Agency Costs, Credit Constraints and Corporate Investment[¤]

Sten Hansen[y]

April 19, 1999

Abstract

The importance of credit market imperfections for investment behavior is analyzed using Swedish …rm level data. Adjustment and agency costs are included in the neoclassical theory of optimal …nancial and investment decisions for …rms. In order to model the possible occurrence of agency costs of debt, and credit constraints, the behavior of banks is reviewed in the light of the theory of imperfect information. The econometric results indicate that investments are a¤ected by both adjustment and agency costs, but not by credit constraints. Moreover, it is also shown that …nancial decisions are a¤ected by agency costs. Finally, there is evidence of credit constraints prior to …nancial deregulation, but not speci…cally for small or independent …rms.

Keywords: credit constraints, debt externalities, expected marginal tax rate, investment, monitoring costs

JEL classi…cation: G31, D92

[¤] I am very grateful to Malin Adolfson, Gunnar Forsling, Kerstin Hallsten, Karl-Markus Modén, Jan Södersten, Anders Vredin and seminar participants at the Department of Economics, Uppsala University and Sveriges Riksbank for comments and suggestions, Sveriges Riksbank for hospitality, and Finanspolitiska Forskningsinstitutet for …nancial support.

[y] Address: Department of Economics, Uppsala University, Box 513, 751 20 Uppsala, Sweden, phone: + 46 18 471 7632, fax: + 46 18 471 1478, e-mail: sten.hansen@nek.uu.se

1 Introduction

Analysis of the investment decisions of …rms occupies a prominent place in research programs in macroeconomics, public economics, industrial organization, and corporate …nance. These research programs have been driven both by theoretical concerns and policy questions, e.g. how to decide which model o¤ers the best explanation of investment behavior, and how changes in monetary policy or tax policy a¤ect investment. Over the past decade a number of researchers have extended conventional models of business investment in …xed capital to incorporate a role for '…nancing constraints' in determining investment. Models that take imperfect information and incentive problems in capital markets into account have shown that information costs and the internal resources of a …rm in‡uence the shadow cost of external funds. This literature argues that when access to external debt and equity is costly, internal funds provide a cheaper source of …nancing. The principal …ndings of these studies are that, …rst, all other things being equal, investment is signi…cantly correlated with proxies for changes in net worth or internal funds, and second, the correlation is higher for …rms that are likely to face information problems related to capital market imperfections.

Following the seminal work of Fazzari, Hubbard and Petersen (1988), a large body of empirical work examines the role of capital market imperfections for investment behavior; see e.g. Devereux and Schiantarelli (1990), Blundell, Bond, Devereux and Schiantarelli (1992), Bond and Meghir (1994), and Chirinko and Schaller (1995). Most studies …nd that …nancial variables such as cash ‡ow help to explain investment spending, even when investment opportunities have been controlled for by using a measure of the price of installed capital relative to uninstalled capital, i.e. Q, as suggested by Tobin (1969). The sensitivity of investment to cash ‡ow is usually interpreted as an indication that the …rm is rationed in the market for credits. However, as argued by Cummins, Hassett and Oliner (1997), and by Gilchrist and Himmelberg (1998), it is not appropriate to use the stock market valuation of equity as a measure of the fundamentals that drive investment. The reason is that the underlying assumptions are not fulfilled, such as linear homogenous net revenue function and perfectly competitive markets, and consequently, average Q does not equal marginal Q. They therefore suggest that instead of using a measure of Q from the supply side of equity, one should use an estimate of the expected present value of future marginal returns to capital, in the spirit of Abel and Blanchard (1986). Another advantage of using a direct forecast of this kind is that small firms, which lack a stock market valuation, can easily be included in the analysis.

The Q-model, as well as the direct forecast model, formalizes investment incentives in terms of the expected present value of future marginal returns to capital. An alternative is to use the Euler equation model, which is based only on information from two subsequent periods. This approach is preferable if the information required by the Q-model is sensitive to various types of misspecifications.[1] In general, the price for avoiding this latter pitfall is large error terms, which however can be compensated for by using large samples. For evaluating capital market imperfections, the Euler equation model, supplemented with a borrowing constraint, has been used by Himmelberg (1990), Whited (1992), Hubbard, Kashyap and Whited (1995), Jaramillo, Schiantarelli and Weiss (1996), van Ees, Garretsen, de Haan and Sterken (1997), and Bond, Elston, Mairesse and Mulkay (1997). When the borrowing constraint is binding, the equation becomes misspecified. Separating firms into different groups, based on the a priori belief that the firm is constrained in the financial market, allows cross-differences in the misspecification to be analyzed. By adopting the generalized method of moments, the J-test of the overidentifying orthogonality conditions is used for evaluating possible credit

[1] Note that the higher the adjustment costs are, the more information is embodied in subsequent investment decisions.

constraints. Unfortunately, the J-test, which is considered to be a very blurred test, easily fails to detect misspecified orthogonality conditions; see e.g. Newey (1985). Besides, if it does detect misspecification, it is not obvious if this is because of the instrumental variables, or because of the model itself. Nevertheless, the Euler equation studies cited above suggest that small firms are more likely to be credit-constrained than large firms are. However, by limiting their analysis to the investment equation, none of the studies offer a satisfactory explanation of the link between the financial decision and the investment decision.

This paper addresses the question of the way in which credit market imperfections may influence the financial decisions and investment behavior of Swedish firms. Investment behavior is captured using the Euler equation model augmented with adjustment and agency costs. Financial behavior is also modeled on the basis of the optimal behavior of firms according to neoclassical theory, augmented with agency costs and credit constraints. Specifically, the model allows for investigating both agency costs of debt and credit constraints independently of the investment behavior. This is achieved by, among other things, using a probit estimate of the expected marginal tax rate, which is substituted for the statutory tax rate in the empirical financial equation. This step has proved to be important, since the model of the tax system otherwise makes debt financing appear unrealistically favorable by suggesting tax rebates in proportion to the much higher statutory tax rate. The importance of agency costs is stressed in recent literature concerning information problems between managers, stockholders and banks. Moreover, credit constrains are incorporate in the model as an attempt to capture the lending policy of Swedish banks, and financial deregulation in the 1980s. The two-equation model that arises is estimated using Swedish firm level data from the period 1979 to 1995. This set-up makes it possible to investigate the interdependence of variables, and the conditional correlation of error terms, and in addition, increases the efficiency of the estimator.

This paper provides empirical evidence for the existence of both positive externalities and monitoring costs of debt …nancing, i.e. agency costs. Firms are assumed to combine di¤erent sources of funds so as to equate their marginal costs. Therefore, the optimal leverage is determined by the required return to equity, the interest rate, the expected marginal tax rate, and the form of the agency cost function. The optimal leverage is shown to be roughly one …fth of the assets. Once agency costs are taken into consideration, there is no further support for the existence of credit constraints where small or independent …rms are concerned. There is, however, support for credit constraints prior to 1988, when the Swedish …nancial market was regulated. Moreover, the empirical investigation con…rms that installing and uninstalling capital are associated with adjustment costs. The investigation also shows that investments are a¤ected by the presence of agency costs, in that a deviation from the leverage at which agency costs are minimized a¤ects the investment to capital ratio downwards. Finally, there is no evidence of e¤ects on investment behavior from dividend and credit constraints.

The structure of the paper is as follows. Section 2 discusses the theoretical foundations for credit rationing in the presence of imperfect information. It also states, in qualitative terms, how banks reach their decisions regarding advances to …rms, which provides information on how the debt ceiling of …rms should be modeled. Section 3 introduces a dynamic model of investment and …nancial behavior in the presence of convex costs for adjusting the capital stock, convex debt …nancing costs, a dividend ‡oor, and a debt ceiling. The model also takes the complex Swedish corporate tax system into consideration, with the purpose of modeling the possible tax bene…ts from debt …nancing. Section 4 describes the data, and provides comprehensive descriptive statistics on Swedish banks and …rms. Section 5 presents an econometric analysis of some quantitative models. Using the generalized method of moments, the investment and …nancial equations are estimated simultaneously, taking their mutual interdependence into consideration. This procedure makes it possible to estimate the covariance between the two decisions. Finally, section 6 gives some concluding remarks.

2 Banks

In a world of uncertainty and information problems, banks provide financial intermediation between creditors and entrepreneurs, i.e., they monitor entrepreneurs on behalf of creditors. More specifically, one important role of banks is to provide capital to firms that cannot finance themselves in the more anonymous security market due to information problems. Unlike standard markets, where the delivery of a commodity by a seller and payment for the commodity by a buyer occur simultaneously, in the credit market a loan received today is exchanged for a promise of repayment of the loan along with accrued interest in the future. One borrower's promise may not be as good as another borrower's promise, and there may be no objective way to determine the probability that the promise will be kept.[2] Therefore, loan contracts may also include 'non-priced' terms, which constrain the activity of the borrower in order to reduce the probability of default. Collateral is among the most important of these. In general, however, collateral may reduce but not eliminate the probability of default, i.e., there is at least one more dimension to a credit contract. Thus, the demand for credit may exceed the supply at the going market interest rate.

2.1 Interest Rate and Collateral

Stiglitz and Weiss (1981) showed that in a world with imperfect information, increasing the interest rate can have both a negative adverse selection effect, and a negative incentive effect on the bank's return. The selection effect is shown by the interest rate, functioning as a screening device. As the interest rate increases,

[2] Note that Altman (1968) put forward the method of linear discriminant analysis for classification of firms into groups based on the probability of they becoming financially distressed. Since then several other methods for measuring the probability of default have been suggested, e.g. logit and probit models, credit scoring models, models describing the hazard rates of failure, and neural networks. Comparisons of some of these methods are given in Altman, Marco and Varetto (1994), and Arminger, Enache and Bonne (1997). However, Swedish banks do not apply any of these methods to determine the conditions on which firms are offered credit.

the average riskiness of those who apply for loans may increase. The second way in which the interest rate may affect the bank's return is by changing the behavior of firms. For instance, higher interest rates may induce firms to undertake riskier projects, i.e., projects with lower probabilities of success but higher profits when successful. This phenomenon is usually called moral hazard. Therefore, although a higher interest rate increases the expected repayment on any given project, the indirect effects of adverse selection and moral hazard may reduce the expected repayment on the total loan portfolio. Consequently, it may be optimal for banks to choose an interest rate below the market clearing rate, thus causing credit rationing.

Several articles have suggested that credit rationing disappears when a bank is able to set collateral requirements and interest rates simultaneously. The argument is that the bank can offer a set of self-selecting contracts that fully reveals the risk character of each firm; see Rothschild and Stiglitz (1970), and Bester (1985). However, this conclusion is likely to hold only if firms' characteristics differ in just as many respects as the range of contracts. Thus, as long as the banks lack any information on firms' characteristics, it is possible to construct plausible models in which credit rationing occurs; see e.g. Jaffee and Stiglitz (1990). Banks may still use collateral as a measure to moderate profit reductions due to incentive effects. Stiglitz and Weiss (1981) demonstrated that although collateral may have beneficial incentive effects, it may also have countervailing adverse selection effects. To be more precise, increasing collateral requirements may increase the bank's return from any given firm. However, due to the assumption of decreasing absolute risk aversion, increasing collateral requirements may imply that both the average and the marginal borrower are riskier. Decreasing absolute risk aversion results in wealthier firms undertaking riskier projects. This adverse selection effect may more than offset the positive incentive effect.

Closely related to the idea of collateral requirements is the balance sheet view, which is a theory that emphasizes the importance of the firm's balance sheet position in obtaining debt financing; see Calomiris and Hubbard (1990), and Gertler (1992). In this setting, a firm's financial position is a key determinant of its terms of credit. The mechanism driving the result is that higher borrower net worth reduces agency costs on the credit market. A stronger balance sheet implies that a firm has more resources available which it can use either directly in financing projects, or as collateral in obtaining outside funds. In addition, business upturns improve net worth and lower agency costs, thereby increasing investments; see Gertler and Gilchrist (1994).

2.2 Classification Schedule

Given that the expected repayment of a loan depends on the risk character of a project, it is natural for banks to try to assess the probability that the firm cannot pay back the loan. Borrower classification, based on risk screening, is a major function of the banking system. After appraising the riskiness of a loan, the bank has a basis for setting the optimal size of the loan and the interest rate. In an efficient classification system, riskier borrowers are charged higher interest rates to take into account their higher probability of default. Classification of borrowers into a small number of groups can be justified by theories other than the theory of imperfect information. The credit rationing theory of Jaffee and Modigliani (1969) postulated that banks have some subjective evaluation of the probable outcomes of projects carried out by different firms. Banks, for example, may use a schedule of quoted interest rates, with the safest borrowers charged the prime rate and riskier borrowers quoted a premium above the prime rate. A premium above the prime rate reflects a higher probability of default. However, legal restrictions, goodwill, and social mores make it inadvisable, if not impossible, for banks to charge widely different interest rates to different customers. Instead, banks tend to limit the spread between the loan rates, and justify the remaining differentials in terms of a few easily verifiable criteria such as firm size, industry class, and standard …nancial measures.

Recent work at Sveriges Riksbank (Daltung and Nedersjö (1997)), suggests that the following three factors are the most important for Swedish banks in classifying borrowers:

- Large …rms may …nd it easier to obtain loans than small …rms. Sales, number of employees, or the value of assets may be used as measures of size. Note, however, that the size of a …rm is usually related to the …rm's age.

- Firms that belong to a corporate group may …nd it easier to obtain loans than independent …rms.

- Good relations with a bank may also increase the possibility that a …rm will obtain a loan. Continuing relationships may entail lower costs for lenders that make a series of loans to the same borrower. Furthermore, as a result of the information provided by a long-term customer relationship, competitors may fear that winning a customer means that the previous lender has learned of adverse developments for the …rm, i.e. the lemons' principle; see Akerlof (1970).

A large number of studies have investigated the relationship between the size of a …rm and its prospects of debt …nancing; see e.g. Devereux and Schiantarelli (1990), Hubbard et al. (1995), and Jaramillo et al. (1996). What all these studies have in common is that they provide empirical support of capital market imperfections a¤ecting small or young …rms, but not large or old …rms. Mulkay (1997) investigated the investment behavior for di¤erent classes of French industrial …rms. He found empirical evidence that …nancial constraints are less important for a subsidiary of a corporate group than for an independent …rm. Moreover, Hoshi, Kashyap and Scharfstein (1991) examined the accessibility to bank loans for two groups of Japanese …rms, one with close …nancial ties to large Japanese banks that serve as their primary source of external …nance, and one with weaker links to a major bank. They found that information and incentive problems in the capital market do affect corporate investment.

2.3 Loanable Funds

Banks obviously need funds to make loans, so the cost and availability of loanable funds necessarily affects loan supply. The credit view, or lending view, is a theory that stresses the importance of the pool of funds available to bank-dependent borrowers, i.e., the importance of the asset side of banks' balance sheets; see Blinder and Stiglitz (1983), Romer and Romer (1990), and Bernanke and Blinder (1992). The validity of the credit view hinges critically on three conditions; see e.g. Gertler and Gilchrist (1993). First, for a large class of borrowers, primarily small firms, close substitutes for bank credit are assumed to be unavailable. Second, there must be legal reserve requirements for bank deposits. Third, it is assumed that banks cannot elastically issue CDs, i.e., certificates of deposit, or other managed liabilities to fund loans.[3]

It is natural to expect that financial and investment behaviors were affected by the financial deregulation in Sweden during the mid-1980s. The deregulation may briefly be described by the following three events: first, the requirement that banks had to hold a certain percentage of their assets in government and mortgage institution bonds was abolished in 1983; second, the regulation of the loan rates for bank advances came to an end in 1985; and third, the lending ceiling, which regulated the volume of bank loans, was removed in 1985.[4] This means that the necessary conditions for the credit view have not existed since the financial deregulation, and the credit view may therefore have characterized the credit market only up until 1986.

[3] Details and properties of CDs are provided, for instance, in Jaffee and Modigliani (1969).
[4] See also Englund (1990) for more information on financial deregulation in Sweden.

3 Firms

On the basis of the standard neoclassical theory, the behavior of a representative firm is modeled here in the presence of adjustment costs of capital, and agency costs of debt. The corporate management is assumed to choose investment I, variable inputs L, and debt B in order to maximize the expected present value of the firm. All variables in the present period are assumed to be known with certainty, whereas all future variables are stochastic. It is assumed that the managers are risk-neutral, and have rational expectations. The maximization problem, which managers have to solve, can be written as:

$$\max_{I_{is};L_{is};B_{is}} \left\{ E_t \left[\sum_{s=t}^{\infty} \left(\prod_{u=t}^{s} \beta_u \right) \theta D_{is} \right] \right\}, \tag{1}$$

where $\beta = 1/(1+r)$ is the one period discount factor, and where r is the tax-adjusted required return to equity. Furthermore, $\theta = (1-\tau^D)/(1-\tau^C)$ is the tax discrimination parameter, and D is the flow of dividend payments to stockholders. τ^D and τ^C are the personal tax rates on dividend payments and capital gains, respectively. The value of the firm is maximized subject to several constraints.

First, let K denote the real capital stock of the firm on which the production is based. The stock of capital changes over time due to gross investments and depreciation, that is:

$$K_{it+1} - K_{it} = I_{it} - \delta K_{it}, \tag{2}$$

where δ is the geometric rate of depreciation. There is also a transversality condition for the stock of capital, which ensures a unique solution of the optimization problem by ruling out 'price bubbles'.

The second constraint defines the firm's dividends. Let τ denote the corporate tax rate, and Γ the present value of tax savings from depreciation allowances and investment tax credits per unit of new investment.[5] Dividend payments are

[5] The present value of tax savings is defined as in Auerbach (1989), and Auerbach and Hassett

determined by the revenue Π less tax payments $\tau\Pi$, plus new debt issue, denoted by $\Delta(qB)$, and less investment expenses net of expected future tax savings from current new investments $q(1-\Gamma)I$. Thus, the sources and uses of funds for the firm are defined as:

$$D_{it} = \Pi_{it} - \tau_t \Pi_{it} + q_t B_{it} - q_{t-1} B_{it-1} - q_t (1 - \Gamma_t) I_{it}, \tag{3}$$

where

$$\Pi_{it} = p_t F_{it} - p_t G_{it} - p_t A_{it} - w_t L_{it} - i_t q_{t-1} B_{it-1}, \tag{4}$$

where p, q and w are the prices of output, capital goods, and variable inputs, respectively. To allow for imperfect competition in the output market I let the price p depend on the level of output, with the price elasticity of demand ε assumed to be constant. The revenue Π is composed of the value of production pF, less costs of adjusting the capital stock pG, monitoring/agency costs of debt pA, costs of variable input factors wL, and interest payments iqB.

The third constraint compels dividends to be non-negative, which in the model prevents the firm from new share issues as well as withdrawals from the stockholders:

$$0 \leq D_{it}. \tag{5}$$

The dividend restriction implies that the firm has only two sources of financing, retained earnings and debt.[6] In Sweden there is also an upper restriction on dividends due to the uniform reporting convention, which requires dividend payouts not to exceed after-tax book profits.[7] Since very few firms have experienced this upper restriction, it is not accounted for in the model.

(1992), although adjusted for the Swedish corporate tax system.

[6] This abstraction is reasonable since very few Swedish firms issues new equity (on average, during the period 1979 to 1995, only 4.2 percent of the firms).

[7] Kanniainen and Södersten (1995) show that the uniform reporting convention leads to an implicit constraint on debt financing. In my model, however, borrowing is constrained according to equation (6) and by the presence of agency costs of debt.

The fourth constraint involves an upper limit on how much the firm is allowed to borrow. Debt is assumed to be entered into for a contract period of one year.[8] Its nominal value is given by qB, and hence, real debt B is measured in terms of the replacement value of capital. The borrowing constraint is given by:

$$B_{it} \leq C_{it}. \tag{6}$$

The debt ceiling C is assumed to depend on firm-specific factors as well as macro factors in the economy. It is assumed to restrict borrowing in cases where asymmetric information is present; see the discussion in section 2.

3.1 Output

The production function $F(K;L)$ is assumed to be linearly homogenous in capital and variable production factors. Likewise, the adjustment cost function $G(K;I)$, and the agency cost function $A(K;B)$, are assumed to be linearly homogenous in capital and investment, and in capital and debt, respectively. Using the Euler theorem gives the following relationship:

$$Y_{it} = \frac{\partial F_{it}}{\partial K_{it}} K_{it} + \frac{\partial F_{it}}{\partial L_{it}} L_{it} - \frac{\partial G_{it}}{\partial K_{it}} K_{it} - \frac{\partial G_{it}}{\partial I_{it}} I_{it} - \frac{\partial A_{it}}{\partial K_{it}} K_{it} - \frac{\partial A_{it}}{\partial B_{it}} B_{it}, \tag{7}$$

where $Y = F - G - A$ is the output function. The Euler theorem, together with additive separability, implies that a parametric form of the production function does not have to be specified in order to estimate the investment equation.

Installing and uninstalling capital are assumed to consume resources, which are incorporated in the model as losses in output. Similar approaches are used by Summers (1981), Hayashi (1982), Whited (1992), and Hubbard et al. (1995); see also appendix A for some additional comments. A quadratic adjustment cost

[8] This assumption is reasonable since de facto, most bank advances to Swedish firms are on a short term basis with a flexible interest rate.

function that is linearly homogenous in its argument is assumed:

$$G(K_{it}; I_{it}) = \frac{\alpha}{2}\left(\frac{I_{it}}{K_{it}} - \delta\right)^2 K_{it}, \tag{8}$$

where α gives the magnitude, and δ corresponds to the investment to capital ratio that minimizes the adjustment cost. Following Chirinko (1987), and Auerbach and Hassett (1992), I let the location of symmetry be equal to the depreciation rate of capital δ, and there are therefore no adjustment costs when the capital stock is in steady state.

The presence of debt in the capital structure of the firm is assumed to induce two effects on output, with opposite characteristics. First, there may be positive effects due to enhanced monitoring, as argued by Kanniainen and Södersten (1994). This should be interpreted such that debt financing mitigates agency problems in the equity market, i.e., problems between managers and stockholders of the firm. Debt financing is thus assumed to exert an influence on the managers to make them choose projects that satisfy the rate of return required by the stockholders.

Second, there may be negative effects because creditors, as a way of supervising the firm, can impose operational restrictions that reduce output; see e.g. Jensen and Meckling (1976), and Myers (1977). It may also be resource-consuming for the firm to obtain debt financing. In addition, there may be negative effects due to the increased probability that the company may go bankrupt, and therefore be unable to repay its loans, a factor which is not fully accounted for in the interest rates claimed by the creditors. For example, Jaramillo et al. (1996) introduced an agency/financial distress cost function that captured the premium paid by firms above the safe rate. However, the spread of interest rates charged on bank advances to Swedish firms is generally very small, so that it is more adequate to think of the agency cost as a decrease in output.[9]

[9] This argument is based upon information on interest rates charged on bank advances to firms

A quadratic agency cost function is assumed to capture both the positive externality and the monitoring cost of debt financing:

$$A(K_{it}; B_{it}) = \frac{\phi}{2}\left(\frac{B_{it}}{K_{it}} - \omega\right)^2 K_{it}, \tag{9}$$

where ϕ gives the magnitude and ω is the location of minimum agency costs, at which the marginal effect is zero.

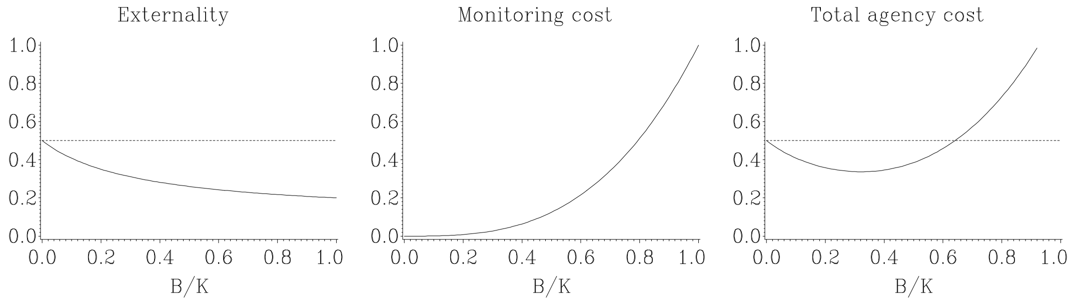
As is well known, for a firm financed entirely by equity, the stockholders incur the full costs of monitoring; see Easterbrook (1984). The stockholders are aware that when a firm acquires debt, it will be reviewed by a financial intermediary that has a gross cost advantage in collecting information to certify that the new securities are backed up by the earnings potential; see e.g. Diamond (1984, 1991). This service is assumed to represent a positive, though at the margin diminishing, externality on the size of output (see Figure 1). Moreover, agency problems between the intermediary and managers of the firm are likely to be more important as the amount of debt increases. These agency problems are thus assumed to cause positive, and at the margin increasing, monitoring costs in terms of lower output (also see Figure 1).

The agency cost function is assumed to represent the sum of the initial agency cost, the externality, and the monitoring cost of debt, and the agency cost function is therefore U-shaped, as shown in Figure 1. Note that the initial level of agency cost, which is assumed to be constant, does not influence the debt decision. It is assumed that a debt to capital ratio equal to one entails maximum agency cost, which means that minimum cost is attained in the open interval $(0; 1)$. Note also that the assumed agency cost function implies that the marginal cost of debt is negative for debt to capital ratios below ω, and positive otherwise.

---

in Sweden during the period 1989 to 1995, taken from the Department of Financial Statistics, Sveriges Riksbank.

Figure 1: Reduction of initial agency costs between managers and stockholders through the externality from debt financing; cost of being monitored by creditors; total agency cost of debt



3.2 First Order Conditions

The theory of optimal control is used to find the solution to the firm's maximization problem. In contrast to the calculus of variation, which requires differentiability, optimal control can deal with corner solutions. The theory is applied by using the discrete time maximum principle by defining the current value Lagrangian. The managers' problem is to find:

$$\max_{I_{is};L_{is};B_{is}} E_t \left\{ \left[\sum_{s=t} \left(\prod_{u=t} \beta_u \right) \left(\theta D_{is} + \lambda_{is} D_{is} + \mu_s q_s \left(I_{is} - \delta K_{is} \right) - \xi_{is} q_s B_{is} \right) \right] \right\}, \quad (10)$$

where μ is the shadow value of the real capital stock, and where λ and ξ are the shadow values associated with the floor in dividend payments and the ceiling in debt issue, respectively. Details on the solution are available in appendix B.

The partial derivatives of the Lagrangian with respect to the control variables investment and variable input factors are set equal to zero:

$$\mu_t = (\theta + \lambda_{it}) \left(\frac{(1 - \tau_t)\alpha p_t}{q_t} \frac{\partial G_{it}}{\partial I_{it}} + (1 - i_t) \right), \quad (11)$$

$$w_t = \alpha p_t \frac{\partial F_{it}}{\partial L_{it}}, \quad (12)$$

where $\eta = 1 - 1/\varepsilon$ is the inverse of the markup. The first order condition with respect to investment, equation (11), states that the firm invests up to the point where the net cost of investment equals the shadow value of capital μ. The investment cost is composed of marginal adjustment costs in terms of a decrease in output, in addition to acquisition costs of capital, net of the present value of future tax savings. Equation (12) is the first order condition with respect to variable input factors, which states that the firm increases inputs until the marginal revenue products equal their costs.

The partial derivative of the Lagrangian with respect to the control variable 'new debt issue' is set equal to zero:

$$E_t\left[\frac{1}{1+r_t}\frac{\theta+\lambda_{it+1}}{\theta+\lambda_{it}}\right] = E_t\left[\frac{1}{1+(1-\tau_{t+1})i_{t+1}}\left(1-\frac{(1-\tau_t)\eta p_t}{q_t}\frac{\partial A_{it}}{\partial B_{it}}-\frac{\xi_{it}}{\theta+\lambda_{it}}\right)\right]. \quad (13)$$

In a complicated way, the left-hand side of equation (13) captures the expected cost of retained earnings, and the right-hand side the expected cost of debt. In order to interpret equation (13), first, assume that the shadow values associated with the dividend constraints are zero. This means that the cost of retained earnings is known with certainty in the present period. Second, using a first order Taylor approximation gives:

$$r_t \approx E_t\left[(1-\tau_{t+1})i_{t+1}+\frac{(1-\tau_t)\eta p_t}{q_t}\frac{\partial A_{it}}{\partial B_{it}}+\frac{\xi_{it}}{\theta+\lambda_{it}}\right]. \quad (14)$$

Hence, in the financial equilibrium, the cost of equity funds equals the after-tax cost of debt, which is composed of the expected after-tax interest rate, plus marginal agency costs. The cost of debt is also affected by the shadow value of the credit constraint.

It is assumed that $r > (1-\tau)i$, which in fact is the case in Sweden, and that in the absence of agency costs of debt and borrowing constraints, the firm will therefore finance all investments by debt. Miller and Modigliani (1963) show that this is one consequence of an asymmetric corporate tax system in which interest expenses are deductible from the tax base. In my model, however, the marginal agency cost increases as the debt to capital ratio increases. Therefore, the firm will eventually find it optimal to finance some parts of its investments by means of retained earnings. Another feature of my model, measured by the shadow value of the debt ceiling, is that banks can turn down a loan request. This mechanism increases the shadow cost of debt enough to induce the firm to increase the share of retained earnings in the financial mix.

The partial derivative of the Lagrangian with respect to the capital stock is set equal to the negative of the change in the shadow value of the capital stock, i.e., $L_K = (\Pi\beta)(rq\mu - q\Delta\mu)$. Rearranging gives:

$$\frac{\partial F_{it}}{\partial K_{it}} - \frac{\partial G_{it}}{\partial K_{it}} - \frac{\partial A_{it}}{\partial K_{it}} = \frac{q_t}{(1-\tau_t)\eta p_t}\frac{\mu_t}{\theta+\lambda_{it}}\left(\delta + r_t - \frac{\Delta\mu_t}{\mu_t}\right), \tag{15}$$

where

$$\Delta\mu_t = (1+r_t)\left(\mu_t - \frac{q_{t-1}}{q_t}\mu_{t-1}\right). \tag{16}$$

Equation (15) states that the marginal output, in the presence of adjustment and monitoring costs, equals the user cost of capital.

3.3 The Investment and Debt Equation

The first step is to derive the investment equation taking financial variables into account. Because of the difficulty in obtaining a reliable measure of the shadow value of capital, the Euler equation approach is used. The idea is to substitute the first order condition with respect to investment, equation (11), into the first order condition with respect to capital, equation (15), thus describing the relationship between two subsequent investment decisions. Analytical expressions are substituted for the partial derivatives of adjustment and agency cost functions, equations (8) and (9), respectively. Moreover, the assumed linear homogeneity of the production function is used to replace the marginal returns to capital with the marginal returns to variable input factors. Finally, in order to make it possible to distinguish the effects of the markup from the effects of output on investments, earnings are defined as:

$$\frac{E_{it}}{K_{it}} = \frac{Y_{it}}{K_{it}} - \frac{w_t}{p_t}\frac{L_{it}}{K_{it}}, \tag{17}$$

which is a measure of the difference between output and variable costs.

The second step is to derive the debt equation. This is accomplished by a slight rewriting of equation (13), where the analytical expression is substituted for the partial derivative of the agency cost function, equation (9).

To sum up, the two-equation system, describing the optimal investment path and debt path, is given by:

$$E_{t-1}\left[\beta_t \frac{\theta+\lambda_{it}}{\theta+\lambda_{it-1}}\frac{1-\tau_t}{1-\tau_{t-1}}\frac{p_t}{p_{t-1}}\left(\alpha\left(\frac{I_{it}}{K_{it}}-\delta\right)\frac{I_{it}}{K_{it}}+\phi\left(\frac{B_{it}}{K_{it}}-\omega\right)\frac{B_{it}}{K_{it}}+\frac{1}{\eta}\frac{E_{it}}{K_{it}}-\frac{1-\eta}{\eta}\frac{Y_{it}}{K_{it}}\right.\right.$$

$$\left.\left.+(1-\delta)\left(\alpha\frac{I_{it}}{K_{it}}-\alpha\delta+\frac{(1-i_t)q_t}{(1-\tau_t)\eta p_t}\right)\right)\right] = \alpha\frac{I_{it-1}}{K_{it-1}}-\alpha\delta+\frac{(1-i_{t-1})q_{t-1}}{(1-\tau_{t-1})\eta p_{t-1}}, \tag{18}$$

$$E_{t-1}\left[\beta_t\frac{\theta+\lambda_{it}}{\theta+\lambda_{it-1}}(1+(1-\tau_t)\,i_t)\right] = 1-\frac{(1-\tau_{t-1})\eta p_{t-1}}{q_{t-1}}\phi\left(\frac{B_{it-1}}{K_{it-1}}-\omega\right)-\frac{\xi_{it-1}}{\theta+\lambda_{it-1}}. \tag{19}$$

I would like to draw attention to certain properties of equations (18) and (19). First, equation (18) is made up of ex post measurable accounting variables, and macro variables, for firms that pay dividends in two subsequent periods, provided that information on the return to equity required by stockholders is available. This makes it possible to estimate the investment equation separately for these firms, without taking the financial decision into account. Moreover, equation (19) is entirely made up of ex post measurable variables for firms that pay dividends in two subsequent periods and do not experience any debt ceiling. However, for firms that are credit-constrained in period $t-1$, the shadow value ξ will represent a markup on the cost of debt. The measurement of this markup is discussed further in section 5.

Second, in the case of perfect competition in the product market, where the inverse of the markup ψ equals one, only earnings will influence investment behavior, not output.[10]

Third, equation (18) and (19) both contain the shadow value of a binding dividend constraint in period t. In the absence of information on the shadow value of the expectation of not paying dividends in the next period, it is possible to assume constant conditional covariance between equation $(\theta + \lambda_{it})/(\theta + \lambda_{it-1})$ and other t dated variables; see Hubbard et al. (1995). This enables us to substitute the financial equation into the investment equation, thus eliminating the discount factor β and the unknown shadow values of binding dividend constraints. However, unexpected changes in the flow of dividend payments affect the investment and financial equation simultaneously, and $(\theta + \lambda_{it})/(\theta + \lambda_{it-1})$ and other t dated variables will consequently present mutual conditional covariance. To avoid this suspected econometric problem, I intend to estimate these two equations simultaneously, so as to take their mutual covariance into account.

4 Data

The statistical part of the analysis is carried out on the database CoSta; detailed information is provided in Hansen (1998). CoSta consists of information on non-financial companies located in Sweden during the period 1979 to 1995. It contains information on the income statements and balance sheets of legal entities. In the manufacturing industry (ISIC 31 to ISIC 38)[11], firms with 20 employees or more are sampled exhaustively, and these are therefore the only firms used in the empirical analysis, although smaller firms are included in the descriptive statistics.

[10] Note that output is the main explanatory variable in ‘accelerator’ models of investment behavior. This theory, however, is essentially different from the neoclassical one.

[11] The classification system ISIC Rev. 2, from 1968, corresponds to the Swedish classification system SNI69 at a four-digit level.

The empirical analysis is carried out on an unbalanced panel of 2;702 …rms, contributing 12;404 observations. Macro variables such as corporate tax rates and interest rates, which are used in the analysis, are provided in Table ?? and Table 4 in appendix C.

In order to show similarities and di¤erences across …rms, descriptive statistics are presented for three subgroups. Firms with more than 500 employees, and …rms with more than 100 employees that belong to a corporate group are put into one group of large …rms. These 718 …rms, contributing 5525 observations, are *a priori* believed to be those least likely to be constrained in the credit market. Firms that do not belong to a corporate group and have more than 20 but less than 50 employees are put into another group of midsize …rms. These 932 …rms contribute 4112 observations. Finally, …rms that have less than 20 employees are put in a third group of small …rms. There are records on 3210 small …rms, contributing 8288 observations. It is evident that, on average, large …rms have more observations each than smaller …rms do, 8 in comparison with 4 (calculated as 5525=718 and 4112=932, respectively).

4.1 Descriptive Statistics

During the late 1980s, the pool of funds o¤ered to bank-dependent …rms increased by roughly 100 percent (see Figure 2), a fact that is explained by the deregulation of the Swedish credit market in the mid-1980s. It seems natural to expect that this dramatic increase in available funds helped to mitigate those credit constraints that may have existed. Figure 2 also displays the interest rate on bank advances to …rms. On average the interest rate charged was 13 percent over the period 1981 to 1995, somewhat higher in the early 1980s, and somewhat lower in the mid-1990s. In connection with deregulation, the interest rate charged and the volume of bank advances began to present substantial covariance, which suggests that market forces were set in action. Furthermore, the positive relationship suggests that the interest rate responded to changes in the demand for credits. The required rate of return to equity, computed as 1:3 times the tax-adjusted interest rate on premium bonds, is also shown in Figure 2.

Because of the asymmetrical treatment of gains and losses, and, in particular, the widespread under-utilization of tax allowances among Swedish …rms (see Forsling (1998)), the statutory corporate tax rate often exaggerates the value to the …rm of interest deductions. I have therefore chosen to introduce a new measure of the expected marginal corporate tax rate, following the approach suggested by Forsling (1998). To measure the expected marginal tax rate I …rst estimate the probability of the …rm entering a taxable state by using a probit model. Second, the expected marginal tax rate is calculated as the statutory tax rate weighted by the probability of entering a taxable state, thus making it …rm-speci…c. As is clear from Figure 3, the expected marginal tax rate so estimated is substantially lower than the statutory tax rate. Furthermore, the expected marginal tax rate is fairly constant during the sample period, on average 20 percent, even though the statutory tax rate was reduced from a high of 57 percent in 1988 to 30 percent in 1991.

The next task is to describe the …nancial situation of the …rms. Figure 4 and Figure 5 show the composition of assets and liabilities, respectively. In the early 1990s …rms in all subgroups slightly increased their long-term liabilities compared with current liabilities. However, there is no evidence of …rms taking the opportunity to replace equity with bank loans at the time of the …nancial deregulation, even though the pool of funds almost doubled in the late 1980s. The banks apparently increased their lending to actors other than corporate …rms in the manufacturing sector. Figure 5 also shows that …rms in all subgroups increased their share of equity …nancing in the early 1990s. Furthermore, at the same time, the shares of untaxed reserves decreased, which may be attributed to the tax reform of 1991.

On the basis of equations (18) and (19), the …rm-speci…c variables of preliminary interest are investment to capital, earnings to capital, output to capital, and debt to capital. The formal de…nitions are provided in appendix C. Figures 6 to 9 show the time patterns of these variables for each subgroup. On average the investment ratios are 0:12 over the period 1981 to 1995 (see Figure 6). They are slightly higher for small …rms than for larger …rms, indicating that small …rms grow faster than larger …rms do. Furthermore, the investment ratios show larger variance for small and midsize …rms than for large …rms. This fact may be a result of smaller …rms facing lower costs for adjusting the stock of capital than large …rms do, or perhaps more likely, a consequence of the indivisibility of investment projects. The most salient feature in the investment ratios is the sharp drop in the early 1990s and the fast recovery in the mid-1990s, which is commonly attributed to the major recession in the early 1990s.

Studies working with the Q-model often …nd that investment is excessively sensitive to earnings for small …rms, but not for large …rms; see e.g. Fazzari et al. (1988). Also this study reveals a resemblance between the patterns over time of the earnings ratios series and the investment ratios series (see Figure 7). Like the investment ratios, the earnings ratios decreased considerably around 1990, and increased later on in the early 1990s to their previous levels. The magnitude of the changes in the earnings ratios is virtually the same for all subgroups, yet the investment ratio responds more strongly for small …rms than for larger …rms. As noted above, this may be a consequence of the indivisibility of investment projects, but it may also be the result of small …rms facing di¢culties in obtaining outside …nancing. Figure 8 indicates that there is little resemblance between investment ratios and output ratios. Moreover, output ratios slowly decrease during the sample period, which can perhaps be explained by the higher shares of …xed assets in the balance sheets shown in Figure 4.

Figure 9 shows the development of debt to capital ratios during the sample period. Small …rms clearly have higher debt ratios than larger …rms do, on average 0:84 compared with 0:67. In the early 1980s midsize and large …rms cut down on their debt ratios by approximately 20 percent, whereas small firms maintained their original level throughout the period. This suggests that midsize and large firms turned to sources other than debt for financing new investments, for example retained earnings and tax debt.

5 Econometrics

The structural parameters in the Euler equation model are estimated using the generalized method of moments, GMM, as described in Hansen and Singleton (1982).[12] This choice is motivated, firstly, by the fact that instruments for endogenous explanatory variables are required, and secondly, because it allows the estimation of nonlinear models. In addition, the GMM provides asymptotically efficient estimates of the parameters in the model, without using any specific assumptions on the structure of the error terms, except for finite first and second order moments.[13] In order to reduce the finite sample bias in the estimated standard errors, the Parzen window as described in Andrews (1991) is imposed on the covariance matrix estimator. Issues such as identification and instrumental variables are discussed separately for each model.

5.1 The Financial Equation

My first step in the empirical analysis is to estimate the equation governing the optimal path of debt. Starting with equation (19), an estimable relationship is obtained by dividing the left-hand side by the right-hand side, followed by removing the expectation operator. Moreover, the term $\xi/(\theta + \lambda)$, capturing the shadow value of a binding credit restriction, is replaced by $\xi^S + \xi^I + \xi^R$, which are measures of credit constraints on account of being a small firm, or an independent

[12] For the asymptotic properties of the GMM the reader may find Hansen (1982) enlightening.
[13] The prospect of efficiency gains in finite samples is not obvious however; see Hansen (1999).

firm, or of there being a regulated credit market, respectively. These measures are chosen on the basis of the discussion in section 2 about classification schedules as screening devices, and the loanable funds of banks. The effect of size on financial behavior is identified by a dummy variable that is one for firms with less than 50 employees, and zero otherwise.[14] The effect of not belonging to a corporate group is identified by a dummy variable that is one for firms that are not part of a corporate group, and zero otherwise. The effect of the credit view, i.e., the financial regulation, is identified by a dummy variable taking the value of one before 1988, and zero in 1988 and onwards. Finally, the financial equation is estimated under the assumption that none of the non-negative restrictions on dividends are binding, and hence, the associated shadow values are assumed to be zero. Thus, the financial equation is given by:

$$\frac{1+(1-\tau_{it})\,i_t}{1+r_t}\left(1-\frac{(1-\tau_{it-1})\,\eta\, p_{t-1}}{q_{t-1}}\,\phi\left(\frac{B_{it-1}}{K_{it-1}}\right)-1\right)-\xi_i^S-\xi_i^I-\xi_{t-1}^R=u_{it}, \quad (20)$$

where the error terms u are independently distributed as a consequence of rational expectations.

Equation (20) is estimated both by using the statutory tax rate, and the expected marginal tax rate. The set of instrumental variables includes I/K, E/K, and B/K dated in $t-2$ and $t-3$, as well as the dummy variables used for identifying the measures of credit constraints. The results are shown in Table 1. On the basis of equation (20), it is not possible to identify, and thereby estimate, both η and ϕ. Therefore, I choose to estimate ϕ by setting η to 0.9, which is a value that conforms with the upcoming estimates of the investment equation.

The model that is based on the statutory tax rate is strongly rejected by the J-test, at the 5 percent level, whereas that based on the expected marginal tax rate is not; see Table 1.[15] This clearly shows the importance of considering the

[14] The number of employees is measured at the beginning of a firm's record in order to make the dummy variable weakly exogenous.

[15] Under the null of valid orthogonality condition, the J-test is asymptotically chi-squared

Table 1: Estimation of structural parameters and e¤ects of credit constraints in the …nancial equation

Parameter	Model based on the statutory tax rate		Model based on the expected marginal tax rate	
	Estimated value	Std. error	Estimated value	Std. error
Á	0:0261¤	0:0011	0:0868¤	0:0005
!	0:0000¤	0:0000	0:7662¤	0:1363
»^{S}	0:0208¤	0:0005	0:0104	0:0068
»^{I}	0:0012¤	0:0005	0:0014	0:0037
»^{R}	0:0342¤	0:0005	0:0064	0:0057
MSE		0:00		0:40
J-test		540:43 (4)		8:10 (4)

Notes: (i) A * indicates signi…cance at the 5 percent level. (ii) Standard errors are corrected for heteroskedasticity in accordance with White (1980). (iii) J-tests are chi-squared distributed with the number of degrees of freedom given in the following parenthesis.

impact of the corporate tax system on the expected value of interest deductions. It is reasonable to believe that the underlying assumptions are correct, since the model based on the expected marginal tax rate is not rejected by the speci…cation test, using the 5 percent level. Thus, there is no evidence against the assumption of non-binding dividend constraints. From now on I will only consider models that are based on the expected marginal tax.

The agency cost parameter Á is estimated to 0:09, and is signi…cantly di¤erent from zero at the 5 percent level. The location of the minimum agency cost ! is estimated at 0:77, also signi…cantly di¤erent from zero at the 5 percent level. Note, however, that the 95 percent con…dence interval for !, (0:49; 1:04), is fairly large. Hence, the estimate of ! does not o¤er a satisfactory quantitative measure of the location of the minimum agency cost. Finally, the estimates of the credit constraint e¤ects are in general less than 0:01, and none of them are signi…cantly

distributed, with degrees of freedom equal to the number of instruments less the number of parameters, i.e., the number of over-identifying restrictions. Although it is a standard test of the speci…cation in the GMM-context, this test can easily fail to detect a misspeci…ed model; see Newey (1985).

different from zero at the 5 percent level.

The result indicates that debt financing is associated with externalities as well as monitoring benefits. It suggests that the minimum agency cost of debt is obtained for a debt to asset ratio, i.e., leverage, of roughly 25 percent.[16] Moreover, the estimate of ϕ suggests that a change in the leverage by 10 percentage units from the optimal level will increase the agency cost of debt by roughly three percentage units. Although minimum agency costs are attained at ω, firms will choose financial sources at which the marginal costs are equal. In this respect, the optimal leverage can be calculated by using equation (20). Inserting the estimates from Table 1, and setting prices, the expected marginal tax rate and interest rates at their average values, indicates that the optimal leverage is roughly 10 percentage units above the minimum agency cost leverage ω. This suggests an optimal leverage of 35 percent.

5.2 The Investment Equation

I continue the empirical analysis by estimating the Euler equation governing the optimal path of investments. Starting with equation (18), an estimable relationship is obtained by dividing the left-hand side by the right-hand side, and then by removing the expectation operator. Moreover, the investment equation is estimated under the assumption that none of the non-negative restrictions on dividends are binding, and hence, the associated shadow values are assumed to be zero. Thus, the investment equation is:

$$\frac{1}{1+r_t}\frac{1-\tau_{it}}{1-\tau_{it-1}}\frac{p_t}{p_{t-1}}\left(\alpha\left(\frac{I_{it}}{K_{it}}-\delta\right)\frac{I_{it}}{K_{it}}+\phi\left(\frac{B_{it}}{K_{it}}-\omega\right)\frac{B_{it}}{K_{it}}+\frac{1}{\eta}\frac{E_{it}}{K_{it}}-\frac{1-\eta}{\eta}\frac{Y_{it}}{K_{it}}+(1-\delta)\left(\alpha\frac{I_{it}}{K_{it}}-\alpha\delta+\frac{(1-i_t)q_t}{(1-\tau_{it})\eta p_t}\right)\right)\Bigg/\left(\alpha\frac{I_{it-1}}{K_{it-1}}-\alpha\delta+\frac{(1-i_{t-1})q_{t-1}}{(1-\tau_{it-1})\eta p_{t-1}}\right)=v_{it}, \quad (21)$$

[16] Note that on average the stock of real capital ammounts to 30 percent of the total assets.

Table 2: Estimation of structural parameters in the Euler equation governing the optimal investment decision

Parameter	Model without time effects		Model incl. time-fixed effects	
	Estimated value	Std. error	Estimated value	Std. error
η	0.9009^*	0.0018	0.8998^*	0.0010
α	0.4927^*	0.0019	0.5069^*	0.0037
ϕ	0.0969^*	0.0020	0.1004^*	0.0014
ω	0.2376^*	0.1123	0.2614^*	0.0667
MSE		167.71		82.34
J-test		13.53 (2)		1.19 (2)

Notes: (i) A $*$ indicates significance at the 5 percent level. (ii) Standard errors are corrected for heteroskedasticity in accordance with White (1980). (iii) J-tests are chi-squared distributed with the number of degrees of freedom given in the following parenthesis.

where the error terms v are independently distributed as a consequence of rational expectations. These error terms may also include time-specific fixed effects.

The Euler investment equation is estimated on the one hand on the assumption of an identical expectation of all error terms v, where I/K, E/K, and B/K dated in $t-2$ and $t-3$ are used as instrumental variables, and on the other hand on the assumption of time-specific effects, where dummy variables associated with these effects are also used as instrumental variables. Table 2 presents the result.

The J-test suggests that the orthogonality conditions are not appropriate for identifying parameters in the model without time effects. In fact, the validity of the orthogonality conditions are rejected at the 5 percent level. However, the J-test does not reject the model specification when the error terms include time-fixed effects. It is therefore reasonable to believe that all firms are exposed to macroeconomic shocks, which are not considered in the baseline model. Note however that none of the parameter estimates are affected by augmenting the model, which may be explained by the fact that the model is nonlinear, whereas the time-fixed effects are additive components in the error term.

The inverse of the markup η is estimated at 0.9, and is significantly different from one at the 5 percent level. This means that the output market is characterized by imperfect competition, and that prices are set roughly 11 percent above the marginal costs. It also implies that output does to some extent influence investment behavior. If, for example, the output ratio is 10 percentage units higher in period t than is expected in $t - 1$, then the investment ratio will be roughly 2.2 percentage units higher in that period than is expected in $t - 1$.[17] The adjustment cost parameter α is estimated to be essentially 0.5 and significantly different from zero. This value is quite reasonable (see e.g. Hubbard et al. (1995)), and implies that a firm for which the investment to capital ratio deviates by 10 percentage units from the depreciation rate, has about 2.5 percent higher investment costs on the margin; see equation (8). The agency cost parameter ϕ is estimated to 0.1, and significantly different from zero. The location of the minimum agency cost ω is estimated at roughly 0.25 and significantly different from zero. Debt financing is thus once again shown to be associated with agency costs that affect the level of output. However, the location of the minimum agency cost is now estimated to be remarkably lower than before, only half as high as the estimate from the financial equation. In addition, the 95 percent confidence interval for ω is remarkably shorter than before, only $(0.13, 0.39)$.

5.3 Simultaneous Estimation

My final step is to estimate the equations governing the optimal paths of debt and investment, equations (20) and (21), respectively, simultaneously. The same set of instruments as for the financial and investment equations is used. However, the main problem in estimating the financial and investment equations simultaneously is the requirement to use the same set of instrumental variables. In this respect, the dummy variables for the credit constraint effects are erroneously applied to the investment equation, which also holds for the time dummy variables for the

[17] Abstracting from quadratic components in equation (21), and assuming all other factors remaining the same, gives $\Delta(I/K) = ((1 - \eta)/(\eta\alpha))\Delta(Y/K)$.

Table 3: Simultaneous estimation of structural parameters in the Euler investment equation, and the financial equation

Parameter	Model without time effects		Model incl. time-fixed effects	
	Estimated value	Std. error	Estimated value	Std. error
η	0.9009^{*}	0.0010	0.9020^{*}	0.0003
α	0.4954^{*}	0.0025	0.4961^{*}	0.0017
ϕ	0.0989^{*}	0.0007	0.1003^{*}	0.0008
ω	0.2715^{*}	0.0379	0.3562^{*}	0.0187
ξ^{S}	0.0021	0.0049	0.0028	0.0031
ξ^{I}	0.0004	0.0043	-0.0054	0.0033
ξ^{R}	0.0268^{*}	0.0047	0.0201^{*}	0.0028
MSE, I/F		$80.00/0.09$		$321.49/0.13$
J-test		50.38 (11)		441.62 (25)

Notes: (i) A * indicates significance at the 5 percent level. (ii) Standard errors are corrected for heteroskedasticity in accordance with White (1980). (iii) J-tests are chi-squared distributed with the number of degrees of freedom given in the following parenthesis.

financial equation. Consequently, the J-tests of overidentifying conditions are not a fair statistic for evaluating the specification. Table 3 presents the he result.

The parameters η, α and ϕ are estimated at 0.9, 0.5 and 0.1, respectively. All of these estimates are significantly different from their null hypotheses at the 5 percent level. These values have thus not changed compared to the estimates from the financial and investment equations estimated separately. The location of the minimum agency cost ω is estimated at 0.27 for the model without time effects, and 0.36 for the model including time effects, both significantly different from zero, but not from each other. These estimates are somewhat lower than those from the financial equation, and only slightly higher than those from the investment equation, although not significantly so. Using equation (20) indicates that the optimal leverage is roughly one fifth of the assets, which seems quite reasonable. Moreover, there is no evidence of credit constraints for small firms, nor for independent firms. There is, however, evidence of credit constraints during the period when the Swedish credit market was regulated. The parameter ξ^{R} is estimated at 0.03 for the model without time effects, and 0.02 for the model including time effects, both significantly different from zero.[18]

It is worth noting that the mean square error is considerably higher for the investment equation than for the financial equation — 80 and 0.09, respectively, for the model without time effects, and 320 and 0.13, respectively, for the model including time effects. This means that it is of little interest, if any, to discuss their mutual covariance. It also shows that the investment decisions are considerably more volatile than the financial decisions. Thus, the fluctuations in investments are not likely to be attributable to changes in the firms' financial decisions.

6 Concluding Remarks

In order to analyze the impact on corporate investment of possible credit market constraints, I have developed an empirical model based on the neoclassical theory of capital accumulation subject to adjustment and agency costs. The distinctive feature of the investment model is that it captures the pros and cons of debt financing with respect to both the corporate tax system and imperfect information. Instead of generating tax rebates in proportion to the statutory tax rate, interest deductions are modeled so as to generate tax rebates in proportion to the expected marginal tax rate. Agency costs of debt are included in the model to capture information problems both between stockholders and managers, and between managers and banks. It is argued that a low leverage essentially leads to positive externalities, whereas a high leverage essentially leads to monitoring costs. Finally, credit constraints are included in the model, since banks can turn down loan applications from firms, and since the credit market in Sweden was substantially regulated prior to 1986.

The econometric analysis was designed to utilize the two-equation system de-

[18] Some experiments have been carried out in order to test the stability of the parameter estimates. There is, however, no evidence of parameter instability, whether across firms or over time.

scribing the simultaneous …nancial and investment decision. Since both equations are nonlinear, and since instrumental variables are required, the generalized method of moments estimator was selected. This choice was also reasonable with respect to the large body of data and existing heteroskedasticity. However, the econometric analysis shows that the two equations present only slight mutual covariance, and can therefore be estimated separately. Thus, there is no evidence of simultaneous equation bias arising. Nevertheless, there are e¢ciency gains from estimating them simultaneously.

The results con…rm that investments are characterized by adjustment costs, which induce …rms to smooth investments. Furthermore, they suggests that debt …nancing is associated with positive externalities as well as monitoring costs, jointly referred to as agency costs. As a consequence, …rms will …nd the optimal leverage to be roughly one …fth of their assets. The results also point to the importance of considering the actual impact of the corporate tax system on the …nancial decision. Moreover, there is no evidence that small …rms are constrained in the credit market, nor that independent …rms are constrained in the credit market. There is, however, evidence that …rms generally were somewhat …nancially constrained in the early 1980s, when the Swedish credit market was regulated. These credit constraints appear to have vanished after 1988, at the time of deregulation.

A Linear Homogeneity

Different specifications of the adjustment cost function can lead to identical first order conditions, but not necessarily. The interpretation of how to measure the firm's output differs. Take for instance the following adjustment cost function:

$$G(K_{it}; I_{it}) = \frac{\alpha}{2}\left(\frac{I_{it}}{K_{it}} - \gamma\right)^2 K_{it} = \frac{\alpha}{2}\left(\frac{I_{it}}{K_{it}} - 2\gamma\right) I_{it} + \frac{\alpha\gamma^2}{2} K_{it},$$

with partial derivatives:

$$\begin{aligned}
\frac{\partial G_{it}}{\partial K_{it}} K_{it} &= G_{it} - \alpha\left(\frac{I_{it}}{K_{it}} - \gamma\right) I_{it} = -\frac{\alpha}{2}\frac{I_{it}}{K_{it}} I_{it} + \frac{\alpha\gamma^2}{2} K_{it},\\
\frac{\partial G_{it}}{\partial I_{it}} I_{it} &= \alpha\left(\frac{I_{it}}{K_{it}} - \gamma\right) I_{it} = G_{it} + \frac{\alpha}{2}\frac{I_{it}}{K_{it}} I_{it} - \frac{\alpha\gamma^2}{2} K_{it}.
\end{aligned}$$

Zero cost is obtained when the investment to capital ratio equals the location of symmetry, $I/K = \gamma$. However, if zero cost is desired for the investment to capital ratio that equals zero, the following function is an alternative:

$$G(K_{it}; I_{it}) = \frac{\alpha}{2}\left(\frac{I_{it}}{K_{it}} - \gamma\right)^2 K_{it} - \frac{\alpha\gamma^2}{2} K_{it} = \frac{\alpha}{2}\left(\frac{I_{it}}{K_{it}} - 2\gamma\right) I_{it},$$

with partial derivatives:

$$\begin{aligned}
\frac{\partial G_{it}}{\partial K_{it}} K_{it} &= G_{it} - \alpha\left(\frac{I_{it}}{K_{it}} - \gamma\right) I_{it} = -\frac{\alpha}{2}\frac{I_{it}}{K_{it}} I_{it},\\
\frac{\partial G_{it}}{\partial I_{it}} I_{it} &= \alpha\left(\frac{I_{it}}{K_{it}} - \gamma\right) I_{it} = G_{it} + \frac{\alpha}{2}\frac{I_{it}}{K_{it}} I_{it}.
\end{aligned}$$

As can be seen, these two functional forms may have the same partial derivatives, and they may not. From the perspective of the Euler theorem, the expressions are equivalent. Note that the former adjustment cost function has a double root at $I/K = \gamma$, and the latter has two single roots, one at $I/K = 0$ and another at $I/K = 2\gamma$.

B The Maximum Principle

Based on the setup in section 3, the optimization problem for the managers, including the shadow values of the dividend floor, capital stock, and debt ceiling, is defined as:

$$\max_{I_{is};L_{is};B_{is}} E_t \left\{ \sum_{s=t}^{\infty} \left[\left(\prod_{u=t}^{s} \beta_u \right) \left((\theta + \lambda_{is}) D_{is} + \mu_s q_s (I_{is} - \delta K_{is}) - \xi_{is} q_s B_{is} \right) \right] \right\},$$

where $D_{it} = \Pi_{it} - \tau_t(\Pi_{it} - H_{it}) + q_t B_{it} - q_{t-1} B_{it-1} - q_t(1 - \phi_{t-1}) I_{it}$, and where $\Pi_{it} = p_t F_{it} - p_t G_{it} - p_t A_{it} - w_t L_{it} - i_t q_{t-1} B_{it-1}$. To ensure a unique solution, transversality conditions for the capital stock and debt are defined as:

$$\lim_{S \to \infty} E_t \left\{ \left[\left(\prod_{u=t}^{S} \beta_u \right) q_S K_{iS} \right] \right\} = 0,$$

$$\lim_{S \to \infty} E_t \left\{ \left[\left(\prod_{u=t}^{S} \beta_u \right) q_S B_{iS} \right] \right\} = 0.$$

Thus, the scrap value of the capital stock and the debt are expected to be zero. It is thus not possible to finance dividend payments by accumulating debt.

As the maximum principle is employed, there are four first order conditions to analyze. The first order condition with respect to investment I is:

$$\frac{\partial L}{\partial I_{it}} = 0$$

$$\Leftrightarrow \left(\prod_{u=t}^{t} \beta_u \right) \left((\theta + \lambda_{it}) \frac{\partial D_{it}}{\partial I_{it}} + q_t \mu_t \right) = 0$$

$$\Leftrightarrow (\theta + \lambda_{it}) \left((1 - \tau_t) \frac{\partial \Pi_{it}}{\partial I_{it}} - (1 - \phi_t) q_t \right) + q_t \mu_t = 0$$

$$\Leftrightarrow (\theta + \lambda_{it}) \left(-(1 - \tau_t) \eta p_t \frac{\partial G_{it}}{\partial I_{it}} - (1 - \phi_t) q_t \right) + q_t \mu_t = 0$$

$$\Leftrightarrow \frac{\partial G_{it}}{\partial I_{it}} = \frac{q_t}{(1 - \tau_t) \eta p_t} \left(\frac{\mu_t}{\theta + \lambda_{it}} - (1 - \phi_t) \right).$$

The first order condition with respect to variable production factors L is:

$$
\begin{aligned}
&\frac{\partial \mathcal{L}}{\partial L_{it}} = 0\\
\Leftrightarrow\; &\left(\prod^{t} \beta_u\right)(\theta + \lambda_{it})\frac{\partial D_{it}}{\partial L_{it}} = 0\\
\Leftrightarrow\; &(\theta + \lambda_{it})(1 - \tau_t)\frac{\partial \Pi_{it}}{\partial L_{it}} = 0\\
\Leftrightarrow\; &(\theta + \lambda_{it})(1 - \tau_t)\left(\eta p_t \frac{\partial F_{it}}{\partial L_{it}} - w_t\right) = 0\\
\Leftrightarrow\; &\frac{\partial F_{it}}{\partial L_{it}} = \frac{w_t}{\eta p_t}.
\end{aligned}
$$

The first order condition with respect to debt is given by:

$$
\begin{aligned}
&\frac{\partial \mathcal{L}}{\partial B_{it}} = 0\\
\Leftrightarrow\; &\left(\prod^{t} \beta_u\right)\left((\theta + \lambda_{it})\frac{\partial D_{it}}{\partial B_{it}} - q_t \xi_{it}\right) + E_t\left[\left(\prod^{t+1} \beta_u\right)(\theta + \lambda_{it+1})\frac{\partial D_{it+1}}{\partial B_{it}}\right] = 0\\
\Leftrightarrow\; &(1 - \tau_t)\frac{\partial \Pi_{it}}{\partial B_{it}} + q_t - \frac{q_t \xi_{it}}{\theta + \lambda_{it}} + E_t\left[\beta_{t+1}\frac{\theta + \lambda_{it+1}}{\theta + \lambda_{it}}\left((1 - \tau_{t+1})\frac{\partial \Pi_{it+1}}{\partial B_{it}} - q_t\right)\right] = 0\\
\Leftrightarrow\; &q_t - (1 - \tau_t)\eta p_t \frac{\partial A_{it}}{\partial B_{it}} - \frac{q_t \xi_{it}}{\theta + \lambda_{it}} = E_t\left[\frac{\theta + \lambda_{it+1}}{\theta + \lambda_{it}}\frac{q_t + (1 - \tau_{t+1})\, i_{t+1} q_t}{1 + r_{t+1}}\right]\\
\Leftrightarrow\; &E_t\left[\frac{\theta + \lambda_{it+1}}{\theta + \lambda_{it}}\frac{1 + (1 - \tau_{t+1})\, i_{t+1}}{1 + r_{t+1}}\right] = 1 - \frac{(1 - \tau_t)\eta p_t}{q_t}\frac{\partial A_{it}}{\partial B_{it}} - \frac{\xi_{it}}{\theta + \lambda_{it}}\\
\Leftrightarrow\; &\frac{\partial A_{it}}{\partial B_{it}} = \frac{q_t}{(1 - \tau_t)\eta p_t} E_t\left[1 - \frac{\xi_{it}}{\theta + \lambda_{it}} - \frac{\theta + \lambda_{it+1}}{\theta + \lambda_{it}}\frac{1 + (1 - \tau_{t+1})\, i_{t+1}}{1 + r_{t+1}}\right].
\end{aligned}
$$

The first order condition with respect to capital stock is:

$$\frac{\partial L}{\partial K_{it}} = \left(\prod \beta_u\right)\left(r_t q_t \mu_t - q_t \Delta \mu_t\right)$$

$$\Leftrightarrow \left(\prod \beta_u\right)\left((\theta + \lambda_{it})\frac{\partial D_{it}}{\partial K_{it}} - \mu_t \delta\right) = \left(\prod \beta_u\right)\left(r_t q_t \mu_t - q_t \Delta \mu_t\right)$$

$$\Leftrightarrow (\theta + \lambda_{it})(1 - \tau_t)\frac{\partial \Pi_{it}}{\partial K_{it}} + (1 - \delta) q_t \mu_t = (1 + r_t) q_{t-1} \mu_{t-1}$$

$$\Leftrightarrow (\theta + \lambda_{it})(1 - \tau_t)\eta p_t \left(\frac{\partial F_{it}}{\partial K_{it}} - \frac{\partial G_{it}}{\partial K_{it}} - \frac{\partial A_{it}}{\partial K_{it}}\right) = q_t \mu_t \left(\delta + r_t - \frac{\Delta \mu_t}{\mu_t}\right)$$

$$\Leftrightarrow \frac{\partial F_{it}}{\partial K_{it}} - \frac{\partial G_{it}}{\partial K_{it}} - \frac{\partial A_{it}}{\partial K_{it}} = \frac{q_t}{(1 - \tau_t)\eta p_t}\frac{\mu_t}{\theta + \lambda_{it}}\left(\delta + r_t - \frac{\Delta \mu_t}{\mu_t}\right),$$

where

$$\Delta \mu_t = (1 + r_t)\left(\mu_t - \frac{q_{t-1}}{q_t}\mu_{t-1}\right).$$

Solving the differential equation gives:

$$\Leftrightarrow (\theta + \lambda_{it})(1 - \tau_t)\frac{\partial \Pi_{it}}{\partial K_{it}} + (1 - \delta) q_t \mu_t = (1 + r_t) q_{t-1} \mu_{t-1}$$

$$\Leftrightarrow \mu_t = \frac{q_{t+1}}{q_t}\frac{(\theta + \lambda_{it+1})(1 - \tau_{t+1})}{(1 + r_{t+1})}\frac{\eta p_{t+1}}{q_{t+1}}\left(\frac{\partial F_{it+1}}{\partial K_{it+1}} - \frac{\partial G_{it+1}}{\partial K_{it+1}} - \frac{\partial A_{it+1}}{\partial K_{it+1}}\right) + \frac{q_{t+1}}{q_t}\frac{(1 - \delta)}{(1 + r_{t+1})}\mu_{t+1}$$

$$\Leftrightarrow \mu_t = \sum_{s=t+1}^{\infty}\left(\prod_{u=t}^{s-1}\left(\frac{1 - \delta}{1 + r_u}\right)^{u-t}\left(\frac{q_{u+1}}{q_u}\right)^{u-t+1}\right) \frac{(\theta + \lambda_{is})(1 - \tau_s)}{(1 + r_s)}\frac{\eta p_s}{q_s}\left(\frac{\partial F_{is}}{\partial K_{is}} - \frac{\partial G_{is}}{\partial K_{is}} - \frac{\partial A_{is}}{\partial K_{is}}\right).$$

C De…nition of Variables

The variables that are used in the empirical investigation are de…ned in terms of those in CoSta; see Hansen (1998). Since CoSta consists of information from income statements and balance sheets, the variables are in nominal, and 'historical' prices, respectively.

Output is the reported value of total sales, which also comprise rents, income from licenses, and royalties:

$$Y_{it} = Var005_{it}.$$

Variable costs include costs of materials, labor, administrative expenses, and general costs. In addition, this measure takes into account government allowances, municipal subsidies to variable costs, declared changes in stock values, and exchange rate di¤erences attributable to the operating the business:

$$C_{it} = Var005_{it} \text{ ¡ } Var011_{it}.$$

Earnings are calculated as the di¤erence between output and variable costs. This de…nition is thus equivalent to earnings before depreciation, interest expenses, and tax payments, i.e., EBDIT:

$$E_{it} = Var011_{it}.$$

Cash ‡ow is a measure of the …rm's liquid surplus in existing plants. It consists of the reported pro…t net of taxes, where the reported value of depreciation has been added back in:

$$\begin{aligned} F_{it} = {} & Var011_{it} + Var013_{it} + Var016_{it} + Var021_{it} + Var026_{it} + \\ & (1 \text{ ¡ } \text{¿}_t)\, Var028_{it} + Var047_{it}. \end{aligned}$$

Investment is a measure of spending on machinery, equipment, and business structures. It also takes into account assets acquired through takeovers, net of assets sold:

$$\begin{aligned} I_{it} = {} & Var115_{it} + Var119_{it} \text{ ¡ } Var127_{it} + Var116_{it} + Var120_{it} \text{ ¡ } Var128_{it} + \\ & Var117_{it} + Var121_{it} \text{ ¡ } Var129_{it}. \end{aligned}$$

The replacement value of the capital stock is not reported. Instead information on the book value of capital stock, i.e., the book value of equipment, buildings, and land and properties, is used the starting value. The perpetual method is then used in order to get the replacement value of the capital stock. This method is carried through as follows: for the first year of data available I take the book value of the stock as proxy for the replacement value. Then later replacement values are constructed by adding investment data according to:

$$K_{i0} = Var146_{i0} + Var147_{i0} + Var075_{i0},$$
$$K_{it} = (1 - \delta) K_{it-1} + I_{it-1}.$$

Debt is defined as the sum of short- and long-term interest-bearing debt to corporate group firms, banks and others. Hence, loans within corporate groups are handled in the same way as bank loans, which is reasonable since CoSta consists of legal entities:

$$B_{it} = Var078_{it} + Var081_{it} + Var084_{it} + Var086_{it}.$$

Assets are defined as the balance sheet total:

$$A_{it} = Var077_{it}.$$

The present value of tax savings from depreciation allowances and investment tax credits per unit of new investment is calculated by using the depreciation rate of capital, the discount rate, and the corporate tax rate:

$$i_t = \frac{\gamma}{\gamma + r_t}\tau_t.$$

The composition of assets is determined by the proportions of fixed assets $Var076_{it}$, and current assets $Var063_{it}$, to the balance sheet total. Moreover, the composition of liabilities is determined by the proportions of equity $Var108_{it}$, untaxed reserves $Var103_{it}$, long-term debt $Var088_{it}$, and short-term debt $Var083_{it}$, to the balance sheet total.

The discount rate, interest rate, producer price index, investment price indices, and corporate tax rates are given in Table 4.

Table 4: Required return to equity, interest rates on bank advances to firms, producer and investment price indices, and corporate tax rates

Year	Interest rates		Prices indices			Tax rates	
	r	i	ppi	ipm	ipb	τ^r	τ^a
1979	0.111	0.119	0.560	0.596	0.652	0.574	0.547
1980	0.121	0.161	0.641	0.652	0.720	0.575	0.575
1981	0.134	0.171	0.704	0.718	0.785	0.577	0.577
1982	0.134	0.162	0.784	0.808	0.839	0.578	0.578
1983	0.139	0.143	0.869	0.930	0.898	0.581	0.581
1984	0.140	0.149	0.949	0.963	0.952	0.526	0.576
1985	0.139	0.172	1.000	1.000	1.000	0.520	0.571
1986	0.143	0.123	1.023	1.055	1.050	0.520	0.571
1987	0.113	0.123	1.058	1.056	1.118	0.520	0.571
1988	0.106	0.127	1.131	1.098	1.213	0.520	0.571
1989	0.121	0.136	1.224	1.139	1.334	0.400	0.547
1990	0.167	0.161	1.283	1.184	1.441	0.400	0.478
1991	0.150	0.146	1.298	1.203	1.463	0.300	0.300
1992	0.139	0.164	1.282	1.198	1.424	0.300	0.300
1993	0.134	0.116	1.337	1.327	1.415	0.300	0.300
1994	0.117	0.100	1.399	1.315	1.400	0.280	0.280
1995	0.129	0.106	1.541	1.324	1.407	0.280	0.280

Notes: (i) r is the tax-adjusted required return to equity. It is calculated by scaling up the interest rate on premium bonds by the personal tax rate on capital gains, and by 30 percent in order to take stock market risk into account; see Dufwenberg, Koskenkylä and Södersten (1994). i is the average interest rate on short- and long-term bank advances to firms. (ii) The producer price index ppi is an average for the manufacturing industry, SNI 31 to SNI 38. The average is calculated for reporting convenience only, and is not used in the empirical analysis. (iii) The investment price indices ipm and ipb are for machinery and business structures, respectively. (iv) The statutory corporate tax rate τ^r comprises both government and local government income taxes for the period 1979 to 1984. τ^a is the statutory corporate tax rate including a markup due to a surcharge, the so-called profit-sharing tax.

Sources: Interest rates are from Riksgäldskontoret and Sveriges Riksbank. Producer price indices are from P 1984:2.3, P10 SM 8503, P10 SM 9002, P10 SM 9502 and P10 SM 9702, Statistics Sweden. Investment price indices are kindly provided by Gunila Nockhammar, Statistics Sweden.

D Figures

Notes on the box plots in Figures 6 to 9: The central horizontal line is drawn at the median, and the bottom and top edges of the boxes are located at the sample's 25th and 75th percentiles. The range depicted is chosen with the aim of eliminating the in‡uence of more extreme observations. Generally the distributions are skewed upwards, and therefore have somewhat higher means than medians.

Figure 2: Volume of bank loans to Swedish …rms; average interest rate charged on short and long term advances to …rms; required return to equity imposed by stockholders

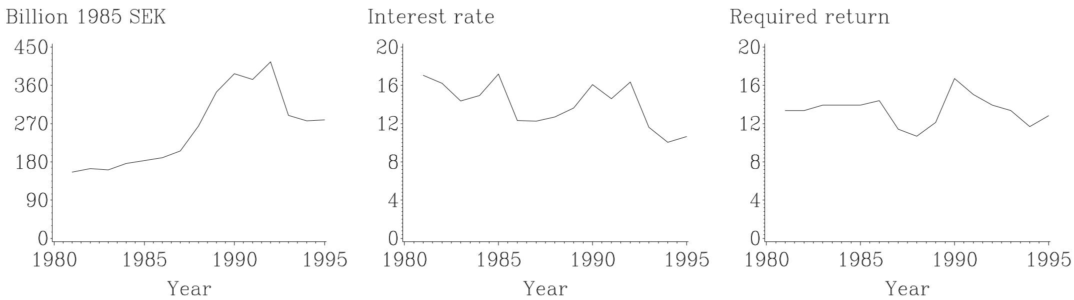


Figure 3: Distribution of the probabilities of paying tax on the marginal income; actual and estimated proportion of …rms that are in a taxable state, solid and dashed lines respectively; statutory and mean expected marginal tax rate, solid and dashed lines respectively

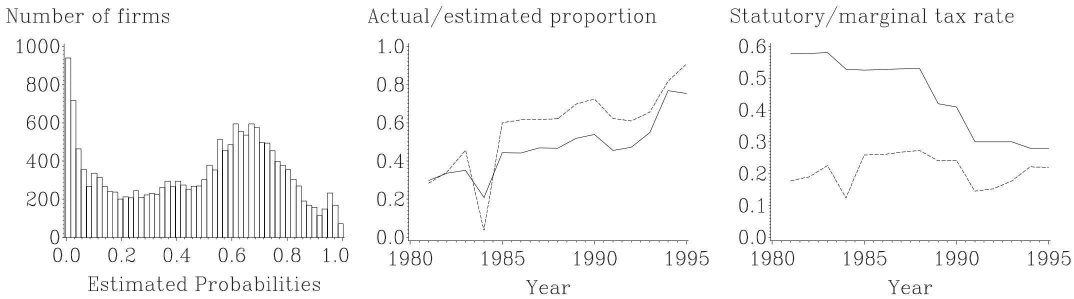


Figure 4: The average composition of assets in balance sheets, from bottom up: …xed assets - current assets

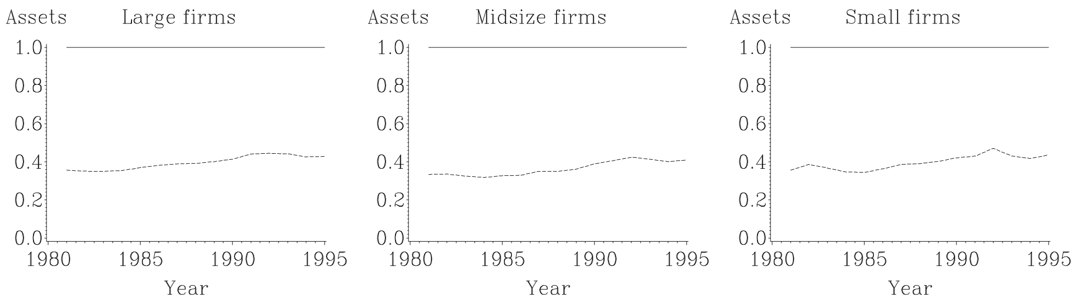


Figure 5: The average composition of liabilities in balance sheets, from bottom up: equity - untaxed reserves - long-term debt - short-term debt

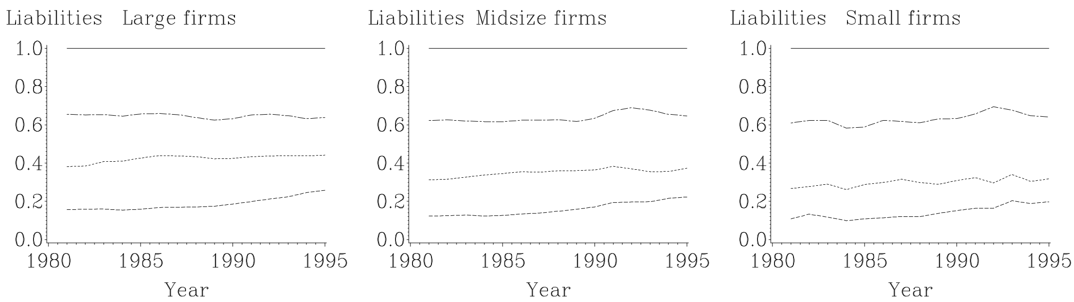


Figure 6: Investment to capital ratio

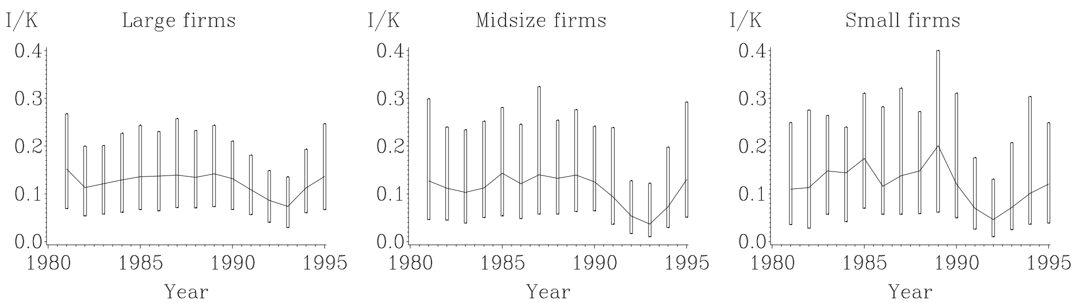


Figure 7: Earnings to capital ratio

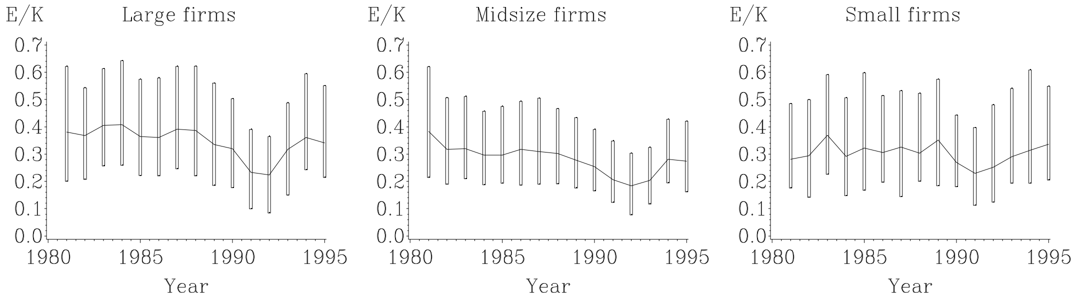


Figure 8: Output to capital ratio

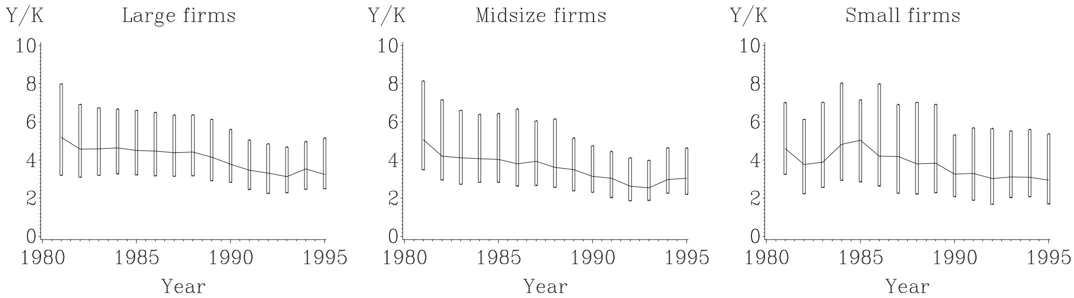
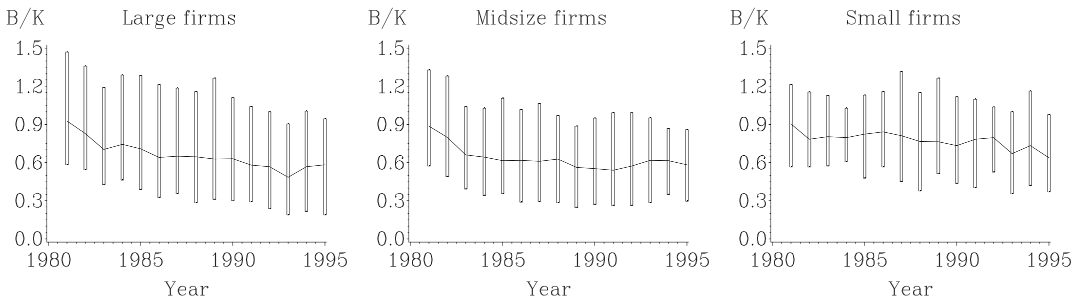


Figure 9: Debt to capital ratio



References

Abel, A. and O. Blanchard (1986), "The Present Value of Pro…ts and Cyclical Movements in Investment", Econometrica 54, 249-273.

Akerlof, G. (1970), "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism", Quarterly Journal of Economics 84, 488-500.

Altman, E. (1968), "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy", Journal of Finance 23, 589-609.

Altman, E., G. Marco and F. Varetto (1994), "Corporate Distress Diagnosis: Comparisons Using Linear Discriminant Analysis and Neural Networks", Journal of Banking and Finance 18, 505-529.

Andrews, D. (1991), "Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation", Econometrica 59, 817-858.

Arminger, G., D. Enache and T. Bonne (1997), "Analyzing Credit Risk Data: A Comparison of Logistic Discrimination, Classi…cation Tree Analysis and Feed-Forward Networks", Computational Statistics 12, 293-310.

Auerbach, A. (1989), "Tax Reform and Adjustment Costs: The Impact on Investment and Market Value", International Economic Review 30, 939-962.

Auerbach, A. and K. Hassett (1992), "Tax Policy and Business Fixed Investment in the United States", Journal of Public Economics 47, 141-170.

Bernanke, B. and A. Blinder (1992), "The Federal Funds Rate and the Channels of Monetary Transmission", American Economic Review 82, 901-921.

Bester, H. (1985), "Screening vs. Rationing in Credit Markets with Imperfect Information", American Economic Review 75, 850-855.

Blinder, A. and J. Stiglitz (1983), "Money, Credit Constraints, and Economic Activity", American Economic Review 73, 297-302.

Blundell, R., S. Bond, M. Devereux and F. Schiantarelli (1992), "Investment and Tobin's Q: Evidence from Company Panel Data", Journal of Econometrics 51, 233-257.

Bond, S., J. Elston, J. Mairesse and B. Mulkay (1997), "Financial Factors and Investment in Belgium, France, Germany and the UK: A Comparison using Company Panel Data", Working Paper 5900, NBER.

Bond, S. and C. Meghir (1994), “Dynamic Investment Models and the Firm’s Financial Policy”, Review of Economic Studies 61, 197-222.

Calomiris, C. and G. Hubbard (1990), “Firm Heterogeneity, Internal Finance and Credit Rationing”, Economic Journal 100, 90-104.

Chirinko, R. (1987), “Tobin’s Q and Financial Policy”, Journal of Monetary Economics 19, 69-87.

Chirinko, R. and H. Schaller (1995), “Why Does Liquidity Matter in Investment Equations”, Journal of Money, Credit, and Banking 27, 527-548.

Cummins, J., K. Hassett and S. Oliner (1997), “Investment Behavior, Observable Expectations, and Internal Funds”, Working Paper, New York University.

Daltung, S. and A. Nedersjö (1997), Unpublished Work, Sveriges Riksbank.

Devereux, M. and F. Schiantarelli (1990), “Investment, Financial Factors, and Cash Flow: Evidence from U.K. Panel Data”, in G. Hubbard, ed., Asymmetric Information, Corporate Finance and Investment (University of Chicago Press, Chicago), 279-306.

Diamond, D. (1984), “Financial Intermediation and Delegated Monitoring”, Review of Economic Studies 51, 393-414.

Diamond, D. (1991), “Monitoring and Reputation: The Choice Between Bank Loans and Directly Placed Debt”, Journal of Political Economy 99, 689-721.

Dufwenberg, M., H. Koskenkylä and J. Södersten (1994), “Manufacturing Investment and Taxation in the Nordic Countries”, Scandinavian Journal of Economics 96, 443-461.

Easterbrook, F. (1984), “Two Agency-Cost Explanations of Dividends”, American Economic Review 74, 650-659.

van Ees, H., L. Garretsen, L. de Haan and E. Sterken (1997), “Investment and Debt Constraints: Evidence from Dutch Panel Data”, Sta¤ Report 10, DNB.

Englund, P. (1990), “Financial Deregulation in Sweden”, European Economic Review 32, 385-393.

Fazzari, S., G. Hubbard and B. Petersen (1988), “Financing Constraints and Corporate Investment”, Brookings Papers on Economic Activity 1:1988, 141-195.

Forsling, G. (1998), Utilization of Tax Allowances and Corporate Borrowing, Economic Studies 37, Uppsala University.

Gertler, M. (1992), "Financial Capacity and Output Fluctuations in an Economy with Multi-Period Financial Relationships", Review of Economic Studies 59, 455-472.

Gertler, M. and S. Gilchrist (1993), "The Role of Credit Market Imperfections in the Monetary Transmission Mechanism: Arguments and Evidence", Scandinavian Journal of Economics 95, 43-64.

Gertler, M. and S. Gilchrist (1994), "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms", Quarterly Journal of Economics 109, 309-340.

Gilchrist, S. and C. Himmelberg (1998), "Investment, Fundamentals and Finance", Working Paper 6652, NBER.

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

Hansen, L. and K. Singleton (1982), "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models", Econometrica 50, 1269-1286.

Hansen, S. (1998), "CoSta — Corporate Statistics Version 1.13", Mimeograph, Uppsala University.

Hansen, S. (1999), Essays on Finance, Taxation and Corporate Investment, Economic Studies 47, Uppsala University.

Hayashi, F. (1982), "Tobin's Marginal Q and Average Q: A Neoclassical Interpretation", Econometrica 50, 213-224.

Himmelberg, C. (1990), Essays on the Relationship Between Investment and Internal Finance, Ph.D. Dissertation, Northwestern University.

Hoshi, T., A. Kashyap and D. Scharfstein (1991), "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups", Quarterly Journal of Economics 106, 33-60.

Hubbard, G., A. Kashyap and T. Whited (1995), "Internal Finance and Firm Investment", Journal of Money, Credit, and Banking 27, 683-701.

Ja¤ee, D. and F. Modigliani (1969), “A Theory and Test of Credit Rationing”, American Economic Review 59, 850-872.

Ja¤ee, D. and J. Stiglitz (1990), “Credit Rationing”, in B. Friedman and F. Hahn, eds., Handbook of Monetary Economics, Volume II (North-Holland, Amsterdam), 838-888.

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

Jensen, M. and W. Meckling (1976), “Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure”, Journal of Financial Economics 3, 395-460.

Kanniainen, V. and J. Södersten (1994), “Cost of Monitoring and Corporate Taxation”, Journal of Public Economics 55, 307-321.

Kanniainen, V. and J. Södersten (1995), “The Importance of Reporting Conventions for the Theory of Corporate Taxation”, Journal of Public Economics 57, 417-430.

Miller, M. and F. Modigliani (1963), “Corporate Income Taxes and the Cost of Capital: A Correction”, American Economic Review 53, 433-443.

Mulkay, B. (1997), “To be Independent or to be Within a Group: What are the E¤ects on Investment of Firms?”, at the Seventh International Conference on Panel Data, La Sorbonne.

Myers, S. (1977), “Determinants of Corporate Borrowing”, Journal of Financial Economics 5, 147-175.

Newey, W. (1985), “Generalized Method of Moments Speci…cation Testing”, Journal of Econometrics 29, 229-256.

Romer, C. and D. Romer (1990), “New Evidence on the Monetary Transmission Mechanism”, Brookings Papers on Economic Activity 1:1990, 149-213.

Rothschild, M. and J. Stiglitz (1970), “Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information”, Quarterly Journal of Economics 90, 630-649.

Stiglitz, J. and A. Weiss (1981), "Credit Rationing in Markets with Imperfect Information", American Economic Review 71, 393-410.

Summers, L. (1981), "Taxation and Corporate Investment: A Q-theory Approach", Brookings Papers on Economic Activity 1:1981, 67-127.

Tobin, J. (1969), "A General Equilibrium Approach to Monetary Theory", Journal of Money, Credit, and Banking 1, 15-29.

White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", Econometrica 48, 817-838.

Whited, T. (1992), "Debt, Liquidity Constraints, and Corporate Investment: Evidence From Panel Data", Journal of Finance 47, 1425-1460.