Do external funds really help to finance investment?*

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Abstract

We build up a Tobin's q type of investment model with an adjustment cost function associated to raising funds on capital markets. The consequence of this financial imperfection is that firms have to pay a "credibility tax" to access external funds. In other terms, firms are financially constrained. We test this model on a panel of 5,300 firms over twenty years. The main empirical result of our paper happens to be that firms tend to increase their self-financing ratio when their stock price surge up, instead of issuing new shares. This phenomenon is more amplified in continental Europe than in the Anglo-American countries.

Keywords: capital market, financial constraint, investment, panel data.

JEL Classification: E22, E44, G31, G32.

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> "If capital is at the heart of capitalism, then well-functioning capital markets are at the heart of a well-functioning capitalist economy. Unfortunately, of all the markets in the economy, the capital markets are perhaps the most complicated and least understood."
>
> Joseph Stiglitz, *Whither socialism?*, 1994, Chapter 12, p. 207.

1 Introduction

There has been a growing discussion in the recent years about the size, determinants and consequences of imperfections on the financial markets. It has reached a point at which it is widely recognized that asymmetric information models prevail to explain the pattern of investment outside of the standardized Tobin's q model or the basic corporate finance models. This departure from the competitive model has contributed to explain why - regardless of taxation - external and internal funds are poor substitutes. In particular, by giving a crucial function to internal funds, it has explained why investment equations depend so much on cash flows. Moreover it has highlighted problems that structurally challenge the efficient allocation of resources on the stock market such as equity rationing, the existence of risk premium, and more generally "lemon" or "agency" problems. This is confirmed empirically by the fact that share or debt issuance do not respond perfectly to a set of prices. These new tools form an apparatus which help to shed light on the behaviors of firms and investors on the capital markets across countries. Numerous papers have quantified empirically the magnitude of these financial imperfections and their real impact on the investment rate of firms. So far, the methodologies involved have tracked the rate of investment and caught the variables that might have driven down this rate.

In this paper, we follow an alternate methodology. It's a well-known fact that, despite durable changes in the relative prices of funds, financial structures of firms do not change accordingly. Some authors see the lack of changes in the firms' financial structures as the proof of a strong inertia (Becker and Wurgler (2002) or Welch (2004)). We propose that - at least a part of - this inertia derives from financial imperfections that plagues the good functioning of the resources allocation on the capital markets. We propose an investment model that embodies financial market imperfections and we test this model on a panel of 5,300 publicly listed firms on the stock market in major OECD countries over the past twenty years (1982-2002). Our empirical results strongly support our hypothesis and our model: financial imperfections appear clearly in data across countries. The striking result of this paper happens to be that firms increase their self financing ratio when their stock price surge up, instead of issuing additional shares. This is a major imperfection that impedes the good functioning of the capital market. This phenomenon is more amplified in Continental Europe than in Anglo-American countries.

The paper is organized as follows. In section 2 we quickly review the existing literature on financial imperfections and their influences on investment. We present our model of investment with financial imperfections in section 3. The data and methodology are presented in section 4 and then we test this model on a panel of firms in section 5. Section 6 concludes.

2 Investment and financial constraints: a survey

In the neoclassical Tobin-Hayashi investment model (Tobin (1969) then Hayashi (1982)), investment is explained by the existence of a discrepancy between the market value of firms' assets and their replacement cost (*i.e.* a q ratio greater than unity)[1], without references to other financial factors. These models follow the spirit of Modigliani and Miller (1958) that had demonstrated that if markets are perfect and complete the financial policy of a firm is irrelevant for its market value.

Over the past two decades, a number of papers have extended the scope of standard models of corporate investment to take into account the possibility of financial constraint derived from market imperfections[2].

These theoretical papers have dealt with asymmetric information and principal-agent relations that make external funds more costly than internal ones. In fact, market imperfections generate information costs and give birth to a correlation between the availability of internal resources and the accessibility of external funds. More precisely, availability of internal funds influences the shadow price of external funds, without affecting investment opportunities of the firm. Applying a framework first developed by Akerlof (1970), Stiglitz and Weiss (1981) and Greenwald *et al.* (1984) provided strong underpinning for capital markets imperfections based on asymmetric information problems. Myers and Majluf (1984) and Myers (1984) dealt with the same problematic to emphasis the equity issue rationing (and then the pecking order theory). Asymmetric information produces a deep alteration of the efficiency of the resources allocation by the market, since market equilibrium is reached at non clearing market prices.

The second major imperfection source is emphasized by Jensen and Meckling (1976), who analyzed the agency problem on capital markets; they were lately followed by Bernanke and Gertler (1989) and Bernanke and Gertler (1990) and Bernanke *et al.* (1996). They find that a premium caused by agency problem exists when a firm wants to raise external funds on capital market, and this premium is negatively

[1] One might think of cases where that is no possibility for further profitable investment. In this case, firms will not invest whatever the q ratio. Nevertheless, a high q ratio is the sign that capital markets think there are investing opportunities.

[2] Early research also emphasizes the importance of financial constraints, see for instance Meyer and Kuth (1957).

correlated to firm's net worth.

The very basic idea of all these models is that external financing is more costly than internal financing for all firms, but the spread between internal and external funds varies among firms, some of them are relatively constrained (*i.e.* have to pay a high risk premium), and a few of them are even totally constrained (ending up with no access to external funds). As a consequence, after taking some variables for granted like the interest rate on the market, investment opportunities, risk premia and information costs, firms with higher net worth ought to invest more.

Based on this hypothesis of capital market imperfections, a blossoming literature has quite successfully assessed the degree of financial constraint. The whole debate was initiated by the seminal paper by Fazzari *et al.* (1988) (FHP hereafter). Numerous papers have followed this direction. We can recall the main (and still debated) results of these empirical studies: firms with higher net worth or internal funds are the one which, all else being equal, invest significantly more and that are less financially constrained. This correlation tends to be more important for firms which face an information-related imperfection (*e.g.* FHP, Hoshi *et al.* (1991), Whited (1992)). The following discussion has been centered on the most appropriate way to identify firms that are financially constrained. The debate was essentially methodological. What is the relevant method to prove that a firm is financially constrained? FHP proposed that firms that cannot afford to pay dividend should be considered as financially constrained. In this category of zero-dividend firm, they showed that there is a stronger correlation between cash flow and investment. Later, Kaplan and Zingales (1997) have shown that these two points are subject to empirical problems. Another methodology has emerged around scoring firms upon different criteria that could determine the degree of financial constraint. This debate is still ongoing, probably because of the difficulty to deal with the empirical challenges raised by this methodology[3]. In particular, one must control for investment opportunities which are, *per se*, very hard to measure and define the right criterion to detect the financial constraint (see Moyen (2004)).

In order to identify financial constraint - and to avoid the aforementioned debate - we propose to go back to basics and to look simply at the correlation between prices and quantities of financial sources. We will argue that, considering that there is a hierarchy of financial sources (usually called the pecking order theory), a change of the relative prices of financial sources should trigger a change in the relative quantity of funds used by firms. A non-reaction of quantities to prices could be viewed as an imperfect allocation of resources on this market. We will interpret these patterns as evidence of market imperfections of a nature that could be tied up to difficulties having access to the capital market. We will point out that firms that have a credibility issue are having trouble breaking the informational problem on the stock market, constraining them not to use external resources. For the sake of this issue, we build up a model in

[3]About these debates and the many empirical studies conducted, see the extensive surveys by Hubbard (1998) and Saltari (2001).

which firms pay a credibility tax when they go on the market for external funds.

3 A credibility tax model: where external and internal funds come to be complementary

Unlike the usual models that present the different sources of financing and propose a hierarchy of financial sources on a static plan (Kyotaki and Moore (1997)) we extend our model to a dynamic framework and emphasize on the role of internal funds in providing cash for investment.

The basic intuition is the following. In the case of a financially constrained firm, external funds demand to be associated with internal ones because investors are insecure about the fact that they could end up buying a "lemon" stock. The only way for shareholders to bridge the information problem on the quality of the project is to compel firms to co-finance projects for which they are raising money. Otherwise, issuing shares would be viewed as getting rid of lemon stocks by managers that do not believe in their projects or that have private information that reveals an overvaluation of the firm by the market. Firms that show a very poor record of investment in the past, which could be highly visible on either the balance sheet or the financial statement, will have to pay a "credibility tax" in the form of a high contribution in internal funds. However, the tax will be smaller if financial performances in the past have been judged rather satisfactory and will eventually vanish if performances remain good.

The practical consequence of this hypothesis is that when the shadow price of capital goes down - which in a simple Tobin's q model should produce issuance of new shares - external investors ask to internal investors co-finance the project. Instead of producing an issuance of shares, a rise of the stock price will then be associated with a rise in the mark-up in case of financial constraints, since an increase of the mark-up is the only mean for a firm to generate additional internal funds. As a matter of fact, it is the opposite of what we should expect from the relationship between price and quantities on a perfect capital market. If the market were to be perfect, additional shares and cash flow should be substitutable financial sources. In case of imperfections, both financial sources become complementary. This phenomenon is consistent with the "new" financial theory based on asymmetric information. On the contrary, if firms are not financially constrained, co-financing is not going to occur. But, in this latest case, it is clear that firms will not issue shares whatsoever. As a matter of fact, there are some fixed costs associated with share issuance that will turn firm to prefer debts. In this case, debts will be associated with the increase of stock prices.

3.1 Setting prices in the model, a critical assumption

There is one rather specific assumption in our model: firms do not invest in physical assets but in intangible assets. More precisely, we assume that firms produce output with a stock of customer. It is a critical assumption that deserves explanations.

In contemporary microeconomic models, firms do not set their price[4]. Prices are determined by the type of competition in which firms operate in, mostly monopolistic competition in modern versions (Dixit and Stiglitz (1977)). We borrow another model of monopolistic competition, the customer market model developed by Phelps and Winter (1970) because it presents some original characteristics that are very appealing to us in term of use of internal funds.

In this family of model that was both synthesized and enriched in Phelps (1994), firms set their price to maximize the shareholder value while they accumulate customer assets that are essential to produce and sell output. The mark-up is determined by the ratio between future profits - that tend to push the mark-up downward in order to capture the large market share possible now - and the immediate need for profits that pushes it upward. When expected profits on assets are high in the future, firms lower the mark-up immediately to attract new customers that will be exploited in the future. The level of the shadow price of customer asset will drive firms increase or decrease their mark-up. This model has two essential virtues for our work. First, it embodies the possibility for firms to set the mark-up at a certain level and by doing so, setting the level of internal funds available. Second, the level of the mark-up will have consequences on the flow of future customers. We reach the crucial features of the model. Firms that have problems accessing external funds will raise their mark-up to get internal funds to invest, however, they will loose some customers in the future because of that.

To summarize the logic of the model we can say that on the one hand, a financially constrained firm can handle its mark-up to bring additional funds, which is positive since it will contribute to fund investment that otherwise would not be funded. On the other hand, it has a negative side since it destroys the customer basis in the future and thus the expansion of the firm. The balance between these two forces will determine the final level of the mark-up.

3.2 The program of the representative firm

The representative firm maximizes its profit under the intertemporal constraint of accumulation of firm's assets that are necessary to produce output. However, firms encounter a problem when they do not have enough funds to finance the accumulation of assets. This problem happens when expected profit on future investment increase, a sign that should normally ease financial constraints[5]. To get rid of this problem and make it appear clearly in our program as a logical pattern, we have introduced a credibility tax that firms pay. This tax forces firms to raise their mark-up to finance

[4]In the seventies, disequilibrium theory, or non-walrasian theory hypothesized a fixed price theory in which firms were able to set price (Benassy (1975)). However, it has failed to convince the audience because of the absence of optimization underpinning this fixed price theory.

[5]Because of increase of the expected profit on future investment decreases the Tobin's q.

their projects. We are going to detail the production function and explain the nature of the assets used by the firm. Then we will highlight the specificity of the model which is the credibility tax that firms are paying while they want to get external funds. We will end up with the intertemporal program of the firm.

3.2.1 The production function

In period t firms maximize a function subject to an intertemporal constraint. On the revenue side we have: output $F(A_t)$ that is produced by a stock of customer asset A_t. Firms charge a mark-up μ_t on the value of the final output. Costs fall into two categories, the firm operate with N employees paid at a nominal wage w. In order to grow up, the customer asset requires some monetary investment x_t. The usual flow of investment in fixed assets in Tobin-Hayashi model is now replaced by x_t which is a flow of investment in an intangible asset, the stock of customers. Firms can finance their investment with either the mark-up μ_t they charge on the consumers (internal funds) or with a flow of debts Z_t (external funds). For a matter of simplification, and because they happen to be always more expensive than debts, we rule out the possibility of issuing shares.

3.2.2 The stock of customer asset

The stock of customer asset A_t grows based upon the following law of motion. Firms invest in their intangible assets by controlling two distinctive variables. They invest by spending money in advertising campaigns or by developing intangibles elements that should increase the size of their customer basis. So, the stock of customer asset A_t, the state variable in our model, depends on the price of goods for the firm i p_i, relative to the market price p. We summarize this relative price with the mark-up ratio μ_t and the amount of money x_t the firm pour into its stock of customers.

3.2.3 The credibility tax

The standard Hayashi model includes an adjustment cost function that embodies physical costs associated to the incorporation of new units of physical capital. This specific function gave birth to the dynamics of the model by creating the possibility of a jump of the shadow price towards a higher level that would be accompanied by a positive accumulation of firm assets to a higher level (otherwise, we would reach this new level instantaneously without any dynamics of capital stock K_t). We borrow this methodology and apply it to the notion of credibility.

When they add an additional unit of customer, firms are more or less constrained by their level of credibility to co-finance by internal funds. We make this level of "credibility" - that is necessary for the firm to get access to external funds - depends on a very simple ratio of indebtedness $b_t = B_t/A_t$ where B_t is the stock of bonds and A_t the book value of the customer asset. The structure of the balance sheet of the representative firm is the following: $A_t = B_t + E_t$ where E_t corresponds to the amount of equity. The function captures the increasing role of debt:

$$\phi(\mu_t; b_t) = -(\mu_t - \mu_{t-1})e^{b_t}x_t$$

Firms maximize their profits under the constraint of the accumulation of customer assets. The only control variable is: x_t (monetary investment in customer assets). The stock of customer asset A_t is the only state variable.

The firm has the following objective function:

$$\max \sum_{t=0}^{\infty}(1+\rho)^{-t+1}\left[\mu_t F(A_t) - wN - \phi(\mu_t; b_t) - x_t + Z_t\right] \tag{1}$$

Subject to the two constraints:

$$\begin{cases} A_t - A_{t-1} + g(\mu_t - \mu_{t-1}; x_t) = 0 \\ \lim_{x \to +\infty}\left(\lambda_{t+x}(1+\rho)^{-t+1}A_t\right) \geq 0 \end{cases}$$

The first constraint is the accumulation equation. The second of these constraints rules out Ponzi games of unbounded borrowing. For the $g(\mu_t - \mu_{t-1}; x_t)$ function, we set up a very simple form:

$$g(\mu_t - \mu_{t-1}; x_t) = -\gamma(\mu_t - \mu_{t-1})x_t$$

The parameter γ corresponds to the elasticity of the stock of customer to a change in the level of the mark-up.

The flow of additional debt Z_t could be easily transformed into stock by expressing the difference between the level of indebtedness between period t and $t-1$ to which we include the interest paid on the past indebtedness[6] (the additional flow of current debt will generate cost in $t+1$).

$$Z_t = B_t - B_{t-1} - rB_{t-1} = B_t - (1+r)B_{t-1}$$

Since $A_t = B_t + E_t$, it is convenient to substitute B_t by $B_t = A_t - E_t$. We can now set up a complete Lagrangian program $\mathcal{L}$ and maximize it. In this program, λ_t is the shadow price of a unit of additional customer. It is the equivalent of Tobin's q in physical investment models.

$$\sum_{t=0}^{\infty}(1+\rho)^{-t+1}\Bigg[\Big(\mu_t F(A_t) - wN - ((\mu_t - \mu_{t-1}) + e_t^b)x_t - x_t + Z_t\Big) + \lambda_t(A_t - A_{t-1} - \gamma(\mu_t - \mu_{t-1}) + x_t)\Bigg] \tag{2}$$

The first order conditions for investment and the stock of customer asset are:

[6] We consider that firms pay an average interest rate r.

$$\frac{\partial \mathcal{L}}{\partial x_t} = (1+\rho)^{-t+1}((\mu_t - \mu_{t-1}) - 1 + \lambda_t) = 0 \quad (3)$$

$$\frac{\partial \mathcal{L}}{\partial A_t} = (1+\rho)^{-t+1}\left(\mu_t F'(A_t) - x_t \frac{B_t}{A_t^2} e^{\frac{B_t}{A_t}} + 1 + \lambda_t\right) + (1+\rho)^{-t}\left[-(1+r)A_t - \lambda_{t+1}\right] \quad (4)$$

Even if the mark-up is not a control variable, we check - because of its key role in our model - the derivative of the program with regard to the mark-up μ_t.

$$\frac{\partial \mathcal{L}}{\partial \mu_t} = (1+\rho)^{-t+1}(F(A_t) - x_t - \lambda_t \gamma) = 0$$

One unit of mark-up brings an additional unit of output that goes with it, minus one unit of investment in customer and finally the loss of customers (the elasticity γ of the stock of customer to the mark-up gives the magnitude). After simplification, we can re-write the derivative of the program and show the dynamic equations.

$$\begin{cases} \mu_t - \mu_{t-1} = \frac{\lambda_t - 1}{e^{b_t}} \\ \lambda_{t+1} - \lambda_t = \rho\lambda_t + (1+\rho)(\mu_t F'(A_t) - \frac{x_t}{A_t} b_t e^{b_t} + 1) - (1+r)A_t \end{cases}$$

These two equations give us a dynamic system for (μ_t, λ_t) in which the dynamics of each variable is expressed as a function of the level of the other one. We can calculate the steady state equation for each of them by setting the variation of the other to zero. If we look at the steady state for $(\mu_t - \mu_{t-1}) = 0$ then $\lambda_t = 1$. Then on the plane (μ_t, λ_t) we can draw an horizontal line for the value $\lambda_t = 1$. With $\mu_t < 1$ Below this line, the mark-up decreases and when $\mu_t > 1$, it increases. If we look now at the steady state for $\lambda_{t+1} - \lambda_t$, we can then calculate the steady state value for λ_t.

$$\lambda_t = \rho\left[-(1+\rho)\left(\mu_t F'(A_t) - \frac{x_t}{A_t} b_t e^{b_t} + 1\right) - (1+r)A_t\right]$$

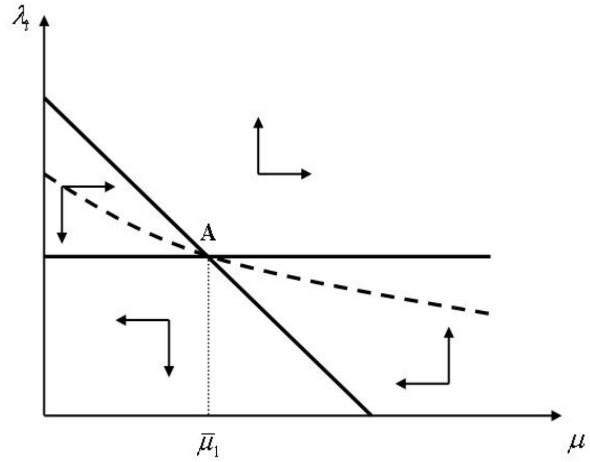
This latest equation has a negative slope for μ_t:

$$\frac{\partial \lambda_t}{\partial \mu_t} = \frac{-(1+\rho)}{\rho} \leq 0$$

We can now solve either numerically[7] or graphically the system. Graphically, it is possible to build up a phase diagram for the couple (μ_t, λ_t). It is straightforward from the dynamic equations that if $\lambda_t > 1$, then the right hand side term is positive, which implies that $\mu_t > \mu_{t-1}$ above the horizontal line splitting the plane in two. Based on the motion of the different variables, we show on the figure 1 that there is a saddle path (the downward sloping dashed line), and a saddle point (point A).

[7] See the Appendix C for the numerical solution.

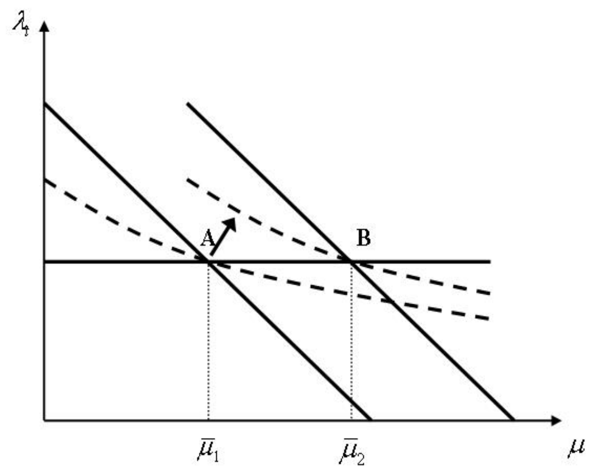
Figure 1: Saddle path in the credibility tax model



3.2.4 Reaction of the system to a change in the shadow price of capital

A jump in the shadow price of capital triggers a jump in the mark-up in order to provide funds to the representative firm. That's the first and most interesting result of this model. Because firms pay a "credibility tax", it means they can't go on the market and issue shares or bonds; they have to raise their mark-up while the shadow price of capital goes up. In the real world, it means that we will find an immediate correlation between an increase in the share prices and firms' cash flow.

Figure 2: A jump in the shadow price in the credibility tax model



3.2.5 Similarities and differences with Tobin-Hayashi model

In the spirit of the Tobin's q model transformed by Hayashi, we obtain a critical value for xxx λ_t q, although meaningless in our case. The critical value is now a ratio between the market value of stocks and the mark-up. Unlike the Tobin's q that refers to equilibrium value in a general symmetrical framework, the equilibrium value here is contingent to an asymmetric context. What the model is telling us is that when the xxx λ_t q ratio goes up, firms tend to increase their mark-up in order to get funds that they actually need to invest. If the credibility tax is set to zero - for instance because indebtedness is equal to zero - then we face a traditional leverage equation in which - if the marginal productivity of firm assets is superior to the average cost of external funds r - the stock of debts will grow up. In that case, the mark-up remains constant. The model stresses out two polar cases:

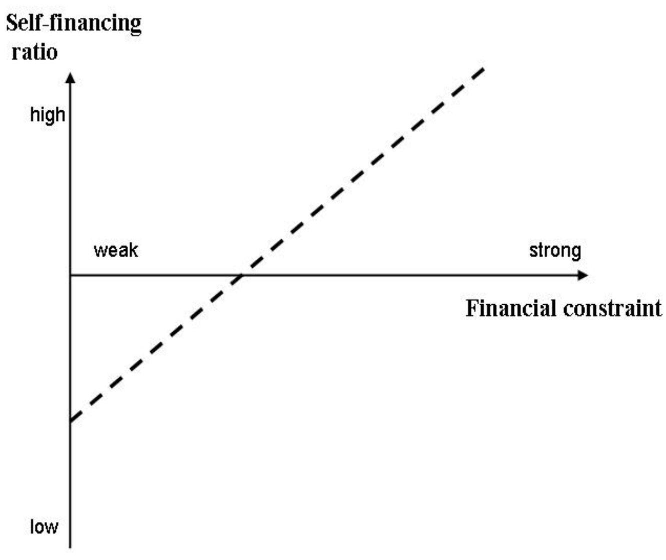
- In case of credibility problems, when the shadow price of capital goes up, the mark-up will go up and provide internal funds (see figure 2).
- If firms do not have credibility problems, then a rise in the shadow price will produce more indebtedness. We essentially rule out share issuance in the model because of excessive costs.

At first glance, therefore, the first case highlighted by the model reveals something trivial. However, there is also something more profound behind that. As a matter of fact, what the model shows is that there is a tie between the price of external funds and the proportion of internal funds firms put in their own investment projects. If firms have credibility problems, when the shadow price go up, then they will increase their self financing ratio (internal funds/ investment), instead of letting it fall, with the self-financing ratio defined as:

$$\frac{\text{internal funds}_t}{\text{investment}_t} = F(\lambda_t)$$

This ratio will fall if firms have no credibility problems since they will now borrow money. Following our model, one can conclude that a relationship exists between the intensity of the financial constraint and the self-financing ratio, as shown in figure 3.

Figure 3: Correlation between the shadow price and the self-financing ratio



4 Data and methodology

We detail here the database we have been using and calculate some descriptive statistics. Then we tackle methodological issues in order to proceed to a set of regressions.

4.1 Sample and descriptive statistics

We have a database that includes 5,298 listed firms on the stock market in 16 major OECD countries[8]. We consider two groups of countries: the so called continental countries and the anglo-american countries. Data cover a time period from 1982 to 2002, but our panel is unbalanced. For each firm/year, a wide range of financial information such as the balance sheet and the financial statement and market data (market capitalization, share price, Price to Earnings...) are available[9]. Tables 1 and 2 provide descriptive statistics. Across countries, firms that belong to this database are significantly different in their size[10]. However, there are equally weighted between industries and sectors. Firms mainly finance their investment with internal funds (cash flows) that accounts for around 60% over the twenty years[11], with wide differences across years. The rest is split into two more or less equal chunks of debts and share issuance of about 20% each. Following the common intuition (see Rajan and Zingales (1995), Rajan and Zingales (2003) and also Jestaz (2003)), anglo-american firms tend to raise external funds mainly share issuance rather than indebtedness, even though continental firms use the stock and debt markets roughly equally. If internal funds contribution has changed over the time, it is clear by looking at the graph 4 that both external funds sources - debt and share issuance - tend to co-vary. However, we have to mention that share issuance tend to be over-represented in our panel. First, the panel includes only publicly listed firms. Second, from a larger panel of firms in 1982, we have retained only firms that were not bankrupt in 2002. Thus we have an obvious survival bias since we do not have in our panel firms that were not doing well.

[8]See table 1 for the list of countries.

[9]See Appendix B for details about the construction of the sample.

[10]We ran our regressions on a sub-panel of firms in order to have a nearly equal average size of firms across countries. Results were not significantly different.

[11]Ireland is the only exception with 30.

Table 1: Descriptive statistics by country (1982-2002)

(median)	Number of firms	Total assets[a)]	Total revenue[a)]	Operating margin rate[b)]	Net margin rate[b)]	Debt ratio[b)]	Employees	Market capitalization[a)]	ROE
Continental firms	1372	n.s.[c)]	n.s.[c)]	10.94%	3.31%	33.23%	2037	n.s.[c)]	10.67%
Austria	*38*	*257.0*	*233.0*	*12.58%*	*3.20%*	*46.04%*	*3231.5*	*110.0*	*6.3%*
Benelux	*178*	*361.0*	*418.0*	*11.08%*	*3.60%*	*34.82%*	*2905*	*160.0*	*14.4%*
Germany	*364*	*183.0*	*235.0*	*9.50%*	*2.04%*	*47.29%*	*1737*	*124.0*	*7.7%*
Denmark	*70*	*1520.0*	*1590.0*	*9.71%*	*3.61%*	*31.61%*	*1364.5*	*623.0*	*11.3%*
Spain	*66*	*626.0*	*440.0*	*15.32%*	*6.23%*	*34.70%*	*3043*	*378.0*	*12.3%*
Finland	*80*	*438.0*	*478.0*	*11.44%*	*3.33%*	*36.65%*	*3084*	*200.0*	*9.2%*
France	*310*	*242.0*	*266.0*	*10.83%*	*3.67%*	*37.75%*	*2218*	*171.0*	*11.6%*
Greece	*47*	*111.0*	*82.3*	*16.94%*	*6.75%*	*23.58%*	*574*	*88.2*	*15.2%*
Italy	*47*	*981.0*	*687.0*	*14.78%*	*4.19%*	*40.68%*	*6011*	*256.0*	*9.5%*
Norway	*43*	*1200.0*	*1060.0*	*13.53%*	*3.88%*	*44.36%*	*1239.5*	*612.0*	*9.3%*
Portugal	*15*	*593.0*	*479.0*	*10.01%*	*3.02%*	*46.58%*	*3296*	*149.0*	*8.8%*
Sweden	*114*	*1260.0*	*1540.0*	*9.64%*	*3.69%*	*34.68%*	*1052*	*710.0*	*11.6%*
Anglo-american firms	3926	n.s.[c)]	n.s.[c)]	9.29%	3.25%	26.43%	827	n.s.[c)]	9.65%
Canada	*331*	*231.0*	*188.0*	*12.55%*	*3.90%*	*29.95%*	*3339.5*	*72.2*	*7.3%*
Great-Britain	*782*	*75.6*	*90.5*	*10.95%*	*4.49%*	*19.78%*	*1148*	*47.5*	*11.9%*
Ireland	*40*	*119.0*	*123.0*	*10.36%*	*4.64%*	*31.13%*	*874.5*	*48.7*	*13.1%*
United States	*2773*	*89.2*	*82.4*	*8.60%*	*2.83%*	*24.00%*	*616*	*93.7*	*9.2%*
Overall	5298	n.s.[c)]	n.s.[c)]	9.75%	3.28%	27.30%	1106	n.s.[c)]	9.9%

[a)]: millions of national currency.
[b)]: see appendix B for details about ratio calculations.
[c)]: national currencies are different across countries.

Table 2: Descriptive statistics by country (1982-2002)

(median)	Number of firms	% of big firms[a)]	Market to book ratio	Investment rate	Tobin's q	Self-financing ratio	P/E ratio
Continental firms	1372	63.58%	1.54	2.57%	1.23	82.14%	14.8
Austria	*38*	*68.71%*	*1.15*	*2.56%*	*.69*	*69.32%*	*13.9*
Benelux	*178*	*55.66%*	*1.61*	*2.37%*	*1.11*	*74.45%*	*13.5*
Germany	*364*	*61.22%*	*1.78*	*2.13%*	*1.34*	*78.52%*	*15.7*
Denmark	*70*	*59.34%*	*1.15*	*2.91%*	*1.08*	*111.82%*	*16.4*
Spain	*66*	*73.39%*	*1.58*	*4.46%*	*1.13*	*87.98%*	*14.6*
Finland	*80*	*70.35%*	*1.04*	*2.39%*	*.91*	*75.37%*	*12.3*
France	*310*	*71.22%*	*1.63*	*2.36%*	*1.39*	*93.74%*	*14.5*
Greece	*47*	*39.28%*	*2.18*	*7.63%*	*2.30*	*87.62%*	*20.1*
Italy	*47*	*94.22%*	*1.15*	*2.10%*	*.99*	*61.79%*	*16*
Norway	*43*	*54.02%*	*1.36*	*2.59%*	*.89*	*58.03%*	*15*
Portugal	*15*	*81.15%*	*1.47*	*3.81%*	*.83*	*57.59%*	*19.65*
Sweden	*114*	*50.90%*	*1.44*	*3.29%*	*1.16*	*74.04%*	*14.65*
Anglo-american firms	3926	46.93%	1.66	2.50%	1.78	72.85%	15.7
Canada	*331*	*78.24%*	*1.22*	*3.46%*	*.96*	*52.89%*	*15*
Great-Britain	*782*	*53.02%*	*1.68*	*2.32%*	*1.80*	*89.91%*	*14.4*
Ireland	*40*	*46.25%*	*1.56*	*4.73%*	*1.40*	*72.85%*	*12.5*
United States	*2773*	*43.33%*	*1.70*	*2.47%*	*1.91*	*70.38%*	*16.6*
Overall	5298	51.98%	1.63	2.53%	1.62	75.06%	15.5

[a)]: more than 999 employees.

Table 3: Flow of new funds (1982-2002)

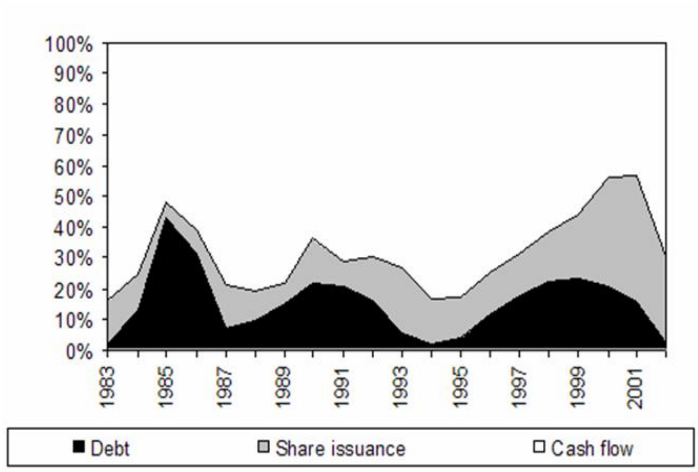
(median)	By country		
	New debt issuance	Share issuance	Internal funds
Continental firms	17.35%	18.49%	64.15%
Austria	*22.8%*	*6.6%*	*70.6%*
Benelux	*18.2%*	*16.0%*	*65.7%*
Germany	*17.9%*	*13.0%*	*69.1%*
Denmark	*12.5%*	*19.1%*	*68.4%*
Spain	*21.3%*	*17.9%*	*60.8%*
Finland	*6.2%*	*38.7%*	*55.1%*
France	*24.1%*	*29.8%*	*46.1%*
Greece	*20.3%*	*24.2%*	*55.5%*
Italy	*21.4%*	*17.2%*	*61.4%*
Norway	*32.8%*	*7.8%*	*59.5%*
Portugal	*41.8%*	*12.5%*	*45.7%*
Sweden	*20.0%*	*14.0%*	*66.1%*
Anglo-american firms	12.55%	25.83%	61.60%
Canada	*12.8%*	*22.3%*	*64.9%*
Great-Britain	*13.4%*	*36.2%*	*50.4%*
Ireland	*31.3%*	*37.7%*	*31.0%*
United States	*12.8%*	*23.6%*	*63.6%*
Overall	14.9%	24.4%	62.7%

4.2 Methodology

The literature on financial constraint was born partially as a response to the poor results that came out after the first wave of Tobin's q equations were tested. Then a second wave of tests improved substantially the first one. Adding the cash flow as a second explanatory variable came to the rescue and took into account financial imperfections.

We can summarize very simply the two paths that have been followed so far. On the one hand, the issue was to embody financial constraint into perfect financial market equations that were tracking investment. By assuming that external funds were not always available to firms when they invest, regressions made a huge step in the direction of capturing investment flows xxx ajouter des références xxx. On the other hand, a set of papers (Cleary (1999) xxx ajouter des références xxx) have focused on defining the variable that determine financial constraint that impede firm to get access to capital market. Ideally, by combining different weighted financial criteria, it could be possible to score firms on a scale of financial constraint. We have picked up a different methodology.

Figure 4: Internal and external funds



Instead of theoretically defining what cause financial constraints, or introducing financial constraint to track the final goal which is investment, we induce financial constraints from relationships between prices and quantities on the financial market. Our approach stems from the conclusions of our model. If financial markets are not perfect, then price/quantities relationship do not hold the same way than if financial market are perfect. So we always take the investment rate as given in our equations, focusing on the sources of funds and the optimal choice between them.

- If market are perfect and firms do have access to external funds, then relative prices of sources of funds and relative quantities of funds raised by firms move the opposite way.

- If markets are imperfect and then prices and quantities move in unexpected directions that betray imperfections. By running these regressions, we expect these estimations to come up with information on the slope of the financial constraint.

5 Econometric results

We have separated our regressions in two different endeavors. First, we look at the correlation between prices and quantities, which means tracking the correlation between share issuance and its price and new debts and its price and to see whether or not firms respond to a change in relative prices. We also address the quantities of external funds raised, to see if they are complementary or substitute. Last, we look at the relationship between the flow of internal and the flow of external funds to see if they are complementary or substitute.

5.1 Prices and quantities of external funds

We examine alternatively debts and share issuance. A change in the cost of indebtedness is expected to change firms' policy toward debt (see table 4). These regressions were performed on the overall panel, as well as on two sub-panels (Anglo-American firms and Continental firms). Since the results are not different, we report only the results for the overall panel.

Among the common variables used in all the columns of table 4, we use the balance sheet size ("Total assets") as a proxy for catching the firm size effect. We use the "Total debt variation" as the dependant variable.

We consider the first lag of "Total debt variation" in the regression. The "cash flow variation" and the "market capitalization" are two proxies for respectively the amount of new internal funds available for investment and the availability of external funds for a firm, since a higher market capitalization eases a share issuance.

We use two different series of interest rate for this regression. In the first column of 4, we use the real interest rate, as defined by the long-term interest rate on government bonds to which we subtract the annualized growth rate of the GDP deflator. In the second column, we use a firm-specific interest rate, defined as the ratio of interest expenses on long term debt bearing interest plus leasing. It allows firms to face different interest rates, accounting for differences in their financial situation and their risk premium. The drawback of this proxy is to suppose that a "backward-looking" interest rate (the average interest rate paid on past debt) is pertinent to explain current decisions of indebtedness[12]. Either way, there is a very strong and negative correlation between the interest rate and the variation of the indebtedness. When the interest rate goes up, firms reduce their indebtedness. This relationship follows exactly the common intuition.

The last column of table 4 provides an additional regression with a look at the elasticity of indebtedness with the variation of the price of shares (here the Tobin's q variation). We find that when the Tobin's q goes up (*i.e.* the price of shares increases), firms tend to reduce their indebtedness. Since a higher q means that investment opportunities are increased for the firm, this result can be interpreted in two ways : firms can use their increased market capitalization in order to issue shares (and by the way reduce indebtedness) or alternatively, firms with higher q have more free cash flows which are used to invest and reduce indebtedness. The next set of regressions will show that the first explanation is not the good one, since share issuance doesn't react to interest rate movements.

In table 5, we test variables that could determine share issuance. We review standard variables that would determine share issuance and we include the structure of

[12] A proxy of future or expected interest rate would be better. However, since indebtedness changes are a slow moving dynamic process, one can suppose that the interest paid on past debt are a reasonably good proxy of the current financial status of the firm, and, consequently, the interest rate that firm will face if it goes to the market to borrow funds.

Table 4: Indebtedness and cost of debt

Dependant Variable: Total debt variation	a)	a)	a)
Intercept	-4.95e+07***	-1.60e+08***	- 8.47e+07***
	(1.11e+07)	(2.13e+07)	(5.69e+06)
Total assets	0.0792***	.0800***	.0741***
	(0.0018)	(0.0015)	(0.0016)
Cash flow variation	- 0.0507***	-.0301***	- .0639***
	(0.0109)	(0.0085)	(0.0094)
Market capitalization	- 0.0105***	-.0107***	- .0125***
	(0.0011)	(0.0007)	(0.0009)
Lag of total debt variation	- 0.3356***	-.3229***	- .268***
	(0.0061)	(0.0049)	(0.0057)
Firm-specific interest rate	- 4.20e+08***	-	-
	(5.87e+07)		
Real interest rate	-	1.12e+07***	-
		(3.09e+06)	
Tobin's q variation	-	-	- 7.18e+06***
			(2.74e+06)
N	28889	44312	37181
Adj. R^2	0.0810	0.1318	0.0763
F-test	***	***	***
ρ	0.3264	0.3590	0.2097

Notes: Standard errors reported in brackets. ρ : fraction of total residual due to firm-specific residual. [a)] Fixed-effect GLS regression (Hausman test rejects the random-effects model at 10%).
***: significant at 1%, **: significant at 5%, *: significant at 10%.

relative prices of funds[13].

All the three regressions provide the same and consistent results. Share issuance is always positively correlated to the size of the firm. The bigger firms are, the more then tend to issue shares and be able to overcome fixed prices that are associated with an issuance. The sign of the coefficient for the cash flow is not expected though. We would expect the profitability of firms - that do issue shares - to set up binding conditions for share issuances. We have found a negative coefficient in the four equations. We interpret this coefficient as an evidence of existence of substitution between cash flow and share issuance.

In addition to this counterintuitive result, we get another one. When the relative cost of stock goes down (price goes up), it does not trigger share issuance (column 1). The price variation of shares is not a significant variable to predict share issuance. The spread of cost between equity and debt[14] is not more significant (column 2). Substituting the share price variation by the Tobin's q variation doesn't improve the results (column 3)[15]. The conventional q theory is here challenged by a lack of empirical confirmation.

We come out an expected asymmetry that is not a surprise, debt variation do react to indebtedness prices while share issuance do not react to changes in share prices. Here again the standard theory of finance would follow the obvious hypothesis that firms issue shares when its price go up. Financial constraints, corporate governance issues or agency problems can impede a firm to issue new shares. This problem is known as the equity rationing problem. Among others, one of the consequence is that equity issuance doesn't depend on share price.

We also show that indebtedness is reduced when share prices are increased and that this increase of share prices doesn't mean that firms will issue more shares. The only explanation, perfectly fitted with our model, is that, when firms have more investment opportunities (more precisely, when the stock market judges that firms have more investment opportunities), firms tend to increase their cash flow or free cash flow to self finance, or at least co-finance the new projects.

Other results are in line with the pecking order theory : indebtedness and share issuances are negatively correlated to cash flow variation. When cash flows goes up, firms prefer to use internal funds first, and reduce their external fund-raising. This result is in line with the.

We can now check these results, with an investigation of the correlation between quantities of funds and figure out if they tend to be substitutable or complementary. We simply look at the quantity of funds raised by each source (debts or stocks) and of internal funds available to see if they vary in the same or in the opposite direction.

[13]These regressions were also performed on two sub-panels (Anglo-american firms and continental firms). Results are the same, so we report only the results for the overall panel.

[14]Defined as the difference of the dividend yield and the firm-specific interest rate.

[15]The Tobin's q in level is even not significant.

Table 5: Equity issuance and equity prices

Dep. Var.: Share issuance	$^{a)}$	$^{b)}$	$^{b)}$
Intercept	2.82e+07***	- 2.62e+07**	-1.49e+08***
	(8.05e+06)	(- 2.04)	(8.75e+06)
Total asset	.0332***	0.1425***	0.1407***
	(.0011)	(0.0031)	(0.0025)
Cash flow variation	- .0554***	-0.1670***	-0.1536***
	(.0140)	(0.0244)	(0.0072)
Lag of share issuance	.1583***	-0.0482***	-0.0371***
	(.0061)	(0.0091)	(0.0075)
Share price variation	- 16493.03	-	-
	(266024.5)		
Lag of share price variation	- 419.0941	-	-
	(14914.87)		
Spread of cost between debt and equities	-	-6.37e+06	-
		(4.98e+06)	
Tobin's q variation	-	-	16758
			(64939)
N	21646	14196	20929
Adj. R^2	0.1858	0.1766	0.1889
Wald $\chi^{2a)}$/ F-test$^{b)}$	3058.56***	***	***
ρ	0	0.3458	0.3978

Notes: Standard errors reported in brackets. ρ : fraction of total residual due to firm-specific residual. $^{a)}$ Random-effects GLS regression (Hausman test doesn't the random-effects model at 1%). Dummies variables for years are included in the regression. $^{b)}$ Fixed-effects GLS regression (Hausman test accepts the random-effects model at 1%).
***: significant at 1%, **: significant at 5%, *: significant at 10%.

Table 6: Quantities of funds

Dep. Var.: Additional debt	All firms	Anglo-american firms	Continental firms
Cash flow	- .0905***	- .0596***	- .1249 ***
	(- 6.75)	(- 5.49)	(- 3.42)
Share issuance	.0139***	.0034	.0365**
	(2.99)	(1.17)	(1.97)
Total asset	.0304***	.0293***	.0345***
	(16.77)	(20.32)	(6.52)
Intercept	- 6114690	- 4.82e+07***	- 4.44e+08***
	(- 0.98)	(- 4.30)	(- 4.88)
Number of observations	30397	24435	5962
Adj. R^2	0.0367	0.0355	0.0462
F-test	***	***	***
ρ	.1668	.1700	.1363

Notes: t-stats reported in brackets. Fixed-effect GLS regression (Hausman test rejects the random-effects model at 10%). ρ : fraction of total residual due to firm-specific residual.
***: significant at 1%, **: significant at 5%, *: significant at 10%.

The general equation we have tested addresses the correlation between additional debt and the other competing financial sources (cash flow or share issuance). Cash flow comes with a negative sign that stresses substitution. This substitution is stronger in the continental firms than in the anglo-american firms. The story is different with the share issuance. Debt and share issuance come along together for the continental firms, but not for the anglo-american firms, for which debt variation and share issuance tend to be independent.

5.2 Accumulation, internal funds and Tobin's q

Even if our goal is not to track the investment rate, capturing financial imperfections makes sense only in the perspective of a better understanding of how binding it might be for firms when they invest. Instead of running a standard regression with the investment rate as dependent variable and both the Tobin's q and the cash flow as explanatory variables (like FHP), we directly run the regression between the Tobin's q and the self financing ratio. If the security market were to be perfect, this regression should imply that if Tobin's q goes up, firm ought to use more external funds since its relative price has fallen.

For this purpose, we have split our sample in quartiles based on the investment rate of firms. Firms with the lowest investment rate are in group 1. One can imagine that firms with opposite features characteristics would be in the first group (the one with the lower investment rate): financially constrained firms, and firms without profitable investment opportunity. The descriptive statistics (table 7) for the different groups show that financially constrained firms are far more common than firms with no investment opportunity: In group 1, firms are more indebted, they pay a higher interest rate on debt, they're less profitable, and their z-score is lower[16]. The different countries are equally weighted in the four groups but the biggest firms are more frequent in the first two groups.

Table 7: Descriptive statistics

(median)	Overall panel	Group 1	Group 2	Group 3	Group 4
Number of observations	23363	6153	6075	5836	5299
Investment rate	.1486	.0297	.0999	.2156	.5090
Indebtedness rate	.1020	.1992	.1864	.1601	.1765
"Firm- specific" interest rate	.0976	.0948	.0941	.0887	.0840
% of big firms[a)]	.6145	.6557	.6676	.6218	.5077
Cash flow on total asset	.0894	.0837	.0905	.0955	.0882
ROA	.0530	.0420	.0520	.0604	.0612
Altman's z	4.86	4.20	4.67	5.40	5.46

[a)]: more than 999 employees.

Table 8 summarizes the different regressions. There is always a positive correlation between the Tobin's q and the self-financing ratio. All around the world, firms tend to invest more with their own internal funds, although the shadow price of external funds has fallen. Moreover, the influence of the Tobin's q on self-financing ratio varies with investment rate. Dummies for sectors or countries are not significant. We find here the confirmation of dynamic imperfections since we get the opposite correlation of the one we could expect if financial were to be perfect. If we consider the investment rate as a coarse proxy for firms that face financial constraints, then we get an interesting result. The more firms invest, the less they need additional cash flow to come along with Tobin's q. It happens to be that these firms that do invest much more than the other and need less internal funds for that, the coefficient is more than ten times lower. This result confirms strongly our assumption that financial constraints for firms imply that they tend to associate more external and internal funds and co-finance their investment.

It happens also that if we split the panel into two groups, anglo-american firms versus continental firms. The same regression ran on these two sub-panels tend to prove that the correlation between the Tobin's q and the self-financing ratio varies with the market firms are listed on. The relationship between Tobin's q and self financing ratio is stronger for the continental firms, and the difference in the coefficients are decreasing

[16]See Altman (1968) for details about the calculation of this score.

Table 8: Tobin's q and self-financing ratio

Dep. Var.: Self-financing ratio	Overall panel	Group 1	Group 2	Group 3	Group 4
Tobin's q	.163***	.915***	.370***	.149***	.059***
	(8.51)	(13.20)	(18.66)	(13.17)	(7.38)
Intercept	1.983***	5.095***	.045	.328***	-.277**
	(8.66)	(8.00)	(0.21)	(2.29)	(-2.31)
N. obs.	24,743	6,072	6,642	6,354	5,675
Adj. R^2	0.030	0.101	0.107	0.092	0.038
Wald χ^2	666.22	543.60	641.64	401.36	219.48
ρ	.2702	.3758	.7162	.7112	.7711

Notes: t-stats reported in brackets. Random-effect GLS regression, Hausman test validates the random-effects model at 5%. Dummies variables for years and countries are included in the regression. ρ : fraction of total residual due to firm-specific residual.
***: significant at 1%, **: significant at 5%, *: significant at 10%.

with the investment rate. In other terms, a convergence between anglo-american firms and continental firms exists for the 4th group (firms with a high investment rate, which are supposed not to be constrained). These regressions tend to confirm that financial constraints on European markets are more prevalent than in the Anglo-American world.

Table 9: Tobin's q and self-financing ratio

Dep. Var.: Self-financing ratio	Reg. 18, a,b Overall panel		Reg. 19, a,b Group 1		Reg. 20, a,b Group 2		Reg. 21, a,b Group 3		Regression 22, a,b Group 4	
	Anglo	Cont	Anglo	Cont	Anglo	Cont	Anglo	Cont	Anglo	Cont
Tobin's q	.1575***	.0765**	.8885***	1.0714***	.3443***	.4412***	.1365***	.2235***	.0591***	.0785***
	(9.86)	(2.22)	(11.48)	(7.57)	(14.74)	(16.02)	(10.36)	(16.08)	(6.44)	(11.32)
Intercept	.3385***	.5519***	5.528***	7.9445***	1.071***	1.816***	.6553***	.9208***	.2147***	.5018***
	(4.55)	(5.02)	(18.40)	(19.66)	(9.12)	(18.00)	(9.05)	(15.33)	(3.55)	(15.74)
N. obs	31908	9710	4541	1531	4929	1713	4771	1583	4409	1266
Adj. R^2	0.003	0.0005	0.051	0.050	0.061	0.213	0.052	0.235	0.006	.149
Wald χ^2	97.25	4.94	131.86	57.35	217.39	256.55	107.29	258.51	41.42	128.21
ρ	.0604	0	.4209	.2417	.7246	.6873	.7096	.7921	.7903	.6731

Notes: t-stats reported in brackets. Random-effect GLS regression, Hausman test doesn't reject the random-effects model at 1%. Dummies variables for years and countries are included in the regression. ρ : fraction of total residual due to firm-specific residual.
***: significant at 1%, **: significant at 5%, *: significant at 10%.

6 Conclusion

In this paper, we have tried to deal with the prevalence of financial imperfections and equity rationing on capital markets. We can offer new evidence. The price system on the stock market, if it does capture the maximum of information available about projects, is doing a poor job in orienting funds that want to be invested. This phenomenon is prevailing on the all OECD stock markets we have been looking at. Investment ought to depend on a set of consistent prices on the financial markets. It happens clearly that prices on the stock market give the direction of the allocation of resources; however, it appears to be that this direction is only followed by internal resources.

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A Sample construction

We started with an initial sample of 10,240 companies from Osiris[17], for each of them we have its annual balance sheet and current account, with some additional variables (number of employees, PER, number of shares...)[18]. We exclude banks, insurance companies and other financial companies (SIC codes 6,000-6,999) are set aside from our sample since we are interested in financial constraints. Public "firms" and firms with non reported industry code are also deleted. The sample is from 1990 to 2002.

We then merge this database with some additional data types (historical market data) from Datastream database. After matching, we obtain data from both sources for 7,179 firms. To ensure the reliability of the data, we exclude the firms reporting non-credible values such as negative debt, negative total assets and firms which report, for at least one year, a current account with a number of months different from 12. These conditions and the usual checking for coherence of both sources of data encourage us to delete 1,881 firms[19]. We obtain our final sample of 5,298 firms.

In some cases, market data from Datastream and accounts from Osiris were libelled in different currencies. We convert market data, using the annual mean of the bilateral exchange rate (source: OECD). For European firms with market data in another currency, we use a fictive exchange rate for the pre-1999 period (source: OECD and Federal Reserve System). We transform every variable in constant-currency (base 1990), deflating each variable by the annual inflation rate of the country (source: World Bank Indicators). Last, we winsorize the data:

- Tobin's q have to be between 0 and 15,
- Cash flow on total assets have to be between -5 and 5.
- XXX.

[17] Osiris is a Bureau Van Dijk's publication. Osiris provides standardized and as reported financial accounts for the world's publicly quoted companies (more than 24,000), up to 15 years on approximately. We use the Osiris DVD version, October 2003.

[18] Criteria for selecting these firms: at least 10 employees, publicly listed, data available (at least 4 years in a row of data), country, standardized account presentation and absence of major event in the firm life (bankruptcy, merger...).

[19] Data types included in both databases from Osiris and from Datastream are used to control the merging and must be similar (number of shares and market price of common shares in particular).

B Ratios calculation

For each ratio used in the paper, we provide the way to calculate it and the item numbers from Osiris ($OS\_$) or Datastream ($DS\_$). For more details about accounting principles, see van Dijk (2003).

$$\text{Operating margin} = \frac{\text{EBITDA } (OS\_D13018)}{\text{Total revenue } (OS\_13004)}$$

$$\text{Net margin} = \frac{\text{Net profit } (OS\_D13045)}{\text{Net sales } (OS\_D13002)}$$

$$\text{Total debt} = \text{Long term interest bearing debt } (OS\_D14016) + \text{Loans (current liabilities) } (OS\_D21010) + \text{Other LT int. bearing debt } (OS\_D21115)$$

$$\text{“Firm-specific” interest rate} = \frac{\text{Interest expenses } (OS\_D13026)}{\text{Total debt}}$$

$$\text{Investment rate} = \frac{\Delta\text{Fixed assets } (OS\_D20085)}{\text{Total assets } (OS\_D13077)}$$

$$\text{Tobin's } q = \frac{\text{Market value } (DS\_MV)}{\text{Fixed assets } (OS\_D20085)}$$

$$\text{Self financing ratio} = \frac{\text{XXX}(OS\_XXX)}{\text{XXX}(OS\_XXX)}$$

$$\text{Debt ratio} = \frac{\text{Total debt}}{\text{Total debt } + \text{Total Shareholders Equity}(OS\_14041)}$$

C Numerical solution for the model

XXX