus Industry effects: volatility transmission
Pilar Soriano Felipe and Francisco J. Climent Diranzo

229/2005 Concurrent Engineering: The Moderating Effect Of Uncertainty On New Product Development Success
Daniel Vázquez-Bustelo and Sandra Valle

230/2005 On zero lower bound traps: a framework for the analysis of monetary policy in the 'age' of central banks
Alfonso Palacio-Vera

231/2005 Reconciling Sustainability and Discounting in Cost Benefit Analysis: a methodological proposal
M. Carmen Almansa Sáez and Javier Calatrava Requena

232/2005 Can The Excess Of Liquidity Affect The Effectiveness Of The European Monetary Policy?
Santiago Carbó Valverde and Rafael López del Paso

233/2005 Inheritance Taxes In The Eu Fiscal Systems: The Present Situation And Future Perspectives.
Miguel Angel Barberán Lahuerta

234/2006 Bank Ownership And Informativeness Of Earnings.
Víctor M. González

235/2006 Developing A Predictive Method: A Comparative Study Of The Partial Least Squares Vs Maximum Likelihood Techniques.
Waymond Rodgers, Paul Pavlou and Andres Guiral.

236/2006 Using Compromise Programming for Macroeconomic Policy Making in a General Equilibrium Framework: Theory and Application to the Spanish Economy.
Francisco J. André, M. Alejandro Cardenete y Carlos Romero.

237/2006 Bank Market Power And Sme Financing Constraints.
Santiago Carbó-Valverde, Francisco Rodríguez-Fernández y Gregory F. Udell.

238/2006 Trade Effects Of Monetary Agreements: Evidence For Oecd Countries.
Salvador Gil-Pareja, Rafael Llorca-Vivero y José Antonio Martínez-Serrano.

239/2006 The Quality Of Institutions: A Genetic Programming Approach.
Marcos Álvarez-Díaz y Gonzalo Caballero Miguez.

240/2006 La interacción entre el éxito competitivo y las condiciones del mercado doméstico como determinantes de la decisión de exportación en las Pymes.
Francisco García Pérez.

241/2006 Una estimación de la depreciación del capital humano por sectores, por ocupación y en el tiempo.
Inés P. Murillo.

242/2006 Consumption And Leisure Externalities, Economic Growth And Equilibrium Efficiency.
Manuel A. Gómez.

243/2006 Measuring efficiency in education: an analysis of different approaches for incorporating non-discretionary inputs.
Jose Manuel Cordero-Ferrera, Francisco Pedraja-Chaparro y Javier Salinas-Jiménez

244/2006 Did The European Exchange-Rate Mechanism Contribute To The Integration Of Peripheral Countries?.
Salvador Gil-Pareja, Rafael Llorca-Vivero y José Antonio Martínez-Serrano

245/2006 Intergenerational Health Mobility: An Empirical Approach Based On The Echp.
Marta Pascual and David Cantarero

246/2006 Measurement and analysis of the Spanish Stock Exchange using the Lyapunov exponent with digital technology.
Salvador Rojí Ferrari and Ana Gonzalez Marcos

247/2006 Testing For Structural Breaks In Variance Withadditive Outliers And Measurement Errors.
Paulo M.M. Rodrigues and Antonio Rubia

248/2006 The Cost Of Market Power In Banking: Social Welfare Loss Vs. Cost Inefficiency.
Joaquín Maudos and Juan Fernández de Guevara

249/2006 Elasticidades de largo plazo de la demanda de vivienda: evidencia para España (1885-2000).
Desiderio Romero Jordán, José Félix Sanz Sanz y César Pérez López

250/2006 Regional Income Disparities in Europe: What role for location?.
Jesús López-Rodríguez and J. Andrés Faíña

251/2006 Funciones abreviadas de bienestar social: Una forma sencilla de simultanear la medición de la eficiencia y la equidad de las políticas de gasto público.
Nuria Badenes Plá y Daniel Santín González

252/2006 "The momentum effect in the Spanish stock market: Omitted risk factors or investor behaviour?".
Luis Muga and Rafael Santamaría

253/2006 Dinámica de precios en el mercado español de gasolina: un equilibrio de colusión tácita.
Jordi Perdiguero García

254/2006 Desigualdad regional en España: renta permanente versus renta corriente.
José M.Pastor, Empar Pons y Lorenzo Serrano

255/2006 Environmental implications of organic food preferences: an application of the impure public goods model.
Ana Maria Aldanondo-Ochoa y Carmen Almansa-Sáez

256/2006 Family tax credits versus family allowances when labour supply matters: Evidence for Spain.
José Felix Sanz-Sanz, Desiderio Romero-Jordán y Santiago Álvarez-García

257/2006 La internacionalización de la empresa manufacturera española: efectos del capital humano genérico y específico.
José López Rodríguez

258/2006 Evaluación de las migraciones interregionales en España, 1996-2004.
María Martínez Torres

259/2006 Efficiency and market power in Spanish banking.
Rolf Färe, Shawna Grosskopf y Emili Tortosa-Ausina.

260/2006 Asimetrías en volatilidad, beta y contagios entre las empresas grandes y pequeñas cotizadas en la bolsa española.
Helena Chuliá y Hipòlit Torró.

261/2006 Birth Replacement Ratios: New Measures of Period Population Replacement.
José Antonio Ortega.

262/2006 Accidentes de tráfico, víctimas mortales y consumo de alcohol.
José Mª Arranz y Ana I. Gil.

263/2006 Análisis de la Presencia de la Mujer en los Consejos de Administración de las Mil Mayores Empresas Españolas.
Ruth Mateos de Cabo, Lorenzo Escot Mangas y Ricardo Gimeno Nogués.

264/2006 Crisis y Reforma del Pacto de Estabilidad y Crecimiento. Las Limitaciones de la Política Económica en Europa.
Ignacio Álvarez Peralta.

265/2006 Have Child Tax Allowances Affected Family Size? A Microdata Study For Spain (1996-2000).
Jaime Vallés-Giménez y Anabel Zárate-Marco.

266/2006 Health Human Capital And The Shift From Foraging To Farming.
Paolo Rungo.

267/2006 Financiación Autonómica y Política de la Competencia: El Mercado de Gasolina en Canarias.
Juan Luis Jiménez y Jordi Perdiguero.

268/2006 El cumplimiento del Protocolo de Kyoto para los hogares españoles: el papel de la imposición sobre la energía.
Desiderio Romero-Jordán y José Félix Sanz-Sanz.

269/2006 Banking competition, financial dependence and economic growth
Joaquín Maudos y Juan Fernández de Guevara

270/2006 Efficiency, subsidies and environmental adaptation of animal farming under CAP
Werner Kleinhanß, Carmen Murillo, Carlos San Juan y Stefan Sperlich

271/2006 Interest Groups, Incentives to Cooperation and Decision-Making Process in the European Union
A. Garcia-Lorenzo y Jesús López-Rodríguez

272/2006 Riesgo asimétrico y estrategias de momentum en el mercado de valores español
Luis Muga y Rafael Santamaría

273/2006 Valoración de capital-riesgo en proyectos de base tecnológica e innovadora a través de la teoría de opciones reales
Gracia Rubio Martín

274/2006 Capital stock and unemployment: searching for the missing link
Ana Rosa Martínez-Cañete, Elena Márquez de la Cruz, Alfonso Palacio-Vera and Inés Pérez-Soba Aguilar

275/2006 Study of the influence of the voters' political culture on vote decision through the simulation of a political competition problem in Spain
Sagrario Lantarón, Isabel Lillo, Mª Dolores López and Javier Rodrigo

276/2006 Investment and growth in Europe during the Golden Age
Antonio Cubel and Mª Teresa Sanchis

277/2006 Efectos de vincular la pensión pública a la inversión en cantidad y calidad de hijos en un modelo de equilibrio general
Robert Meneu Gaya

278/2006 El consumo y la valoración de activos
Elena Márquez y Belén Nieto

279/2006 Economic growth and currency crisis: A real exchange rate entropic approach
David Matesanz Gómez y Guillermo J. Ortega

280/2006 Three measures of returns to education: An illustration for the case of Spain
María Arrazola y José de Hevia

281/2006 Composition of Firms versus Composition of Jobs
Antoni Cunyat

282/2006 La vocación internacional de un holding tranviario belga: la Compagnie Mutuelle de Tram-ways, 1895-1918
Alberte Martínez López

283/2006 Una visión panorámica de las entidades de crédito en España en la última década.
Constantino García Ramos

284/2006 Foreign Capital and Business Strategies: a comparative analysis of urban transport in Madrid and Barcelona, 1871-1925
Alberte Martínez López

285/2006 Los intereses belgas en la red ferroviaria catalana, 1890-1936
Alberte Martínez López

286/2006 The Governance of Quality: The Case of the Agrifood Brand Names
Marta Fernández Barcala, Manuel González-Díaz y Emmanuel Raynaud

287/2006 Modelling the role of health status in the transition out of malthusian equilibrium
Paolo Rungo, Luis Currais and Berta Rivera

288/2006 Industrial Effects of Climate Change Policies through the EU Emissions Trading Scheme
Xavier Labandeira and Miguel Rodríguez

289/2006 Globalisation and the Composition of Government Spending: An analysis for OECD countries
Norman Gemmell, Richard Kneller and Ismael Sanz

290/2006 La producción de energía eléctrica en España: Análisis económico de la actividad tras la liberalización del Sector Eléctrico
Fernando Hernández Martínez

291/2006 Further considerations on the link between adjustment costs and the productivity of R&D investment: evidence for Spain
Desiderio Romero-Jordán, José Félix Sanz-Sanz and Inmaculada Álvarez-Ayuso

292/2006 Una teoría sobre la contribución de la función de compras al rendimiento empresarial
Javier González Benito

293/2006 Agility drivers, enablers and outcomes: empirical test of an integrated agile manufacturing model
Daniel Vázquez-Bustelo, Lucía Avella and Esteban Fernández

294/2006 Testing the parametric vs the semiparametric generalized mixed effects models
María José Lombardía and Stefan Sperlich

295/2006 Nonlinear dynamics in energy futures
Mariano Matilla-García

296/2006 Estimating Spatial Models By Generalized Maximum Entropy Or How To Get Rid Of W
Esteban Fernández Vázquez, Matías Mayor Fernández and Jorge Rodriguez-Valez

297/2006 Optimización fiscal en las transmisiones lucrativas: análisis metodológico
Félix Domínguez Barrero

298/2006 La situación actual de la banca online en España
Francisco José Climent Diranzo y Alexandre Momparler Pechuán

299/2006 Estrategia competitiva y rendimiento del negocio: el papel mediador de la estrategia y las capacidades productivas
Javier González Benito y Isabel Suárez González

300/2006 A Parametric Model to Estimate Risk in a Fixed Income Portfolio
Pilar Abad and Sonia Benito

301/2007 Análisis Empírico de las Preferencias Sociales Respecto del Gasto en Obra Social de las Cajas de Ahorros
Alejandro Esteller-Moré, Jonathan Jorba Jiménez y Albert Solé-Ollé

302/2007 Assessing the enlargement and deepening of regional trading blocs: The European Union case
Salvador Gil-Pareja, Rafael Llorca-Vivero y José Antonio Martínez-Serrano

303/2007 ¿Es la Franquicia un Medio de Financiación?: Evidencia para el Caso Español
Vanesa Solís Rodríguez y Manuel González Díaz

304/2007 On the Finite-Sample Biases in Nonparametric Testing for Variance Constancy
Paulo M.M. Rodrigues and Antonio Rubia

305/2007 Spain is Different: Relative Wages 1989-98
José Antonio Carrasco Gallego

306/2007 Poverty reduction and SAM multipliers: An evaluation of public policies in a regional framework
Francisco Javier De Miguel-Vélez y Jesús Pérez-Mayo

307/2007 La Eficiencia en la Gestión del Riesgo de Crédito en las Cajas de Ahorro
Marcelino Martínez Cabrera

308/2007 Optimal environmental policy in transport: unintended effects on consumers' generalized price
M. Pilar Socorro and Ofelia Betancor

309/2007 Agricultural Productivity in the European Regions: Trends and Explanatory Factors
Roberto Ezcurra, Belen Iráizoz, Pedro Pascual and Manuel Rapún

310/2007 Long-run Regional Population Divergence and Modern Economic Growth in Europe: a Case Study of Spain
María Isabel Ayuda, Fernando Collantes and Vicente Pinilla

311/2007 Financial Information effects on the measurement of Commercial Banks' Efficiency
Borja Amor, María T. Tascón and José L. Fanjul

312/2007 Neutralidad e incentivos de las inversiones financieras en el nuevo IRPF
Félix Domínguez Barrero

313/2007 The Effects of Corporate Social Responsibility Perceptions on The Valuation of Common Stock
Waymond Rodgers , Helen Choy and Andres Guiral-Contreras

314/2007 Country Creditor Rights, Information Sharing and Commercial Banks' Profitability Persistence across the world
Borja Amor, María T. Tascón and José L. Fanjul

315/2007 ¿Es Relevante el Déficit Corriente en una Unión Monetaria? El Caso Español
Javier Blanco González y Ignacio del Rosal Fernández

316/2007 The Impact of Credit Rating Announcements on Spanish Corporate Fixed Income Performance: Returns, Yields and Liquidity
Pilar Abad, Antonio Díaz and M. Dolores Robles

317/2007 Indicadores de Lealtad al Establecimiento y Formato Comercial Basados en la Distribución del Presupuesto
Cesar Augusto Bustos Reyes y Óscar González Benito

318/2007 Migrants and Market Potential in Spain over The XXth Century: A Test Of The New Economic Geography
Daniel A. Tirado, Jordi Pons, Elisenda Paluzie and Javier Silvestre

319/2007 El Impacto del Coste de Oportunidad de la Actividad Emprendedora en la Intención de los Ciudadanos Europeos de Crear Empresas
Luis Miguel Zapico Aldeano

320/2007 Los belgas y los ferrocarriles de vía estrecha en España, 1887-1936
Alberte Martínez López

321/2007 Competición política bipartidista. Estudio geométrico del equilibrio en un caso ponderado
Isabel Lillo, Mª Dolores López y Javier Rodrigo

322/2007 Human resource management and environment management systems: an empirical study
Mª Concepción López Fernández, Ana Mª Serrano Bedia and Gema García Piqueres

323/2007 Wood and industrialization. evidence and hypotheses from the case of Spain, 1860-1935.
Iñaki Iriarte-Goñi and María Isabel Ayuda Bosque

324/2007 New evidence on long-run monetary neutrality.
J. Cunado, L.A. Gil-Alana and F. Perez de Gracia

325/2007 Monetary policy and structural changes in the volatility of us interest rates.
Juncal Cuñado, Javier Gomez Biscarri and Fernando Perez de Gracia

326/2007 The productivity effects of intrafirm diffusion.
Lucio Fuentelsaz, Jaime Gómez and Sergio Palomas

327/2007 Unemployment duration, layoffs and competing risks.
J.M. Arranz, C. García-Serrano and L. Toharia

328/2007 El grado de cobertura del gasto público en España respecto a la UE-15
Nuria Rueda, Begoña Barruso, Carmen Calderón y Mª del Mar Herrador

329/2007 The Impact of Direct Subsidies in Spain before and after the CAP'92 Reform
Carmen Murillo, Carlos San Juan and Stefan Sperlich

330/2007 Determinants of post-privatisation performance of Spanish divested firms
Laura Cabeza García and Silvia Gómez Ansón

331/2007 ¿Por qué deciden diversificar las empresas españolas? Razones oportunistas versus razones económicas
Almudena Martínez Campillo

332/2007 Dynamical Hierarchical Tree in Currency Markets
Juan Gabriel Brida, David Matesanz Gómez and Wiston Adrián Risso

333/2007 Los determinantes sociodemográficos del gasto sanitario. Análisis con microdatos individuales
Ana María Angulo, Ramón Barberán, Pilar Egea y Jesús Mur

334/2007 Why do companies go private? The Spanish case
Inés Pérez-Soba Aguilar

335/2007 The use of gis to study transport for disabled people
Verónica Cañal Fernández

336/2007 The long run consequences of M&A: An empirical application
Cristina Bernad, Lucio Fuentelsaz and Jaime Gómez

337/2007 Las clasificaciones de materias en economía: principios para el desarrollo de una nueva clasificación
Valentín Edo Hernández

338/2007 Reforming Taxes and Improving Health: A Revenue-Neutral Tax Reform to Eliminate Medical and Pharmaceutical VAT
Santiago Álvarez-García, Carlos Pestana Barros y Juan Prieto-Rodriguez

339/2007 Impacts of an iron and steel plant on residential property values
Celia Bilbao-Terol

340/2007 Firm size and capital structure: Evidence using dynamic panel data
Víctor M. González and Francisco González

341/2007 ¿Cómo organizar una cadena hotelera? La elección de la forma de gobierno
Marta Fernández Barcala y Manuel González Díaz

342/2007 Análisis de los efectos de la decisión de diversificar: un contraste del marco teórico "Agencia-Stewardship"
Almudena Martínez Campillo y Roberto Fernández Gago

343/2007 Selecting portfolios given multiple eurostoxx-based uncertainty scenarios: a stochastic goal programming approach from fuzzy betas
Enrique Ballestero, Blanca Pérez-Gladish, Mar Arenas-Parra and Amelia Bilbao-Terol

344/2007 "El bienestar de los inmigrantes y los factores implicados en la decisión de emigrar"
Anastasia Hernández Alemán y Carmelo J. León

345/2007 Governance Decisions in the R&D Process: An Integrative Framework Based on TCT and Knowledge View of The Firm.
Andrea Martínez-Noya and Esteban García-Canal

346/2007 Diferencias salariales entre empresas públicas y privadas. El caso español
Begoña Cueto y Nuria Sánchez- Sánchez

347/2007 Effects of Fiscal Treatments of Second Home Ownership on Renting Supply
Celia Bilbao Terol and Juan Prieto Rodríguez

348/2007 Auditors' ethical dilemmas in the going concern evaluation
Andres Guiral, Waymond Rodgers, Emiliano Ruiz and Jose A. Gonzalo

349/2007 Convergencia en capital humano en España. Un análisis regional para el periodo 1970-2004
Susana Morales Sequera y Carmen Pérez Esparrells

350/2007 Socially responsible investment: mutual funds portfolio selection using fuzzy multiobjective programming
Blanca Mª Pérez-Gladish, Mar Arenas-Parra , Amelia Bilbao-Terol and Mª Victoria Rodríguez-Uría

351/2007 Persistencia del resultado contable y sus componentes: implicaciones de la medida de ajustes por devengo
Raúl Iñiguez Sánchez y Francisco Poveda Fuentes

352/2007 Wage Inequality and Globalisation: What can we Learn from the Past? A General Equilibrium Approach
Concha Betrán, Javier Ferri and Maria A. Pons

353/2007 Eficacia de los incentivos fiscales a la inversión en I+D en España en los años noventa
Desiderio Romero Jordán y José Félix Sanz Sanz

354/2007 Convergencia regional en renta y bienestar en España
Robert Meneu Gaya

355/2007 Tributación ambiental: Estado de la Cuestión y Experiencia en España
Ana Carrera Poncela

356/2007 Salient features of dependence in daily us stock market indices
Luis A. Gil-Alana, Juncal Cuñado and Fernando Pérez de Gracia