Stock Interest Rate Risk and Inflation Shocks

Francisco Jareño* and Eliseo Navarro*

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* Departamento de Análisis Económico y Finanzas. Universidad de Castilla-La Mancha

Facultad de Ciencias Económicas y Empresariales de Albacete

Plaza de la Universidad, 2, 02071 Albacete (España)

Francisco.Jareno@uclm.es (corresponding author)

Eliseo.Navarro@uclm.es

Tel: +34 967599200

Fax: +34 967599220

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Abstract

In this paper we proceed to estimate a measure of the flow-through capability of the firms listed in the Spanish Stock Exchange. The flow-through capability is defined as the ability of firms to transmit inflation shocks to the prices of the products and services sold by the company. According to a strand of literature, this flow-through capability can explain, to some extent, the so called "stock duration paradox", that is the difference between the theoretical stock duration derived from the DDM model and its empirical estimates. The line of reasoning suggest that if a company can pass on inflation shocks to the prices of its own outputs and then to profits and dividends, nominal interest rate changes due to variations in the expected inflation will have a limited impact on stock prices. So in this paper we first estimate the flow-trough capability for different industries finding strong differences among them. Then, we analyse the link between flow-through capability and stock duration finding a significant negative relationship between them as claimed by part of the literature.

Keywords: Flow-through capability; stock duration; sectorial analysis

JEL Classification: E31, G12, G3, L2

1. Introduction. The duration paradox

The main approaches to estimate the sensitivity of stock returns to interest rate changes were usually based on the discount dividend model (DDM). Particularly, the Gordon-Shapiro formulation assumes that future dividends are determined by a constant growth rate, leading to its very well known equity valuation formula:

$$P = \sum_{t=1}^{\infty} \frac{D_0(1+g)^t}{(1+k)^t} = \frac{D_0(1+g)}{k-g} \qquad [1]$$

where

P = the theoretical value of the stock

D_0 = the last dividend paid by the company

g = expected dividend growth rate

k = the nominal discount rate

Then, equity duration, that is, the sensitivity of equity price to changes in the discount rate,[1] is calculated as the derivative of the natural logarithm of P with respect to k:

$$D_{DDM} = -\frac{\partial \ln P}{\partial k} = \frac{1}{k-g} = \frac{1}{d} \qquad [2]$$

where d is the next period expected stock dividend yield, $D_0(1+g)/P$. Using data from the Spanish Stock Market[2] the median dividend yield in 2005, for the main listed companies, is around 2.20 % that applied to formula [2] would give a equity duration over 40 years which clearly overestimates the results of most empirical analysis.[3] This is what is known in the literature as the stock duration paradox.

[1] Although duration is a concept used to measure the price sensitivity of an asset to interest rate changes, equity duration is usually employed to refer the stock price sensitivity to changes in the nominal discount rate. Only if we assumed that there is a one to one relationship between both variables (discount rate and nominal interest rate) both sensitivities would be equal.

[2] See Servicio de Estudios de Bolsa de Madrid (2005). For the firms quoted in the Dow Jones Industrial Index, dividend yields have been historically very low. According to Lease et al. (2000), since 1905 the average yield of the Dow has been 4.30 %, a figure that according to formula [2] would give a duration of 23.25 years.

[3] Ferrer et al. (1999) and Soto et al. (2005) estimate empirical durations for the Spanish Stock Market obtaining values between four and seven years.

Different explanations have been developed in order to solve this contradiction. One of them relies on the fact that the dividend growth rate is not independent of those factors that affect the discount rate pointing to inflation as one of these common factors. In this sense, Leibowitz (1989) pointed out that the discount rate is the sum of two components, the market risk premium and the nominal interest rate which at the same time can be divided, approximately, into two parts: the expected inflation rate and the real interest rate. But the growth rate of nominal dividends may depend too on the expected inflation and the real interest rate. For instance, an increment in the discount rate due to a rise in the expected inflation may be accompanied by an increase in the expected growth of nominal dividends if firms are capable of passing through this inflation shock to the prices of its products and services and so to its expected future nominal profits. According to Leibowitz and Kogelman (1990) the impact on stock prices of changes in nominal interest rates due to variations in the expected inflation depends, to a large extent, on the capability of firms to absorb these inflation shocks.

This argument led to the definition of the flow-through coefficient (Estep and Hanson, 1980, and Asikoglu and Ercan, 1992) as the expected inflation percentage which flows into firm expected nominal cash-flows and so into firm profits and dividend growth.

Some authors (Estep and Hanson, 1980) suggest that industries with a high level of inflation absorption capability are less inflation sensitive than industries with a low flow-through coefficient. This is the line of reasoning followed by Leibowitz and Kogelman (1990, 1993) and Asikoglu and Ercan (1992): the greater the capability to transfer inflation shocks to prices, the smaller the stock price sensitivity to variations in nominal interest rates caused by changes in the expected inflation rate. Moreover, Asikoglu and Ercan (1992) document a negative relationship between inflation and stock returns and estimate the flow-through coefficients at industrial level showing that companies that operate in sectors with high-through capability are less sensitive than those firms that operate in low flow-through capability sectors.

Hevert et al (1998a, 1998b) and Sweeney (1998) suggest that a company's investment opportunities are similar to options and options react differently to interest rate changes than other sort of assets. These authors examine growth option sensitivity to inflation induced changes in interest rates using a binomial model concluding that growth options are generally less sensitive to interest rate changes than assets in place. The magnitude and sign of their interest rate sensitivity depends crucially on how much of those changes in expected inflation can be flowed through to changes in the projects nominal cash flows, that is, depends on the companies flow-through coefficients.

More recently, Hamelink et al. (2002) analyse the property and equity durations deriving a general formula for different sort of assets. It shows that calculations which assume, usually implicitly, that the flow through of inflation to cash flows is zero, produce misleadingly high durations for property and equities, whereas for realistic flow-through rates, equities have a higher sensitivity than property. So this flow-throw capability appears a key element in the estimation of asset duration.

However, there is a lack of empirical studies of this hypothesis. So, our objective is to investigate the relationship between stock duration and flow-throw capability. However, although empirical estimation of stock duration can be derived without too many difficulties, the estimation of the flow-throw capability is a much harder task.

By definition, the flow-through coefficient is the sensitivity of dividend growth (or alternatively profit growth if a constant pay-out ratio is assumed) to changes in inflation rate. However, company profits are extremely unstable even at industrial level and may depend on more or less arbitrary decisions concerning amortizations, depreciations, etc. and other events as mergers and acquisitions may make very difficult to obtain robust estimations of these coefficients.

In this paper we propose an indirect way to estimate the firm capability to transfer inflation shocks to the prices of their outputs and so to their nominal profits by analysing the behaviour of a much more stable variable, company' turnover, which should also reflect the capability of the firm to absorb inflation shocks. The results obtained show that there are important differences among industries and more importantly a negative relationship between the flow-through capability and stock duration.

2. Flow-through capability estimation

In this section we propose an indirect way to estimate the capability of firms to pass trough general inflation shocks to the price of its outputs and so to its nominal profits and dividends. These estimates must be related with the flow-trough coefficient defined by Estep and Hanson (1980) and Estep et al. (1983) as the fraction of inflation that flows to profit (and dividend) growth. More recently, Leibowitz et al. (1989) assume that the growth rate of a company profits can be modelled approximately by the following expression:

$$g \approx g_0 + \gamma \cdot r + \lambda \cdot \pi \qquad [3]$$

where

g = growth rate of a company profits which would be equal to g in equation [1] if a constant pay-out ratio is assumed

r = real interest rate

π = expected rate of inflation

g_0 = is a constant that represents the growth rate of profits in the long term

γ = is a parameter that represents the sensitivity coefficient of the growth rate of future profits to changes in real interest rates

λ = is the inflation flow-through coefficient

Following Leibowitz et al. (1989) we assume that the discount rate can be decomposed into three parts:

$$k = i + h(r, \pi, ...) \approx r + \pi + h(r, \pi, ...) \qquad [4]$$

where

i = the nominal interest rate

$h(\cdot)$ = the equity market risk premium

If we calculate the differential of the natural logarithm of P with respect to expected inflation and real interest rate, we obtain the following relationship:

$$\frac{dP}{P} = -D_{DDM}(1-\gamma+\frac{\partial h}{\partial r})dr - D_{DDM}(1-\lambda+\frac{\partial h}{\partial \pi})d\pi \qquad [5]$$

This expression states that changes in nominal interest rates may have a different impact on stock prices depending upon this change is induced by a shift in inflation expectations or caused by changes in real interest rates. A very controversial point in the literature concerns the stability of real interest rate, that is, if the so called Fisher effect holds or not. It is not clear either the sign of the response of the risk premium to changes in inflation expectations of real interest rates. In any case, what equation [5] indicates is that a change in nominal interest rates caused by a variation in inflation expectations depends clearly on coefficient λ, that is, the ability of the firm to absorb inflation shocks. The bigger the value of λ, the smaller the effect of nominal interest rate changes on stock prices.

If we assume that the risk premium does not change with changing inflation, a value of λ equal to one would mean that increases (or decreases) in interest rates would have no effect on stock prices. Note that a value of λ =1 means that the firm is capable to transmit a general increase in prices entirely to the prices of its own outputs and so to its nominal expected profits and this would leave the stock price unchanged. On the contrary, a value of λ close to zero (as assumed in the traditional DDM) would lead to a very extremely high sensitivity of stock prices to interest rate changes. Of course this capability of transferring inflation shocks to nominal profits may depend on the industry this company operates. It would not be the same a company running business in an industry exposed to foreign competence (in this case λ would be close to zero) than another one with a significant market power.

Then, we should expect a negative relationship between stock duration and flow-through coefficient. In order to test this hypothesis, we should make estimates of this flow-through coefficient which according to equation [3] is linearly related with profit growth. However, profits is a very volatile variable (especially if they are close to zero and, moreover its relative changes can be meaningless when there is a change of sign) and to some extent arbitrary, depending on changing accounting standards and decisions such as depreciations and amortizations or events such as mergers and acquisitions. Also, when working with a small sample (firms reports are made public only semi-annually), the estimation error may be too high to obtain results robust enough. So, taking into account what is behind the concept of flow-throw absorption capability we propose an alternative way of measuring this firm ability.

The flow-through capability would be related with the ability of the firm to pass on an inflation shock to firm output prices, that is, to Δp_t. Particularly, we will assume that:

$$\frac{\Delta p_t}{p_t} = f(\pi_t, \pi_{t-1}, \ldots) = \alpha_0 + \alpha_1 \pi_t + \alpha_2 \pi_{t-1} + \cdots + u_t \qquad [6]$$

where α_i measures the capability of the firm to transmit current and past inflation shocks to its output prices. Thus this parameter captures in essence the same concept that the flow-through coefficient and so we will focus our research on its estimation.

So our study starts with the following theoretical model:

$$\Delta V_t = p_{t+1} \cdot q_{t+1} - p_t \cdot q_t \qquad [7]$$

where:

V_t = firm revenue during period t

p_t = the mean price of the firm outputs during period t

q_t = the number of output physical units sold by the firm during period t

Rearranging terms to obtain:

$$\Delta V_t \approx \Delta p_t q_{t+1} + p_t \Delta q_t \qquad [8]$$

One of the main problems we have to deal with to obtain an estimate of α_i is that neither p_t not q_t are available at firm or industry level. If the output sold were constant then all changes in V_t would be due to changes in prices. However, production and sales volume are seldom constant so a control for this variable is needed.

A possible proxy for q_t could be the number of employees, a data that can be obtained from firm reports. In this case, equation [7] can be rewritten as follows:

$$\Delta V_t = \Delta p_t(\omega_{t+1} \cdot l_{t+1}) + p_t \cdot l_t \Delta\omega_t + p_t \cdot \omega_t \cdot \Delta l_t \qquad [9]$$

where ω_t = average number of employees during period t

l_t = the employee productivity (number of units of output sold over mean number of employees)

If we assume a constant productivity that is $l_t = l_{t+1}$ we obtain:

$$\frac{\Delta V_t}{V_t} = \frac{\Delta p_t}{p_t}\left[\frac{\Delta\omega_t}{\omega_t} + 1\right] + \frac{\Delta\omega_t}{\omega_t} = \frac{\Delta p_t}{p_t} \cdot \frac{\Delta\omega_t}{\omega_t} + \frac{\Delta p_t}{p_t} + \frac{\Delta\omega_t}{\omega_t} \qquad [10]$$

Equation [10] says that relative changes in firm turnover is equal to the sum of three terms: relative change in prices, relative change in "volume" (the latter proxied by the number of employees) and its crossed product. If we assume that the last term is negligible, we have:

$$\frac{\Delta V_t}{V_t} \approx \frac{\Delta p_t}{p_t} + \frac{\Delta\omega_t}{\omega_t} \qquad [11]$$

Equations [6] and [11] yield the following relationship:

$$\frac{\Delta V_t}{V_t} = \alpha_0 + \alpha_1\pi_t + \alpha_2\pi_{t-1} + \cdots + \delta\frac{\Delta\omega_t}{\omega_t} + e_t \qquad [12]$$

where e_t is an error term.

In order to relate model [12] with Leibowitz's equation [3] and the flow-through coefficient, we assume that g, the profit growth rate, depends on the relative changes in company turnover and other variables, that we denote by $\overline{\theta}$:

$$g = f(\Delta V_t / V_t, \overline{\theta}) \qquad [13]$$

According to equation [12] we have:

$$g = f(\beta_0 + \beta_1 \Delta\omega_t / \omega_t + \beta_2 \pi_t + \beta_3 \pi_{t-1} + \cdots + e_t, \overline{\theta}) \qquad [14]$$

If we assume that f is linear[4] with respect to π, we can write:

$$g = m(\beta_0 + \beta_1 \Delta\omega_t / \omega_t ; \overline{\theta}) + \phi_1 \pi_t + \phi_2 \pi_{t-1} + u_t \qquad [15]$$

Assuming that $E_t[u_t] = 0$ and comparing equation [15] with equation [3] we have:

$$g_0 + \gamma \cdot r \approx m(\beta_0 + \beta_1 \Delta\omega_t / \omega_t ; \overline{\theta}) \qquad [16]$$

that is, the long term growth rate of firm profits and real interest rate are related with business cycle, and so indirectly with increments in the labour force, and other omitted variables such as technological changes and other macroeconomic factors.

The remaining terms of equation [15] ($\phi_1 \pi_t + \phi_2 \pi_{t-1}$) are related with the flow-through capability, $\lambda \cdot \pi$. Particularly, we will assume that Φ is monotonically related with λ, then testing a negative relationship between flow-through capability and stock duration would be equivalent to finding a negative relationship between parameters Φ_i and stock sensitivity to nominal interest rate changes.

[4] Alternatively, we can assume that f is approximately a linear function with respect to π or that f is a smooth enough function of π.

3. Data and model testing

To estimate inflation absorption capability through equation [12] we use half-yearly data corresponding to firms listed in the Spanish Stock market covering the period from the first semester of 1993 to the first semester of 2005 (25 observations). They comprise data from 115 firms corresponding to all Spanish based companies (foreign companies quoted in the Spanish Stock Exchange were removed from the sample) that are currently quoted or have been quoted on the Spanish Stock Exchange during the sample period.[5] The data used (extracted from public balance report and profit and losses account) are the following: half-yearly company sales and the average number of employees of each semester.

With respect to the inflation rates, we obtain, for each semester, the average of the annual rate of the Consumer Price Index published on a monthly basis by the Spanish Instituto Nacional de Estadística.

In order to avoid seasonality problems with relative changes in sales and labour force, they are calculated each semester as the $(V_t - V_{t-2})/V_{t-2}$ and $(\omega_t - \omega_{t-2})/\omega_{t-2}$, where V_t is the turnover of semester t and ω_t is the number of employees during semester t respectively.

These data are calculated for each company and then aggregated industry by industry on an equally weighted basis. This aggregation is also done for the whole market. That is, we proceed as follows:

a) First all companies are assigned to a given industry according to the scheme defined by Madrid Stock Exchange. However, sectors 2 and 4 have been split up into two subsectors. Sector 2 has been divided into “Building sector” (S2B) and “Non Building sector” (S2WB) and sector 4 into “Media sector” (S4M) and “Non Media sector” (S4WM). This additional subdivision provides two advantages: now the companies of each sector are more homogeneous and also we have two more estimates of flow-through capability and stock duration.

[5] See Appendix A1 and A2 for a more detailed information.

b) Second, changes in relative terms for turnover and number of employees were worked out as described above for each company.
c) Finally, the equally weighted average of turnover and number of employees were obtained within each industry.

In order to avoid survival bias, we consider not only those firms with data available for the whole sample period but all companies that have been quoted during period covered by this study. Only the data corresponding to the first and the last semester a company was quoted was removed. Table 1 shows the name of the six sectors and the number of companies included in each of them.

[INSERT TABLE 1]

The classical unit root tests[6] confirm that the variable *Turnover*, $(V_t - V_{t-2})/V_{t-2}$, is stationary in mean, however, only two tests confirm the stationarity of the other two variables: *Employees* and *Inflation*. So we estimate model [12] in first differences becoming:

$$\Delta RT_t = \beta_0 + \beta_1 \Delta RLF_t + \beta_2 \Delta \pi_t + u_t \qquad [17]$$

where $RT_t = (V_t - V_{t-2})/V_{t-2}$ is the relative change in firm turnover from semester t-2 to semester t

$RLF_t = (\omega_t - \omega_{t-2})/\omega_{t-2}$ is the relative change in the number of employees from semester t-2 to semester t

π_t = average inflation rate during semester[7] t

Then, the dependent variable represents the increment in relative changes in turnover and the independent variables the increment in relative changes in the number of employees and changes in the inflation rate.

With respect to the parameter interpretation, β_0 should be equal to zero as far as equation [17] is the result of taking first differences in model [12]. β_1 would be a measure of productivity which we have assume to be constant, and so it should take a

[6] The tests applied were Dickey-Fuller, Phillips-Perron and KPSS. The results are not exhibit for simplicity although they are available under request.
[7] The model was also tested using as an additional independent variable lagged values of $\Delta\pi_t$ but they were not significant and so they have been removed from the final model.

value close to 1. Finally parameter β_2 correspond to α_1 of model [12] that is the measure of the flow-trough capability of inflation shocks by the companies belonging to a given sector and its estimation constitutes the main objective of this study. Traditional DDM based stock duration assumes this coefficient is equal to zero, that is, the company sales do not respond to changes in nominal interest rates caused by changes in expected inflation. The bigger the value of β_2, the bigger the flow-through capability of the firms included in a given industry and so a lower sensitivity to changes in nominal interest rate, that is, a lower stock duration should be expected.

4. Flow-Through estimates

The results of the estimation of the parameters of model [17] are shown in Table 2. These estimates were obtained using the SUR method (seemingly unrelated regression[8]) taking into account heteroskedasticity and the possible contemporaneous correlation in the error terms across equations.

[INSERT TABLE 2]

First we can see that the intercept is not significantly different from zero for any of the sectors considered and for the whole market. This was an expected result as model [17] was the result of taking first differences in model [12]. With respect to β_1 the result is much more heterogeneous, depending on the industry considered. An interesting result is that the estimate of β_1 for the whole market is lower than one, an outcome that is in concordance with one of the main drawbacks of the Spanish economy during the sample period: the low increase of the labour productivity despite the persistent growth of GDP during the last decade.

With regard to β_2 (the parameter that measures the flow-through capability), its estimates differ considerably across industries. It ranges from -2.03 to 8.46. The lowest values correspond to the building sector meanwhile the highest values are those of the technological and financial sectors. A negative value of $\hat{\beta}_2$ indicates that increases in the inflation rates are accompanied of decrease in the growth rate of industry turnover and vice-versa. Then, higher values of $\hat{\beta}_2$ should imply a higher sensitivity of stock

8 Zellner (1962). It would be unrealistic to expect that the equation errors would be uncorrelated among sectors. SUR methodology takes into account this fact yielding different regression coefficients, standard errors, R^2's, etc.

returns to changes in nominal interest rates whereas smaller values would be closer to the traditional DDM assumption of a null flow-through capability.[9]

5. Stock duration

Once a measure of the companies' flow-through capability is obtained the next step consist of getting an estimate of stock duration across different industries. In fact, there is a lot of previous literature the body of which is the Stone (1974) two-factor model.[10] Most of these studies focus on the financial sector. For the Spanish case, it should be pointed out Ferrer's studies[11] where estimates of stock duration for the Spanish Stock market can be found using alternative methodologies and explanatory variables (mainly interest rates with different terms to maturity). In this paper, to analyse sector return sensitivity to changes in nominal interest rates and market returns , we will also apply Stone's model based on CAPM that extends the single-factor market model to a model with two factors to better explain the stochastic process that generates security returns:

$$r_t^j = \alpha^j + \beta^j \cdot r_{mt} + \gamma^j \cdot \Delta i_t^u + \varepsilon_t^j \qquad [18]$$

where r_t^j is the return of stock j in month t, β^j shows the stock sensitivity to market portfolio, r_{mt} is the return on the market portfolio,[12] Δi_t^u represents unexpected changes in nominal interest rates and γ^j is the sensitivity of stock returns to interest rate changes, that is, this parameter captures the stock duration. Finally, ε_t^j is an error term.

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[9] In any case it should be pointed out that a value of $\hat{\beta}_2 = 0$ does not mean a zero flow-through capability, that is that λ in equation [3] is equal to zero. We only assume that there is a monotonic relationship between $\hat{\beta}_2$ and λ.

[10] Lynge and Zumwalt (1980), Sweeney and Warga (1986), O'Neal (1998), Fraser et al. (2002), Bartram (2002), Soto et al. (2005) and Jareño (2006a) analyze this interest rate sensitivity. Jareño (2006b) uses an extension of the Stone two-factor model with factors of the Fama and French three-factor model.

[11] Ferrer et al. (1999), Ferrer and Matallín (2004), Soto et al. (2005) and Ferrer et al. (2005).

[12] To avoid the effects of the multicolinearity between explanatory variables, some orthogonalization procedures are usually applied. Following Lynge and Zumwalt (1980), Flannery and James (1984), Sweeney (1998) and Fraser et al. (2002), the market return has been regress against a constant and the series of nominal interest rates using OLS. Thus, market returns are replaced by the residuals of the former regression.

5.1. Data and methodology

The data used are monthly returns (calculated the last day of the month) of each company covering the period January 1993 to June 2005. Then, data are aggregated by industry on an equally weighted basis to obtain the series of monthly returns for each sector.

The proxy for the market portfolio used in this research is the IGBM (Índice General de la Bolsa de Madrid) which comprises a wider number of companies than the more selective Ibex-35.

Finally, with respect to the interest rate, we have to deal with two problems. First we have to choose an interest rate among all possible maturities. Most literature uses long-term interest rates as they incorporate future expectations of economic agents and they are used to determine the corporate borrowing cost. The second problem is what is to be considered as an unanticipated variation in interest rates.

With respect to the first question we eventually decided to use the one year Treasury yield. On the one hand this is one of the most liquid references[13] and on the other hand its correlation with both shorter and longer interest rates is very high.[14]

Regarding the second issue, although alternative proposal about what can be considered a non anticipated change in interest rates[15] has been used, we finally used the total variation of interest rates to capture these unanticipated changes.[16]

[13] See Díaz, Merrick and Navarro (2006) for an analysis of the liquidity of the Spanish Public Debt Market.
[14] See Appendix A2. Other interest rates with different terms to maturity have been used to estimate the stock return sensitivity to changes in nominal interest rates (particularly 3 year and 10 year interest rates) but the results are very similar.
[15] For instance, Flannery and James (1984) used the forecast error of an ARIMA process to model the behaviour of interest rates, Mishkin (1982) considered the difference between current spot rates and former forward rates, Froot (1989) and Benink and Wolff (2000) employed survey data on US Federal funds rate.
[16] This is the most usual choice in this strand of literature. See, for example, Sweeney and Warga (1986), Kane and Unal (1988), Oertmann et al. (2000) and Bartram (2002).

5.2. Empirical results

The estimation of the parameters of model [18] has been run using the SUR method (seemingly unrelated regression) taking into account heteroskedasticity and the possible contemporaneous correlation in the error terms across equations. The results are shown in Table 3.

[INSERT TABLE 3]

First it should be pointed out the high explanatory power of the model ranging between 47 % and 68 %. All sector returns exhibit (as expected) a positive and significant sensitivity to variations in market returns.

With respect to the sensitivity of stock returns to changes in nominal interest rates, that is the stock duration, the results confirm the previous literature: stock returns are negatively related with interest rate movements with a very high degree of significance. However, stock durations varies strongly across sectors ranging from 7.92 in sector 6, "Technology and Telecommunications", to 2.82 in financial sector. In fact, Wald test indicates that interest rate sensitivity is significantly different across industries.

Then the next step will be to test whether these differences can be explained by the flow-throw capability.

6. Flow-through capability and stock duration

According to the previous literature,[17] companies with a high flow-through capability, that is that can translate to the prices of its output a shock in interest rate, should have a lower sensitivity to nominal interest rate changes and vice versa.

In order to analyse this relationship we first depict a graph with industry flow-through capability and stock durations (see figure 1). As we can see, except sector 6 (and to some extent S4WM) all other points seem to exhibit a negative relationship between these two variables. It should be pointed out that sector six corresponds to telecommunications industry where three out of the eight firms included in this sector

[17] Estep and Hanson (1980), Leibowitz and Kogelman (1990, 1993), Asikoglu and Ercan (1992), Hevert et al. (1998a, 1998b), Sweeney (1998) and more recently Hamelink et al. (2002) and Jareño (2005).

correspond to Telefónica and its subsidiaries (Terra and Telefónica Móviles) which were segregated and merged or sold thereafter. It is well known that this sector was the most affected by the technological bubble ended with a very severe correction in February 2000. So it can be considered, somehow, as an "outlier".

[INSERT FIGURE 1]

If we eliminate this observation (sector 6) from the analysis, we can test the relationship between stock duration and flow-through capability running the following regression:

$$\hat{\gamma}^j = \psi_0 + \psi_1 \cdot \hat{\beta}_2^j + u^j \qquad [19]$$

where $\hat{\gamma}^j$ is the estimate of sector *j* stock duration, $\hat{\beta}_2^j$ is the flow-through capability of sector *j* according to model [17] and u^j is an error term.

[INSERT TABLE 4]

The results of this regression (by OLS and with *t*-statistics corrected by White to take into account the presence of autocorrelation and heteroskedasticity) are shown in table 4. The R^2 is close higher than 45 %, indicating that flow-through capability can explain a good deal of the differences in the sensitivity of stock returns to changes in nominal interest rates, that is differences in stock duration. The negative relationship found between these two variables is also significant although we only have seven observations to test it.

7. Conclusions

First, it should be pointed out that the stock return sensitivity to interest rate changes, that is, stock duration varies strongly across industries and so the exposure of stock returns to interest rate changes depend on the sector the firm belongs to. Also it should be highlighted the diversity in both flow-through capability found in the different sectors considered in this study.

In any case, the main result of this study is the evidence of a strong relationship between the sensitivity of stock returns to changes in nominal interest rates and its flow-through capability that is the ability of firms to transmit inflation shocks into the prices of its products and services. To the best of our knowledge, this is the first time this relationship has been tested empirically and confirms the negative relationship claimed by many authors as a possible explanation of the so called duration paradox. Particularly, the results show that flow-through capability can explain near a 50 % of the differences found in stock durations for the different economic sectors.

Appendix A1: Companies list taken into account in this research and the sector they belong to (alphabetical order by code)

	Company	Code	Sector
1	Antena 3 de Televisión, S.A.	**A3TV**	4
2	Abertis Infraestructuras, S.A.	**ABE**	4
3	Abengoa, S.A.	**ABG**	2
4	Acs, Actividades de Const.y Servicios S.A.	**ACS**	2
5	Acerinox, S.A.	**ACX**	2
6	Sdad. General Aguas de Barcelona, S.A.	**AGS**	1
7	Corporación Financiera Alba, S.A.	**ALB**	5
8	Aldeasa, S.A.	**ALD**	4
9	Altadis, S.A.	**ALT**	3
10	Amper, S.A.	**AMP**	6
11	Amadeus Global Travel Distribution, S.A.	**AMS**	4
12	Acciona, S.A.	**ANA**	2
13	Banco de Andalucía, S.A.	**AND**	5
14	Tavex Algodonera, S.A.	**ASA**	3
15	Avanzit, S.A.	**AVZ**	6
16	Azkoyen S.A.	**AZK**	2
17	Banco Bilbao Vizcaya Argentaria, S.A.	**BBVA**	5
18	Barón de Ley, S.A.	**BDL**	3
19	Inbesos, S.A.	**BES**	5
20	Bankinter, S.A.	**BKT**	5
21	Befesa, Medio Ambiente, S.A.	**BMA**	2
22	Banco Español de Crédito, S.A.	**BTO**	5
23	Banco de Valencia, S.A.	**BVA**	5
24	Const. y Auxiliar de Ferrocarriles S.A.	**CAF**	2
25	Grupo Inmocaral, S.A.	**CAR**	5
26	Banco de Castilla, S.A.	**CAS**	5
27	Banco de Crédito Balear S.A.	**CBL**	5
28	Cía. Española de Petróleos, S.A.	**CEP**	1
29	Tecnocom, Telecomunicaciones y Energía, S.A.	**CIB**	6
30	Cie Automotive, S.A.	**CIE**	2
31	Inmobiliaria Colonial, S.A.	**COL**	5
32	Campofrío Alimentación,S.A.	**CPF**	3
33	Cementos Portland Valderrivas, S.A.	**CPL**	2
34	Cortefiel, S.A.	**CTF**	3
35	Compañía Vinícola del Norte de España, S.A.	**CUN**	3
36	Dogi International Fabrics, S.A.	**DGI**	3
37	EADS, European Aeronautic Defence and Space Co., N.V.	**EAD**	2
38	Ercros S.A.	**ECR**	2
39	Endesa, S.A.	**ELE**	1
40	Grupo Empresarial Ence, S.A.	**ENC**	3
41	Elecnor, S.A.	**ENO**	2
42	Europistas Concesionaria Española, S.A.	**EUR**	4
43	Ebro Puleva, S.A.	**EVA**	3

	Company	Code	Sector
44	Faes Farma, S.A.	**FAE**	3
45	Fomento de Constr. y Contratas S.A.	**FCC**	2
46	Grupo Ferrovial, S.A.	**FER**	2
47	Funespaña, S.A.	**FUN**	4
48	Banco de Galicia, S.A.	**GAL**	5
49	Gamesa Corporación Tecnológica, S.A.	**GAM**	2
50	Gas Natural Sdg, S.A.	**GAS**	1
51	Grupo Catalana de Occidente S.A.	**GCO**	5
52	Global Steel Wire, S.A.	**GSW**	2
53	Banco Guipuzcoano, S.A.	**GUI**	5
54	Iberdrola, S.A.	**IBE**	1
55	Iberia, Líneas Aéreas de España, S.A.	**IBLA**	4
56	Indo Internacional, S.A.	**IDO**	3
57	Indra Sistemas, S.A.	**IDR**	6
58	Inditex, Industria de Diseño Textil, S.A.	**ITX**	3
59	Jazztel, P.L.C.	**JAZ**	6
60	Lingotes Especiales, S.A.	**LGT**	2
61	Cia. de Distribucion Integral Logista, S.A.	**LOG**	4
62	Arcelor, S.A.	**LOR**	2
63	Corporación Mapfre, S.A.	**MAP**	5
64	Miquel y Costas & Miquel, S.A.	**MCM**	3
65	Duro Felguera, S.A.	**MDF**	2
66	Mecalux, S.A.	**MLX**	2
67	Metrovacesa S.A.	**MVC**	5
68	Natra, S.A.	**NAT**	3
69	Nicolás Correa S.A.	**NEA**	2
70	Nh Hoteles, S.A.	**NHH**	4
71	Natraceutical, S.A.	**NTC**	3
72	Obrascón Huarte Laín, S.A.	**OHL**	2
73	Europac, Papeles y Cartones de Europa, S.A.	**PAC**	3
74	Banco Pastor, S.A.	**PAS**	5
75	Federico Paternina, S.A.	**PAT**	3
76	Banco Popular Español, S.A.	**POP**	5
77	Promotora de Informaciones, S.A.	**PRS**	4
78	Prosegur S.A., Cía. de Seguridad	**PSG**	4
79	Pescanova, S.A.	**PVA**	3
80	Reno de Medici, S.P.A.	**RDM**	3
81	Recoletos Grupo de Comunicación, S.A.	**REC**	4
82	Red Eléctrica de España, S.A.	**REE**	1
83	Repsol, Ypf, S.A.	**REP**	1
84	Bodegas Riojanas, S.A.	**RIO**	3
85	Banco de Sabadell, S.A.	**SAB**	5
86	Banco Santander Central Hispano, S.A.	**SAN**	5
87	Seda de Barcelona, S.A. (la)	**SED**	2
88	Sogecable, S.A.	**SGC**	4
89	Sniace	**SNC**	3

	Company	Code	Sector
90	Sol Meliá, S.A.	**SOL**	4
91	Sos Cuétara, S.A.	**SOS**	3
92	Service Point Solutions, S.A.	**SPS**	4
93	Sotogrande S.A.	**STG**	5
94	Sacyr Vallehermoso, S.A.	**SYV**	2
95	Transportes Azkar, S.A.	**TAZ**	4
96	Telefónica, S.A.	**TEF**	6
97	Telefónica Móviles, S.A.	**TEM**	6
98	Tableros de Fibras, S.A.	**TFI**	2
99	Gestevisión Telecinco, S.A.	**TL5**	4
100	Telefónica Publicidad e Información, S.A.	**TPI**	4
101	Tele Pizza S.A.	**TPZ**	4
102	Tubos Reunidos, S.A.	**TRG**	2
103	Terra Networks, S.A.	**TRR**	6
104	Testa Inmuebles en Renta, S.A.	**TST**	5
105	Tubacex, S.A.	**TUB**	2
106	Sdad. Española del Acumulador Tudor, S.A.	**TUD**	2
107	Unión Fenosa, S.A.	**UNF**	1
108	Unipapel, S.A.	**UPL**	3
109	Uralita, S.A.	**URA**	2
110	Inmobiliaria Urbis, S.A.	**URB**	5
111	Banco de Vasconia, S.A.	**VAS**	5
112	Vidrala S.A.	**VID**	3
113	Viscofan, S.A.	**VIS**	3
114	Volkswagen Aktiengesellchft	**VWG**	3
115	Española del Zinc, S.A.	**ZNC**	2

Appendix A2

Figure A2.1.- Evolution of the variables included in the analysis

Panel A: Relative changes in Turnover, Number of employees and Inflation rate (axis "y"-right) (total stock market)

Panel B: Interest rates: **i1a, i3a, i10a** denotes 1, 3 and 10-year interest rates

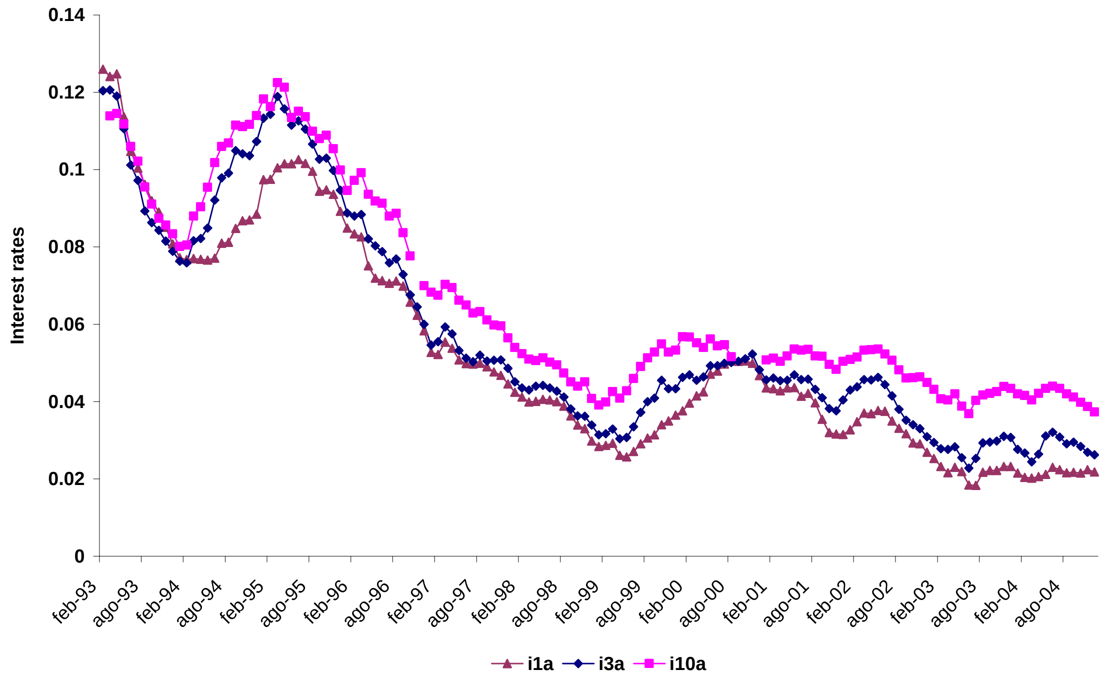

Figure A2.2.- Evolution of the variables included in the analysis (cont.)

Panel C: Total stock market return (**RST**)

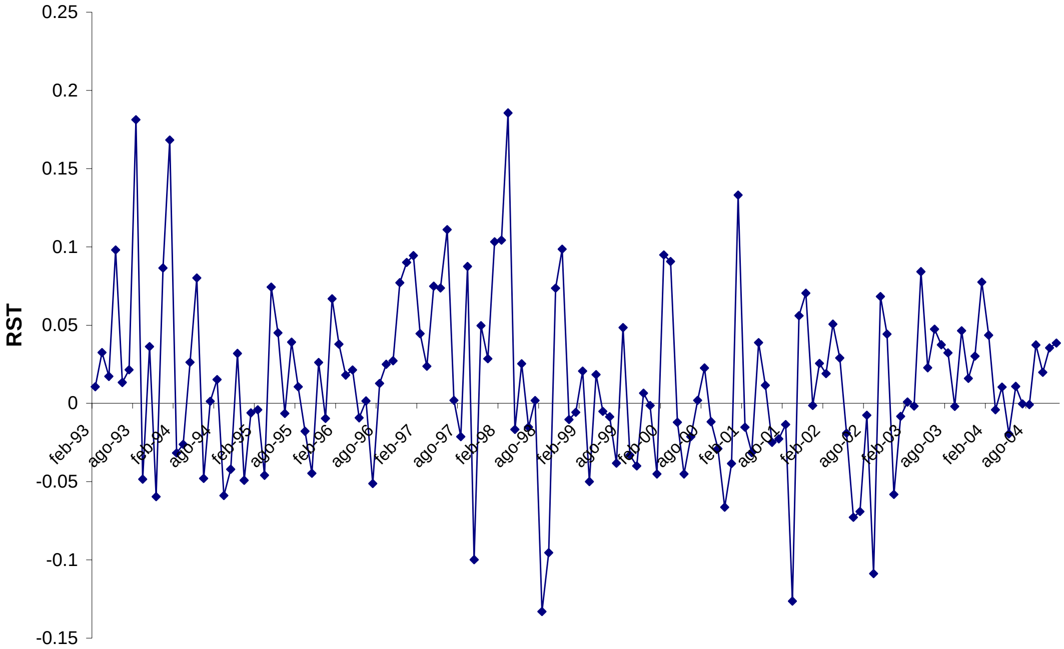

Table A2.1.- Main statistics of the variables included in the analysis
S1, S2-WB …, **ST** denotes sector 1, sector 2 without "building" industry …, sector 6 and total stock market

Panel A: Relative changes in Turnover

	S1	S2-WB	S2-B	S3	S4-WM	S4-M	S5	S6	ST
Mean	0.0668	0.0554	0.0213	0.0448	0.0420	0.0999	0.0098	0.0123	0.0356
Median	0.0529	0.0617	0.0106	0.0351	0.0347	0.1242	-0.0022	0.0076	0.0314
Maximum	0.2007	0.1935	0.1540	0.1746	0.2072	0.1710	0.2711	0.2854	0.1136
Minimum	-0.0326	-0.0765	-0.1165	-0.0418	-0.0909	-0.0716	-0.1404	-0.2648	-0.0089
Std. Dev.	0.0612	0.0704	0.0752	0.0515	0.0735	0.0742	0.1088	0.1345	0.0331
Skewness	0.4446	-0.0487	-0.0096	0.6884	0.3877	-1.0404	0.6013	0.2156	0.7020
Kurtosis	2.2896	2.2432	1.9049	3.1588	2.9506	3.1166	2.7824	2.8350	2.9306
Jarque-Bera	1.2414	0.5579	1.1496	1.8408	0.5785	2.3526	1.4313	0.2043	1.8936
Probability	0.5376	0.7566	0.5628	0.3984	0.7488	0.3084	0.4889	0.9029	0.3880
Observations	23	23	23	23	23	13	23	23	23

Panel B: Relative changes in Number of employees

	S1	S2-WB	S2-B	S3	S4-WM	S4-M	S5	S6	ST
Mean	0.0215	0.0198	-0.0091	-0.0052	0.0186	0.0369	0.0059	-0.0155	0.0054
Median	0.0263	0.0204	-0.0078	-0.0035	-0.0059	0.0200	0.0043	-0.0185	0.0042
Maximum	0.0783	0.1013	0.0510	0.0296	0.2004	0.1875	0.0566	0.0977	0.0542
Minimum	-0.0238	-0.0434	-0.1120	-0.0441	-0.0818	-0.0445	-0.0241	-0.1139	-0.0226
Std. Dev.	0.0312	0.0359	0.0392	0.0201	0.0768	0.0684	0.0193	0.0471	0.0188
Skewness	0.1199	0.1785	-0.7226	-0.1066	0.6423	1.0809	0.5546	0.3033	0.6827
Kurtosis	1.8593	2.5315	3.3963	2.1677	2.5081	3.1344	3.3390	3.2925	3.2006
Jarque-Bera	1.3021	0.3325	2.1522	0.7073	1.8135	2.5412	1.2891	0.4346	1.8254
Probability	0.5215	0.8468	0.3409	0.7021	0.4038	0.2807	0.5249	0.8047	0.4014
Observations	23	23	23	23	23	13	23	23	23

Panel C: Sectorial stock returns
RS1, RS2-WB …, **RST** denotes the stock return for sector 1, sector 2 without "building" industry …, sector 6 and total stock market

	RS1	RS2-WB	RS2-B	RS3	RS4-WM	RS4-M	RS5	RS6	RST
Mean	0.0150	0.0128	0.0180	0.0133	0.0106	0.0134	0.0151	0.0216	0.0141
Median	0.0109	0.0053	0.0095	0.0077	0.0075	-0.0018	0.0136	0.0122	0.0115
Maximum	0.2356	0.3182	0.2208	0.2383	0.1855	0.6030	0.1885	0.3352	0.1857
Minimum	-0.1732	-0.1615	-0.1486	-0.1436	-0.1985	-0.3201	-0.1218	-0.2026	-0.1330
Std. Dev.	0.0557	0.0734	0.0697	0.0619	0.0649	0.1485	0.0460	0.1066	0.0547
Skewness	0.5683	0.8852	0.6936	0.5463	0.0923	1.0230	0.1612	0.4432	0.3079
Kurtosis	5.7546	5.4437	3.7487	4.6988	3.4870	6.0446	4.6287	3.2217	3.9141
Jarque-Bera	52.9103	54.2560	14.8060	24.3085	1.6163	37.0022	16.4259	4.9734	7.2385
Probability	0.0000	0.0000	0.0006	0.0000	0.4457	0.0000	0.0003	0.0832	0.0268
Observations	143	143	143	143	143	66	143	143	143

Panel D: Interest rates
i1a, i3a, i10a denotes 1, 3 and 10-year interest rates

	i1a	i3a	i10a
i1a	1.000000	0.984636	0.970977
i3a	0.984636	1.000000	0.993994
i10a	0.970977	0.993994	1.000000
Mean	0.05257	0.05775	0.06628
Median	0.04280	0.04630	0.05350
Maximum	0.12600	0.12060	0.12250
Minimum	0.01830	0.02280	0.03690
Std. Dev.	0.02792	0.02819	0.02589
Skewness	0.77872	0.82294	0.79133
Kurtosis	2.48281	2.34641	2.12140
Jarque-Bera	16.04640	18.68608	18.70484
Probability	0.00033	0.00009	0.00009
Observations	143	143	137

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Table 1.- Sectors included in this analysis and number of companies incorporated in each one

Sector name	Subsectors	Number of firms
Sector 1: Oil and Energy	1.1.: Oil 1.2.: Electricity and Gas 1.3.: Water and Others Total	8
Sector 2: Basic Materials, Industry and Construction	Subsector: Without Building industry 2.1.: Minerals, Metals and Transformation 2.2.: Manufacture and assembly of capital assets 2.5.: Chemistry Industry 2.7.: Aerospace Subtotal: 19 Subsector: Building industry 2.3.: Building Industry 2.4.: Building Materials 2.6.: Engineering and Others Subtotal: 11 Total	30
Sector 3: Consumer Goods	3.1.: Food and Drinks 3.2.: Textile, Clothes and Footwear 3.3.: Paper and Graphic Arts 3.4.: Car 3.5.: Pharmaceutical Products and Biotechnology 3.6.: Other Consumer Goods Total	26
Sector 4: Consumer Services	Subsector: Total without Media 4.1.: Tourism and Hotel and Catering Business 4.2.: Retail Trade 4.4.: Transport and Distribution 4.5.: Motorways and Car Parks 4.6.: Other Services Subtotal: 13 Subsector: Media 4.3.: Media and Advertising Subtotal: 6 Total	19
Sector 5: Financial and Real State Services	5.1.: Bank 5.2.: Insurance 5.3.: Portfolio and Holding 5.4.: SICAV 5.5.: Real State Agencies and Others Total	24
Sector 6: Technology and Telecommunications	6.1.: Telecommunications and Others 6.2.: Electronics and Software Total	8
Total market		115

Table 2.- Regression between the relative change in firm turnover, the relative change in the number of employees and average inflation rate (in first differences)

S1, S2-WB …, **ST** show returns of the sector 1, sector 2 without building industry …, sector 6 and the total stock market. Sectorial response of the relative change in firm turnover (*RT*) to movements in the relative change in the number of employees (*RLF*) on a sectorial level and average inflation rate (π), all in first differences. Sample: from first semester of 1994 to first semester of 2005 and the following regression has been estimated using SUR methodology. *t*-statistics in parentheses [c] $p < 0.05$ [b] $p < 0.10$ [a] $p < 0.15$

$\Delta RT_t = \beta_0 + \beta_1 \cdot \Delta RLF_t + \beta_2 \cdot \Delta \pi_t + u_t$

	S1	**S2-WB**	**S2-B**	**S3**	**S4-WM**	**S4-M**	**S5**	**S6**	**ST**
Intercept	0.0116 (1.0463)	0.0130 (0.5946)	0.0103 (0.3565)	-0.0061 (-0.5436)	-0.0018 (-0.1487)	-0.0058 (-0.2688)	0.0150 (0.9232)	0.0181 (0.5487)	0.0051 (0.8703)
N. Employ.	-0.1535 (-0.3455)	1.1571 (1.3626)	-0.0130 (-0.0261)	-0.1659 (-0.4520)	-0.2613 [b] (-1.7108)	-0.2077 (-1.3666)	-0.0579 (-0.0862)	0.9017 (1.4155)	0.4370 (1.3870)
Inflat.	5.6457 [c] (2.4594)	1.9477 (0.4449)	-2.0293 (-0.3438)	0.5848 (0.2747)	-0.0641 (-0.0264)	6.0377 (1.3499)	8.1448 [c] (2.6499)	8.4640 (1.3183)	3.8010 [c] (3.4728)
R^2	0.2582	0.0565	0.0197	-0.0054	0.1249	0.1488	0.2441	0.2055	0.3639
Adj R^2	0.1801	-0.1794	-0.2254	-0.1112	-0.0939	-0.0640	0.1645	0.1219	0.2970

Table 3.- Sensitivity of sectorial stock returns to variations in nominal interest rates and market return

RS1, RS2-WB …, **RST** denotes returns of the sector 1, sector 2 without building industry …, sector 6 and the total stock market. r_t^j represents stock returns at time t for each sector j, r_{mt} is the return on the market portfolio, Δi_t^u represents changes in nominal interest rates, γ^j is the sensitivity of stock returns to interest rate changes and, finally, ε_t^j is the error term. The sample extends from January 1993 to June 2005 and the following regression has been estimated using SUR methodology. t-statistics in parentheses ^{a} $p < 0.10$, ^{b} $p < 0.05$, ^{c} $p < 0.01$

$$r_t^j = \alpha^j + \beta^j \cdot r_{mt} + \gamma^j \cdot \Delta i_t^u + \varepsilon_t^j$$

	RS1	**RS2-WB**	**RS2-B**	**RS3**	**RS4-WM**	**RS4-M**	**RS5**	**RS6**	**RST**
r_{mt}^{*}	0.7586 ^{c}	0.9044 ^{c}	0.8302 ^{c}	0.7083 ^{c}	0.8358 ^{c}	1.9236 ^{c}	0.6549 ^{c}	1.3408 ^{c}	0.8157 ^{c}
	(15.419)	(12.298)	(11.592)	(10.842)	(13.242)	(10.037)	(17.325)	(13.001)	(21.022)
Δi_t^u	-3.9811 ^{c}	-5.6676 ^{c}	-5.9794 ^{c}	-5.7347 ^{c}	-3.4019 ^{b}	-4.2939	-2.8151 ^{c}	-7.9203 ^{c}	-4.4341 ^{c}
	(-3.5476)	(-3.3830)	(-3.6607)	(-3.8515)	(-2.3664)	(-0.6838)	(-3.2684)	(-3.3733)	(-5.0133)
Adj R^2	0.6300	0.5208	0.4993	0.4695	0.5472	0.6157	0.6773	0.5515	0.7603

Figure 1.- Relationship between sectorial flow-through capability and nominal interest rate sensitivity

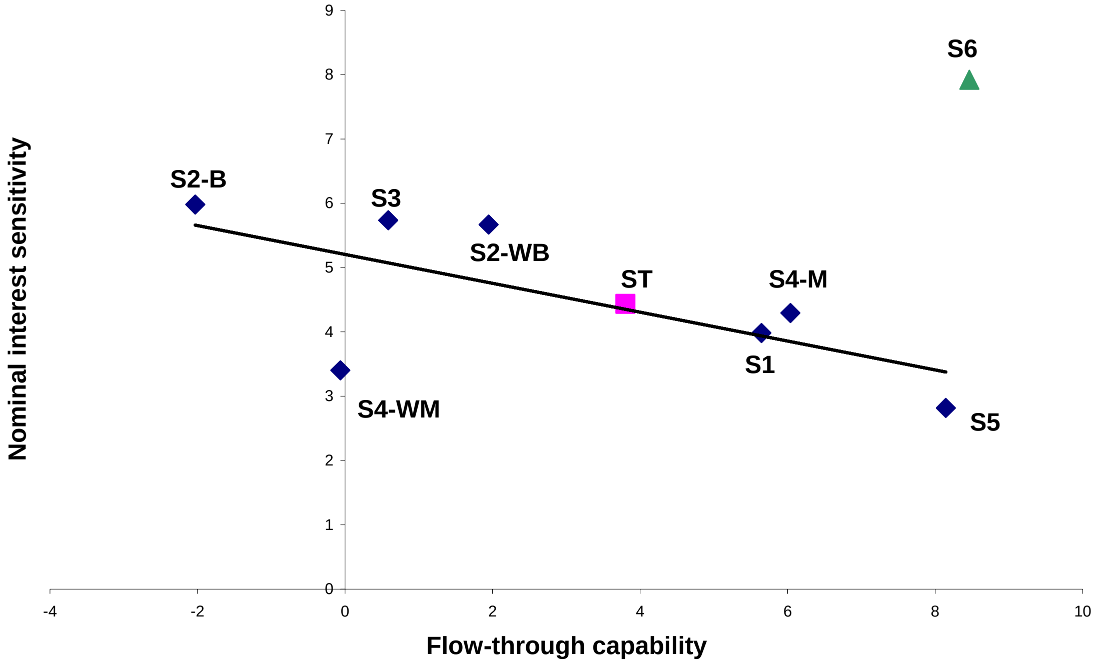

Table 4.- Regression between nominal interest rate sensitivity and sectorial flow-through capability

The following regression has been estimated using OLS techniques with standard errors corrected for autocorrelation and heteroskedasticity using the White procedure. *t*-statistics in parentheses [c] $p < 0.05$ [b] $p < 0.10$ [a] $p < 0.15$

$$\hat{\gamma}^j = \psi_0 + \psi_1 \cdot \hat{\beta}_2^j + u^j$$

$\hat{\gamma}^j$ is the estimate of sector *j* stock duration, $\hat{\beta}_2^j$ is the flow-through capability of sector *j* according to model [17] and u^j is an error term.

Intercept	Ψ_1	R^2	Adj R^2	**F (*p-valor*)**
5.2035 [c] (8.7151)	-0.2245 [b] (-2.3816)	0.4512	0.3414	0.0984 [b]