Investment Equations and Financial Restrictions at Firm Level: The Case of Uruguay[1]

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Abstract

Three alternative specifications of an investment equation have been tested using panel data of Uruguayan firms: a traditional accelerator model of investment, an error-correction version of the accelerator model and an Euler equation for the capital stock. These models of investment were used to test for the existence of financial constraints in the investment decision process. Our estimates confirm the existence of financial restrictions on investment decisions of Uruguayan firms in the period under consideration (1997 – 2000). We explored the effect on firms' ability to finance investment of two of firms' attributes: size and foreign ownership. Regarding to size, our results suggest that small firms face greater constraints to finance their desired levels of investment. We also explored whether foreign owned firms suffered less from financial restrictions than national firms. Our results leave the issue unresolved. Lastly, our estimates suggest a general increase in the severity of financial restrictions following the 1999-2000 crisis. In particular, smaller firms were affected the most.

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1. Introduction

The development of the capital market in Uruguay did not accompany the deepening of the banking sector after the financial liberalization that took place in the seventies. Uruguay can be considered a typical case of a bank-based financial system, as opposed to a market-based system, where the capital market plays an important role in the determination of the financial structure of firms. The main objective of this study is to evaluate the effect of financial restrictions on firms' investment in the context of a system based on short-term credit by banks.

As it will be shown, there has been a recent expansion of the use of corporate bonds as a financing instrument, which creates several issues of interest. This instrument allowed some firms to finance restructuring projects that were extremely difficult to fund through the banking sector. On the other hand, there were recent default (or near-default) episodes that remind us of agency problems and opportunistic behavior of shareholders over bondholders in the case of long-term-debts. Those cases of default have discouraged investors from participating in the incipient capital market since 1998, at least with volumes similar to those registered in 1996-1997.

Macroeconomic shocks, like the Russian crises of 1998 and the devaluation of the Real in 1999 have also been responsible for the recent contraction in the evolution of credit and in the issues of corporate bonds to the market. A second objective of the paper is to evaluate the impact of that change in the economic and credit conditions on the investment decisions of firms.

Finally, we are interested in evaluating the impact of different characteristics of firms on their access to credit. The third objective of the paper is to test whether firm attributes like size and ownership structure (foreign versus domestically owned) matter in determining the availability of financial resources.

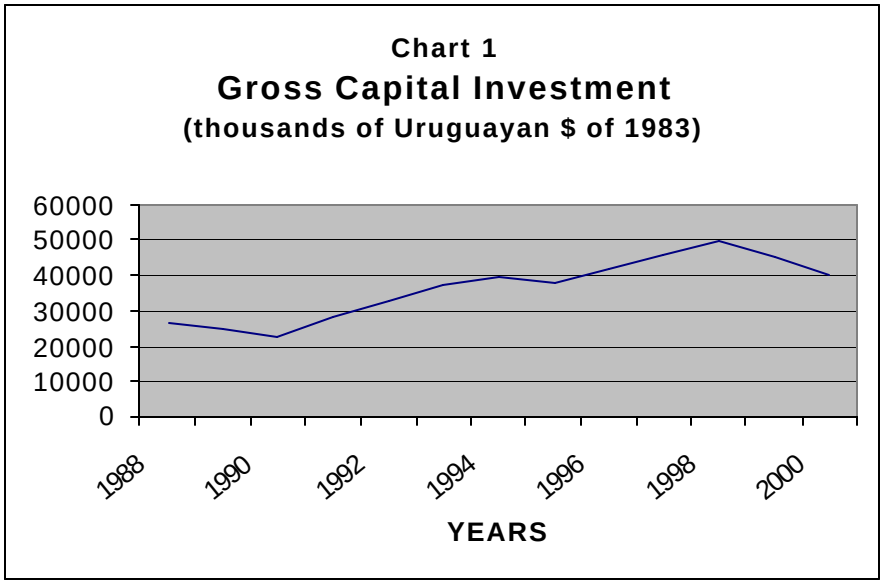
The second section of the paper includes a brief analysis of the macroeconomic environment of Uruguay, emphasizing the relative importance of the credit market. Some indicators of the financial system of Uruguay will be provided, showing the strong importance of the banking sector as a supplier of funds to firms. The evolution of the capital market as a supplier of funds will also be analyzed, showing its expansion and contraction in the second half of the nineties.

The third section will present the model to be used to address the issue of financial constraints at the firm level. Based on the neoclassical firm-profit-maximizer paradigm, two models of investment under intertemporal optimization will be used. In the first one, financial constraints are introduced explicitly. This model leads to an Euler equation that will be used for empirical purposes. In order to compare the empirical results of the Euler equation with other specifications, other models in the traditional investment-accelerator approach will be formulated. These models will imply a long run relationship between capital and output (in levels or in differences, depending on the specification). An augmented version of these models will be estimated and used to draw conclusions about the presence of financial constraints.

The forth section will deal with the empirical implementation of the models and their estimations. The data set will be introduced, and several methodological issues will be discussed. The fifth section will present the results for both models and finally the sixth section concludes.

2. Macroeconomic environment and the financial market

The last two years have been characterized by an intense and long depression that has troubled the country and the productive sector. GDP growth has been mildly negative during this period. As can be shown in the following chart, private investment dropped 14% in 1999 and another 14% in 2000. Nevertheless, the government has been successful in keeping the fiscal deficit under control. This has greatly benefited the country's image in the international capital markets and has contributed to a low country-risk premium relative to the region.



Uruguay has a relatively developed financial system, a la "European", characterized by heavily concentrated public banking and a few local banks. Stability, especially as compared to Uruguay's neighbors, Argentina and Brazil, makes the financial markets appear as a safe haven. As a direct consequence the amount of total deposits is high, especially by non-Uruguayan depositors.

Overall, the financial sector has exhibited stable behavior and is currently undergoing a slow process of consolidation and mergers, as well as the restructuring of its institutions to accommodate the number of firms to market size. In 2001 actions have been taken to ensure the sale and restructuring of troubled institutions. Banking institutions are developing a whole range of new products in accordance with the global trends. Average profitability has been acceptable despite the recession.

Table 1
Issues of Private Sector Debt

Year	Number of Issues	Amount (*)
1990-1992	0	0
1993	1	3975
1994	13	30600
1995	10	14000
1996	20	111000
1997	30	211726
1998	9	24880
1999	11	132434
2000	9	30222
Total	103	558837

(*) thousands of dolars

Source: Banco Central del Uruguay

The Demirgüc-Kunt and Levine (1999) database on financial systems development confirms the favourable position of the Uruguayan banking system in comparison with the region. It has:

- ratios of overhead costs and bank net interest margin lower than those of Argentina and Brazil,
- a ratio of liquid liabilities over GDP higher than that of those countries, and
- higher bank assets to GDP ratio and higher claims of deposit money banks on private sector to GDP ratio than Argentina and similar to those of Brazil.

But when the indicators of the Uruguayan banking system are considered in a wider environment, there seems to be a long road ahead to achieve a well-developed financial system. The indicators of banking development for Uruguay in the Demirgüc-Kunt and Levine database are below world averages, and so it is considered, in this classification, as an underdeveloped banking system. Whether this leads to restrictions on the capacity of firms to invest is the main issue to be examined in this paper.

The Uruguayan capital market is even less developed, even within the region. The market capitalization as percentage of GDP is less than 1%, total value traded is almost insignificant and the turnover ratio (the value of stock transactions relative to the size of the market) is around 3%. World averages, according with the Demirgüc-Kunt and Levine database, are respectively 39%, 17% and 35%.

Given these figures, Uruguay can be classified as an underdeveloped bank-based economy, as opposed to a market-based system. In relation with this, capital markets have had a minimal role in the development of the financial sources of funds. In 1990 the market value of private sector securities accounted for only US$ 0.8 million out of a US$ 721 million securities market. The first figure represents the value of stock outstanding, constituting the only private sector securities at that point. In comparison, total bank deposits in both local and foreign currency

accounted for US$ 10,747 million, while total loans accounted for US$ 7,401 million in 1995 on average.

Uruguay experienced a period of strong growth between 1996 and 1998, and as it is usual, the credit of the banking sector had a pro-cyclical evolution during that period. The credit of the private banking sector (the state owned Banco de la República is excluded because its behavior can not be characterized as profit-maximizing) to the domestic private non-financial sector grew at an average rate of 18% a year in real terms between December 1995 and December 1998.

Table 2
Total Outstanding Debt in the financial market

Year	Issuers	Amount (*)
1990-1992	0	0
1993	1	4.0
1994	11	56.3
1995	17	160.5
1996	27	309.8
1997	43	544.7
1998	45	602.7
1999	43	759.5
2000	39	688.0

(*) millions of dolars, end of year.

Source: Banco Central del Uruguay

After the Central Bank's introduction of prudential restrictions for the banking sector at the end of 1998, the rate of growth of credits of private banks to the domestic non-financial sector (excluding the government) was reduced to 3.8% a year in 1999 and 2000. Besides the impact that macroeconomic conditions may have had on investment, an issue to be addressed in this paper is whether this tightening in financial conditions have affected the decisions of firms to invest.

Notwithstanding its small size, the Uruguayan capital market also experienced an expansion cycle, supported by some institutional changes, followed by a contraction phase. Starting in 1996, new legislation and rulings regarding private sector debt (Obligaciones Negociables) were introduced. Before that, in 1994, rules established the maximum amount that could be issued by each firm as the equivalent of 50% of capital. In 1996, the Law of Securities Markets (Law Nº 16.749) was passed. This law established the issuing procedure and the role that the Central Bank had to play with regard to transparency and investor information (among other requirements), and helped with the organization of formal markets. From that moment on the market started to grow at a fast rate, which continued until 1999.

Other legislation organized and favored the securities market such as the Mutual Funds law (Law Nº 16.774) and the Pension Funds law (Law Nº 16.713). The Mutual Funds law set up and regulated Mutual Funds and how they could invest in each type of security. The Pension Law

(Law Nº 16713) set the percentage of private sector securities that each pension fund could have in its portfolio.

As previously stated, with respect to private bonds and commercial papers, a new law was passed in 1996, which created a more adequate regulatory framework for private papers. The result was immediate, and private new issues accounted for around 20% of the capitalization in 1997 and 1998. Around that time most sizable firms were family owned and managed, having some undesirable consequences. Unfortunately, the level of leverage for private issuing firms was far from desirable and this adversely affected the market and its credibility when the first default became public. Worse still, the case proved to be a conspicuous scam and the scandal hit all private issues as well as constituting a deterrent for new issues. As a by-product, a series of new regulations came into place regarding credit rating and information disclosure.

The year 2000 has seen a fall in the total financial market debt outstanding for the first time in a seven-year period. This can be seen in Table 2, where total security debt fell close to seventy million, about 9%. Nevertheless, a closer look at the figures poses some issues. First, there has been a significant change in the sector distribution of private sector debt, as can be seen in Table 3 and Table 4. In the year 2000, more than 75% of the new issues are from financial firms as compared to less than 40% in 1996. There has been a steep fall not only in total issues, but moreover in issues by non-financial firms.

Table 3
Debt Capitalization in percentages

	1996	2000
Financial Sector	35%	66%
Non Financial Sector	65%	34%
Tourism	NA	15%
Services	NA	5%
Chemistry	NA	2%
Industry	NA	4%
Agro-industry	NA	8%

Source: Banco Central del Uruguay

Table 4
Percentage of dollar Amount

	1996	2000
New Issues	19	9
Financial Sector	40%	75%
Non Financial Sector	60%	25%

Source: Banco Central del Uruguay

The previous description suggests interesting issues to be analyzed in relation with the behavior of investment and the conditions of financial markets. As was noted, Uruguay experienced soft credit conditions until 1999, both because the expansion of domestic credit and the appearance of new financial instruments in the capital market, despite its small size. After the Brazilian crises and other external shocks since the end of 1998, along with some domestic problems with some firms that went to the market in previous years and experienced near-default or default problems, conditions in the financial market became more stringent. Whether the decrease in investment in 1999 and 2000 is related to more severe credit conditions or is just the consequence of a demand slowdown, is a question to be addressed in the forth section. First, the theoretical framework for our analysis will be illustrated in the following section

3. The theoretical model

Two theoretical approaches will be used as a framework for the empirical analysis done in this paper. The first approach derives the optimal level of the capital stock as a function of output and the user cost of capital. Then a specific mechanism of adjustment between desired and actual levels of capital is assumed and as a consequence, an investment equation is obtained. As a second alternative, the financial constraints will be explicitly introduced in the investment decision process of a profit-maximizing firm. The first-order conditions of the optimization process will help to derive an Euler equation that relates the investment ratio of the firm with financial variables and other determinants.

3.1. An Accelerator Model of Investment with Error Correction

This first approach is more flexible (and ad hoc) than the one we present in subsection 3.2. Firms are assumed to be profit maximizers but we do not introduce explicitly financial constraints, nor do we model the decision to pay dividends or to issue new shares. Therefore, a firm's problem is to maximize:

$$\sum_{t=0}^{\infty} b^{t}\left[p_t F(K_t, N_t) - p_t^K I_t\right] \qquad (1)$$

subject to:

$$I_t = K_t - (1-d)K_{t-1} \qquad (2)$$

where E is the conditional expectations operator, p is output price, $F(\cdot)$ is a gross value-added function, K is the capital stock, N is labor, I is gross investment, p^K is the price of capital goods and d is the depreciation rate.

If the price of firm output and the price of the investment goods are constant over time, the steady state solution is:

$$F'(K_t, N_t) = \frac{p^K}{p}\left(\frac{r+d}{1+r}\right) = uc \qquad (3)$$

where *uc* denotes the user cost of capital.

If prices are allowed to vary over time, the solution has an extra term.

$$F'(K_t, N_t) = \frac{p_t^K}{p_t}\left[\left(\frac{r+d}{1+r}\right) + \frac{\Delta p_{t+}^K}{p_t^K}\frac{1-d}{1+r}\right] = uc_t \qquad (4)$$

The extra term on the right hand side of equation (4) reflects the capital gain (or loss) due to a change in prices.

Assuming a functional form for the production function it is possible to obtain the basic relationship between capital and output. Under a Cobb Douglas specification, $Y_t = F(K_t, N_t) = A_t K_t^a N_t^b$ equation (4) can be rewritten as:

$$K_t = a\frac{Y_t}{uc_t} \qquad (5)$$

and taking logs

$$k_t = y_t + h_t \qquad (6)$$

where $h_t = \log a - \log uc_t$.

Under a more general CES production function like

$$Y_t = F(K_t, N_t) = A_t\left[aK_t^{\frac{s-1}{s}} + bN_t^{\frac{s-1}{s}}\right]^{\frac{s}{s-1}n}$$

the relation between capital and output is:

$$k_t = yy_t + h_t \qquad (6')$$

where $y = \left(s + \frac{1-s}{n}\right)$ and $h_t = s\log(an) - \frac{1-s}{n}\log A_t - s\log uc_t$ and s and n are respectively the elasticities of substitution and scale.

Both equations (6) and (6') imply that the long run capital level is proportional to output (and more generally to sales) and a term reflecting the user cost of capital and the parameters of the production function. [2]

Consider now a specific firm. Since adjustment is not instantaneous, we explore the following dynamic adjustment specification between capital and output, provided by sales:

[2] Note that (6) is a particular case of (6') when $s = 1$.

$$k_{it} = a_0 + g_1 k_{it-1} + b_0 y_{it} + b_1 y_{it-1} + h_{it} \qquad (7)$$

Rewriting it in error correction form

$$\Delta k_{it} = a_0 + b_0 \Delta y_{it} + (g_1 - 1)[k_{it-1} - {}_1\, y_{it-1}] + (g_1 - 1 + b_0 + b_1) y_{it-1} + h_{it} \qquad (8)$$

Besides the h_t term, the growth rate of capital depends on the growth rate of sales, an error correction term and a scale factor.

When estimating equation (8) we assume that the term reflecting the user cost of capital and parameters of the production function can be controlled including year specific and firm specific effects. We also use the investment ratio $\frac{I_t}{K_{t-1}}$ to proxy the growth rate of capital. Finally, we augment equation (8) with the profit to capital ratio, to control for financial constraints in this relationship. Summing up, the equation to be estimated is:

$$\frac{I_{it}}{K_{it-1}} = a_0 + b_0 \Delta y_{it} + (g_1 - 1)[k_{it-1} - {}_1\, y_{it-1}] + (g_1 - 1 + b_0 + b_1) y_{it-1} + j_0 \frac{\Pi_{it}}{K_{it-1}} + j_1 \frac{\Pi_{it-1}}{K_{it-2}} + h_{it} \qquad (9)$$

where $h_{it} = e_{it} + a_i + d_t$ and Π_{it} represent the profits of firm i at time t.

We expect the error correction coefficient $g_1 - 1$ to be negative, implying that when the capital level is above the desired level, investment will be lower. We also expect the scale coefficient $g_1 - 1 + b_0 + b_1$ not to be statistically different from 0. If the profit terms capture only transitory effects, the sum of the coefficients on profits $j = j_0 + j_1$ would not be significant.

Another possible specification of the investment equation is the traditional accelerator-profit model, that is derived by differencing equations like (7), removing the possibility of an equilibrium relationship of the variables in levels[3]. Using again the investment rate as a proxy for the net growth in capital stock, we get the following expression:

$$\frac{I_{it}}{K_{i,t-1}} = a_0 + g_1 \frac{I_{i,t-1}}{K_{i,t-2}} + b_0 \Delta y_{it} + b_1 \Delta y_{i.t-1} + j_0 \frac{\Pi_{it}}{K_{i,t-1}} + j_1 \frac{\Pi_{i,t-1}}{K_{i,t-2}} + \Delta h_{it} \qquad (10)$$

In this specification, the implied long-run parameter $\frac{b_0 + b}{1 - g_1}$ characterizes the long-run relationship between the variables in *differences* (sales growth and investment) and not in *levels* (sales and capital).

[3] The error-correction specification is a consequence of a long-run relationship between the variables in levels. If the error-correction is not a good description of the data process, then the variables in levels are not cointegrated and there is no long-run relationship between them.

3.2. Euler equation approach

We consider a model of investment and financing decisions of firms where the restrictions on the debt - equity financing are explicitly introduced. These restrictions can be tested using an Euler equation approach, as in Jaramillo, Schiantarelli and Weiss (1996), or by a more ad-hoc regression strategy (introduced in section 3.1), as is more common in the literature.

Firms are assumed to maximize their value for shareholders, given by:

$$W_t = E_t \sum_{j=0}^{\infty} b_t^i \left(D_{t+j} - Q_{t+j}^n \right) \tag{11}$$

subject to:

$$\begin{aligned} D_t = (1-t_t)\left\{ p_t \left[F(K_t, N_t) - G(K_t, I_t) \right] - w_t N_t - \left[i_t + r_t(B_{t-1}, K_{t-1}) \right] B_{t-1} \right\} \\ + v_t p_t^K K_{t-1} + (B_t - B_{t-1}) - p_t^K I_t + Q_t^n \end{aligned} \tag{12a}$$

$$I_t = K_t - (1-d) K_{t-1} \tag{12b}$$

$$D_t \geq 0 \tag{12c}$$

$$B_t \geq 0 \tag{12d}$$

$$Q_t^n \geq 0 \tag{12e}$$

where W is the value of the firm, D are dividends (or cash - flow), Q^n is the nominal value of new shares, E is the conditional expectations operator, t is the corporate tax rate, p is output price, $F(\cdot)$ is a gross value - added function, $G(\cdot)$ is a convex adjustment cost function (both assumed to be linearly homogeneous), K can be interpreted as total assets or capital stock, N is labor, I is gross investment, p^K is the price of capital goods, v is the fiscal impact on the firm's flow of funds of the tax deductions from depreciation of the stock of capital, B is total debt, i is the risk-free rate of interest, and $r(\cdot)$ is the premium per unit of debt, which can be expressed as a function of leverage (end of previous period B and K) and size (K again)[4].

Besides the restrictions (12), the firm may also be subject to financial constraints that could affect the leverage ratio. As in Jaramillo, Schiantarelli and Weiss (1996), a restriction indicating an upper limit to the leverage ratio is introduced in the maximization process:

$$M - \frac{B_t}{p_t^K K} \geq 0 \tag{13}$$

4 As the literature of agency costs on financing shows, problems of asymmetric information may introduce conflicts of interest between bondholders and stockholders, which result in a higher premium over the risk-free rate of interest as the leverage ratio (debt to total assets) increases. Other explanations rely on reasons not related with agency problems. Caprio and Demirgüc-Kunt (1997) survey theoretical arguments and show evidence on the intention of firms to match the maturity of assets and debts. Demirgüc-Kunt and Maksimovic (1994) also argue that firm size may be relevant for financing choices, because access to financial markets may be a function of size.

From the first order conditions for *K*, *I*, *N*, *B*, and Q^n of the problem of maximizing (11) subject to (12) when (13) is not binding, the following Euler equation for the case of no financial constraints can be derived:[5]

$$E_t\left[b^0_{t+1}(1-d)\frac{p_{t+1}}{p_t}G_{I_{t+1}}\right]-\frac{G(\cdot)}{K_t}+G_I\left(\frac{I_t}{K_t}-1\right)=\frac{1}{e-1}\frac{Y_t}{K_t}+$$
$$\frac{e}{e-1}\left\{\left(\frac{1}{1-t}-\frac{p_t}{p_t^K K_t}\right)\frac{p_t^K}{p_t}-E_t\left[b^0_{t+1}\frac{1}{1-t}\frac{p_{t+1}}{p_t}\frac{p^K_{t+1}}{p_{t+1}}(1-d-v_{t+1})\right]\right\}+ \qquad (14)$$
$$\frac{e}{e-1}E_t\left[b^0_{t+1}\frac{r_K B_t}{p_t^K}\frac{p_t^K}{p_t}\right]-\frac{e}{e-1}\frac{l^M_t}{p_t(1-t)}\frac{B_t}{p_t^K K_t^2}$$

This equation determines the (incremental) investment to capital ratio as a function of the product-capital (or sales-capital) ratio and two terms that reflect the opportunity cost of capital.

If constraint (3) is binding, the Euler equation in the presence of financial constraints will be:

$$E_t\left[b^0_{t+1}(1-d)\frac{p_{t+1}}{p_t}G_{I_{t+1}}\right]-\frac{G(\cdot)}{K_t}+G_I\left(\frac{I_t}{K_t}-1\right)=\frac{1}{e-1}\frac{Y_t}{K_t}+$$
$$+\frac{e}{e-1}\left\{\left(\frac{1}{1-t}-\frac{p_t}{p_t^K K_t}\right)\frac{p_t^K}{p_t}-E_t\left[b^0_{t+1}\frac{1}{1-t}\frac{p_{t+1}}{p_t}\frac{p^K_{t+1}}{p_{t+1}}(1-d-v_{t+1})\right]\right\}+$$
$$+\frac{e}{e-1}E_t\left[b^0_{t+1}\frac{r_K B_t}{p_t^K}\frac{p_t^K}{p_t}\right]+\frac{e}{e-1}E_t\left\{b^0_{t+1}\left[r_{t+1}(\cdot)+r_B B_t\right]\right\}\frac{p_t^K}{p_t}\frac{B_t}{p_t^K K_t}- \qquad (15)$$
$$-\frac{e}{e-1}E_t\left\{\frac{1-b^0_{t+1}\left[(1-t)i_{t+1}+1\right]}{1-t}\right\}\frac{p_t^K}{p_t}\frac{B_t}{p_t^K K_t}$$

This equation is similar to the one obtained for the no financial constraint case, equation (4), except for the inclusion of the last two terms. These terms incorporate the effect of the leverage ceiling on the investment ratio.

Making the following assumptions from the expectations terms and after an appropriate parameterization of the adjustment cost function $G(\cdot)$ and the premium term $r(\cdot)$, the equation (5) can be estimated, as it will be done in the following section.

- *Rational expectations*: this assumption implies that $E_t(X_{t+1})=X_{t+1}+u_{t+1}$, being *u* a white noise expectation error, not correlated with any period t information.
- *Adjustment cost function*: it is assumed that $G(\cdot)$ can be written as

$$G(K_t I_t)=\frac{b}{2}\frac{I_t^2}{K_t}$$

[5] For details in this procedure see Jaramillo, Schiantarelli and Weiss (1996).

where $b>0$

- *Premium*: The premium function $r(\cdot)$ is supposed to be linear in the debt to capital ratio, that is,

$$r_t(K_{t-1}I_{t-1}) = \frac{c}{2}\frac{B_{t-1}}{p^K_{t-1}K_{t-1}}$$

where $c>0$.

Substituting these expressions for $G(\cdot)$ and $r(\cdot)$ in equations (14) and (15), and applying the rational expectations operator, the following parameterized Euler equations are obtained. Equation (14') is the specification under the hypothesis of non-binding financial constraints and (15') the alternative specification when financial constraint (3) is binding.

$$b^0_{t+1}(1-d)\frac{p_{it+1}}{p_{it}}\frac{I_{it+1}}{K_{it}} + \frac{1}{2}\left(\frac{I_{it}}{K_{it-1}}\right)^2 - \frac{I_{it}}{K_{it-1}} - \frac{1}{b(e-1)}\frac{Y_{it}}{K_{it}} + \frac{e}{b(e-1)}\frac{p^K_{it}}{p_{it}}\frac{p_{it}}{p^K_t K_{it}}$$
$$+ \frac{ce}{2b(e-1)}b^0_{t+1}\frac{p^K_{it}}{p_{it}}\left(\frac{B_{it}}{p^K_{it}K_{it}}\right)^2 = u_{t+1} + f_i + Year_{t+1} \qquad (14')$$

$$b^0_{t+1}(1-d)\frac{p_{it+1}}{p_{it}}\frac{I_{it+1}}{K_{it}} + \frac{1}{2}\left(\frac{I_{it}}{K_{it-1}}\right)^2 - \frac{I_{it}}{K_{it-1}} - \frac{1}{b(e-1)}\frac{Y_{it}}{K_{it}} + \frac{e}{b(e-1)}\frac{p^K_{it}}{p_{it}}\frac{p_{it}}{p^K_{it}K_{it}}$$
$$- \frac{ce}{2b(e-1)}b^0_{t+1}\frac{p^K_{it}}{p_{it}}\left(\frac{B_{it}}{p^K_{it}K_{it}}\right)^2 + \frac{e}{b(e-1)}\left\{\frac{1-b^0_{t+1}[(1-t)i_{t+1}+1]}{1-t}\right\}\frac{p^K_{it}}{p_{it}}\frac{B_{it}}{p^K_{it}K_{it}} = \qquad (15')$$
$$u_{t+1} + f_i + Year_{t+1}$$

Note that we have introduced the suffix i to denote firms.

In these equations, *f* is a fixed, firm-specific effect, while *Year* is a time-specific effect. These are the equations to be estimated in section 5.

4. Empirical tests

4.1. Data set

The data used was comprised of annual account data extracted from two main sources. First, the financial statements of firms that report their accounting data to the Superintendencia del Mercado de Valores, at the Central Bank of Uruguay (which is the regulatory agency for the Uruguayan capital market). These are publicly traded firms and (for the most part) companies that issued corporate bonds through the capital market. Second, the financial statements of firms that provide accounting data to the Liga de Defensa Comercial, a not-for-profit organization devoted to promoting transparency in the credit market. This organization usually prepares

reports on the credit history of their affiliates, some of them based on financial statements information.

While the companies that go public and issue of shares or corporate bonds are compelled to report their financial accounts to the Central Bank, the information provided to the Liga de Defensa Comercial is voluntary. Accounting data from 54 companies that report information to the Central Bank and 100 firms that do the same with the Liga de Defensa Comercial were collected. But most of that data was not useful in implementing the estimation of the models presented in the previous section, because the information was incomplete in many cases, and most firms only report financial statements to the Liga de Defensa Comercial occasionally.

Two types of adjustments were made to the raw data, as described in the Appendix. First, all the financial statements were expressed in terms of pesos of December 2000. The second adjustment tries to estimate the result of having nominal accounts exposed to inflation in the financial statements. This correction typically affects the financial results of the firm, and tries to clear the net income of inflation distortions. While most of the firms make adjustments for valuation of the fixed assets, and they are usually presented as values at the end of the fiscal year, the other items of the financial statements are presented as historical values. This causes a problem when the financial results are presented, because interests of loans denominated in local currency are expressed in nominal terms, while loans denominated in foreign currencies explicitly introduce an adjustment for devaluation. The correction of financial statements for inflation must express interest payments in real terms as explained in the appendix.

Information about the ownership structure of firms was also collected, identifying those companies controlled by foreign entities or with significant foreign participation (including in this definition all firms in which foreign shareholders possess at least 30% of total shares) and those that belong to national investors (the rest).

At the end, an unbalanced panel of 56 firms with at least five consecutive years of data of all the variables included in the models to be estimated was constructed. Summary information of the financial data is presented in table 5, for the 1995 - 2000 period.

Indicators of investment show a picture roughly similar to that described for the country as a whole in the first section. Both gross and net investment grew until 1998, and suffered a strong contraction in 1999, when Uruguay confronted the macroeconomic problems associated with the devaluation of the Brazilian currency, the Real, at the beginning of the year. During the year 2000, the investment ratios remained low, with a notable decrease in investment by new firms, which showed the higher investment rates during the period considered.

Table 5
Summary of indicators: 1995-2000

Concept	1995	1996	1997	1998	1999	2000
Investment						
Gross investment/Fixed Assets	**14.1%**	**22.4%**	**31.4%**	**34.9%**	**23.6%**	**20.1%**
Old firms	*11.7%*	*19.8%*	*28.1%*	*32.4%*	*21.3%*	*22.6%*
New firms	*45.9%*	*53.2%*	*61.1%*	*59.8%*	*42.0%*	*9.1%*
Smaller than average (total assets)	*3.0%*	*19.8%*	*35.5%*	*37.9%*	*22.9%*	*7.4%*
Bigger than average (total assets)	*21.4%*	*26.4%*	*24.4%*	*27.9%*	*25.3%*	*41.3%*
Smaller than average (total sales)	*12.3%*	*18.8%*	*32.1%*	*30.1%*	*24.8%*	*5.9%*
Bigger than average (total sales)	*15.8%*	*24.2%*	*30.4%*	*39.7%*	*19.5%*	*35.1%*
Net investment/Fixed Assets	**4.7%**	**6.9%**	**14.5%**	**21.6%**	**12.6%**	**13.3%**
Old firms	*2.4%*	*4.1%*	*10.4%*	*18.4%*	*9.6%*	*15.1%*
New firms	*34.9%*	*40.3%*	*51.1%*	*54.5%*	*35.8%*	*5.3%*
Smaller than average (total assets)	*-8.1%*	*2.5%*	*16.3%*	*24.1%*	*11.4%*	*0.7%*
Bigger than average (total assets)	*12.4%*	*13.7%*	*11.3%*	*15.6%*	*15.2%*	*34.2%*
Smaller than average (total sales)	*6.0%*	*3.8%*	*15.5%*	*17.6%*	*14.0%*	*-0.3%*
Bigger than average (total sales)	*3.0%*	*7.5%*	*12.5%*	*24.3%*	*7.6%*	*27.1%*
Activity and growth						
Sales growth (%)	**NA**	**4.3%**	**36.2%**	**14.5%**	**1.2%**	**9.1%**
Old firms	*NA*	*3.3%*	*23.5%*	*6.5%*	*-1.3%*	*10.3%*
New firms	*NA*	*51.8%*	*165.5%*	*117.6%*	*26.2%*	*2.7%*
Smaller than average (total assets)	*NA*	*0.1%*	*50.0%*	*6.5%*	*1.9%*	*3.2%*
Bigger than average (total assets)	*NA*	*10.0%*	*13.0%*	*31.7%*	*-0.4%*	*19.9%*
Smaller than average (total sales)	*NA*	*-0.2%*	*52.0%*	*14.9%*	*0.7%*	*-0.5%*
Bigger than average (total sales)	*NA*	*9.0%*	*8.1%*	*13.7%*	*2.1%*	*21.5%*
Asset turnover (Sales/Total assets)	**133.1%**	**132.3%**	**142.8%**	**132.5%**	**109.5%**	**61.8%**
Old firms	*138.4%*	*145.1%*	*153.5%*	*143.2%*	*122.3%*	*71.8%*
New firms	*34.8%*	*43.4%*	*42.2%*	*28.4%*	*25.7%*	*24.6%*
Smaller than average (total assets)	*163.6%*	*154.0%*	*166.7%*	*152.1%*	*124.4%*	*64.6%*
Bigger than average (total assets)	*70.3%*	*79.8%*	*84.4%*	*79.7%*	*66.0%*	*57.0%*
Smaller than average (total sales)	*136.1%*	*129.5%*	*144.7%*	*133.3%*	*109.3%*	*42.7%*
Bigger than average (total sales)	*146.7%*	*157.4%*	*160.0%*	*141.5%*	*127.1%*	*93.8%*
Profitability						
Net operating income/Sales (%)	**13.0%**	**10.6%**	**11.1%**	**10.6%**	**4.4%**	**0.1%**
Old firms	*12.7%*	*10.3%*	*10.7%*	*9.7%*	*5.6%*	*1.0%*
New firms	*28.5%*	*13.8%*	*15.6%*	*22.5%*	*-8.5%*	*-4.4%*
Smaller than average (total assets)	*13.4%*	*11.4%*	*11.2%*	*11.8%*	*5.9%*	*-1.4%*
Bigger than average (total assets)	*12.1%*	*9.0%*	*10.9%*	*7.5%*	*0.2%*	*1.7%*
Smaller than average (total sales)	*13.7%*	*10.0%*	*11.0%*	*10.4%*	*2.1%*	*-5.6%*
Bigger than average (total sales)	*12.0%*	*11.8%*	*11.3%*	*11.0%*	*8.8%*	*7.5%*
Net operating income/Total assets (%)	**16.8%**	**14.2%**	**13.1%**	**10.6%**	**7.8%**	**2.5%**
Old firms	*17.2%*	*15.0%*	*13.7%*	*11.0%*	*8.4%*	*3.3%*
New firms	*9.6%*	*8.8%*	*7.8%*	*7.1%*	*3.9%*	*-0.2%*
Smaller than average (total assets)	*20.8%*	*16.9%*	*14.3%*	*12.0%*	*8.8%*	*1.8%*
Bigger than average (total assets)	*8.5%*	*7.7%*	*10.3%*	*7.1%*	*5.0%*	*3.7%*
Smaller than average (total sales)	*19.4%*	*15.1%*	*13.9%*	*10.4%*	*6.7%*	*-0.6%*
Bigger than average (total sales)	*15.1%*	*14.9%*	*13.5%*	*12.1%*	*11.0%*	*6.6%*

Table 5 (continuation)
Summary of indicators: 1995-2000

Concept	1995	1996	1997	1998	1999	2000
Net income/Sales (%)	**20.0%**	**13.3%**	**6.9%**	**5.4%**	**-6.7%**	**-9.4%**
Old firms	*20.0%*	*10.0%*	*6.0%*	*4.7%*	*-0.3%*	*-7.0%*
New firms	*22.8%*	*47.3%*	*17.2%*	*14.0%*	*-74.6%*	*-22.3%*
Smaller than average (total assets)	*13.8%*	*13.5%*	*7.3%*	*6.6%*	*1.7%*	*-11.7%*
Bigger than average (total assets)	*33.9%*	*13.0%*	*6.1%*	*2.2%*	*-30.8%*	*-6.6%*
Smaller than average (total sales)	*25.8%*	*15.4%*	*6.4%*	*5.0%*	*-11.1%*	*-18.7%*
Bigger than average (total sales)	*11.4%*	*9.6%*	*7.9%*	*6.2%*	*1.8%*	*2.7%*
Net income/Net worth (%)	**44.5%**	**34.1%**	**29.8%**	**19.1%**	**0.7%**	**-8.9%**
Old firms	*45.2%*	*34.8%*	*29.9%*	*19.2%*	*1.6%*	*-8.6%*
New firms	*24.3%*	*28.8%*	*28.1%*	*18.6%*	*-6.2%*	*-10.1%*
Smaller than average (total assets)	*50.8%*	*40.6%*	*36.0%*	*23.6%*	*1.5%*	*-14.4%*
Bigger than average (total assets)	*31.2%*	*19.1%*	*14.9%*	*7.1%*	*-1.8%*	*-0.1%*
Smaller than average (total sales)	*59.0%*	*40.1%*	*32.4%*	*22.9%*	*-4.9%*	*-22.1%*
Bigger than average (total sales)	*24.7%*	*25.6%*	*22.1%*	*12.0%*	*9.6%*	*5.7%*
Leverage and liquidity						
Total debt/Total assets (%)	**55.0%**	**58.3%**	**58.7%**	**60.7%**	**57.1%**	**59.5%**
Old firms	*54.5%*	*60.0%*	*58.2%*	*61.3%*	*58.3%*	*59.8%*
New firms	*64.6%*	*46.5%*	*64.0%*	*54.4%*	*49.0%*	*58.4%*
Smaller than average (total assets)	*55.7%*	*59.3%*	*60.1%*	*63.5%*	*57.2%*	*61.8%*
Bigger than average (total assets)	*53.6%*	*55.9%*	*55.4%*	*52.9%*	*56.7%*	*55.6%*
Smaller than average (total sales)	*55.9%*	*61.3%*	*59.4%*	*63.3%*	*57.4%*	*63.0%*
Bigger than average (total sales)	*53.8%*	*55.7%*	*55.4%*	*57.6%*	*62.3%*	*60.6%*
Financial debt/Net assets (%)	**39.6%**	**44.6%**	**38.6%**	**40.3%**	**42.7%**	**53.0%**
Old firms	*38.6%*	*45.8%*	*37.4%*	*39.4%*	*42.3%*	*52.2%*
New firms	*56.6%*	*35.7%*	*50.2%*	*49.1%*	*45.0%*	*55.8%*
Smaller than average (total assets)	*37.1%*	*43.5%*	*35.8%*	*39.9%*	*40.4%*	*55.0%*
Bigger than average (total assets)	*44.6%*	*47.3%*	*45.5%*	*41.4%*	*49.3%*	*49.5%*
Smaller than average (total sales)	*39.3%*	*47.7%*	*37.5%*	*40.1%*	*42.4%*	*58.3%*
Bigger than average (total sales)	*39.1%*	*41.3%*	*40.0%*	*41.8%*	*47.4%*	*51.3%*
Long-term debt/Net worth (times)	**0.351**	**0.529**	**0.793**	**0.977**	**1.010**	**1.362**
Old firms	*0.350*	*0.507*	*0.716*	*0.943*	*0.943*	*0.713*
New firms	*0.368*	*0.681*	*1.510*	*1.314*	*1.448*	*3.771*
Smaller than average (total assets)	*0.305*	*0.547*	*0.543*	*1.117*	*0.813*	*1.912*
Bigger than average (total assets)	*0.442*	*0.484*	*1.397*	*0.602*	*1.586*	*0.399*
Smaller than average (total sales)	*0.384*	*0.699*	*0.872*	*1.085*	*1.142*	*2.117*
Bigger than average (total sales)	*0.309*	*0.250*	*0.447*	*0.767*	*0.841*	*0.619*
Current ratio (%)	**153.9%**	**143.5%**	**192.9%**	**173.6%**	**164.3%**	**116.8%**
Old firms	*153.7%*	*144.2%*	*190.3%*	*174.6%*	*165.1%*	*111.1%*
New firms	*158.2%*	*138.9%*	*216.9%*	*162.6%*	*157.4%*	*141.2%*
Smaller than average (total assets)	*172.5%*	*157.3%*	*216.9%*	*189.1%*	*178.9%*	*107.1%*
Bigger than average (total assets)	*115.8%*	*110.1%*	*134.4%*	*132.5%*	*121.0%*	*133.0%*
Smaller than average (total sales)	*158.9%*	*149.9%*	*208.0%*	*198.9%*	*189.3%*	*118.7%*
Bigger than average (total sales)	*140.4%*	*135.1%*	*139.4%*	*127.6%*	*122.0%*	*110.1%*

Source: Own calculations from our database

When firms are classified according to their size, and the value of total assets is used as an indicator of size, investment ratios tend to be higher in bigger firms. When companies are classified taking sales into account, the investment ratios have a similar evolution in small and large firms, suggesting some kind of proportionality between investment and sales.

The indicators of activity also give a good synthesis of the scenario that Uruguay confronted during the second half of the last decade. Sales growth increased until 1997, and then began to decelerate. Asset turnover (sales/total assets) has also slowed since 1997, causing deterioration in profitability ratios, as will be shown immediately. The asset turnover ratio tends to be higher in larger firms, when they are defined according to their assets value. Again, the distinction between large and small firms is not so clear when they are classified by sales volume.

The profitability ratios showed a steady decline during the period considered, with notable reductions in 1999 and 2000. The net operating income (income before financial charges and taxes) became almost zero in 1999 and 2000, while net income became negative in the last two years of the period. There is no clear distinction in the relative performance of large and small firms during the recent crisis. When size is defined according to total assets, small firms performed better in 1999, but when total sales is used as an indicator, the picture is the opposite. On a different dimension, the recession seems to have affected the results of new firms, defined as those created during the nineties, more substantially.

The ratios of indebtedness were remarkably stable during the period under study, and were very similar for all types of firms. Old firms tend to have larger leverage ratios than new firms (consistent with the hypothesis that stressed the importance of age in the access to credit), and large firms tend to be more indebted than the small ones (which is also consistent with the theories that emphasize the importance of collateral in the determination of the financial structure). But all types of companies analyzed showed leverage ratios around 60% during the last five years.

While profitability declined, financial debts increased their importance as the funding instrument for working capital, as the Financial Debt/Net Assets ratio shows. This trend is visible for all types of companies described. Moreover, as profits were reduced and eventually became negative, the net worth of firms grew less than total assets, so long-term debt increased its importance as a mean of long-term financing.

Notwithstanding the stability of the leverage ratio, the current ratio (Current Assets/Current Liabilities) had a pronounced fall during the last two years, indicating the relative increase in short-term financing instruments as a source of funds with respect to other mechanisms, including the internal generation of resources. The latter source of funds, which is related with the capacity of the firms to obtain profits, has been negatively affected by the current economic recession.

To what extent the reduction in the investment ratio during the last two years is a consequence of a financial constraint that firms faced, and therefore is related with the fall in the internal capacity of generate funds, or both results are the simultaneous outcome of the macroeconomic adversities that Uruguay is suffering, is the question to be examined.

4.2. Estimation issues

Two broad strategies can be followed to test if constraints on financing decisions are relevant to the investment process of the firms. One approach uses the Euler equation derived from the maximization problem outlined above. As Mairesse, Hall and Mulkay (1999) pointed out, the Euler equation method allows dealing with the problem of expectations on future profitability of the investment. Average profitability, the product to capital ratio and the one-period ahead expected change in the adjustment costs of investment are all that is needed to describe the change in expectations about the future profitability of investments. The Euler equation approach does not require computing the Tobin's q ratio, which is very difficult in markets like that of Uruguay, where only a few firms trade their shares in a stock exchange.

To allow for the potential endogeneity of the regressors in the Euler equation, the GMM method will be used (see Hansen, 1982, Arellano and Bond, 1991, on the application of the GMM method in panel data and Hansen and Singleton, 1982, on application of the GMM method to first order conditions). The significance of the additional parameters included in the binding restriction model will allow us to draw conclusions about the relevance of financial constraints in the investment decision. The only difference between equations (14') and (15') is the sign of the debt term and the appearance of a term with the square of debt in the restricted case. Nevertheless, it is necessary to warn that the results from an Euler equation approach are very sensitive to the specification of the model. In our case, the specification of the $r(\cdot)$ and $G(\cdot)$ functions can introduce an arbitrary structure in the equation to be estimated.

For this reason, we supplement the results obtained from Euler equations with the use of an error-correction formulation and the traditional accelerator-profit model, as in equations (9) and (10) in section 3.1. In fact, the error correction equation (9) and the accelerator-profit model (10) are not very different from the Euler equation (15'), so the two methodologies can shed light over the same phenomenon despite the different macroeconomic foundations.

The estimation procedure for equations of the type (9), (10) and (15') using panel data has traditionally dealt with the "permanent unobservable differences" across firms included in the error term, by within firm transformation (subtracting from each variable the time-average over the sample period) or by first-differencing the data.

Consider the usual linear regression model written for panel data with firm and year effects:

$$y_{it} = x_{it}\beta + \alpha_i + \delta_t + \varepsilon_{it} \qquad (16)$$

with $i = 1 \ldots N$, $t = 1 \ldots T$, y_{it} is the variable to be explained, x_{it} is the vector of explanatory variables (including lagged y_{it}) and α_i and δ_t are firm-specific and time-specific effects, respectively. The year-specifities can be treated by year dummies, but possible problems arise from the α_i, which if ignored can introduce persistent serial correlation of the residuals. The within transformation eliminates α_i, but does not make it possible to obtain consistent estimates

if the variables on the right hand side are endogenous or predetermined. We will deal with this problem by first differencing, in which case equation (16) transforms to

$$\Delta y_{it} = \Delta x_{it} b + \Delta d_t + \Delta e_{it} \qquad (17)$$

These "first differences estimates" are free from potential correlated effects due to unobserved firm-specific factors that are constant over time.

In our model, it is highly probable that the dependent variable and some of the explanatory variables are simultaneously determined, introducing biases in the estimations. To deal with this problem, GMM estimates based on instrumenting the equation (17) by the lagged level values of the variables were conducted. The statistical package DPD for Ox was used to perform the estimations (Arellano, Bond and Doornik, 1997).

5. Results

5.1. The accelerator model of investment with error correction: the traditional approach

For purpose of comparison we start by presenting in Table 6 the within regression results for equation (9). As in all the regressions, the estimates are for the period 1997-2000, and dummies for each year are included (but their estimates not reported). While data for the period 1995-2000 is available, the first two years will allow for lags of order two to serve as instruments in estimation.

We present the results for the basic equation and several augmented equations where we try to capture the effects of firm size and type of ownership. A priori we expect larger and foreign owned firms to suffer less from financial constraints. In what respect to foreign firms, conventional wisdom sees the acquisition of a foreign partner to be a sign of strength for a firm. This strength can be the result of brand name reputation the inflow of new capital a more efficient internal organization or new (probably more aggressive) strategic competition. In any event, foreign participation should ease the fundraising efforts of firms.

As was mentioned in section 3, we expect larger firms to have less financial restrictions than smaller firms. At least we have two reasons to expect smaller firms to face tighter financial restrictions. Public information about smaller firms in general is worse than information about larger firms, there are no easy ways to solve this asymmetry in order to attract investors. Moreover, larger firms may be able to offer larger collateral which in many cases is required for longer-term loans.

Firm size is defined on the basis of average capital. The dummy variable Size takes the value of one for all firms with capital level above average capital. We have also created a dummy variable taking value one for all firms with more than 70% of national ownership (i.e. Origin=1 is our approximation for a national firm).

We are also interested in the interaction of the relevant variables with the effects of the 1999-2000 Crisis. We explored several alternatives but we report just two: a dummy for the post

crisis years of 1999 and 2000, and with the spread between foreign and domestic currency denominated interest rates. This spread reflects the expected devaluation of the local currency, given the high dollarization of the Uruguayan economy, higher expected devaluation implies higher firm liabilities and lower access to funds capacity.

In all specifications, the error-correction term has the correct sign and is significant. But the lagged sales term is also significant and its coefficient very similar to the error-correction term. Implicitly then, the two sales terms cancel and the investment-capital ratio is linked to the lagged log of capital.

More important, also in all specifications, the coefficient estimates of the current and lagged terms of the proxy for cash inflows[6] are positive and significant. This is consistent with the presence of financial restrictions. Moreover liquidity constraints are not temporary and are not eliminated in the following periods.

We explored other proxies for the liquidity constraints, like net income, net operating income and a cash approximation, calculated as net income plus depreciation of capital, all scaled by the capital stock. The results do not differ too much, with all the coefficients being of similar order. Net investment (also scaled by capital) is the dependent variable in all the error-correction and accelerator equations. Gross investment was also used, but the results were robust to these modifications.

[6] The proxy for cash inflows is the contribution margin less interest payments. The contribution margin is calculated as net operating income (earnings before interests and taxes) plus capital depreciation.

Table 6
Error-Correction Model for I/K
Within estimates, 1997-2000

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Usable observations	213	213	213	213	213	213	213
Dy (t)	0.242***	0.255***	0.233***	0.271***	0.239**	0.245***	0.240***
	(0.125)	(0.124)	(0.124)	(0.126)	(0.125)	(0.124)	(0.125)
k-y (t-1)	-0.869***	0.869***	-0.882***	-0.842***	-0.867***	-0.880***	-0.884***
	(0.120)	(0.118)	(0.119)	(0.121)	(0.120)	(0.119)	(0.119)
y (t-1)	-0.932***	-0.935***	-0.945***	-0.901***	-0.933***	-0.946***	-0.941***
	(0.110)	(0.109)	(0.110)	(0.112)	(0.111)	(0.109)	(0.110)
C/K (t)	0.108***	0.110***	0.020	0.104***	0.151**	0.050	0.014
	(0.016)	(0.016)	(0.056)	(0.028)	(0.093)	(0.126)	(0.056)
C/K (t-1)	0.234***	0.233***	0.259***	0.110	0.234***	0.256***	0.261***
	(0.020)	(0.020)	(0.025)	(0.092)	(0.020)	(0.026)	(0.025)
Sum of C coef.	0.342	0.343	0.309	0.214	0.385	0.306	0.274
Size*C/K (t)		-0.438***				-0.415***	
		(0.210)				(0.212)	
Crisis*C/K (t)			0.094**	0.380		0.081	
			(0.057)	(1.319)		(0.060)	
Crisis*C/K (t-1)				4.085*			
				(2.905)			
Origin*C/K (t)					-0.042	-0.016	
					(0.091)	(0.094)	
(1-Size)*Cri*C/K(t)							0.101**
							(0.057)
R-squared	0.789	0.795	0.793	0.792	0.789	0.798	0.793
Wald	530	546	539	535	528	550	541

Notes: I/K, net investment over capital at the beginning of the period; Dy, first difference in log of sales; k, log of capital, y, log of sales; C/K, contribution margin (net operating income plus capital depreciation) over capital at the beginning of the period; Size, a dummy with value 1 for firms with capital greater than average; Crisis in columns C, F and G is a dummy with value 1 for years 1999 and 2000, in column D is the spread between foreign and domestic currency denominated interest rates; Origin in column E and F has a value 1 for firms with less than 30% of foreign ownership. Standard errors in parenthesis.

***significant at 5%, **significant at 10%, *significant at 15%

The within results in column A of Table 6 are consistent with the existence of financial constraints for investment in the period under consideration. More convincing information is contained in the following columns. The regression allowing for an interaction with size is in column B, and with the crisis variables in columns C and D. Column E splits by ownership. Column F includes the three interactions together and finally column G explores what happened with small firms after the crisis.

The estimate of the product of the size dummy and the cash proxy are negative suggesting that larger firms experience lower or no financial constraints. The coefficient estimates of both crisis proxies have the expected sign suggesting that financial constraints of the Uruguayan firms have increased during the recent recession. However, their significance level is not high (10% and 15%). The coefficient of the interaction with type of ownership is not statistically or economically significant.

Given the significance of size and crisis we explored the effects of the crisis for small firms. [7] Column G results implies that small firms were especially adversely affected after the Crisis.

Given the strong significance of the lagged capital sales difference and the lagged difference, it seems appropriate to experiment with a different specification like the accelerator model of equation (10).

As Mairesse, Hall and Mulkay (1999) pointed out, the error-correction specification (9) can be seen as a reparameterization of the basic equation (7) in levels, while the simple accelerator model of (10) is derived from first-differencing equation (7). If the "permanent unobservable differences" are present only in the equation in levels, they are still present in the error-correction specification and the "within estimates" are the appropriate procedure. But in the case of the accelerator specification, the firm specific effects are removed when equation (7) is first-differenced. For this reason, "total estimates" of the equation (10) are presented in Table 7, column A1. However, to account for the possibility of different trends in capital and output growth rates at the firm level, the within estimator is also computed and included in column A2.

As in the case of the error-correction formulation, proxies to account for size, origin and the 1999-2000 crisis are included. Both the individual and the sum of the coefficients of the liquidity variable are positive, with the same implication as in the error correction specification.

Qualitatively the accelerator model reflects the same conclusions as the Error Correction formulation. In column B we have the negative coefficient estimate for the product of size and cash reflecting that larger firms suffer less from financial constraints. What is more the magnitude in absolute value of this estimate is basically the same as the sum of the cash variables. Thus for large firms there are no financial constraints. In column D we find that the coefficient of the interaction of cash flow with the spread between domestic and foreign currency denominated interest rates lagged one period has the expected sign and is significant. Finally,

[7] We also explored double and triple interactions between size, crisis and origin but we do not report them here. They are available from the authors upon request.

foreign or national ownership does not seem to play a relevant role in explaining financial constraints on investment.

Table 7
Accelerator model for I/K
Total and within estimates, 1997-2000

	Total	Within					
	(A1)	(A2)	(B)	(C)	(D)	(E)	(F)	(G)
Usable observations	213	213	213	213	213	213	213	213
I/K (t-1)	0.004	-0.034**	-0.036**	-0.037**	-0.026	-0.034**	-0.038**	-0.038**
	(0.024)	(0.020)	(0.020)	(0.021)	(0.021)	(0.020)	(0.205)	(0.021)
Dy (t)	0.619***	0.459***	0.475***	0.455***	0.487***	0.458***	0.471***	0.458***
	(0.122)	(0.116)	(0.116)	(0.116)	(0.116)	(0.117)	(0.117)	(0.116)
C/K (t)	-0.055***	0.136***	0.138***	0.068	0.129***	0.159*	0.111	0.051
	(0.017)	(0.019)	(0.019)	(0.069)	(0.033)	(0.112)	(0.155)	(0.069)
C/K (t-1)	0.172***	0.309***	0.309***	0.330***	0.084***	0.309***	0.326***	0.336***
	(0.020)	(0.021)	(0.021)	(0.029)	(0.113)	(0.021)	(0.030)	(0.029)
Sum of C coef.	0.116	0.445	0.447	0.398	0.213	0.468	0.437	0.387
Size*C/K (t)			-0.444**				-0.431**	
			(0.258)				(0.261)	
Crisis*C/K (t)				0.073	0.618		0.058	
				(0.070)	(0.699)		(0.074)	
Crisis*C/K (t-1)					7.280***			
					(3.529)			
Origin*C/K (t)						-0.042	-0.027	
						(0.110)	(0.116)	
(1-Size)*Cri*C/K(t)								0.090
								(0.070)
R-squared	0.378	0.683	0.690	0.686	0.695	0.684	0.691	0.687
Wald	117	306	313	308	319	305	312	309

Notes: Variable definitions in Table 6.

***significant at 5%, **significant at 10%, *significant at 15%

5.2. GMM estimators of the error correction and accelerator model

The within estimates can not deal with problems of biases caused by random measurement errors in the right-hand side variables, simultaneity between contemporaneous right-hand variables and the disturbance and the predetermined nature of some of the right hand side variables. To deal with these problems, an instrumental variable method of estimation is needed. In the case of correlation of the disturbances over time, the strategy usually implemented is the General Methods of Moments (GMM) estimation applied to the model in first differences.

The first problem with GMM estimates is the selection of the instruments for the differenced variables. If residuals are not serially correlated, the lagged levels of the variables included in the regression starting from the second lag are candidates for instruments.

The First Difference GMM estimates[8] are presented in Table 8 for the error-correction model and in Table 9 for the simple accelerator model. The cash flow coefficient tend to be smaller compared to the within estimates of Table 6 and 7. The signs of all the relevant coefficients are similar to the ones reported there. The cash flow coefficients are significantly positive. Large firms have a smaller cash flow coefficient, but the difference between large and small is not statistically significant. Financial constraints are greater in the crisis period. In that period smaller firms suffer significantly more from financial restrictions, compared to larger firms. The interaction with the ownership dummy is not statistically significant. In the accelerator model the cash flow coefficient for smaller firms is significantly larger. The interaction with the crisis dummy also confirms the previous results. However, the coefficient of the triple interaction size-crisis-cash flow is not significant. Finally, the Sargan test for overidentification has acceptable values in all specifications.

[8] For all GMM estimations, we report the first step First Difference GMM estimators using robust standard errors. The Sargan is from the two step estimation. Our instruments are the lag two and three of net income and all model independent variables.

Table 8
Error-Correction Model for I/K
GMM estimates, 1997-2000

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Usable observations	157	157	157	157	157	157	157
Dy (t)	0.092	0.101	0.053	0.096	0.082	0.060	-0.033
	(0.418)	-(0.419)	(0.426)	-(1.256)	(0.426)	(0.435)	(0.306)
k-y (t-1)	-1.268***	-1.271***	-1.290***	-1.256***	-1.253***	-1.290***	-1.645***
	(0.330)	(0.330)	(0.325)	(0.333)	(0.337)	(0.330)	(0.424)
y (t-1)	-1.311***	-1.299***	-1.311***	-1.300***	-1.310***	-1.290***	-1.736***
	(0.249)	-(0.249)	(0.257)	(0.247)	(0.250)	(0.269)	(0.415)
C/K (t)	0.073***	0.074***	0.013	0.055***	-0.029	-0.038	-0.013
	(0.035)	-(0.034)	(0.073)	(0.024)	(0.284)	(0.214)	(0.053)
C/K (t-1)	0.204***	0.203***	0.224***	0.209***	0.205***	0.226***	0.213***
	(0.029)	(0.029)	(0.040)	(0.031)	(0.030)	(0.041)	(0.045)
Sum of C coef.	0.277	0.277	0.237	0.264	0.176	0.188	0.200
Size*C/K (t)		-0.151				-0.287	
		(0.463)				(0.540)	
Crisis*C/K (t)			0.070	1.637**		0.078	
			(0.077)	(0.925)		(0.077)	
Origin*C/K (t)					0.103	0.046	
					(0.279)	(0.204)	
(1-Size)*Cri*C/K(t)							0.110**
							(0.057)
R-squared	0.810	0.810	0.813	0.816	0.806	0.811	0.784
Wald	885	935	3011	2393	1078	3719	10833
Sargan	22.385	21.579	18.611	20.813	21.555	16.464	13.512

Notes: Variable definitions in Table 6.

***significant at 5%, **significant at 10%, *significant at 15%

Table 9
Accelerator model for I/K
GMM estimates, 1997-2000

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Usable observations	157	157	157	157	157	157	157
I/K (t-1)	-0.055	-0.105**	-0.061	-0.054	-0.048	-0.139*	-0.060
	(0.052)	(0.064)	(0.053)	(0.053)	(0.057)	(0.095)	(0.053)
Dy (t)	0.168	-0.080	0.126	0.215	0.140	-0.181	0.132
	(0.427)	(0.485)	(0.429)	(0.422)	(0.436)	(0.523)	(0.429)
C/K (t)	0.140***	0.145***	0.035	0.093*	-0.018	0.165	0.045
	(0.011)	(0.011)	(0.138)	(0.015)	(0.502)	(0.414)	(0.142)
C/K (t-1)	0.315***	0.316***	0.351***	0.319***	0.315***	0.401***	0.347***
	(0.018)	(0.021)	(0.037)	(0.016)	(0.019)	(0.049)	(0.039)
Sum of C coef.	0.455	0.461	0.386	0.412	0.297	0.566	0.392
Size*C/K (t)		-3.343*				-4.007*	
		(2.194)				(2.666)	
Crisis*C/K (t)			0.112	2.784***		0.264*	
			(0.138)	(0.649)		(0.177)	
Origin*C/K (t)					0.160	-0.270	
					(0.500)	(0.510)	
(1-Size)*Cri*C/K(t)							0.101
							(0.143)
R-squared	0.641	0.434	0.642	0.650	0.636	0.295	0.642
Wald	2037	863	7304	3398	2557	4845	6900
Sargan	17.454	17.048	18.457	15.578	17.285	13.741	18.378

Notes: Variable definitions in Table 6.

***significant at 5%, **significant at 10%, *significant at 15%

5.3. Euler equation

In order to implement equation (15') we run the following regression:

$$\frac{I_{it+1}}{K_{it}} = a_0 \frac{I_{it}}{K_{it-1}} + a_1 \left(\frac{I_{it}}{K_{it}} \right)^2 + a_2 \frac{Y_{it}}{K_{it}} + a_3 \frac{B_{it}}{p_{it}^K K_{it}} a_4 \left(\frac{B_{it}}{p_{it}^K K_{it}} \right)^2 + a_5 \frac{p_{it}}{p_{it}^K K_{it}} + u_{t+1} + f_i + Year_{t+1} \tag{18}$$

proxying $\frac{p}{p^K K}$ with contribution margin (calculated as net operating income[9] plus capital depreciation) and $\frac{Y}{K}$ with the sales to capital ratio. If the specification is correct we should expect a_o, a_2 and a_4 to be positive and a_1, a_3 and a_5 to be negative. Recall also that the difference between the Euler equation for the case of no constraints (equation (14')) and the financially constrained Euler equation are the signs of the two debt terms. Therefore finding $a_3 < 0$ and $a_4 > 0$ and significant is evidence in favor of firms having hit the leverage ceiling. Alternatively finding $a_3 = 0$ and $a_4 < 0$ is consistent with the existence of a premium for debt and with a non-binding debt ceiling.

In Table 10, column A, we present the econometric results of estimating equation (16) by GMM. We also considered several augmented versions of the same regression to test its robustness and goodness of fit. The results are convincing. Most of the signs have the expected pattern and are significant. More relevant to the scope of this paper, the coefficient estimation for the squared debt to capital ratio is very significant and negative (the expected sign for the firms where the levearge ceiling is binding). This suggests the relevance of the extra financial constraints in equation (13) in the firm maximization problem (equations (11) and (12)). The only reason for caution is that the debt to capital ratio has a negative sign but is not significant. The sing and significance of the coefficients of the interactions of the leverage terms with the various dummies do no lead to very clear and non ambiguous conclusions. The Sargan test of overidentifyng restrictions does not reject the specification in any of the models.

[9] We define Net operating income as earnings before interest and taxes (EBIT).

Table 10
Euler equation
GMM estimates, 1997-2000

	(A)	(B)	(C)	(D)
Usable observations	157	157	157	157
GI/K (t-1)	0.319**	0.336***	0.336***	0.339***
	(0.017)	(0.168)	(0.172)	(0.171)
GI/K (t-1) squared	-0.015***	-0.015***	-0.015***	-0.016***
	(0.007)	(0.007)	(0.007)	(0.008)
Y/K (t-1)	0.025***	0.023***	0.002	0.026
	(0.011)	(0.010)	(0.055)	(0.023)
B/K (t-1)	-0.078	-0.039	-0.233**	-0.177
	(0.188)	(0.188)	(0.143)	(0.208)
B/K (t-1) squared	0.028***	0.029***	0.029***	0.028***
	(0.007)	(0.006)	(0.007)	(0.007)
MC/K (t-1)	-0.304**	-0.354***	-0.154	-0.245*
	0.166	0.168	0.155	0.168
Size*B/K (t)		2.039		
		(1.495)		
Size*Bsquared/K (t)		1.372		
		(1.690)		
Crisis*B/K (t)			3.082	
			(5.022)	
Crisis*Bsquared/K (t)			-0.031	
			(0.40)	
Origin*B/K (t)				0.139*
				(0.097)
Origin*Bsquared/K (t)				-0.005***
				(0.002)
R-squared	0.536	0.527	0.579	0.533
Wald	15045	14631	37617	16520
Sargan	26.638	24.397	41.631	26.406

Notes: GI/K is the dependent variable. GI/K, gross investment over capital at the beginning of the period;
Y/K, sales over capital at the beginning of the period; B/K, total debt over capital at the beginning of the period;
MC/K, contribution margin over capital at the begining of the period;
Crisis is the spread between foreign and domestic currency denominated interest rates.
***significant at 5%, **significant at 10%, *significant at 15%

6. Concluding remarks

Three alternative specifications of an investment equation have been tested using panel data of Uruguayan firms: a traditional accelerator model of investment, an error-correction version of that accelerator model, and an Euler equation approach. These models of investment were used to test for the existence of financial constraints in the investment decision process.

The more flexible (and ad hoc) error correction and accelerator models suggest that cash flow plays an important role in investment decisions. Moreover there is evidence that financial restrictions are more severe for smaller firms. We also find evidence that financial constrains were tighter during the crisis years of 1999-2000. This was particularly true for smaller firms. So there is evidence that the decrease in investment in 1999-2000 is associated with more sever credit conditions.

We also explore the effects of ownership type on the access to financial resources. Although we conjectured that foreign owned firms would suffer less severe restrictions, we were not able to find supporting evidence. This is probable due to fact that most national firms in our database are well established, mature firms with respectable brand name.

Taking into consideration the relative robustness of the results of the accelerator and error correction models, it can be said that our estimates confirm the presence of financial restrictions on investment decisions of the Uruguayan firms in the period under consideration (all estimates correspond to 1997 – 2000). Finally, also the estimates of the Euler equation model confirm the importancie of financial constraints for Uruguayan firms.

References

Arellano, M. and S. Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Situations", *Review of Economic Studies*, Vol. 58: 277-297.

Arellano, M., S. Bond and J. A. Doornik (1997): *Dynamic Panel Data Estimation Using DPD for Ox*, mimeo, Oxford University.

Arellano, M. and O. Bover (1995): "Another Look at the Instrumental-Variable Estimation of Error-Component Models", *Journal of Econometrics*, Vol. 58: 29-52.

Caprio, G. Jr. and A. Demirgüc-Kunt (1997): *The Role of Long Term Finance: Theory and Evidence*, Policy Research Department Working Paper, The World Bank.

Demirgüc-Kunt, A. and R. Levine (1999): *Bank-Based and Market-Based Financial System: Cross-Country Comparisons*, manuscript, The World Bank.

Demirgüc-Kunt, A. and V. Maksimovik (1994): *Capital Structures in Developing Countries: Evidence from Ten Countries*, Policy Research Working Paper 1320, The World Bank.

Gallego, F. and N. Loayza (2000): *Financial Structure in Chile: Macroeconomic Developments and Microeconomic Effects.* Working Paper, Central Bank of Chile.

Hansen, L.P. (1982): "Large Sample Properties of Generalized Method of Moment Estimators", *Econometrica* 50: 1029-1054.

Hansen, L.P. and K.J. Singleton (1982): "Generalized Instrumental Variables Estimation of Non-Linear Rational Expectations Models", *Econometrica* 50: 1269-1286.

Heshmati, A. (1994): "On the single and multiple trends representation of technical change", *Applied Economics Letters*, 3: 495-499.

Jaramillo, F., F. Schiantarelli and A. Weiss (1996): "Capital Market Imperfections Before and After Financial Liberalization: An Euler Equation Approach to Panel Data for Ecuadorian Firms", *Journal of Development Economics*, 51: 367 - 386.

Levine, R., N. Loayza and T. Beck (2000): "Financial Intermediation and Growth: Causality and Causes", *Journal of Monetary Economics*, 46, 31-77.

Mairesse, J., B. H. Hall and B. Mulkay (1999): *Firm-Level Investment in France and the United States: An Exploration of What We Have Learned in Twenty Years*. NBER Working Paper 7437.

Schiantarelli, F. and V. Srivastava (1996): *Debt Maturity and Firm Perfomance: A Panel Study of Indian Public Limited Companies*, Working Paper of the Policy Research Department, World Bank.

Schmukler, S. and Vesperoni, E. (2000): *Does Integration with Global Markets Affect Firm's Financing Choices? Evidence from Emerging Economies*. World Bank, mimeo.

Appendix
Adjustment for changes in price levels

This appendix explains in detail the methodology employed to adjust the financial statements information to December 2000 values, including the computation of the effect of inflation on nominal accounts. While it is widely recognized the importance of the distortion on accounting information generated by changes in price levels, the usual practice in Uruguay is to restrict the adjustment to the fixed assets item. So, a comprehensive adjustment was made to most of the financial statements included in the sample.

As it is common in Uruguay, fixed assets information is corrected for changes in price levels by using the Wholesale Price Index computed by the Central Bank. To make the comprehensive adjustment of financial statements for changes in price levels consistent with this criteria, the same index will be employed to compute the end-of-fiscal-year values of all the items.

The Wholesale Price Index for month i in year t is denoted by $P_{i,t}$, and so $P_{12,2000}$ represents the Wholesale Price Index for December 2000.

Balance sheets information adjustment

We will denote by $X_{i,t}$ the value not adjusted for inflation of variable X in fiscal year t ended in month i. The same variable expressed in December 2000 values will be denoted by $X'_{i,t}$.

All the firms included in the sample make corrections for price level changes in the fixed assets and cumulated depreciation items. As cash, receivables, commercial liabilities and financial debt are usually expressed at end-of-fiscal-year values, the only item among the assets and liabilities that needs to be adjusted for price level changes is inventories. The balance of this item at end-of-fiscal-year reflects the cost of production or acquisition of units of goods at different points in time, so a correction is needed to express it at values of end-of-fiscal-year date.

An accurate adjustment for inflation in the inventories item requires more detailed accounting information than the one usually revealed in financial statements, so an approximation was needed. Most of the firms in the sample compute the value of their cost of sales according the First-In, First-Out (FIFO) criteria, which means that the balance of the inventories at end-of-fiscal-year reflects the value of the units most recently produced or acquired. It was estimated that, on average, inventories were equivalent to three months of production, so its balance at end-of-fiscal-year cumulate the value of units produced during the last three months of the year, according to the FIFO method.

If we represent by $\tilde{P}_{i,t} = \frac{1}{3}\sum_{j=0}^{j=2} P_{i-j,t}$ the average index for the three months previous to the end of the fiscal year, and by $I_{i,t}$ the non-adjusted value of inventories according to the balance sheet at the end of fiscal year *t*, the December 2000 value of inventories at the end of fiscal year *t* is given by:

$$I'_{i,t} = I_{i,t} \frac{P_{12,2000}}{\tilde{P}_{i,t}}$$

The rest of the items that are included in the assets and liabilities of the firm are already expressed in figures valued at the end of the fiscal year. As was mentioned, all of the firms in the sample adjust their fixed assets to end-of-fiscal-year values, so this information is already corrected for inflation. Cash, receivables and liabilities denominated in Uruguayan pesos are, by definition, figures expressed in end-of-fiscal-year values. These same concepts, but originated in transactions denominated in foreign currency, are converted to pesos at the end-of-fiscal-year exchange rate, so these figures also correspond to end-of-fiscal-year values. For all of the variables *X* included in this category, the conversion to December 2000 values is simply given by:

$$X'_{i,t} = X_{i,t} \frac{P_{12,2000}}{P_{i,t}}$$

The net worth adjusted for inflation expressed in December 2000 values is just the difference between the adjusted values of assets and liabilities. There was not enough information available to decompose the adjusted value of net worth in its two main components: increases in equity by owners and retained earnings.

Income statement information

The items included in the income statements are flow variables, and their adjustment for changes in price levels cannot be done with the price index corresponding to the last month of the fiscal year, as it was done in general for the items included in the balance sheet. It was assumed that income and expenses are distributed uniformly along the year, and so the adjustment to December 2000 values of all this flow variables is given by:

$$X'_{i,t} = X_{i,t} \frac{P_{12,2000}}{\overline{P}_{i,t}}$$

where $\overline{P}_{i,t} = \frac{1}{12}\sum_{j=0}^{j=11} P_{i-j,t}$ is the average price index of the fiscal year ended in month *i* of year *t*.

The only exception of this criteria was the computation of the adjusted cost of sales. The value of the cost of production *Q* not adjusted for inflation is given by:

$$Q_{i,t} = C_{i,t} + \left(I_{i,t} - I_{i,t-1}\right)$$

where *C* is cost of sales not adjusted and *I* inventories, as before. The cost of production calculated in this way was expressed in December 2000 values computing:

$$Q'_{i,t} = Q_{i,t} \frac{P_{12,2000}}{\overline{P}_{i,t}}$$

Given this estimation, the adjusted cost of sales was finally calculated according to the following:

$$C'_{i,t} = Q'_{i,t} - \left(I'_{i,t} - I'_{i,t-1} \right)$$

Correction for the effect of inflation on the net profit

An estimation of the impact of inflation on the loss of value of the monetary assets of the firm was made. It was assumed that, while inventories and fixed assets adjust their value approximately in equal proportion to the changes in price levels, cash, receivables and liabilities do not adjust in the same manner. Strictly speaking, for cash, receivables and liabilities denominated in Uruguayan pesos there is no adjustment, while when they are denominated in foreign currency they are adjusted by the devaluation rate. In this way, this correction for the effect of inflation on monetary assets and liabilities can be interpreted as an adjustment of interest payments and the result of changes in the exchange rate to "real" terms.

For the calculation, we defined Net Monetary Assets (*M*) as the difference between current assets excluded inventories (that is, in broad terms, cash and receivables) and total liabilities. The net result (loss if it is negative) attributed to changes in the price level, *F*, is given by the formula:

$$F'_{i,t} = \left[- M_{i,t-1} \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right) - \left(M_{i,t} - M_{i,t-1} \right) \left(\frac{P_{i,t}}{\overline{P}_{i,t}} - 1 \right) \right] \frac{P_{12,2000}}{\overline{P}_{i,t}}$$

If initial *M* is positive and constant during the fiscal year, the first term in the right-hand side computes the loss of attributed to inflation of maintaining a certain level of net monetary assets during the exercise, and the second term will be zero. So the second term in the right-hand side computes the average loss derived from an increment in the initial net monetary position. If this position is negative, and decreases during the fiscal year, the firm will obtain a gain due to the price level change effect.