

# Risk, Return and Volume in an Emerging Stock Market: The Bilbao Stock Exchange, 1916-1936\*

Stefano Battilossi ([stefano.battilossi@uc3m.es](mailto:stefano.battilossi@uc3m.es))

Stefan Houpt ([shoupt@clio.uc3m.es](mailto:shoupt@clio.uc3m.es))

Department of Economic History and Institutions  
Universidad Carlos III de Madrid

This preliminary draft: June 2006.  
Please do not quote.

## Abstract

We constructed a unique data set including price and trade volumes for the Bilbao Stock Exchange (BSE) in the interwar period in order to calculate two alternative market indices (weighted and unweighted). The characteristics of the weekly returns on the market portfolio and trading volumes are analyzed in order to test the existence of various phenomena typical of emerging markets, such as autocorrelation and high persistence of volatility shocks, and other features of advanced markets, such as the risk-return relationship and the relationship between trading volumes and returns. The methodological approach is based on an augmented GARCH-cum-volume model. We find strong evidence in favour of autocorrelation and GARCH effects, no evidence of risk-return relationship, and weak evidence of a contemporaneous impact of trading volumes on returns. These findings are generally in line with the results obtained by recent studies on emerging markets.

JEL Classification: C32, G12, N24

Keywords: GARCH, trading volume, emerging stock market, interwar Spain

\* Financial support from the Dirección General de Universidades e Investigación, Consejería de Educación, Comunidad de Madrid, Proyecto 06/HSE/140/2004 is gratefully acknowledged. We also wish to thank Juan Carlos Rojo Cagigal for his excellent research assistance, and Juana Lamote de Grignon, Devora Itriago and Raul Sánchez-Kobashi for their valuable help in constructing the data set.

*“It takes volume to make prices move.”*

## **Introduction**

A recent stream of financial studies emphasises the relevance of trading volumes for stock returns, namely that trading volumes should be regarded as critical information which influences both future prices and price volatility. On one hand, price movements and trading volumes can be jointly considered as aggregate market information. On the other hand, trading volumes have the specificity of reflecting the cumulative response of investors to “news”, whereas price movements can only capture the impact of that “news” on the average change in investors’ expectations. Thus, trading volumes should be a critical complement in the process that generates stock returns and volatilities. In fact, empirical studies of modern stock markets tend to confirm the existence of a positive relationship between volumes and prices in developed markets. The question arises, however, to what extent the empirical findings for highly liquid stock markets of industrial countries in the second half of the 20<sup>th</sup> century should hold also for emerging stock markets past and present. In fact, the peculiar characteristics of risk and returns in emerging stock markets represents the focus of a recent literature, which may provide interesting insights of historical cases of emerging markets. At the same time, we contend that the emergence of informationally efficient financial markets is an important facet of any country’s economic modernization, with far-reaching implication for its macroeconomic stability and performance. For this reason, a historical test of the volume-return relationship, and other characteristics of emerging markets in the early 20<sup>th</sup> century, can not only make a contribution to a well-established stream of empirical financial studies, but also turn out to be relevant in a broader historical economic perspective.

Due to the absence of historical information on trading volumes even for major stock exchanges, this hypothesis has never been tested in the financial history literature. We exploit the fortunate circumstance that trading volume information was systematically reported by the Bilbao Stock Exchange (BSE) in the interwar period in order to shed light on the risk, return and volume relationship in the historical case of an emerging stock market in the first half of the 20<sup>th</sup> century. Bilbao, located in the north of Spain, lie at the heart of the industrialising Basque Country, and its stock exchange became after the turn of the century the most important Spanish stock market as far as the trading of corporate and industrial securities was concerned. We have collected

daily data on prices, trading volumes, nominal and paid-up capital, and number of shares for all securities listed in the BSE from January 1916 to August 1936, just before the breakout of the Spanish civil war. This unique data set allowed us to construct a BSE market index, and then to use returns on the market portfolio and trading volumes in order to test the ‘structure’ of the returns generating process. In doing so, we adopt a modern approach based on ‘augmented’ GARCH-M-cum-volume models. We find that the Bilbao Stock Exchange in the interwar years shared a number of characteristics which are deemed to be characteristic of emerging stock markets at the end of the 20<sup>th</sup> century. More specifically, we find strong evidence in favour of high autocorrelation and GARCH effects. However, we obtain only weak evidence in favour of an impact of trading volumes on returns. This suggests that the volume of transactions did not contribute to reducing informational asymmetries.

The paper is structured as follows. Section 1 provides a concise survey of the volume-return theoretical and empirical literature. Section 2 provides a historical sketch of the Bilbao stock exchange, as well as some basic information about its legal framework and microstructure. Section 3 presents the data set and the Bilbao Stock Exchange Index we have constructed. Section 4 presents some preliminary results of the empirical exercise based on the GARCH-cum-volume approach. Section 5 concludes.

## **1. Stock returns and trading volume: a survey**

The importance of trading volumes for the stock price generating process represents a pillar of the so called Mixture of Distribution Hypothesis (MDH). The latter contends that stock returns and trading volumes both depend on a latent information flow variable. The underlying economic argument is that, in the presence of an increasing flow of news, an increasing number of investors will have an incentive to trade as they interpret differently the impact of news on a stock’s value and their expectations of future returns diverge. If we assume that volume data are a good proxy for this stochastic information process, a strong positive correlation between trading volumes and return volatility should be observed (Clark 1973, Epps and Epps 1976). Related to this hypothesis is the notion that news are revealed to investors sequentially, not simultaneously, which in turn originates a sequence of transitional price equilibria compounded by the persistence of high trading volumes. Due to the sequential nature of the process, lagged trading volume may help to predict current stock returns, as much as lagged returns may have predictive power for current volume (Copeland 1976). Other recent studies suggest that

trading volumes deliver to investors information that is qualitatively different from the information conveyed by prices. By instance, the trading activity of informed investors may transmit private information to the market by allowing uninformed investors to use volume data as an indicator of the reliability of the signals received, thus contributing to reduce information asymmetries (Blume et al. 1994; Suominen 2001).

The contemporaneous and dynamic relationships between trading volumes and stock returns have been also the subject of a substantial stream of empirical studies, using a variety of methods (including cointegration analysis). Generally based on market indices, these studies find ample evidence of a positive volume-to-price relationship, which in some cases is regarded as evidence of causality (Karpoff 1987; Gallant et al. 1992; Hiemstra and Jones 1994). Some also find that returns of stock with high trading volumes tend to lead to returns of stock with lower trading volumes, supposedly because high volume stocks, being more reactive to news, enhance the dissemination of market-wide information (Chordia and Swaminathan 2000).

The role of the rate of information arrival (proxied by the volume of transactions) as stochastic mixing variable has been proposed as an explanation for the well-known persistence of volatility shocks in return time series. Such persistence, captured by the phenomenon of volatility clustering, in which large (small) movements are usually followed by large (small) movements, can account for the non-normality and non-stability of the observed empirical distributions of stock returns. The intuition behind this notion is that the time-varying return volatility can be accounted for by the time-varying news arrivals about an individual share or the market as a whole. The most successful empirical workhorse for modelling this characteristic of financial time series is the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) process of Engle. In fact, it has been suggested that the autoregressive structure of conditional variance imposed by the GARCH model can adequately capture the serial correlation characteristics of the informational flow. The use of GARCH models in the study of price-volume investigation has been pioneered by Lamoreux and Lastrapes (1990), who found that the GARCH effect in stock returns (i.e. the persistence of stock return variance) disappears when trading volume is included in the conditional variance. This finding, generally interpreted as empirical evidence in favour of the MDH, has been subsequently confirmed for stock markets of industrialized countries (Andersen 1996; Brailsford 1996; Gallo and Pacini 2000; Omran and McKenzie 2000). All such studies assume that the trading volume is exogenous—a necessary prerequisite, for otherwise

any inference would be dumped by simultaneity bias. Indeed, Bollerslev et al. (1992) argue that such might well be the case for Lamoreux and Lastrapes' results. At this stage, we adopt the customary assumption of exogeneity and leave for future research to test empirically this assumption and investigate the direction of causality between volume and returns.

Formally, the GARCH-cum-volume model of Lamoreaux and Lastrapes (1990), which we use as a benchmark, is composed of a mean and a variance equation:

$$R_{i,t} = \alpha_0 + \alpha_1 R_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

and

$$h_{i,t} = \beta_0 + \beta_1 \varepsilon_{i,t-1}^2 + \beta_2 h_{i,t-1} + \beta_3 V_{i,t} \quad (2)$$

where  $R_i$  is the return of stock  $i$ , and  $\varepsilon_i \sim N(0, h_i)$  represents the unpredictable component of the returns. Equation (1) allows for autoregression in the mean of return, whereas equation (2) models the variance of the unexpected returns as a GARCH process depending on 'price news' ( $\varepsilon_i^2$ , the ARCH term capturing information about volatility observed in the previous period and measured as the lagged squared residual from the mean equation), past expectations (the GARCH term capturing information about forecasted variance from the last period), and the rate of information arrivals (as proxied by the total volume of stocks traded). The parameters  $\beta_1$ ,  $\beta_2$  and  $\beta_3$  are the weights assigned respectively to the three determinants of volatility. If  $\beta_1$  and  $\beta_2$  are positive, shocks to volatility (risk) persist, and the magnitude of the two parameters determine the degree of persistence; usually their sum should be lower than 1 in order to prevent an explosive process. However, if  $\beta_3$  is found to be positive and trading volume is serially correlated,  $\beta_1$  and  $\beta_2$  should be small and statistically insignificant, and their sum (the persistence of variance) negligible, as the GARCH effect in the data is entirely explained by the uneven flow of information (Lamoreux and Lastrapes 1990: 223).

## 2. The Bilbao Stock Exchange

The Bilbao Stock Exchange (BSE) was authorised by royal decree on July 21<sup>st</sup>, 1890, and celebrated its first trading session on February 5<sup>th</sup>, 1891. It was a private initiative and was constituted as a joint stock company. By adopting the same specific regulations as the Madrid Stock Exchange (the only official stock exchange in Spain) from its very beginning, it paved the way to being declared the second official stock exchange in Spain in 1910; Barcelona was to follow as the third official exchange in 1915. The

institution was governed by a Stock Exchange Council made up of elected Stock Exchange brokers. The Stock Exchange followed the general legislation on stock markets and the internal regulations which it had copied from the Madrid Stock Exchange.

Trading was done face-to-face on a trading floor. BSE was a 'listed' exchange, for only stocks listed with the exchange or on the Madrid Stock Exchange could be traded. Orders entered by way of brokers who were members of the exchange. Prices were determined using an auction method: a potential buyer bid a specific price for a stock and a potential seller asked a specific price for the stock. When the bid and ask prices matched, a sale took place on a first-come-first-served basis if there were multiple bidders or askers at a given price. Once a sale had been made, the details of the transaction were written down by each broker and then reported to the Stock Exchange register to be quoted on the slate. At the end of the trading session all brokers present on the floor gave a full report of their trading activities, and the Stock Exchange authorities recorded all sales including the closing price and the trade volume for each traded asset.

The BSE was founded by members of the previously existing informal stock market operated by licensed brokers. Over time their number had been limited to eight; by 1829 there were more than ten registered brokers and by 1882 their number had increased to 47. This abrupt increase reflected the economic upswing of the Basque Country's economy over the last third of the nineteenth century. By practise dating back to the eighteenth century, licensed brokers were forbidden from being merchants, dealing with bills of exchange, holding accounts for merchants or merchandise, or having anyone do so on their behalf. Neither were they allowed to underwrite or insure ships or vessels. On the other hand, they were obliged to record all their intermediations in daily record books which were centrally archived upon their death. At the beginning of each year they had to swear by oath that they had recorded all transactions of the previous year.

The declaration of BSE as an official stock exchange created a new agent to stock trading, the official stock exchange broker (*agente de cambio y bolsa*). Both groups of traders —licensed brokers and official brokers— organised as separate associations and had the right to operate on the Bilbao stock exchange. In its origins there was no limit on the number of official stock brokers that could operate on the Exchange and their number grew from six in 1890, to fifteen in 1895, twenty-two in 1897 (46 licensed brokers) and thirty-two in 1900. The 1901 stock market crisis in

Madrid and Bilbao lead to considering limitations and quality checks. The legislation passed on December 10<sup>th</sup>, 1910 limited the number of official stock brokers in Madrid to 50 and in Bilbao to 40. At the same time it imposed a stricter entry procedure: four fifths of the association members had to approve candidates; they had to take a formal exam and were finally appointed by the Finance Ministry according to their exam results. The 1910 legislation also provided that no further licensed brokers should be appointed and gave licensed brokers preference in becoming official stock brokers. By 1928 there were only official stock brokers operating in Bilbao. From 1920 on the exchange obliged all brokers to settle daily operations (paper and money) with its clearance office.

Sessions were held Monday through Saturday from 11 to 12.30 in the morning with the exception of the King's, Queen's and Crown Prince's birthdays, national and local holidays. From the end of February 1921 to October 1923 there is no trading on Saturdays, which holds true for summer sessions after 1923. We know that from 1921 on, sessions were divided into three periods: the first period was dedicated to fixed interest securities, the second to foreign exchange and the final session to all stocks.

### 3. The BSE-16 Market Index

In order to implement our empirical strategy, we had first to estimate a market index. For such purpose, we have collected daily prices and quantities traded for all listed stocks in the BSE from January 1916 to July 18<sup>th</sup>, 1936. This information was taken from *La Revista Información*, which published half-monthly summaries of quoted prices and traded quantities. Missing summaries have been reconstructed with quotes taken directly from the daily stock exchange register. Since all transactions were registered in order to be quoted on the slate and were recorded together with the closing price and total amount of each stock traded in a daily trade summary drafted by the Stock Exchange council and the brokers present at the trading session, we argue that the price reported is resulting from actual trade. The price was reported as last exchange — *último cambio*—, thus we assume it to be the closing price of the day. The summaries also included information on traded quantities expressed in current Pesetas, from which we were able to infer also the number of shares traded.<sup>1</sup>

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<sup>1</sup> According to our primary source, the value reported was in fact equal to the number of stocks traded multiplied by the nominal paid-up capital of each stock. Thus, calculating the number of stocks traded

The vast majority of stocks did not use to trade regularly; indeed, many stocks reported price/quantities with very low frequencies. In other cases, periods of regular trading alternate with periods of irregular trading. We have considered 16 bank securities, 21 railway stocks, 50 electrical securities, 32 mining company shares, 46 shipping company stocks, and 100 industrial securities. We have assumed that the high incidence of very infrequent trading can be regarded as evidence either of merely formal quotations or lack of a true secondary market. Since including a high number of these infrequently traded stocks in the market index would have dramatically reduced returns' variance, thus introducing a strong bias in favour of stability, we decided to exclude the stocks which reported trading prices and volumes less than 12 fortnights out of the 26 possible for any of the years being examined.<sup>2</sup> We hereby reduced the 265 securities to 101 possible series. For these 101 series we have complemented the information for those years in which they quote in less than 12 fortnights. Out of these 101 series we have made a first selection of the securities which were listed and quoted prices regularly on a weekly basis throughout the whole period we are examining. This actually reduced the sample to 22 stocks only. Even within this reduced sample, however, the problem of infrequent trading looms large as a possible source of bias. For this reason, we focused on weekly rather than daily observations as an attempt to reduce the shortcomings stemming from daily sampling yields (e.g. the biases associated with non-trading and non-synchronous prices: cfr. Lo and MacKinlay 1999: 27) without sacrificing too many observations.

The selected 22 stocks have been eventually used to construct a market index. For each stock a summary indicator of liquidity and market capitalization (ILC) has been estimated annually as follows:

$$ILC = p_{it}q_{it} + \alpha_m p_{it}v_{it} \quad (3)$$

where  $p_{it}q_{it}$  is the average market capitalization of stock  $i$ ,  $p_{it}v_{it}$  is the average trading volume of stock  $i$ , and  $\alpha_m$  is the ratio of the average market capitalization and trading volume ( $p_{mt}q_{mt} / p_{mt}v_{mt}$ ).<sup>3</sup> Each year stocks have been ranked according to their ILC, and the 6 stocks with the lowest value have been eliminated from the sample. The remaining 16 stocks, representing the most liquid and most highly capitalized securities available

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required the collection of detailed information about the nominal capital, number of shares and paid-up capital of each of the 22 selected stocks for the period 1916-1936.

<sup>2</sup> Since prices are quoted only for stocks that report quantities traded, we argue that the price reported is resulting from actual trade.

<sup>3</sup> This method is currently used by stock exchanges in order to select the stocks which enter their market indices (en example is the MIB-30 calculated by the Milan Stock Exchange).

in the Bilbao stock exchange, have been used to construct two indices: a BSE-16 Unweighted Index, assigning equal weight to each stock, and a BSE-16 Capitalization-Weighted Index. The reason for having different indices is to check the robustness of our findings when different benchmarks are used for the market portfolio return. The unweighted Index gives equal relevance to all stocks and can be therefore very sensitive to higher volatility of new emerging companies, whereas the weighted Index is strongly influenced by a very small group of most highly capitalized stocks. As shown in Figure 1, the latter diverged quite significantly from the former.

FIGURE 1 HERE

Both indices, however, capture adequately the cyclical swings of the Spanish economy, as shown in Figure 2. The fortune of Spanish economy before World War I had remained tied to an inefficient agrarian economy with highly undercapitalized and risk adverse manufacturing and service sectors. Only two regions had showed a clear deviation from this pattern: Catalonia and Bilbao. Of the two, the Bilbao estuary and the surrounding mining and industrial districts stood out as one of main industrial centres in southern Europe. Its heavy industry and the shipping trade associated to exporting ores and importing raw materials, machinery and goods were fully capitalist and an important part of the growing economic activity was organised through joint-stock incorporations which raised investment through the Stock Exchange. The First World War had mostly positive effects on the Bilbao region, for it enhanced the fortunes of shipping and mining sectors, withdrew foreign competitors from home markets and opened numerous opportunities to import-substitution industrialization. This asymmetrical impact on the economy of the Basque Country can account for the upward swing of the Bilbao stock exchange during the war, in contrast with other macro indicators for the general economy.

FIGURE 2 HERE

This brought about major changes in industrial structure and policy. Post-war disruption of trade and reconstruction efforts in central Europe postponed the return to normality until 1920. The worldwide economic slump evoked by war economies returning to their industrial capacities and competitiveness put an end to the dreams of Spanish industrial prowess. The profound restructuring of industrial sectors made

pressure for state intervention strong. On top of that, the following three years of social unrest surfaced the economic grievances of land peasantry and urban working class which combined poorly to an explosive cocktail with the alternating political parties who had no solutions to offer. We find a reflection of this in macroeconomic variables. Industrial production remained stagnant between 1916 and 1920 and grew only moderately up to 1922.

The demand for restoration of law and order gave widespread support to the military coup staged by General Primo de Rivera in September of 1923. The military dictatorship restored the illusion of industrial grandeur by promoting social overhead capital formation—roads, railways, ports, hydro-electrical dams and urban infrastructures, suppressing labour unrest, reinforcing protectionism and re-establishing business confidence. The programmes themselves had little economic impact besides creating important public debts, which was bound to heavily burden budgets and hinder economic policy manoeuvring during the economic recession which hit Spain as the rest of Europe in the 1930's. However, from 1925 to 1930 the Spanish economy went through an expansionary cycle. Throughout the dictatorship, industrial production stayed on a confidence path and grew at a constant pace between 1923 and 1930. Stock markets remained shallow up to 1926 when both the index and trading volumes picked up anew, reaching their peak in 1928. This expansion was accompanied by macroeconomic stability. In spite of having more than doubled during the First World War, prices remained exceptional stable throughout the rest of the period without major inflationary or deflationary pressures, as opposed to strong cyclical movements in foreign exchange. Martín Aceña and Comín (1984: 240-41) register depreciation in 1921, 1922-24, and 1927 to 1932, appreciation between 1925 and 1927 and 1932 and 1934, with some stability up to the end of 1935.

Political instability exacerbated the general economic reversal of the early 1930s. From 1928 onwards the dictatorship had trickled off to a lifeless end in January of 1930 and gave way to a period of uncertainty and political turmoil. This period found an abrupt turning point when the Second Spanish Republic was declared in April of 1931. The elected factions were unable to enact the outstanding reforms in land reform, secularization of civil institutions, public education and social welfare. The left suffered an important backlash in the November 1933 elections which brought an even more moderate and less reformistic government to power. Munting and B.A. Holderness (1991: 167-8) stress that political polarization intensified through the increasing

dissociation of achievement and expectation on the left, and radicalization as a reaction to republican and reformist discourses on the right. Stock market's agony was stretched over the thirties with two clear waves of capital flight—first in 1930-31, and again from 1934 on.

Spain during the 1930's was caught up in restrictive fiscal policies conditioned by the excess government spending during the dictatorship. It had little manoeuvring ground for anti-cyclical public expenditure given the debt burden inherited from preceding administrations. Balancing budgets guaranteed price stability with restrictions; high interest rates held foreign accounts in balance but imposed restrictions on credit, debt and investment; foreign exchange stability favoured trade for development and foreign capital flows but restricted monetary policy. Spain, as many emerging nations today, was caught up in the dilemma of maintaining financial credibility and engineering economic progress and development.

#### **4. A risk-return-volume empirical test: preliminary results**

The return on the market portfolio is the weekly return calculated as  $R_{m,t} = \log(\text{INDEX}_t / \text{INDEX}_{t-1}) * 100$ . The trade volume is expressed in nominal pesetas. Figure 3 plots the returns series of both unweighted and weighted market indices: both clearly exhibit volatility clustering.

FIGURE 3 HERE

Figure 4 provide histograms and descriptive statistics of the annualized returns series. Returns' volatility turns out to be particularly high. The histograms exhibit also higher peaks and fatter tails than a normal distribution. The kurtosis and Jarque-Bera statistics confirm that the annualized logarithmic return on the BSE index is leptokurtic and non-normal.

FIGURE 4 HERE

This evidence is strongly consistent with a number of characteristics—in fact, high volatility, non-normality of distributions, excess kurtosis—that contemporary studies tend to find in emerging markets (Bekaert and Harvey 1997; Bekaert et al. 1998).

Our empirical exercise for the return-volume relationship requires some preliminary tests. First, before searching for the existence of a GARCH structure in the data, we should be able to reject the absence of such a structure. According to the weak-form efficiency notion proposed by Fama (1970), successive one-period stock returns should follow a random walk and past returns should have no predictive power for future returns. Empirically, this implies that the index data should have a single unit root and that the market portfolio weekly returns should be IID (independently and identically distributed). We use unit root tests and BDS test of independence respectively in order to test these implications. The results, presented in panel A and B of Table 1, confirm that the index series is non-stationary with a single unit root, but strongly reject the hypothesis of IID for weekly returns.<sup>4</sup> This means that the weak-form efficiency hypothesis can be rejected, so that we should be able to identify some ‘structure’ in the data. Second, since the temporal dependence of the trade volume is a key requirement, we test autocorrelation for the market portfolio trade volume. The Ljung-Box Q-statistics for autocorrelation up to 4 lags, presented in panel C of Table 1, are large and significant. Thus, we can conclude that the rate of informational arrival as measured by the trading volume is serially correlated.

TABLE 1 HERE

Both the failure of the weak-efficiency test and the strong evidence in favor of temporal dependence in trade volumes justify our attempt to fit the data into a GARCH-like process, in which returns on the market portfolio are allowed to be correlated (the non-random-walk hypothesis of Lo and MacKinley) and the error terms—hence the returns—show heteroscedasticity (time-varying variance). The assumption of autocorrelation of returns, which contradicts the orthodox hypothesis of market efficiency, is again widely accepted in studies of emerging stock markets, in which autocorrelation is found to be substantially higher than in advanced markets (Harvey 1995; Bekaert and Harvey 1997). GARCH models also successfully capture the persistence of volatility shocks leading to volatility clustering. In addition, we have attempted to exploit the additional information provided by the volume of traded stocks

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<sup>4</sup> In BDS Independence test, the null hypothesis is that the series is IID. The critical value of BDS statistics in order to reject the null is circa 6. The size of the sample (1070 observations) rules out the possibility that the results are affected by a small sample bias, for which a cut off of 500 data points is generally accepted.

by including contemporaneous and lagged volumes, either in level or first difference, in the mean or variance equations, or both. In fact, the scatter plots presented in Figure 4 graphically suggest that there may exist a positive relationship between levels of trading volumes and level of the market index in the long run, although this relationship is much harder to be observed when differenced data are plotted.

FIGURE 5 HERE

Finally, we will also test the possible existence of a GARCH-M process, which allows for conditional (time-varying) variance to have a feedback effect on the mean return: this amounts to test whether the expected return on the market portfolio is related to its expected risk.

The mean return equations of the GARCH-M-cum-volume specification can be summarized as follows:

$$R_{m,t} = \alpha_0 + \alpha_1 \Sigma(R_{m,t-x}) + \alpha_2 V_{i,t} + \lambda h_{m,t} + \varepsilon_{m,t} \quad (4)$$

where  $R_{m,t}$  is the period  $t$  return on the market portfolio,  $R_{m,t-x}$  is the up to  $x$  period lag of the dependent variable to account for possible serial correlation,  $V_{m,t}$  is the contemporaneous volume of stocks traded in the market,  $h_{m,t}$  is the contemporaneous variance of the return on the market portfolio (i.e. risk, which is assumed to influence its return),  $\alpha_0$  is a constant,  $\alpha_1$  is the serial correlation coefficient,  $\alpha_2$  is the contemporaneous effect of volume on returns,  $\lambda$  is a coefficient measuring the trade-off between risk and return (in fact, a measure of risk premium), and  $\varepsilon_{m,t}$  is an error term which is assumed to be conditionally normally distributed.

The conditional variance of the market portfolio is the one-period ahead forecast variance based on past information, and is specified as

$$h_{m,t} = \beta_0 + \beta_1 \varepsilon_{m,t-1}^2 + \beta_2 h_{m,t-1} + \beta_3 V_{m,t-1} \quad (5)$$

where  $\beta_0$  is a constant representing a long-run average variance,  $\varepsilon_{m,t-1}^2$  is the ARCH term capturing information about volatility observed in the previous period (measured as the lag of the squared residual from the mean equation),  $h_{m,t-1}$  is the GARCH term capturing information about forecasted variance from the last period,  $V_{m,t-1}$  is the lag of the weekly volume of stocks traded, and  $\alpha_1$ ,  $\alpha_2$ ,  $\alpha_3$  are the weights assigned respectively to “news” (the ARCH term), past expectations and the additional information provided by the lagged volume of traded stocks. This equation can be interpreted as a process in which investors adjust their estimated return variance—that is, the expected risk of the

market portfolio—after observing unexpectedly large returns (either positive or negative) and increasing trade activity.

Table 2 presents the results of different specifications for both the unweighted and the weighted index. The mean equation of the simple GARCH model without trading volume (column 1) shows an intercept insignificantly different from zero and strong evidence of autocorrelation (higher in the unweighted index than in the weighted one: coefficients 0.261 vs 0.170). In the variance equation, the sum of the ARCH and GARCH coefficients is close to 1 (.868 and .912), showing very high persistence of volatility shocks. The results do not change when a GARCH-M model (column 2) is specified in order to test the existence of a risk-return relationship: in fact, no evidence of a feedback of volatility on return is found, as the risk premium coefficient is positive but statistically insignificant. Overall, these specifications find strong evidence in favour of GARCH effects in the returns on both indices, and also suggest that the unweighted index has a lower long-run average volatility—that is, was less risky than the unweighted one.

In order to test whether the inclusion of trading volumes affects the GARCH effects, in column 3 we replicate the Lamoreux-Lastrapes specification by including the first difference of the log-transformed contemporaneous trading volume in the variance equation. The results show that the parameters are negative (thus suggesting that increasing trading volumes may reduce return volatility) but statistically insignificant, leaving the ARCH and GARCH parameters unaffected.<sup>5</sup> Indeed, the only specification for which we have been able to find evidence of a volume-return relationship is reported in column 4. Here we found that including the log-transformed contemporaneous trading volume in the mean equation and the same lagged variable in the variance equation obtains a positive impact of volume on return, although only in the case of the unweighted index. In the variance equation, the GARCH effects are hardly reduced, although the “news” coefficient (.332) is more than doubled vis-à-vis previous estimates, and the GARCH coefficient significantly reduced (.417). The absence of a clear impact of trading volume on returns is hardly surprising, since this characteristic has been documented almost exclusively in highly developed financial markets.

## 5. Conclusion

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<sup>5</sup> Specifying the trading volume variable in levels does not alter the results.

We have constructed two alternative indices of the Bilbao Stock Exchange in the interwar period in order to test the existence of GARCH and trading volume effects on the weekly returns on the market portfolio. We found strong evidence in favour of autocorrelation and GARCH effects, but only weak evidence in favour of the hypothesis that informational flow—proxied by the volume of market transactions—had an impact on returns. All these findings suggest that the features of the informational flow in the Bilbao market was intrinsically different from what we usually associate with modern, developed markets. Interestingly, these results and other statistical characteristics of our returns data are strongly in line with the evidence provided by recent studies on emerging stock markets of the late 20<sup>th</sup> century. Such similarities suggest that the Bilbao stock exchange may have been a thin market, lacking in liquidity and with a limited ability to diversify—the elements which are usually regarded as explanatory factors of the peculiarities observed in emerging market nowadays.

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FIGURES

Figure 1  
BSE-16 Weekly Market Indices and Trade Volume

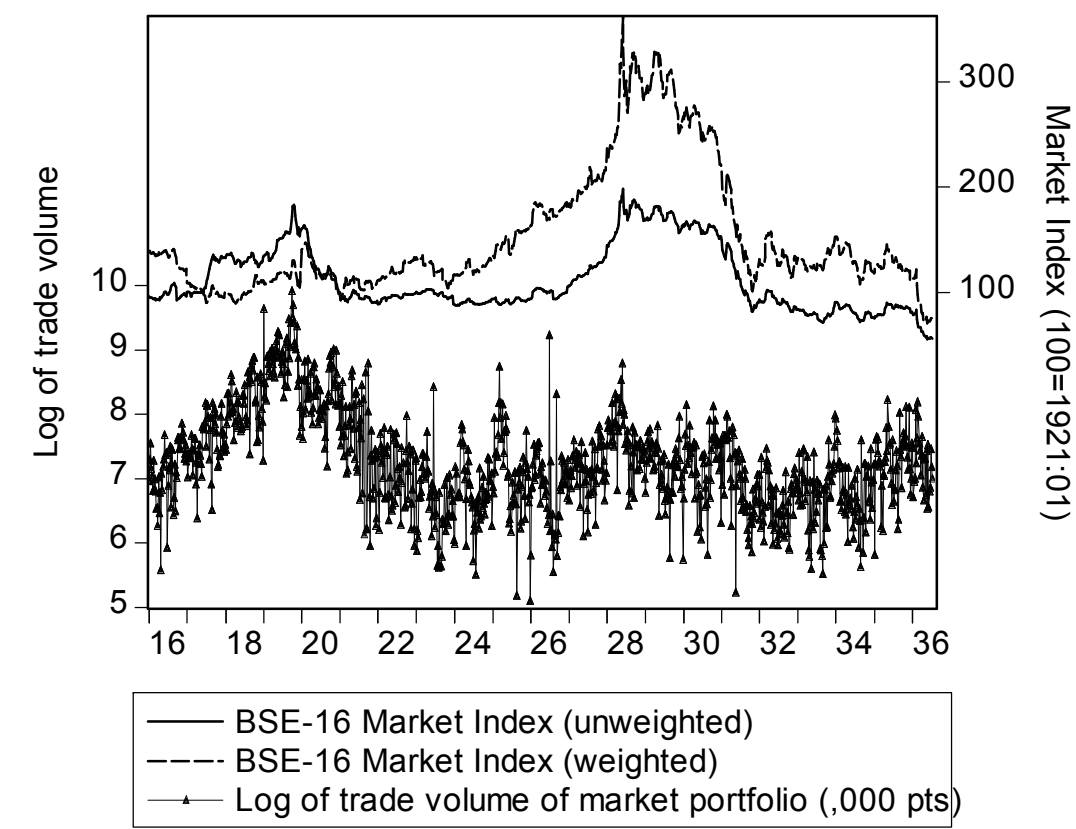
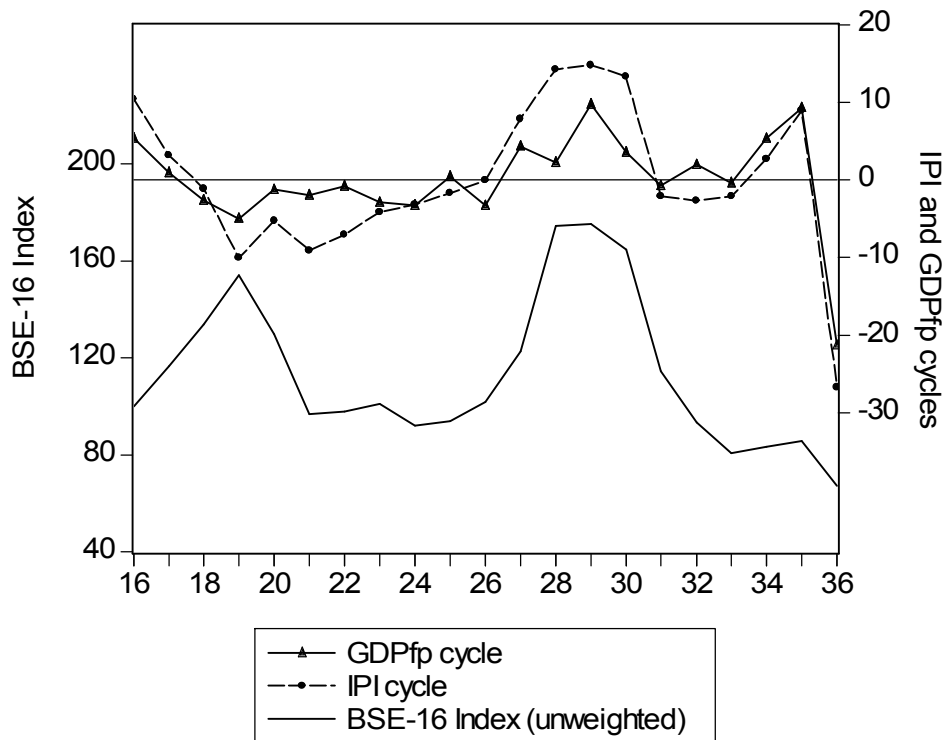


Figure 2  
BSE-16, Industrial Production and GDP cycles



Note. IPI and GDPpc cycles are obtained from detrended indices (HP filter).  
Sources: IPI and GDPfp, Prados de la Escosura (2003 & unpublished mimeo).

Figure 3  
Weekly Returns on the Bilbao Market Portfolio

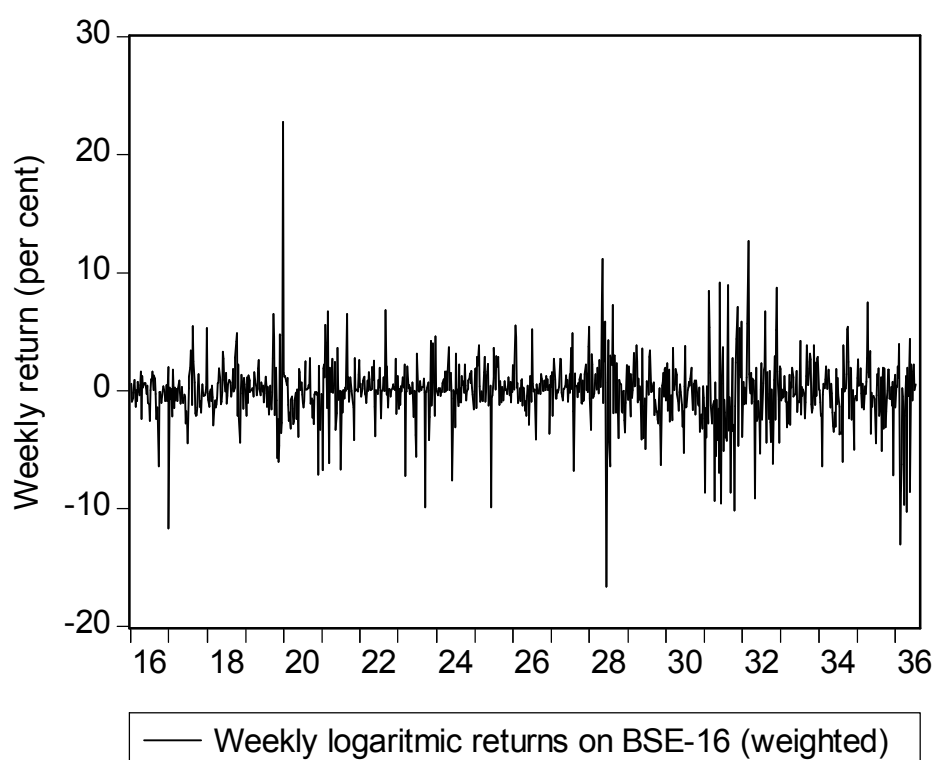
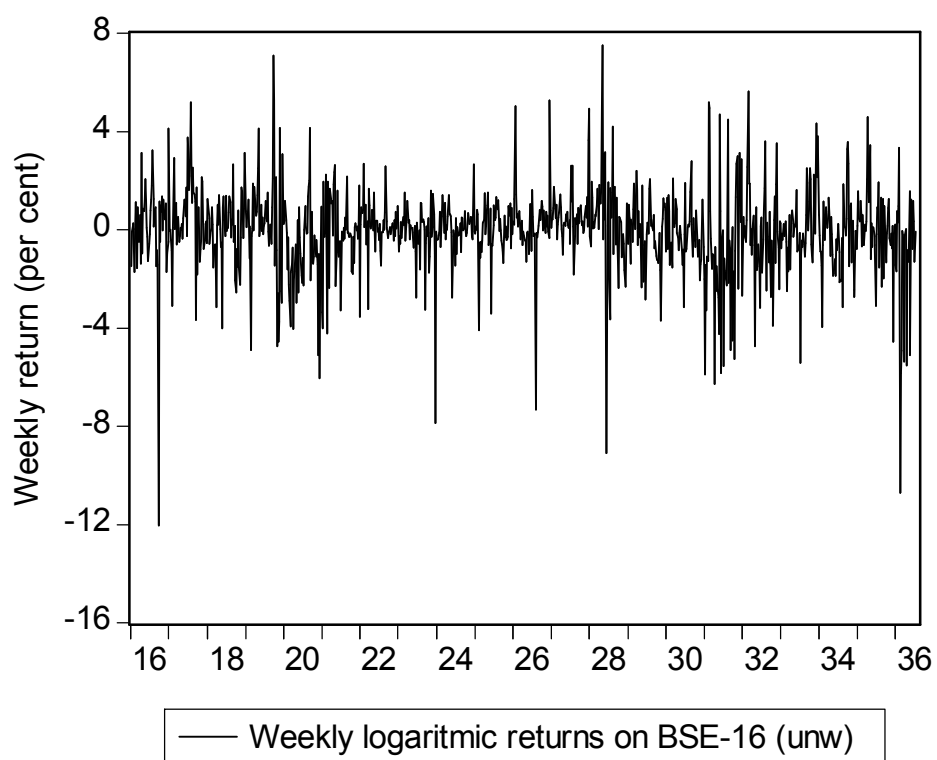


Figure 4

Descriptive statistics of market portfolio annualized weekly returns (per cent) and trade volume (,000 pts)

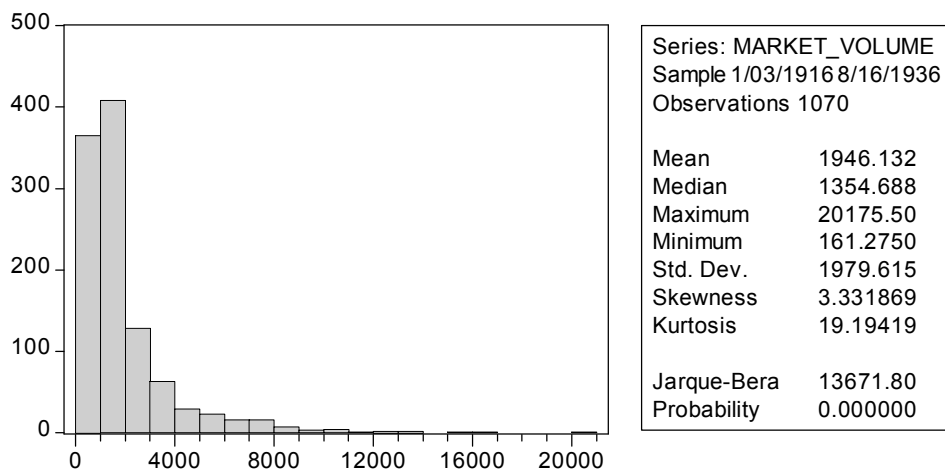
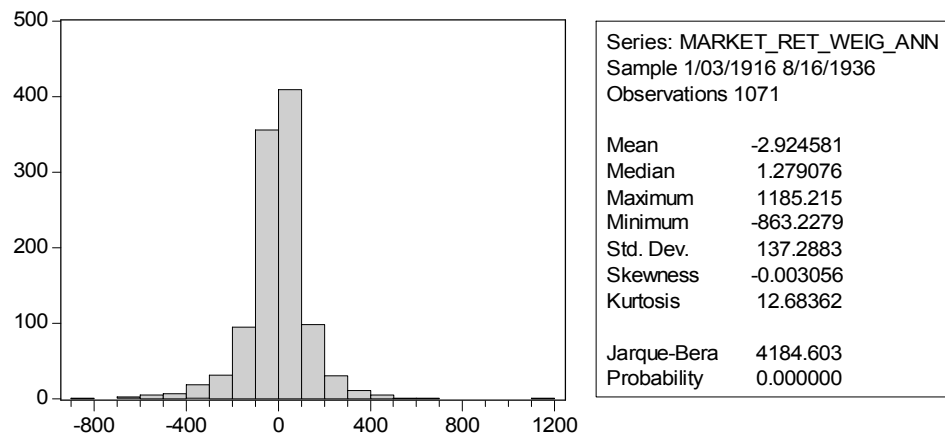
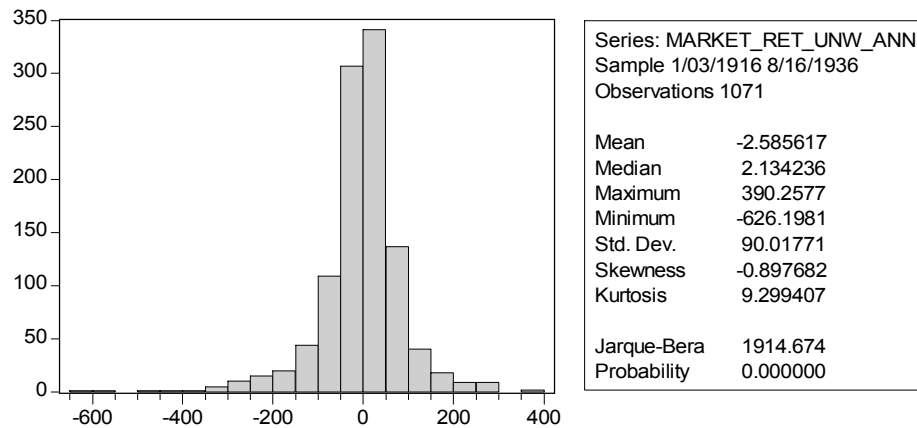
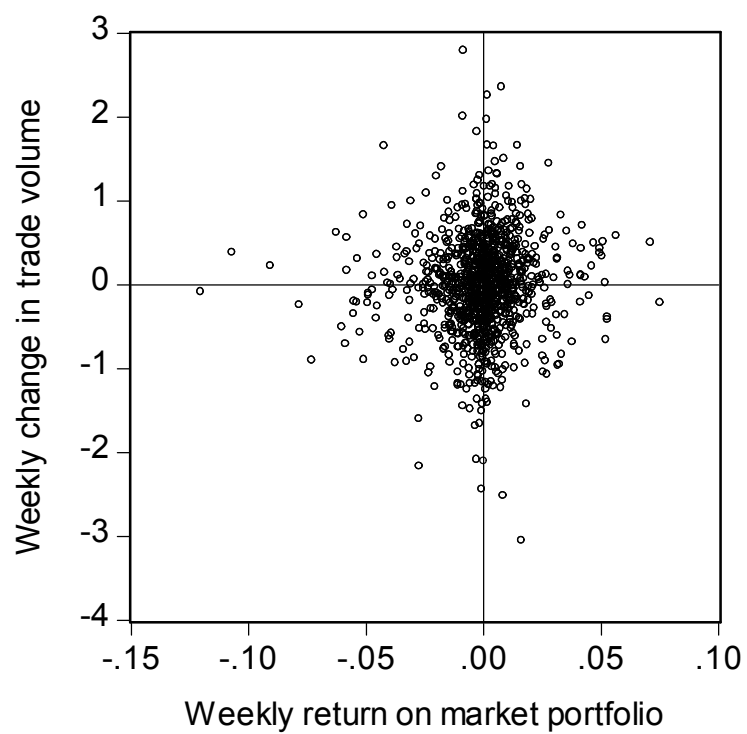
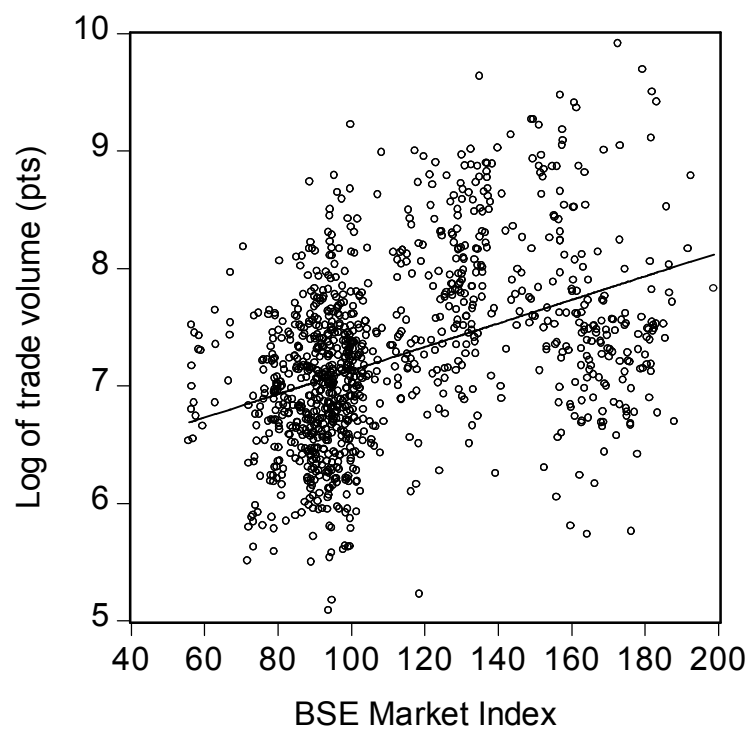


Figure 5  
Trading volume and returns



## TABLES

Table 1  
Unit Root and BDS Tests

Variable	Unit Root Tests			
	ADF	PP	DF-GLS	Verdict
3SE-16 Market Index (unw)				
level	-0.696	-0.682	-1.361*	unit root
first difference	-14.161***	-25.519***	-8.811***	stationary
E-16 Market Index (weighted)				
level	-0.722	-0.753	-1.052	unit root
first difference	-13.832***	-28.274***	-12.690***	stationary
BDS Independence Test				
	$\varepsilon$	m=4	m=5	m=6
Market Return (unw)	0.60	12.083	12.621	13.323
	0.70	9.655	9.850	9.956
	0.80	6.951	7.141	7.196
Market Return (weighted)	0.60	11.417	12.300	13.231
	0.70	9.634	10.347	10.916
	0.80	7.583	8.212	8.604
Ljung-Box Q-stats				
	(-1)	(-2)	(-3)	(-4)
Trade Volume				
level	619.83	1201.1	1740.6	2316.7
first difference	210.45	210.66	224.49	251.49

Table 2  
Estimates of GARCH model

BSE-16	GARCH		GARCH-M		GARCH-cum-vol (1)		GARCH-cum-vol (2)	
	unw	wei	unw	wei	unw	wei	unw	wei
	Mean equation							
$\alpha_0$	-0.000 (-0.44)	-0.001 (-0.75)	-0.000 (-0.23)	-0.001 (-0.73)	-0.019 (-0.42)	-0.001 (-0.73)	0.008 (0.16)	-0.001 (-0.71)
R(-1)	0.261*** (6.39)	0.170*** (3.80)	0.261*** (6.20)	0.171*** (3.73)	0.261*** (6.38)	0.170*** (3.84)	0.255*** (6.02)	0.172*** (3.84)
h			0.173 (0.04)	0.796 (0.34)				
d(V)							0.137* (1.60)	0.703 (0.54)
	Variance equation							
$\beta_0$	0.396** (2.19)	0.673*** (2.66)	0.398** (2.19)	0.694*** (2.65)	0.391** (2.19)	0.639*** (2.72)	0.898*** (3.08)	0.674*** (2.76)
$\varepsilon_2(-1)$	0.129*** (2.66)	0.163*** (3.16)	0.130*** (2.65)	0.168*** (3.16)	0.131*** (2.67)	0.153*** (3.10)	0.332*** (3.10)	0.169*** (3.17)
h(-1)	0.739*** (8.69)	0.749*** (12.40)	0.738*** (8.65)	0.742*** (11.90)	0.739*** (8.72)	0.762*** (13.34)	0.417*** (3.21)	0.745*** (12.18)
d(V)					-0.102 (-0.32)	-0.025 (-0.24)		
d(V(-1))							0.141 (0.53)	-0.051 (-0.45)
$\beta_1 + \beta_2$	0.868	0.912	0.868	0.910	0.870	0.915	0.749	0.915
Log-likelihood	2901.708	2472.926	2901.709	2473.002	2901.904	2473.600	2903.950	2476.892
Error distribution	normal	normal	normal	normal	normal	normal	normal	normal
Robust standard errors	B-W	B-W	B-W	B-W	B-W	B-W	B-W	B-W

Note. Estimates based on Maximum Likelihood, normal (Gaussian) distribution of errors, Bollerslev-Wooldrige robust standard errors and covariance. T-statistics in parenthesis; \*, \*\* and \*\*\* denote significance at 10, 5 and 1 per cent level respectively.