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Evidence from a Panel of Uruguayan Firms

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Abstract[1]

This paper explores whether the extent of informality in a sector affects a firm's investment decision directly or indirectly through a credit availability channel. The dataset used in the estimation of the econometric models consists of an unbalanced panel of Uruguayan firms for the period 1997-2008. The results suggest that financial restrictions affect investment decisions in Uruguay, as an increase in credit to the private sector translates into higher investment rates. A one percentage point increase in overall credit growth translates into a one half percent increase in investment rates. It is also found that, although there is no direct effect of informality on the firm investment decision, there is an indirect effect through the borrowing channel. More specifically, financial restrictions reduce the amount of investment undertaken by Uruguayan firms, the effect being smaller if the firm operates in a sector with lower informality.

JEL classifications: E26, G21, O4, O16
Keywords: Investment decisions, Credit constraints, Informality, Uruguay

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1. Introduction

Catão, Pagés and Rosales (2009) argue that the link between financial development and firms' informality has been much overlooked. They suggest that the incentives for firms to become formal increase as financial markets deepen, as they experience a higher likelihood of accessing the credit market. Using data on Brazilian firms, they find evidence that financial deepening led to higher employment formalization rates in sectors where firms are typically more dependent on external finance. In a previous paper, Gandelman and Rasteletti (2012), we reported similar results for Uruguay. In this paper, we focus on a different firm decision that might be affected in the presence of financial restrictions. More specifically, we test whether financial restrictions affect firms' investment decisions in Uruguay. We also study whether the extent of informality in a given sector exacerbates this effect.

The role of informal firms in the economic development process is not very well understood by economists. This is in part due to the different views in the profession on the nature of informal firms. La Porta and Shleifer (2008) divide these views into three groups, which they label the romantic view, the parasite view, and the dual view. According to the romantic view, informal firms are productive firms that are unable to reach their full potential due to excessive government regulation and taxation.[2] The other two views have a more negative perspective on the nature of informal firms. According to the parasite view, informal firms are unproductive firms that choose to gain competitiveness through the avoidance of government taxes and regulations.[3] This view considers informal firms to be actual competitors of formal firms, and their existence therefore hampers growth and productivity of formal firms. The dual view also portrays informal firms as unproductive firms but not as competitors of formal firms. According to the dual view, formal and informal firms operate in different markets, addressing the needs of a different customer bases.[4]

The dual view seems to be the one that has gained the most acceptance among economists. In fact, the very thorough and widely cited work of La Porta and Shleifer (2008) suggests that the empirical evidence is mostly consistent with the dual view. They find very large differences in productivity between formal and informal firms, which are unlikely to be merely

[2] La Porta and Schleifer (2008) associate the romantic view with the work of De Soto (1989, 2000).
[3] La Porta and Schleifer (2008) mention the work of McKinsey Global Institute as an example of this view. See, for example, Farrell (2004).
[4] This view relates to the work of Harris and Todaro (1970).

due to government regulation. Therefore, they argue that the data are not consistent with the romantic view. They also affirm that surveys results indicate that formal firms do not view competition from informal firms as a serious problem, which is inconsistent with the parasite view.

Even though formal firms might not view competition from informal firms as a serious problem, their presence might still influence the actions taken by formal firms. For example, formal firms might spend resources to distinguish or protect themselves from informal firms, which might reduce the productivity of formal firms. Most of the literature on firm formality has focused on the effects of the firm's formality status on its own performance (e.g., La Porta and Schleifer, 2008, and Fajnzylber, Maloney and Montes-Rojas, 2009). To the best of our knowledge, there is no work looking at the effects informal firms have on the behavior of other firms in the same sector.

This paper fills part of the knowledge gap just mentioned by studying whether sector-level informality affects firms' investment decision. Theoretically, the effect can be ambiguous. If informal firms are actual competitors of other firms, higher informality levels could lead to higher investments, as firms expand their capital stocks in order to achieve cost reductions to better compete with informal firms within the sector. On the other hand, if informality increases unfair competition and the probability of business failure, investment becomes more risky, reducing incentives to invest. Given this theoretical ambiguity, one needs to study the presence of informality externalities empirically.

Besides the direct effect of informality on investments, this paper also explores an indirect channel. Based on the results of Catão, Pagés and Rosales (2009) and Gandelman and Rasteletti (2012) among others, we conjecture that informality in a sector can have a negative effect on firm investment through the credit channel. The reason why exploring this channel seems worthwhile is the presence of asymmetric information in the credit market. The seminal work of Stiglitz and Weiss (1981) showed that informational asymmetries can lead to credit rationing. They also showed that the cost of credit and the extent of the rationing will vary across observationally different firms' groups, with groups that are less profitable from the lender's perspective experiencing higher credit rationing and costs. One dimension lenders use to group firms is their industry of operation. All else equal, if lenders conjecture that firms operating in sectors with a higher proportion of informal firm face more unfair competition, they can

differentially restrict the financing provided to firms in such sectors. If this is the case, even in cases where the extent of industry informality does not affect firms' actual performance directly, it can affect it indirectly through the credit channel.

There is an extensive literature testing whether credit constraints affect the firm investment decision. The early literature used aggregate data. One of the earliest empirical works highlighting the negative effect of financing constraint on investment is that of Meyer and Kuh (1957).The more recent literature is based on micro data. One of the first studies using micro data to test the effect of credit constraints in investment decisions is that of Fazzari, Hubbard and Petersen (1988); using the q, neoclassical, and accelerator models of investment, they find evidence that credit constraints negatively affect investment in the United States. De Brun, Gandelman and Barbieri (2003) apply a similar methodology to a dataset of Uruguayan firms and find evidence that financial restrictions affect the investment decisions of Uruguayan firms.

To test whether sector level informality affects the firm investment decision, either directly or indirectly, we present a simple investment decision model and test a departure from its fundamentals. Firms' past profits are not supposed to affect firm current investment in a context without credit constraints. If they do so, this is interpreted as evidence that firms need to generate internal financial resources to carry out investments, which in turn interpreted as evidence of financial restrictions. Sector informality is also not a fundamental in an investment decision and according to the pure theoretical model should not be statistically significant. The model is estimated using a dataset of Uruguayan firms, spanning the years 1997 through 2008. The advantage of using data from Uruguay to study the link between informality and investment is that it presents substantial variation in the variables of interest. In 2002, Uruguay experienced a severe economic and financial crisis, which was shortly followed by a period of rapid economic expansion. This gave raise to significant changes in informality and investment rates, both within and across sectors. This is convenient for identification, since informality tends to be a slow-moving variable.

The reason why the Uruguayan case is an interesting case study is that the Uruguayan economy presents some idiosyncrasies that distinguish it from other Latin American economies in regard to investment and informality. Uruguay stands out both for its low ratio of private investment to GDP as well as for its low levels of informality. According to data from the IMF World Economic Outlook (2012), over the last 30 years the ratio of gross private fixed capital

formation to GDP in Uruguay was always lower than the average observed in other Latin American and Caribbean countries.[5] Even though private investment increased substantially in Uruguay during the economic expansion after the 2002 economic crisis, it still remained at low levels when compared to other countries in the region.[6] In regard to informality, the local tax authority reports low levels of tax evasion. In the case of the value-added tax, which represents about half of Central Government revenues, evasion was estimated at 15 percent in 2010 (DGI, 2011), one of the lowest levels in the region. In respect to employment informality, the ILO (2011) reports that 39.8 percent of employees in Uruguay are informal, while the average for the other 15 Latin American countries reported was 58.7 percent.

This work contributes to the literature studying the interactions between informality, credit markets and firms' investment decision. There is a long strand of literature, dating at least back to Gurley and Shaw (1955) that tests the effect of financial constraints on the firm's investment decision. Hubbard (1998) and Bond and Van Reenen (2007) are excellent reviews of this literature. For the case of Uruguay, the effect of credit constraints on investment was studied by de Brun et al. (2003). This literature is nevertheless silent on the role of informality on the firm's investment decision. Meanwhile, the effects of credit constraints on informality have been studied by some recent IDB working papers. Catão, Pagés and Rosales (2009) and Gandelman and Rasteletti (2012) find that higher access to credit decreases informality in Brazil and Uruguay, respectively. Meanwhile, Morón, Salgado and Seminario (2012) and Caro, Galindo and Meléndez (2012) find either smaller or no effects for Peru and Colombia, respectively. To the best of our knowledge, there is no paper that looks at the effects of informality on the firm investment decision.

Our results suggest that financial restrictions affect investment decisions in Uruguay. We find that an increase in credit to the private sector translates into higher investment rates. A one-percentage point increase in overall credit growth translates into a one half percent increase in the investment rate. We also find that, even though there is no direct effect of informality on the firm investment decision, there is an indirect effect through the borrowing channel. More specifically, we find that financial restrictions reduce the amount of investment undertaken by

[5] The average ratio for Uruguay over the period is 10.7 percent, while the average ratio for the other 27 countries included in the sample is 14.9 percent

[6] Only 10 countries presented ratios of private fixed capital formation to output lower than that observed for Uruguay. All these countries have GDP per capita significantly lower than Uruguay (Barbados, Bolivia, Dominica, Dominican Republic, El Salvador, Guyana, Paraguay, Suriname, Trinidad and Tobago and Venezuela).

Uruguayan firms, with the effect being smaller if the firm operates in a sector with lower informality.

The rest of this paper is organized as follows. Section 2 describes the different data sources as well as the main variables used in the empirical analysis. Section 3 describes several relevant events that took place in Uruguay, which helps in understanding the evolution of investment and informality in the period under consideration. The section also presents descriptive statistics on the variables of interest. In Section 4 we present an economic model of firm investment decisions. Extensions of the model's optimality conditions allow the equations to be estimated econometrically. Section 5 discusses the econometric model and estimation methods used. It also presents the econometric results and robustness checks. Finally, conclusions are presented in Section 6.

2. Data

The data used in this study are drawn from two sources. All the information on firms comes from the Encuesta Anual de Actividad Económica (Economic Activity Survey). The data on sector level informality are produced using the Encuesta Continua de Hogares (Continuous Household Survey). We now describe in more detail these datasets as well the variables to be used in the empirical section.

2.1 Firm Data

The dataset on firms is an unbalanced panel containing annual observations spanning the years 1997-2008. The panel was constructed from the annual Economic Activity Survey, a dataset produced by the National Statistics Institute. The survey gathers information at the firm level, and it adequately covers the manufacturing, commerce, hotels and restaurants, transportation and communication services, education and health services sectors. The three main sectors not covered in the survey are the financial sector, agriculture and construction. Only firms with more than five employees are covered in survey.

The Economic Activity Survey is based on the 1997 Economic Census. The sampling method is stratified sampling. All firms with 50 employees or more are included in the survey. Firms with less than fifty employees but with sales above a certain threshold are also included in

the sample.[7] Probabilistic samples are drawn for the strata covering firms with less than 50 employees. These probabilistic samples are representative of each four-digit International Standard Industrial Classification (ISIC) sector.

The survey collects detailed information on sales, revenues and expenditures as well as on the number of employees and their remuneration. In regards to investment, the survey divides investments into three groups: land and construction, machinery and equipment, and others, which includes intangibles (trademarks, patents and royalties). The INE gathered the data, but the panel had many problems, including lack of adequate deflators. A team of researchers leaded by Carlos Casacuberta from the Universidad de la República transformed several years of firm data in nominal terms into a homogenized database where all definitions (output, employment, etc.) were consistent and where nominal variables were deflated. For this task industry deflators were constructed to obtain constant price measures of output and intermediate consumption. Capital stocks were obtained by adding investment at constant prices and applying depreciation rates by the perpetual inventory method. Definitions of variables and valuation were made compatible across years. The estimations in this paper are carried out using machinery and equipment investment, since the other two are much more affected by accounting practices.

For the purpose of this paper, the two main drawbacks of the survey are that it does not gather information on firms' credit sources. The surveys do not gather balance sheet information either, which forces us to compute a proxy for the firm's profits.

The coverage of the surveys also varies substantially across years. Between 1997 and 1999 about 1,400 firms were included in the survey each year. Between 2000 and 2005 the number of firms included increased, to an average of 2,100 firms per year. Since then, the number of firms surveyed fell considerably. Only 783 firms were surveyed in 2006, a figure that then rose somewhat to 971 in 2007 and 1,034 in 2008. This drop in the sample size is mainly due to reduction in the sample size of the strata of firms with less than 50 employees. The size of the sample of firms with more than 50 employees did not change significantly in those years.

2.2 Measuring Informality

Measuring the extent of informality in a sector is an inherently difficult task, mainly due to misreporting biases. There are also different forms of informality. On the one hand, an economy

[7] The threshold is updated following local inflation. In 1997, the threshold was 10 million 1996 pesos (roughly 1.2 million 1996 US dollars).

can have unregistered firms, which do not report any type of activity to the tax authorities. On the other hand, there can be registered firms that only report part of their activities to the authorities. In this paper, since we are interested in studying the effect of unfair competition on investment, we are interested in any type of underreporting, regardless of the registration status of the firm.

Given the lack of datasets gathering information on firm formality in Uruguay, most of the literature on this subject has focused on employment informality, which can be measured from household surveys. Clearly, employment informality and firm informality are different concepts. Many formally registered firms can hire workers informally or fail to declare their full compensation. Similarly, firms with formal workers might fail to declare part of the revenues to the authorities. Despite these differences, one would expect employment informality and firm informality to be highly correlated, as tax authorities could detect inconsistencies between output and employment levels. We therefore decide to use employment informality in a sector as a proxy for informality in that same sector.

The informality measures used in this paper are the same as in Gandelman and Rasteletti (2012). They create three different variables of sector-level employment informality, based on commonly used definitions of employment informality. According to local regulations, all workers must pay social security taxes; they also have rights to an "aguinaldo"[8] and to health coverage by a private HMO. Based on these regulations, they create three measures informality, which they call social security, aguinaldo and health-rights. The health-rights measure can be constructed for all the years for which we have firm-level data, but the other two measures can only be constructed from 2001 onwards.

To create the sector level measures of informality, Gandelman and Rasteletti (2012) use data from Household Surveys (ECH),[9] also produced by Uruguay's National Institute of Statistics (INE). They follow a two-step procedure. First, they classify every worker in the sample as informal according to the social security measure if he or she does not pay social security taxes. A similar procedure is followed for the aguinaldo and health-rights measures, classifying workers as informal if they do not receive an aguinaldo and do not have coverage of a

[8] The "aguinaldo" is a thirteenth salary that Uruguayan formal workers are entitled to by law. Half of this extra salary is paid in June and the other half is paid in December.

[9] The Continuous Household Survey covers households in every urban area with a population over 5,000. The survey has detailed information on all household members.

private HMO, respectively. Second, they construct the sector-level variables by calculating the proportion of informal workers in different economic sectors and years. These proportions are calculated only for workers that are 14 years of age or older. Sectors with less than 50 workers in the sample are dropped, due to representativeness concerns.

It is important to highlight that these variables are likely to suffer from some misclassifications. In particular, the social security and, to a lesser extent, the aguinaldo measures are likely to suffer from an underreporting problem. This is less of a concern for health coverage, since the question appears in a section of the survey not related to the income or work sections. On the other hand, this measure fails to capture those informal workers that pay their HMOs out-of-pocket. Despite the drawbacks just mentioned, Gandelman and Rasteletti (2012) report that all three measures of informality are highly correlated, presenting correlations among themselves above 0.9.

2.3 Bank Credit

To study how credit availability affects investment levels, we focus on banking credit, as it is the most important source of external funding for firms in Uruguay (e.g., Munyo, 2005). As mentioned above, the firm-level dataset used in this paper does not have information on either credit used or on credit sources available to firms. But even if those data were available, their usefulness would probably be limited due to an endogeneity problem.

The data on credit to the private sector are produced by the Superintendency of Financial Services, which is part of the Central Bank. The credit measure includes the stock of credit provided by private and public banks. The data are published as a time series with monthly observations. Given that for all the other data we have annual information, we construct our measure of credit in a given year as the annual average of the monthly stocks.

3. An Overview of the Uruguayan Economy and Descriptive Results

3.1 Firm Size Distribution

The distribution of firms in Uruguay is concentrated in small firms. According to the National Statistical Institute (INE), in the time period covered in our sample, about 84 percent of firms had 4 employees of less. Another 13 percent of firms had between 5 and 19 employees, and only 0.5 percent had more than one hundred employees. About 38 percent of firms were operating in

the retail and wholesale trade sector. Firms in the transportation and telecommunications sector represented about 13 percent of all firms, and those in the manufacturing sector another 11 percent. The distribution of firms changed substantially in the period under consideration. In the years after the economic crisis the share of firms with less than 5 employees experienced a spike, reaching almost 90 percent of all firms in 2003. In the period after the crisis, the distribution became more dispersed. The share of firms with less than 5 employees fell to 83 percent in 2003. Meanwhile, the share with firms with 20 or more employees increased to 3 percent in 2008, up from 1.9 percent in 2003.In respect to sector composition, in the aftermath of the economic crisis the share of firms in trade and manufacturing substantially declined, later recovering in the expansionary period.[10]

In regard to the use of external financing, Uruguayan's firms have characterized themselves for their little use of bank credit as a source of finance. A 2008 survey of the Ministry of Industry, Energy and Mining reveals that 96 percent of micro, small and medium enterprises do not use bank financing, retained earnings being the main source of investment financing. In regard to bank loans for investment financing, the survey reveals that only 3.2 percent of firms with 5 to 19 employees used it. This figure increases to 9.5 percent for firms with 20 to 99 employees. The low figures might be related to the lack of a well-developed microfinance sector in Uruguay and the high cost of credit.[11]

3.2 Investment, Credit and Informality over the Business Cycle

The rates of both investment and informality have varied significantly in Uruguay in the period covered by the dataset. This is mainly explained by the severe economic crisis that hit the country in mid-2002 and the rapid recovery observed in the aftermath of the crisis. The Uruguayan crisis is closely linked to a crisis experienced a few months earlier by Argentina, a neighboring country. Before the crisis, Argentina maintained a currency peg that guaranteed the conversion of one peso to one dollar. After a few years of recession and real currency appreciation, however, the public started to doubt the Central Bank's ability to keep the peg in place. This fear eventually led to large purchases of dollars and a bank run. The Government was

[10] The shares of firms in retail and wholesale trade and manufacturing in 2003 were 30 percent and 9 percent, respectively. These figures increased to 38 percent and 13 percent in 2008.

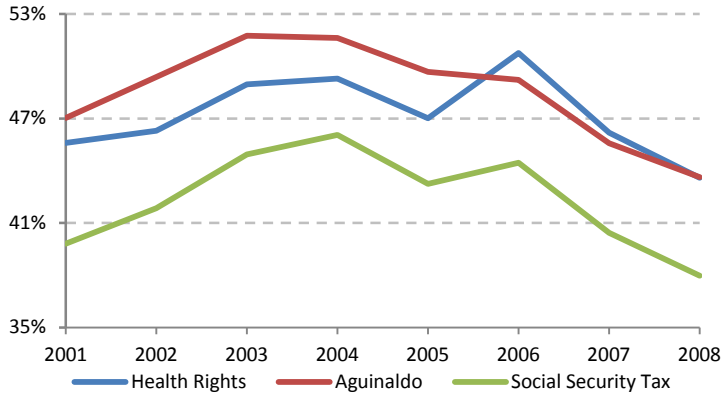
[11] Figures from the BCU indicate that the interest rate on dollar loans paid by firms averaged 9.3 percent in the period under study. Real interest rates on local currency loans averaged 38 percent.

finally forced to leave the peg and to default on its debt, which led to a large currency devaluation.

The bank run in Argentina soon after spread to Uruguay, as a large number of Argentines had deposits in the Uruguayan banking system and Uruguay was itself going through a recession at the time of the Argentine crisis. The Uruguayan Government was also forced to let the currency experience a large depreciation and to restructure its sovereign debt. During the year of the crisis, Uruguayan GDP fell by 7.7 percent and grew by a mere 0.8 percent in 2003. This, added to the 7.5 percent contraction experienced during the 1999-2001 recession, implied that at the end of 2003 the Uruguayan economy was 14 percent smaller than it was in 1998. After the crisis, the Uruguayan economic entered a period of rapid expansion, with an average growth rate of 6 percent between 2004 and 2008.

This economic dynamic led to movements in unemployment and informality. The unemployment rate, which averaged 9.9 in December 1998, climbed to 19.4 percent in March 2003. Once the economic recovery started, the unemployment rate started to fall, reaching 7 percent by the end of 2008. Employment informality followed a similar trajectory (see Figure 1), although it continued to increase for an extra year after unemployment peaked. The fall in informality was particularly rapid starting in 2006.

Figure 1. Employment Informality in Uruguay

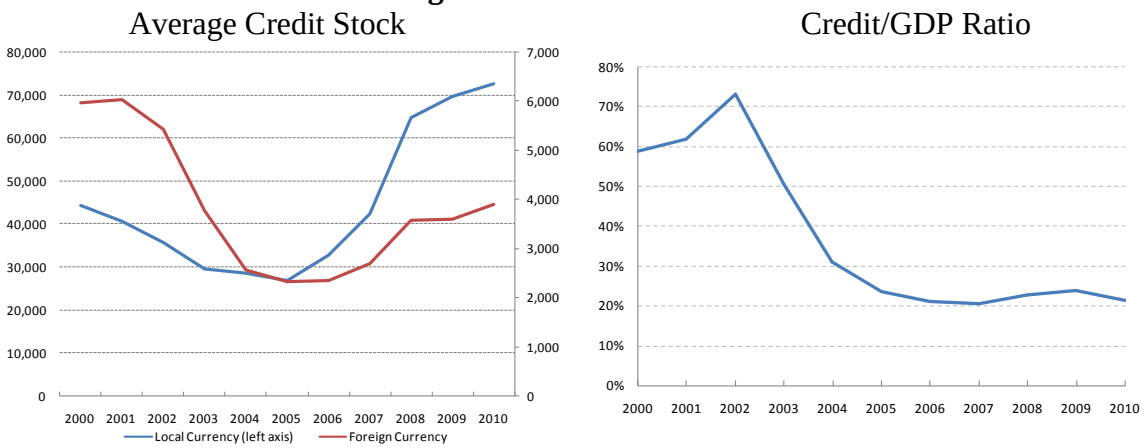


Source: Authors' compilation based on household surveys.

The loss of deposits during the crisis led banks to cut down on credit. In 2002 the stock of dollar-denominated credit (which accounted for about two-thirds of total credit) dropped by 16.1 percent. The stock of dollar credit continued falling until October 2006, and as of October 2011

it had still not returned to its pre-crisis peak (see Figure 2, left panel). Meanwhile, the stock of peso-denominated credit dropped by 12.8 percent in 2002 and continued falling until February 2005, only returning to its pre-crisis peak in December 2007. Despite the recovery, credit growth tended to fall behind growth in activity. Credit to GDP fell every year between 2002 and 2007, and by the end of 2010 the ratio of credit to GDP stood at barely one third of its pre-crisis level (see Figure 2, right panel).

Figure 2. Credit Evolution



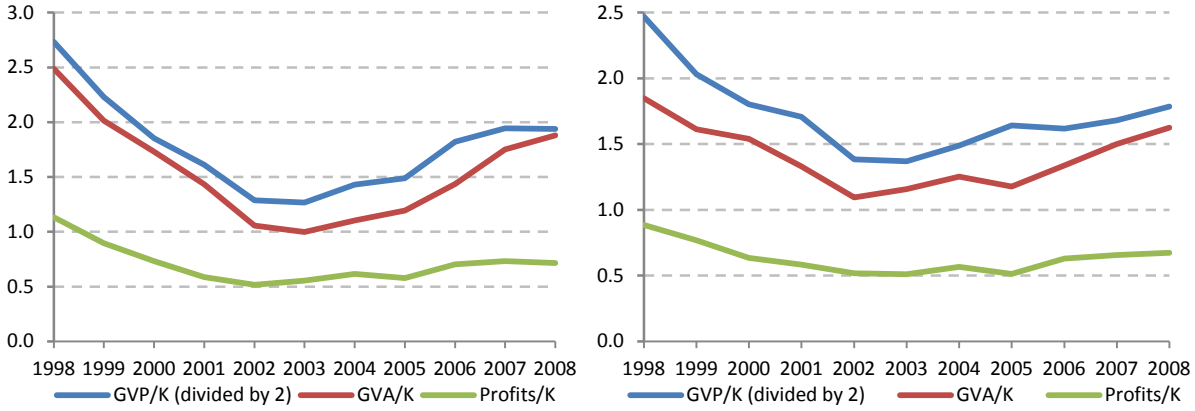
Source: Authors' compilation based on Banco Central del Uruguay data

The economic crisis also had a sizeable impact on the performance of firms. Figure 3 below shows the evolution of gross value of production (GVP), gross value added (GVA) and profits[12] as a share of the median firm's capital stock. We present the figure for all firms as well as for firms that are present in every year in the sample. The evidence suggests that returns on the capital invested in the firm decreased substantially during the period of the economic recession and economic crisis. After the crisis, these indicators started improving, but they did not reach pre-crisis levels.

[12] Gross value added is defined as gross value of production minus material inputs used in productions. Profits deduct salaries from the gross value added.

Figure 3. Firm Performance

All Firms (Medians) Continuing Firms (Medians)

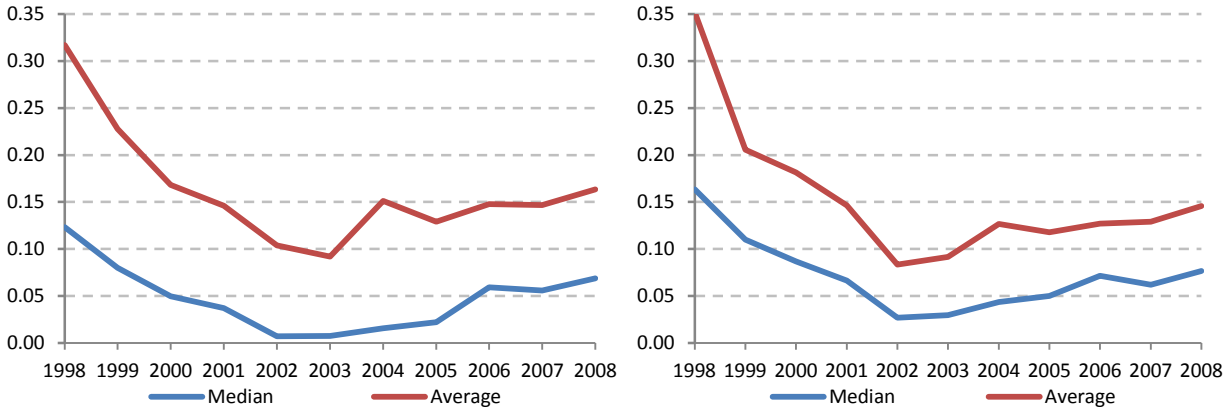


Source: Authors' compilation based on INE data.

A similar trajectory can be observed for investments. The overall investment rate, defined as the ratio of investments to capital stock, experienced a large drop during the recession and crisis (see Figure 4). This fall is in part due to the fact that a lower proportion of firms were undertaking investments (see Figure 5). While 82 percent of firms undertook some kind of investment in 1998, that ratio had dropped to 62 percent in 2002. After the crisis the investment recovered, with 90 percent of firms undertaking some kind of investment in 2008. However, the average investment rate did not reach the levels observed in 1998.

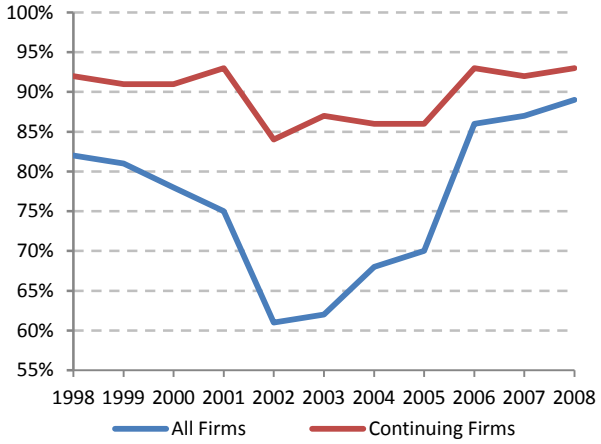
Figure 4. Investment Rates

All Firms (Investment Rates) Continuing Firms (Investment Rates)



Source: Authors' compilation based on INE data.

Figure 5. Percentage of Firms Undertaking Investments



Source: Authors' compilation based on INE data.

3.3 Industry Variation

To explore the effect of informality on investment, we exploit not only the time dimension but also differences across sectors. In regard to informality in Uruguay, it varies widely across sectors (see Table A1 in the Appendix). While in some sectors informality is almost nonexistent (e.g., manufacturing of vehicles) in others informality is very high (e.g., retail, furniture). The reaction of informality to the economic crisis also varied considerably across sectors. While in most sectors informality spiked during the crisis, subsequently falling in the recovery, the size of the spike varied considerably. In a few sectors informality did not show a spike (e.g., textiles, supporting transport activities).

Investment also varies considerably across sectors (see Table A2 in the Appendix). In some sectors the median investment rates of firms is low across years (e.g., education). In others, the median investment rate is relatively high (e.g., tanning). As in the case of informality, the reaction of the median investment rate during the economic crisis differed widely over sectors. For some sectors the median investment fell sharply (e.g., wholesale) while in others the median investment rate actually increased (e.g., motor vehicles).

Interestingly, the informality in a sector and the median investment rate seem to be correlated. Table 1 shows the results of projecting the median investment rate on industry dummies and sector informality, introduced one at a time. Sectors with lower informality tend to present higher median investments ratios. The correlation is also present in differences. That is to

say, sectors that experienced increases in informality also tended to experience a drop in the median investment rate. Clearly, these correlations do not imply causation, as negative sectoral shocks can lead to simultaneous drops in formality and investment. The following section studies the link between sectoral formality and investment more carefully.

Table 1. Correlations between Formality and Median Investment Rates

	In Levels			In Differences		
	Coefficient	Std. Err.	p-value	Coefficient	Std. Err.	p-value
Health-Rights	0.08	0.04	0.05	0.06	0.03	0.06
Aguinaldo	0.18	0.03	0.00	0.11	0.03	0.00
Social Security	0.14	0.04	0.00	0.08	0.03	0.00

4. An Economic Model of Firm Investment Decisions

To test whether the extent of informality in a sector affect the firm's investment decision, we follow a methodology that has already an established tradition based on the seminal contribution by Fazzari et al. (1988).[13] The basic idea is to test whether, besides fundamentals, other variables that proxy for sector informality affect firm's investment decisions.

Standard neoclassical firm theory assumes that firms choose their level of gross investment (I_t), intermediate inputs (M_t) and labor input (N_t) in order to maximize the discounted value of current and future profits. The firm problem can then be represented with the following maximization problem:

$$\max_{\{I_t,N_t,M_t\}} \left\{ \sum_t \left(\frac{1}{1+r}\right)^t \left[p_t F(K_t, N_t, M_t) - rK_t - wN_t - mM_t - p_t^K I_t\right] \right\} \quad (1)$$

subject to

$$K_t = (1-\delta)K_{t-1} + I_t \quad (2)$$

where $F(\cdot)$ is a production function, K_t is the physical capital stock, δ is the depreciation rate of physical capital and r is the discount rate (as well as the rental price of physical capital). *m* is the

[13] See Hubbard (1998) for an early survey of the literature and Bond and Van Reenen (2007) for the newer additions to this literature. The latter work presents a generalized version of the model here presented and illustrates how this framework can be used to test for, besides financial restrictions, other variables affecting firm performance.

price of intermediate inputs, and w is the wage paid to employees. The price of the good produced by the firm is p_t, and p_t^K is the price of a unit of physical capital.

Under the assumption of perfect access to capital markets, the first order condition of the maximization problem with respect to investment establishes that at an optimum

$$F_K(K_t, N_t, M_t) = \frac{r}{p_t} + \left(\frac{1-\delta}{1+r}\right)\frac{p_{t+1}^K}{p_t} - \frac{p_t^K}{p_t} = uc_t \tag{3}$$

where uc_t denotes the user cost of capital. Assuming the value-added function takes the CES functional form:

$$Y_t = F(K_t, N_t) = A_t\left[\alpha K_t^{\frac{\sigma-1}{\sigma}} + \beta N^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{4}$$

equation (3) becomes

$$A_t\left[\alpha K_t^{\frac{\sigma-1}{\sigma}} + \beta N^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1} \alpha K_t^{-\frac{1}{\sigma}} = uc_t \tag{5}$$

or simply

$$k_t = y_t + h_t \tag{6}$$

where $k_t = log(K_t)$, $y_t = log(Y_t)$, and $h_t = \sigma log(\alpha) - (1-\sigma)logA_t - \sigma log(uc_t)$. Equation (6) then establishes that at an optimum, the stock of physical capital is a function of the gross value added, the user cost of capital and the parameters of the production function.

The problem with the model described above is that changes in the user cost of capital or the productivity parameter A_t lead to very rapid adjustments in the capital stock. These rapid adjustments in capital do not tend to be observed in the data. Given this feature of the data, several authors have extended the model above to include adjustment costs (Abel, 1982; Hayashi, 1982) and non-convexities (Abel and Eberly, 1994; Cooper and Haltiwanger, 2006). These models lead to adjustment processes that are not instantaneous. To allow the econometric model to account for slow adjustment processes, we specify a dynamic adjustment mechanism between capital and output as an autoregressive distributed lag of length two:

$$k_{it} = \alpha_0 + \gamma_1 k_{it-1} + \gamma_2 k_{it-2} + \beta_0 y_{it} + \beta_1 y_{it-1} + \beta_2 y_{it-2} + h_{it} \tag{7}$$

This equation is more flexible and nests equation (6). Imposing that the long-run elasticity of capital to output be 1 as in equation (6), equation (7) can be rewritten in error correction form as:

$$\Delta k_{it} = \alpha_0 + (\gamma_1 - 1)\Delta k_{it-1} + \beta_0 \Delta y_{it} + (\beta_1 - \beta_0)\Delta y_{it-1} + (\gamma_2 + \gamma_1 - 1)[k_{it-2} - y_{it-2}] + h_{it} \tag{8}$$

Therefore, equation (8) establishes that the growth rate of capital depends on past capital growth, the growth rate of output, the error correction term between output and capital, and the user cost of capital.

As mentioned above, this model assumes that firms have perfect access to capital markets. If this is not the case, other variables measuring the extent of access to finance will also explain levels of firms' investments. To account for the possibility of credit constraints, we follow the literature and extend equation (8), allowing the firm's own resources to explain investments. In particular, we allow investment to depend on previous profits (π_{it}), so that

$$\Delta k_{it} = \alpha_0 + (\gamma_1 - 1)\Delta k_{it-1} + \beta_0 \Delta y_{it} + (\beta_{1-}\beta_0)\Delta y_{it-1} + (\gamma_2 + \gamma_1 - 1)[k_{it-2} - y_{it-2}] + \sum_{j=t-1}^{t-T} \varphi_t \pi_{ij} + h_{it} \quad (9).$$

Positive values of φ_t are interpreted as proof of existence of financial constraints.

5. Econometric Model and Results

5.1 Estimation Issues

In the estimation of equation (9) we include year dummies and firm fix effects, which should capture part of the variation in the user cost of capital. The dependent variable (difference of the log of capital) Δk_{it} is proxied by the ratio of investment to capital $\frac{I_{it}}{K_{it-1}}$ as is commonly used in the empirical investment literature. Since this is a growth rate normalized by previous capital stock, the past profit term is also introduced as a ratio of profit over capital, $\frac{\pi_{it-1}}{K_{it-2}}$. Finally, we extend equation (9) to allow for sector formality to affect investment. We include the sector level formality both alone and interacted with firms' previous profits, our proxy for credit constraints.

With the modifications mentioned above, the error-correction specification equations estimated are variations of:

$$\frac{I_{it}}{K_{it-1}} = \alpha_0 + (\gamma_1 - 1)\frac{I_{it}}{K_{it-1}} + \beta_0 \Delta y_{it} + (\beta_1 - \beta_0)\Delta y_{it-1} + (\gamma_2 + \gamma_1 - 1)[k_{it-2} - y_{it-2}] + \\ + \varphi_1 \frac{\pi_{it-1}}{K_{it-2}} + \varphi_2 f_{it} + \varphi_3 f_{it} \frac{\pi_{it-1}}{K_{it-2}} + \eta_{it} \quad (10)$$

where $\eta_{it} = \alpha_i + d_t + \varepsilon_{it}$.

The equations above cannot be estimated by OLS since it is likely that dependent variable and some of the explanatory variables are simultaneously determined. Equation (10) is a linear dynamic panel data model with one lag of the dependent variable as a covariate. It contains unobserved panel-level effects that by construction are correlated with the lagged dependent variables, making OLS estimators inconsistent. A possible alternative is the method developed

by Arellano and Bond (1991) that produces a consistent GMM estimator. The procedure (called the difference estimator) relies on the idea that internal lagged variables, if they are not correlated with future error terms, can be used as instruments. Blundell and Bond (1998) point out that this GMM estimator might be unreliable and biased in small samples. In particular, this problem arises when there is high persistence in the explanatory variables—as is likely the case here—because the lagged levels would be weak instruments of the first differences. In order to address this problem, we implement the system GMM method developed by Arellano and Bover (1995) and Blundell and Bond (1998).

5.2 Results

Tables 2 and 3 show the results from the estimation of various versions of the error correction representation of machinery investment. We present a Sargan test whose null hypothesis is that the overidentifying restrictions are valid. When the idiosyncratic errors are i.i.d., the first differenced errors must present first order serial correlations but not second order correlation. The reported p-values for these tests support the different specifications.

Column A1 of Table 2 presents the basic error correction. As expected, there is a positive correlation between current and past investment and between current and past output growth. This suggests that firms whose sales are growing invest more. The negative sign of the error correction term suggest that short-run deviations from the optimal capital to output ratio are adjusted in the longer run.

Before extending the model to test for financial restrictions in column A2 we include credit growth in the whole economy. Our data does not have information on firm's credit; which in any case would be endogenous to the investment decision. Given the size of firms, credit growth for the private sector of the whole economy can reasonably be considered exogenous to the firm's investment decision. The 0.420 estimated coefficient suggests that a one point increase in credit to the private sector translates into about a half point increase in the rate of investment.

Column B1 and B2 augments both previous error correction representations with past profits. The statistically significant positive coefficient suggests that firms suffer from financial restrictions. Columns C1 and C2 splits the effect to address possible firm size and crisis effects. Past profits are interacted with a dummy variable that takes the value 1 for larger firms (top third by output) and also with a variable reflecting country risks. The source for country risk is

República AFAP. It is measured daily as the average spread between the yield of Uruguayan and US bonds. Larger spreads are a reflection of worse economic conditions and higher financing cost for the private sector. At the beginning and end of our period of study this variable was around 200-300 basis points, but during the 2002 crisis it rose by more than 2,000 basis points. In our estimation we use the annual average. Our results suggest that larger firms suffer less from financial restrictions than smaller firms. This result is common in the literature. More surprisingly, we fail to find evidence that financial restrictions were tighter during the 2002-2003 crisis. In column C2 credit growth is not statistically significant. This is probably because it is highly correlated with the crisis variable.

Table 2. The Error Correction Investment Model

	(A1)	(A2)	(B1)	(B2)	(C1)	(C2)
Lag investment rate	0.0308**	0.0310**	0.0301**	0.0298**	0.0348**	0.0355**
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]
Output growth	0.0590***	0.0554***	0.0600***	0.0568***	0.0485**	0.0490**
	[0.020]	[0.020]	[0.020]	[0.020]	[0.021]	[0.021]
Lag output growth	0.103***	0.0968***	0.0989***	0.0942***	0.0832***	0.0835***
	[0.023]	[0.023]	[0.023]	[0.023]	[0.024]	[0.024]
Error correction term	-0.0693***	-0.0617**	-0.0667**	-0.0605**	-0.0510*	-0.0514*
	[0.026]	[0.027]	[0.026]	[0.027]	[0.027]	[0.027]
Credit growth		0.420*		0.398*		-0.0347
		[0.24]		[0.24]		[1.74]
Lag profit			0.00199*	0.00185*	0.00457**	0.00457**
			[0.0011]	[0.0011]	[0.0018]	[0.0018]
Lag profit * Size					-0.00383*	-0.00373*
					[0.0021]	[0.0021]
Size (dummy top 33%)					-0.00000144	-0.00000146
					[0.0000013]	[0.0000013]
Crisis (country risk)					0.0565	0.0559
					[0.038]	[0.038]
Lag profit * Crisis					-0.000973	-0.00098
					[0.00051]	[0.0037]
Observations	11030	11030	11019	11019	11019	11019
Number of firms	2022	2022	2021	2021	2021	2021
Sargan (pvalue)	0.155	0.138	0.166	0.141	0.159	0.150
ar1 (pvalue)	0.000	0.000	0.000	0.000	0.000	0.000
ar2 (pvalue)	0.182	0.263	0.196	0.2686	0.278	0.285

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

In Table 3 we present our main results on the interaction of formality, credit and investment.[14] Regarding the effect of sector-level informality on investment, we fail to find a

[14]We also estimated these specifications including credit growth as an additional control. The results were about the same. In the social security estimation, the credit growth variable was dropped from the estimation due to collinearity, therefore we prefer to present all estimations without credit growth.

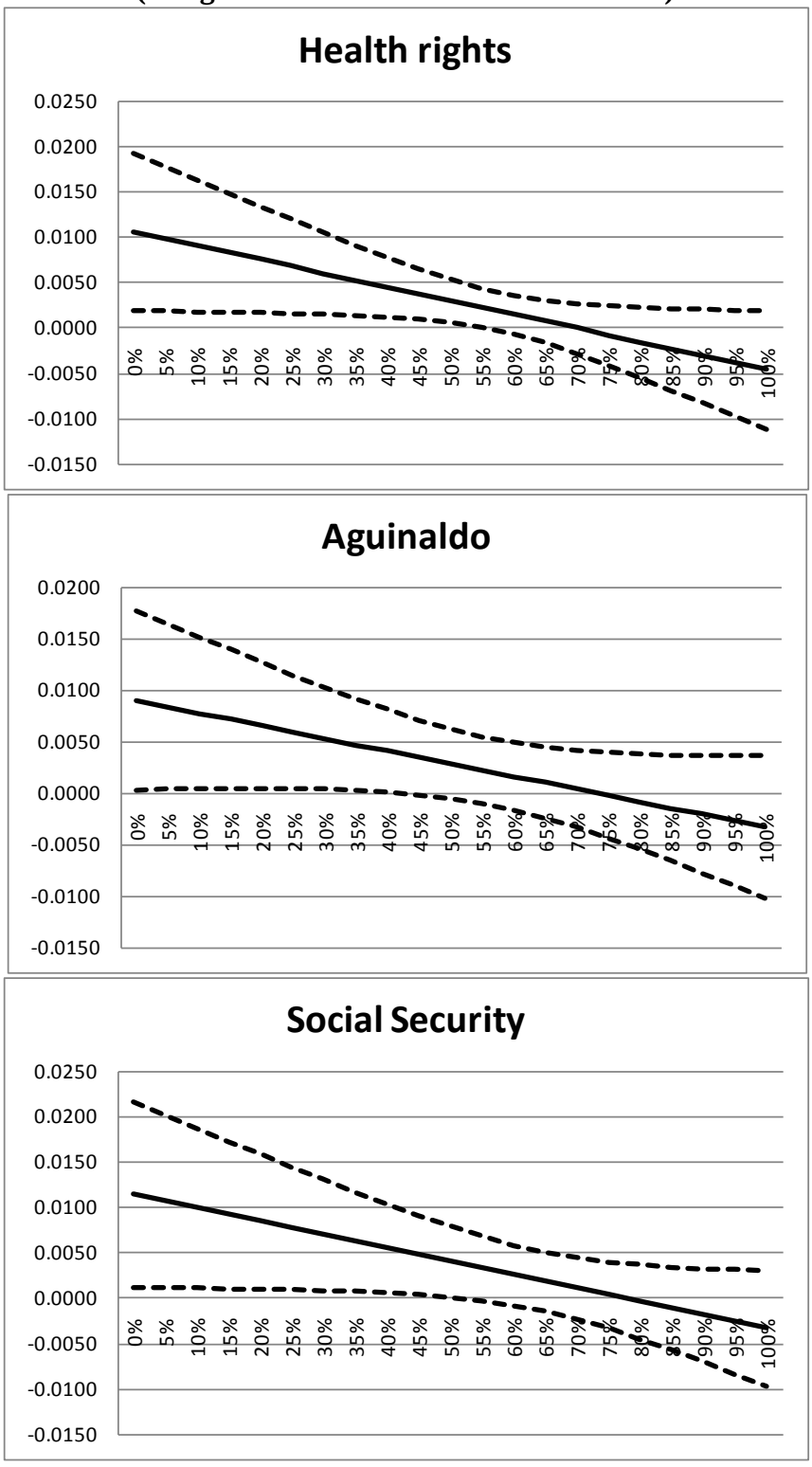
direct effect on investment (columns A, B and C). Nevertheless our results suggest an indirect effect since the interaction term (columns D, E and F) between formality and past profits is statistically significant at traditional significance levels. The coefficient of past profit is positive and statistically significant. This coefficient alone suggests that firms that had larger profits in the past tend to make larger investments. This use of generated cash flows is interpreted as evidence of financial restrictions. The interaction terms with formality has a negative sign. This suggests that the financial restrictions are lower in more formal sectors than in more informal sectors. Our results also suggest that sectors with full formality (formality =100 percent) do not experience financial restrictions at all. This follows form the estimated coefficient for the interaction being of about the same size (or larger) in absolute value than the coefficient for lagged profits. Figure 6 presents the marginal effects in graphical form. The confidence intervals for the three estimations suggest that credit constraints are not statistically significant for formality levels above 50 percent.

Table 3. The Error Correction Investment Model with Formality

	Health (A)	Aguinaldo (B)	Soc.Sec. (C)	Health (D)	Aguinaldo (E)	Soc.Sec. (F)
Lag investment rate	0.0308**	0.0430***	0.0426***	0.0308**	0.0451***	0.0448***
	[0.015]	[0.016]	[0.016]	[0.015]	[0.016]	[0.016]
Output growth	0.0590***	0.0385*	0.0391*	0.0601***	0.0395*	0.0397*
	[0.020]	[0.021]	[0.021]	[0.020]	[0.022]	[0.021]
Lag output growth	0.103***	0.0781***	0.0788***	0.0981***	0.0730***	0.0728***
	[0.023]	[0.025]	[0.025]	[0.023]	[0.025]	[0.025]
Error correction term	-0.0695***	-0.0588**	-0.0600**	-0.0658**	-0.0535*	-0.0540*
	[0.026]	[0.029]	[0.029]	[0.026]	[0.030]	[0.030]
Formality	-0.0139	0.117	0.0667	0.00202	0.124	0.0776
	[0.14]	[0.16]	[0.18]	[0.14]	[0.16]	[0.18]
Lag profit				0.0106**	0.00895**	0.0115**
				[0.0044]	[0.0044]	[0.0052]
Lag profit * Formality				-0.0152**	-0.0122*	-0.0148*
				[0.0074]	[0.0072]	[0.0077]
Observations	11030	9054	9054	11019	9047	9047
Number of firms	2022	1960	1960	2021	1959	1959
Sargan (pvalue)	0.139	0.172	0.162	0.150	0.168	0.158
ar1 (pvalue)	0.000	0.000	0.000	0.000	0.000	0.000
ar2 (pvalue)	0.188	0.138	0.136	0.214	0.155	0.151

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

Figure 6. Financial Restrictions by Formality Level
(marginal effect and confidence intervals)



6. Conclusions

Previous research on Latin American countries has shown that formality and credit availability are positively correlated. That research has also found the existence of financial restrictions for firm investment. Sectors with greater formality are sectors that have greater access to credit from the banking system, but this not necessarily translates into investment decisions. In this paper, we study whether sector formality and credit constraints affect a firm's investment decision. Our results for the effects of credit constraints on investment are in line with previous research for Uruguay, which suggests that Uruguayan firms' external financial sources are scarce. We find that increases in credit to the private sector translate into increases in the investment rate. We also find that firms need to generate internal funds in order to finance their investment projects, which the literature on investment equations usually interprets as a financial constraint for firm growth.

Our results on informality suggest that sector level informality does not have a direct effect on firm's investments but we do find it has an indirect impact through the credit channel. The reduction in investment produced by financial restrictions is larger for firms operating in sectors with larger employment informality. This could be the result of asymmetric information between firms and the banking system. Banks have a noisy signal of each firm's behavior but a better view of the sector as a whole. Therefore, banks may update the firm signal with what they know about the sector and affect negatively those in more informal sectors. We believe this negative spillover is another negative effect of informality not previous mentioned in the literature.

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Table A1. Summary Statistics of Alternative Measures of Informality

ISIC	Sector	Health Rights			Salary Bonus "aguinaldo"			Social Security Tax		
		2001	2005	2010	2001	2005	2010	2001	2005	2010
15	Manufacture of food products and beverages	30.49%	30.40%	24.95%	26.81%	25.37%	17.13%	27.21%	28.34%	19.38%
17	Manufacture of textiles	30.49%	38.35%	44.97%	31.71%	38.35%	48.66%	30.49%	39.10%	48.66%
18	Manufacture of wearing apparel	72.09%	73.13%	64.56%	74.27%	75.47%	69.51%	69.17%	73.36%	68.24%
19	Tanning and dressing of leather	33.33%	25.23%	28.20%	31.85%	27.03%	25.56%	29.63%	24.32%	22.56%
20	Manufacture of wood and of products of wood and cork	65.05%	67.50%	51.93%	64.08%	70.00%	45.61%	61.17%	67.50%	49.12%
21	Manufacture of paper and paper products	25.00%	28.57%	13.14%	25.00%	22.45%	10.22%	25.00%	28.57%	8.76%
22	Publishing, printing and reproduction of recorded media	27.08%	34.42%	24.71%	26.39%	33.77%	21.76%	23.61%	31.82%	17.94%
24	Manufacture of chemicals and chemical products	12.15%	13.81%	14.49%	10.50%	11.60%	5.94%	9.39%	12.15%	5.94%
25	Manufacture of rubber and plastics products	11.58%	13.16%	14.96%	10.53%	11.84%	5.56%	10.53%	13.16%	7.26%
26	Manufacture of other non-metallic mineral products	66.95%	74.44%	55.76%	65.25%	73.33%	52.04%	64.41%	72.22%	52.42%
27	Manufacture of basic metals	30.77%	40.00%	35.71%	38.46%	20.00%	21.43%	23.08%	30.00%	28.57%
28	Manufacture of fabricated metal products	45.97%	45.41%	41.15%	47.58%	47.96%	40.63%	40.73%	43.37%	37.67%
29	Manufacture of machinery and equipment n.e.c.	29.27%	31.58%	28.05%	31.71%	39.47%	36.59%	29.27%	26.32%	28.66%
31	Manufacture of electrical machinery and apparatus n.e.c.	33.33%	31.25%	24.32%	27.78%	31.25%	10.81%	33.33%	25.00%	9.46%
32	Manufacture of radio, television and communication equip.	40.00%	30.00%	9.09%	40.00%	20.00%	18.18%	40.00%	10.00%	18.18%
33	Manufacture of medical, precision and optical instruments	10.53%	53.57%	30.59%	26.32%	60.71%	43.53%	5.26%	46.43%	22.35%
34	Manufacture of motor vehicles, trailers and semi-trailers	0.00%	0.00%	3.03%	14.29%	7.69%	0.00%	0.00%	0.00%	0.00%
35	Manufacture of other transport equipment	48.39%	57.45%	48.48%	61.29%	59.57%	50.00%	48.39%	51.06%	39.39%
36	Manufacture of furniture; manufacturing n.e.c.	70.43%	74.63%	64.93%	73.48%	77.21%	71.64%	66.52%	73.90%	66.27%
50	Sale, maintenance and repair of motor vehicles & fuel	51.40%	53.53%	48.61%	53.88%	55.13%	49.82%	47.20%	51.44%	45.91%
51	Wholesale trade	31.03%	41.23%	34.07%	31.66%	44.55%	31.09%	25.75%	38.03%	26.51%
52	Retail and commission trade	50.33%	54.79%	47.56%	54.49%	58.30%	49.99%	45.29%	51.69%	44.13%
55	Hotels and restaurants	41.24%	43.56%	43.07%	35.92%	41.45%	38.14%	35.92%	40.92%	37.20%
60	Land transport; transport via pipelines	24.37%	28.52%	23.88%	32.05%	37.52%	26.05%	20.70%	25.98%	17.75%
62	Air transport	3.85%	11.11%	20.37%	3.85%	11.11%	5.56%	3.85%	11.11%	5.56%
63	Supporting transport activities; activities of travel agencies	46.11%	30.89%	34.21%	49.72%	32.05%	28.82%	39.72%	28.19%	26.20%
64	Post and telecommunications	28.57%	39.10%	26.57%	23.47%	38.35%	22.99%	24.49%	33.08%	17.91%

Table A1 (continued). Summary Statistics of Alternative Measures of Informality										
ISIC	Sector	Health Rights			Salary Bonus "aguinaldo"			Social Security Tax		
		2001	2005	2010	2001	2005	2010	2001	2005	2010
72	Computer and related activities	32.11%	43.81%	36.43%	47.71%	55.67%	43.21%	26.61%	35.05%	23.30%
74	Other business activities	53.23%	50.60%	50.85%	53.44%	57.85%	57.94%	34.07%	36.81%	34.17%
80	Education	31.21%	30.65%	28.75%	31.41%	31.83%	23.39%	27.36%	27.90%	21.46%
85	Health and social work	24.35%	23.67%	25.75%	23.86%	25.71%	21.59%	15.11%	17.47%	13.45%

Table A2. Summary Statistics: Median Investment Rates

ISIC	Sector	2001	2002	2003	2004	2005	2008
15	Manufacture of food products and beverages	4.1%	1.3%	2.2%	3.1%	3.9%	8.7%
17	Manufacture of textiles	1.2%	0.2%	0.5%	1.4%	1.5%	2.9%
18	Manufacture of wearing apparel	2.2%	0.0%	0.0%	0.3%	1.7%	5.5%
19	Tanning and dressing of leather	11.2%	12.0%	8.2%	15.9%	15.5%	5.4%
20	Manufacture of wood and of products of wood and cork	2.5%	1.1%	0.9%	2.1%	5.9%	7.4%
21	Manufacture of paper and paper products	0.9%	0.9%	3.4%	3.2%	2.6%	13.6%
22	Publishing, printing and reproduction of recorded media	3.5%	1.2%	0.9%	1.2%	1.7%	3.6%
24	Manufacture of chemicals and chemical products	6.4%	3.2%	4.4%	6.1%	6.0%	7.2%
25	Manufacture of rubber and plastics products	4.7%	3.9%	0.5%	0.7%	2.6%	8.4%
26	Manufacture of other non-metallic mineral products	4.2%	0.6%	0.3%	0.5%	0.8%	11.6%
27	Manufacture of basic metals	5.4%	4.1%	8.4%	2.2%	9.2%	10.5%
28	Manufacture of fabricated metal products	1.7%	0.4%	0.0%	1.0%	3.5%	8.1%
29	Manufacture of machinery and equipment n.e.c.	0.5%	0.7%	2.7%	1.9%	9.7%	16.6%
31	Manufacture of electrical machinery and apparatus n.e.c.	5.7%	3.1%	3.3%	0.2%	3.3%	11.1%
32	Manufacture of radio, television and communication equip.	1.8%	0.0%	0.8%	0.0%	0.0%	.
33	Manufacture of medical, precision and optical instruments	8.2%	2.7%	4.4%	5.8%	0.9%	10.5%
34	Manufacture of motor vehicles, trailers and semi-trailers	5.1%	8.8%	2.7%	3.6%	6.7%	4.9%
35	Manufacture of other transport equipment	0.2%	5.6%	1.3%	0.7%	1.5%	2.4%
36	Manufacture of furniture; manufacturing n.e.c.	5.3%	3.1%	1.3%	5.2%	7.8%	21.0%

50	Sale, maintenance and repair of motor vehicles & fuel	1.8%	0.3%	0.1%	0.9%	1.3%	6.2%
51	Wholesale trade	4.0%	1.3%	1.0%	2.4%	3.2%	9.8%
52	Retail and commission trade	6.0%	0.3%	0.3%	1.0%	1.7%	10.5%
55	Hotels and restaurants	0.9%	0.3%	0.1%	0.5%	0.9%	3.2%
60	Land transport; transport via pipelines	3.2%	0.1%	0.0%	0.6%	0.7%	10.4%
62	Air transport	3.2%	0.0%	0.0%	1.3%	0.3%	7.8%
63	Supporting transport activities; activities of travel agencies	2.8%	1.9%	2.3%	2.9%	1.7%	9.6%
63	Post and telecommunications	13.6%	2.0%	1.4%	3.1%	3.6%	14.2%
72	Computer and related activities	10.4%	1.4%	8.1%	3.6%	7.9%	13.4%
74	Other business activities	2.3%	0.0%	0.6%	0.5%	2.3%	9.5%
80	Education	0.4%	0.0%	0.0%	0.2%	0.0%	2.5%
85	Health and social work	5.7%	0.7%	0.6%	2.4%	2.9%	7.0%