DISCUSSION PAPER

Financial Risks, Bankruptcy Probabilities, and the Investment Behaviour of Enterprises

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HWWA DISCUSSION PAPER

299

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
2004
ISSN 1616-4814

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
Neuer Jungfernstieg 21 - 20347 Hamburg, Germany
Telefon: 040/428 34 355
Telefax: 040/428 34 451
e-mail: hwwa@hwwa.de
Internet: http://www.hwwa.de

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Hamburg Institute of International Economics (HWWA)
Neuer Jungfernstieg 21 - 20347 Hamburg, Germany
e-mail: hwwa@hwwa.de

* **Acknowledgements**
I would like to thank the Deutsche Bundesbank for granting access to the firm-level data of the balance sheet statistics and for the technical support. The analysis of the data took place at the premises of the Deutsche Bundesbank. Only anonymized data were used in order to maintain the confidentiality of the data.

This discussion paper is assigned to the HWWA's research programme "Business Cycle Research"

Edited by the Department International Macroeconomics
Head: Dr. Eckhardt Wohlers

HWWA DISCUSSION PAPER 299
October 2004

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ABSTRACT

The link between investment and finance usually enters the empirical literature in the form of financial constraints which are defined as the wedge between the costs of internal and external finance or as the risk of being rationed on the credit market. In this context, the sensitivity of investment with respect to single internal or external finance indicators is assumed to be appropriate to proxy for these constraints. However, enterprises that rely on external funds do not only face this external finance premium and potential borrowing limits, but also the risk of not being able to meet their repayment obligations and thus the risk of bankruptcy.

If the risk of bankruptcy enters the profit maximization of the firm, the resulting empirical investment function includes the probability of survival as an additional explanatory variable. This modified neoclassical investment equation is tested with West German panel data which include more than 6000 enterprises and cover a period of 12 years. The empirical results confirm the assumption that the risk of bankruptcy is an important determinant of the enterprises' investment behaviour. Additionally, the results raise the question whether financial constraints respective cash flow sensitivies are the appropriate way to test for the influence of the financial sphere on the investment decisions of enterprises, or whether bankruptcy probabilities better account for these potential financial risks.

JEL-Classification: E22, D92, G33, C23

Keywords: Investment, Bankruptcy, Financial Constaints, GMM

Kai Kirchesch
Department of International Macroeconomics
HWWA-Hamburg Institute of International Economics
Neuer Jungfernstieg 21
D-20347 Hamburg
Germany
Tel.: +49-40-42834368
e-mail: kirchesch@hwwa.de

1 Introduction

Real economies unfortunately seldom satisfy the rather strict assumptions of the most famous investment theories like the neoclassical model of investment or Tobin's q theory. Even though early empirical investgations found evidence for the financial decisions of enterprises being an important determinant of their investment behaviour, these theories eclipse the financial sphere with the postulation of a perfect world as it was put forward by the famous Modigliani-Miller (1958) irrelevance theorem. In their world without any frictions, the financial structure of an enterprise does not influence its investment decisions. Hence, the determination of the firm's demand for new capital is merely driven by factor prices and technology. Cash flow, the level of debt, and other financial variables are to be ignored while deciding about the level of investment, since firms will always obtain enough funds at the economy-wide riskless interest rate to finance all of their desired investment projects if capital markets are perfect and no frictions arise.

Starting with the seminal lemon paper of Akerlof (1970), the proceedings in the literature on asymmetric information in capital markets shed light on the shortcomings of the neoclassical approach and emphasized potential capital market imperfections between borrowers and lenders and their consequences on the functioning of these markets. As borrowers usually possess more information about their investment projects than lenders do, the latter will have to find ways to mitigate their risk by means of credit contracts that account for the existing informational asymmetries and implement mechanisms which entail self-selection and costly state verification. These mechanisms lead the banks to either demand a risk premium on the market interest rate for borrowed funds or to refrain from meeting the complete demand for credits in case borrowers appear to be too risky. However, as soon as it becomes more expensive to raise borrowed funds than to rely on own funds in order to finance an investment project, the irrelevance of the financial structure on business fixed investment does no longer hold. Due to these capital market imperfections, firms will prefer to use internal rather than external funds to finance their investment spending, as predicted by the pecking order theory. As a consequence, the internal net worth of the firms as well as the level of its indebtness may play a crucial role in the determination of the enterprise's optimal level of investment.

The past 15 years have witnessed a number of publications pursuing this track and extending the above mentioned conventional models of business investment with elements of asymmetric information to incorporate the role of financial factors in determining the demand for new capital. As regards the implementation of these financial factors, the performed studies focus on the existence of financial constraints and their impact on business fixed investment.

In this context, financial constraints denote either the risk premium that enterprises have to bear in order to receive borrowed funds, or the risk of being credit rationed by the bank, both of which owe to the incidence of adverse selection or moral hazard for these providers of external funds.

In order to analyze the impact of financial constraints on the investment behavior of enterprises, most studies followed the influential paper of Fazzari-Hubbard-Petersen (1988) and performed tests referring to the excess sensitivity of internal funds such as cash flow with respect to the firm's investment spending. Since firms that are subject to more severe financial constraints are assumed to rely more heavily on retained earnings and even bank debt than on direct credit, the investment spending of this type of firm is supposed to be more sensitive to fluctuations in internal net worth. The same holds true for enterprises that face some sort of borrowing limits. Furthermore, a number of studies account explicitly for financial constraints by including some sort of external finance premium into the profit maximization of the firm. With this risk premium depending on the enterprise's level of debt and its capital stock, the empirical investment equation usually contains the firm's leverage rather than its cash flow. The same holds true for the inclusion of a debt ceiling and the firm's leverage as a proxy for the risk of reaching this boundary. The appropriateness of cash flow or other financial variables to proxy for financial constraints, as well as the methods of classifying enterprises according to these variables, meet with severe criticism in the course of a still ongoing debate.

Yet, these studies do not account for the complete effect of the enterprise raising external funds in order to finance its investment. Without doubt, the higher costs of external funds and the likelihood that the availability of these funds may be restricted constitute one important part of the financial risks that firms are facing. Yet, borrowing external funds also entails the risk of not being able to repay these funds and consequently default on the debt repayments. Hence, if an enterprise aims at maximizing its future profits by defining the optimal capital accumulation path, it has to take into account the danger of facing bankruptcy in some future period.

The present study therefore tries to expand the conventional literature on financial constraints by establishing the connection between the firm's investment decision and financial risks as a whole. Hence, the intention of this study is the empirical estimation of an investment function which explicitly accounts for the risk of bankruptcy as a complete measure for the enterprises' financial risks. Therefore, these bankruptcy risks are introduced into the neoclassical theory of investment by altering the calculations of the profit maximizing firm insofar that its expected future revenues will be weighted with its probability of survival. The resulting modified investment function which contains the firm's survival probability will then be tested with data stemming from the balance sheet statistic of the Deutsche Bundesbank.

The remainder of the paper is organized as follows. Section 2 shortly reviews the existing literature on financial constraints before introducing the concept of financial risks and explaining its advantages compared to the narrower definition of financial constraints. The modified neoclassical model of investment which explicitly includes the risk of bankruptcy will be described in section 3. After the description of the dataset in section 4, the empirical results will be presented in section 5. Section 6 concludes.

2 Financial Risks and Financial Constraints

Fazzari-Hubbard-Petersen (1988) were the first to investigate whether capital market imperfections lead to corporate underinvestment as a result of insufficiently available internal funds.[1] In order to estimate these financial constraints, they assume the existence of asymmetric information and a resulting hierarchy of finance, while credit rationing does not occur. The presumption that at least some enterprises are constrained as regards the costs of credits is tested by quantifying the investment sensitivity of these enterprises with respect to their cash flow. Firms with lower dividend payout ratios are assumed to be more constrained on the credit market, and therefore are expected to exhibit stronger cash flow sensitivities. The empirical results confirm these assumptions in the way that all groups of enterprises exhibit significant coefficients for these sensitivities, and those firms with higher retention ratios prove to be more sensitive with respect to changes in their cash flow than firms that are deemed to be less financially constrained.

While there is considerable support of the results obtained by Fazzari-Hubbard-Petersen, Kaplan-Zingales (1997) among others address criticism concerning the usefulness of cash-flow sensitivities to represent financial constraints by challenging the monotonicity assumption of these sensitivities with regard to the financial constraints. Additionally, they disapprove the method of classification that Fazzari-Hubbard-Petersen apply. Cleary (1999) confirms the results obtained by Kaplan-Zingales using a large sample of U.S. enterprises and employing a more objective classification criterion which is obtained by using multiple discriminant analysis analogous to the proceeding of Altman (1968).

[1] At least, their study can be regarded as the most influential paper. For an overview of this strand of literature as well as the earlier liquidity theory literature, see Kirchesch (2004).

However, Fazzari-Hubbard-Petersen paved the way for a large body of empirical studies that adopted their indirect approach of testing the role of financial constraints for the enterprises' investment decision in the framework of the q theory. Furthermore, Whited (1992) and Bond-Meghir (1994) were the first to discard the q model in favor of an Euler equation approach, with financial constraints being tested by including variables that account for the external rather than internal finance of the enterprise. Meanwhile, a vast quantity of studies for numerous countries is available which test the influence of financial decisions on the enterprises' investment behaviour in either theoretical framework.[2] Yet, all of these studies mostly apply internal or external finance sensitivity tests by adding single financial variables to the empirical investment equation in order to find out whether departures from the standard model hold under conditions of imperfect capital markets.

Hence, theories of investment in consideration of the firms' financial sphere are hitherto limited to theories of financial constraints in the presence of asymmetric information, with the prevalent definition of these financial constraints being unanimously accepted. Without doubt, all firms that rely on external finance are financially constrained in the way that external funds are more expensive than internal funds. Additionally, but not necessarily, the firm can face some sort of credit rationing.[3] Yet, the question remains whether the effect of external finance is fully captured by these financial constraints and thus the wedge between internal and external funds. In a world of asymmetric information, lenders charge an interest premium due to the uncertainty about the enterprise being able to repay its obligations in the future. If this is not the case, the firm will file for bankruptcy, and the bank has to write off its loan. Analogous to the bank, the enterprise has to allow for this risk while calculating its optimal capital accumulation path. However, while many studies are aware of the danger of bankruptcy in case of external financing, this kind of risk does not enter neither the theoretical models nor most of the empirical investment equations in a comprehensive way.

In some studies, the risk of bankruptcy enters the theoretical model of investment in a similar way to the external finance premium in the form of an agency cost function.[4] Under the common assumption that the default risk will rise with the level of the firm's debt and decline with its capital stock, the specification of the investment function does not differ significantly from the models that include an external finance premium. Yet, those studies do not account for the risk of not being able to earn future revenues as the result of a possible bankruptcy.

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[2]See Schiantarelli (1996), Hubbard (1998), or Chatelain (2002) for overviews of these studies.

[3]In this study, credit rationing is not taken into consideration since it would not impose any significant changes as regards the functional form of the model.

[4]See, for example, Leith (1999) or Pratap-Rendòn (2003). Other studies include financial distress costs functions in order to capture the effect of the external finance premium on business investment, see, among others, Hansen-Lindberg (1997), Hansen (1999) or Siegfrid (2000).

If this risk enters the maximization calculus of an enterprise, future profits must be weighted with the probability of survival and therewith the likelihood of gaining future revenues at all. In case the survival probability enters the firm's profit maximization, the resulting investment equation will contain an additional variable which accounts for this probability. Since the researcher is given plenty of rope to vitalize this bankruptcy probability in the course of the estimation, it must not necessarily be interpreted as the pure risk of bankruptcy, but rather as a comprehensive measure for the financial distress a firm may face. Actually, there exist many possibilities to empirically model this financial risk. In the simplest case, some leverage variable could be employd in order to account for this risk with the consequence of the investment function being equal to many empirical functions that account for financial constraints. Yet, as there exist explicit measures to estimate the firms' bankruptcy probabilities, these measures can definitely be regarded as being more appropriate to account for the firms' financial distress.

Bond-Meghir (1994) are one of the few to include both the risk premium on the interest rate as well as the risk of bankruptcy into their model of investment behavior both of which are dependent on the company's debt in relation to its capital stock. In addition to the risk of default, bankruptcy costs enter the model which depend only on the level of debt, but not on the capital stock. However, the empirical equation does not entail explicitly the risk of bankruptcy, but rather the squared debt-to-capital ratio as the indicator for this risk, since the danger of bankruptcy does not enter the profit maximization as a discounting weight for future revenues. Leith (1999) includes the costs of bankruptcy into a model of aggregate investment by substracting these costs from the revenues in the firm's profit maximization. Since the model describes aggregate investment spending, the probability of bankruptcy is included in form of the liquidation rate amongst all firms.[5] According to Leith, this liquidation rate can be seen as a reflection of general macroeconomic conditions, while the bankruptcy probability also depends on firm-specific factors represented by the firm's cash flow. Integrating this bankruptcy probability into a q model of investment yields a wedge between the rate of investment and marginal q. As a consequence, the adjustment process is slower than without accounting for the firm's likelihood of insolvency.

Besides the classification of the sample according to the firm's creditworthiness ratio, Kalkreuth (2001) introduces this ratio as explanatory variable into his estimation of an autoregressive distributed lag model. Drawing his conclusions from the debate about cash flow sensitivities, he argues for the use of rating data to classify the enterprises according to their differential

[5]The liquidation rate calculates the number of firms being insolvent in one period in relation to the total number of firms in the economy, see Leith (1999), 6.

access to external finance. In this context, the creditworthiness ratio does not account for the risk of bankruptcy, but rather for the financial risks of firms in terms of a potential increase of the external finance premium in case of financial distress. Frisse-Funke-Lankes (1993) introduce a borrowing limit into the profit maximization of the firm which is assumed to depend on the firm's Z-score of Altman (1968) as an indicator for the firm's risk of bankruptcy. The Z-score is used both as explanatory variable and as classification criterion, yielding the result that the group of firms that is considered to be less solvent exhibit significantly higher sensitivities with respect to the Z-score than the more solvent enterprises.

Wald (2003) is the first to include the probability of bankruptcy as a weight into the firm's profit maximization in order to account for the relationship between risk and investment. This approach yields an empirical investment equation which contains the survival probability as well as a term that is almost identical to q, yet multiplied with the survival probability. Wald draws the conclusion that those studies that supply evidence on the existence of financial constraints may mistake these constraints with bankruptcy risks. Hence, the risk of bankruptcy is not interpreted as an extension of the existing literature on financial constraints, as in the present case, but rather as their counterpart. Yet, both measures indicate some sort of financial distortion due to a deterioration of the borrower's creditworthiness, with the distinction that financial constraints are the result of informational asymmetries, while the risk of bankruptcy may even occur in an environment with symmetric information, but uncertain revenues.[6] According to Wald, a high bankruptcy risk will decrease the expected value of the firm's investment and thus renders some projects unprofitable. In contrast, financial constraints will not lower the value of investment, but rather cause the firm to miss profitable investment opportunities. However, while this may be the case if enterprises face some sort of credit rationing, it does not apply if firms are confronted with a risk premium on their borrowed funds, as is the case in the present model. Both a rise in the bankruptcy probability and an increase of the risk premium will lower the costs of postponing the investment decision until tomorrow and consequently renders some investment projects unprofitable.

In order to conclude, it is noteworthy that most of the described studies include a measure of the firm's default probability into their investment models in a rather ad hoc manner. Only a few studies, which include Bond-Meghir (1994) and Wald (2003), explicitly account for this determinant by introducing some sort of bankruptcy probability into the profit calculation of the firm and the derivation of the optimal investment level. Yet, only the Wald study captures the complete effect of bankruptcy risks on the investment decision of the firm. This approach will be prosecuted subsequently by deriving a model of investment that contains the firm's

[6] See Wald (2003), 3-5.

likelihood to survive as a part of its objective function, and consequently as a part of the empirical investment equation.

3 The Model

In this chapter, the model of corporate investment behavior under asymmetric information and financial risks will be derived. The special feature of this model is, as addressed above, the explicit inclusion of financial risks as a whole into the investment decision of enterprises. These financial risks occur in form of the firm's uncertainty about its future existence which depends on whether the firm is able to pay back its borrowed funds or not. This risk of bankruptcy has two implications for the investment behaviour of the enterprise, one of which is that the interest rate the firm has to pay for its borrowed funds will depend on the degree of the firm's financial risks. Hence, the cost of capital will rise with the degree of the firm's indebtness. Secondly, the company has to account for its default risk by weighting its future profits with its probability of survival. As a consequence, investment projects may become less profitable if the firm accumulates borrowed funds.

The subsequently derived model of investment behavior follows the standard neoclassical partial equilibrium approach that can be found in numerous contributions that deal with Tobin's q theory or with Euler equations. In order to reproduce the lender's behavior, the model will integrate the approach that is used among others in Bernanke-Gertler-Gilchrist (1999) by deriving the optimal contractual arrangement between the lender and the borrower and its impact on the investment decision of the firm. As a result, the external finance premium as well as the bankruptcy probability depend on the level of debt as well as the capital stock of the enterprise. Both types of financial risks will be introduced into the profit maximization of the firm. Additionally, the firm's future revenues will be weighted by the firm's survival probability. As a consequence, financial variables as well as the probability of survival will enter the resulting investment equation.

3.1 The Basic Setting

Time is discrete, indexed by $t \in \{0, 1, ...\}$. All variables in the current period are known, whereas all future variables are stochastic. The time horizon is finite.[7] There exists an infinite

[7]Most of the theoretical models argue in infinite-time optimization models. However, they do not address problems concerning the existence of the optimal solution which is not trivial in case of these models. In order to simplify the analysis, the finite-time horizon is chosen, see Janz (1997), 22.

number of enterprises in the economy that is involved in the production process. Each firm i produces the output Y_t^i with period t's real input factors capital, K_t^i, and labor, L_t^i, according to the usual neoclassical technology, $Y_t^i = F(K_t^i, L_t^i)$. The concave production function is twice continuously differentiable in capital and labor, with the technology being characterized as usual by positive, but diminishing returns with respect to any input factor.[8] Changing the capital stock of a company entails adjustment costs, $G(I_t^i, K_t^i)$, which depend on the level of investment, I_t^i, and the capital stock, K_t^i. These adjustment costs are introduced into the model in the form of lost output which means that a part of the production is lost due to a resource consuming process of installing new capital. The adjustment cost function is convex in both its arguments and, as usual, it is assumed to be twice continuously differentiable with increasing marginal costs.[9] The capital good that is acquired in period t will become productive in the same period, as will be defined later in the capital accumulation constraint. The existing capital of the previous period is subject to depreciation at the beginning of the following period at the constant economic rate of depreciation δ, where $0 \leq \delta \leq 1$.

Earnings of firm i before interest and taxes, $EBIT_t^i$, are defined as the revenue from producing the output good less the labor outlays and capital adjustment costs:

$$EBIT_t^i = p_t^i F(K_t^i, L_t^i) - w_t L_t^i - p_t G(I_t^i, K_t^i). \tag{1}$$

where w_t denotes the wage rate identical for all firms, and p_t is the price of the output good. There exist two alternatives to finance the firm's investment projects one of which is the use of internal funds, while the other is debt financing. The firm will, in accordance with the pecking order theory, primarily use its retained earnings, RE_t^i. This is the part of the firm's after tax profits, π_t^i, that is not distributed among the owners of the enterprise. If these internal funds do not suffice to finance all investment projects the firm wants to undertake, it has to borrow the required amount of debt, B_t^i, at the specified interest rate, r_t^i, from the bank, since the issuance of new shares is not possible. Thus, at the beginning of period t, the firm receives the demanded amount of debt, and repays it along with the associated interest at the end of the same period.[10]

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[8] That means $F_K(K_t, L_t) > 0$, $F_{KK}(K_t, L_t) < 0$, $F_L(K_t, L_t) > 0$, and $F_{LL}(K_t, L_t) < 0$. Additionally, the production function satisfies the Inada conditions that bound K_t^i and L_t^i away from zero, i.e. $F_L(K_t^i, 0) = F_K(0, L_t^i) = \infty$ for positive K_t^i and L_t^i, as well as the conditions $F_L(K_t^i, \infty) = F_K(\infty, L_t^i) = 0$. Note that the term F_x will subsequently denote the first partial derivative of a function $F(x, \cdot)$, i.e. $\frac{\partial F(x,\cdot)}{\partial x}$, while F_{xx} will denote the second partial derivative, i.e. $\frac{\partial F^2(x,\cdot)}{\partial x^2}$.

[9] That means $G_I(I_t, K_t) > 0$, $G_K(I_t, K_t) > 0$, $G_{II}(I_t, K_t) > 0$, and $G_K(I_t, K_t) > 0$.

[10] This assumption simplifies the notation while leaving the results unchanged. Note that under this assumption, nominal debt equals real debt.

With τ being the corporate profit tax rate that is equal to all firms, and $0 \leq \tau < 1$, the earnings after taxes and interest payments, and thus the profit of the firm, can be written as

$$\pi_t^i = (1 - \tau) \left[p_t F(K_t^i, L_t^i) - w_t L_t^i - p_t G(I_t^i, K_t^i) - r_t^i B_t^i \right]. \tag{2}$$

Interest payments serve as a tax shield in terms of the static tradeoff hypotheses, which means that the firm is balancing the rising distress costs caused by a higher debt level with the tax benefits of deducting the associated interest payments from corporate taxation.[11]

Since firms are not necessarily incorporated, profits that are not retained in the company are assumed to be paid out to the owners in the form of entrepreneurial profits. Yet, the usual notation for dividends, D_t^i, applies for the latter as the implications for the model remain the same. These entrepreneurial profits will be positive if the retained earnings exceed the amount of new capital goods that the enterprise intends to purchase. Since investment is financed with retained earnings or net borrowing, the possibility of negative entrepreneurial profits is exluded from the model. The owner of the firm is not obliged to pay the firm's debt if it is not able to cover its debt payments with its earnings, since there is no credit rationing and firms may borrow as much as they want.[12]

With the firm's investment being financed with retained earnings and net borrowed funds, $p_t^I I_t^i = RE_t^i + B_t^i$, and after-tax profits being composed of retained earnings and entrepreneurial profits less debt repayments, $\pi_t^i = RE_t^i + D_t^i - B_t^i$, entrepreneurial profits can be written as

$$D_t^i = (1 - \tau) \left[p_t F(K_t^i, L_t^i) - w_t L_t^i - p_t G(I_t^i, K_t^i) - r_t^i B_t^i \right] - p_t^I I_t^i + B_t^i - B_t^i. \tag{3}$$

The objective function of the firm's management will be the maximization of entrepreneurial profits over the given time horizon, with these profits being the excess of the firm's cash inflows over its cash outflows. Each firm has to deal with a firm-specific shock, ω_t^i, which will be the determinant of bankruptcy in this model.[13] This idiosyncratic disturbance to the return of firm i is a random variable that is independent and identically distributed across time and firms with the continuously differentiable probability density function $f(\omega_t^i)$ and the

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[11] See Miller (1977), 262 or Myers (1984), 577.

[12] See Groessl-Hauenschild-Stahlecker (2000), 4. Yet, the firm-specific interest rate rises with the amount of debt which may lead firms to refrain from borrowing and rather cut back their investment spending if the level of debt rises too high.

[13] For reasons of simplicity, the economy does not face any aggregate uncertainty which means no aggregate productivity shock occurs.

probability distribution function $F(\omega_t^i)$.[14] Note that this shock can be both a positive and a negative shock. Yet, the random variable has a non-negative support and an expected value of $E\{\omega_t^i\} = 1$ for all t. In case a negative shock is large enough, the firm will not be able to meet its repayment obligations and thus will default. Besides the firm's earnings before interest and taxes, the firm-specific shock will also affect its capital stock after depreciation, as will be defined later.

3.2 Debt Contracts and the Risk of Bankruptcy

Recalling the link between finance and investment, the amount of debt needed in period t can be written as that part of the enterprises' investment that exceeds the firm's retained earnings, and thus $B_t^i = p_t^I I_t^i - RE_t^i$. In order to obtain external funds, the enterprise has to negotiate debt contracts with the bank. Under the assumption of informational asymmetries between borrowers and lenders, the determination of the contract conditions will be difficult. Whilst firms can observe the state of nature without any costs, banks cannot. Since the latter cannot act on the assumption that the firm has necessarily an incentive to always report the correct outcome, it would have to specify a comprehensive debt contract. Since this is not possible, a costly state verification (CSV) problem is assumed as put forward by Townsend (1979)[15] In this context, lenders can undertake audits to gather missing information which involve monitoring costs. The auditing fee that the bank has to pay in case of monitoring can be interpreted as bankruptcy costs, with these costs being proportional to the value of the monitored firm. The situation in which the lender monitors the borrower can be interpreted as bankruptcy of the latter.[16]

Without any aggregate uncertainty, the optimal contract is a standard debt contract including risky debt, as described in Gale-Hellwig (1985). The optimality stems from the fact that this contract maximizes the borrower's expected profits from being truthful under the constraint of minimizing the informational costs of the lender. The basic feature of a standard debt contract relies on the borrower's promise to offer a constant repayment over states, with the bank being

[14] See, for example, Williamson (1987a), 136 and Bernanke-Gertler-Gilchrist (1999), 1349, or in the case of price uncertainty Groessl-Hauenschild-Stahlecker (2000), 3.

[15] See also Gale-Hellwig (1985) or Williamson (1987a). Bernanke-Gertler-Gilchrist (1999) apply such a CSV problem in the general equilibrium approach.

[16] See Williamson (1987a), 135. Note that there only exist short-term relationships between borrowers and lenders due to the presumably high anonymity on financial markets. Otherwise informational asymmetries could be reduced, and the contracting problem would take the form of a repeated game with moral hazard. For a theoretical analysis of that case see Gertler (1992). Note also that the assumption of no economies of scale in monitoring may meet with criticism, but it is set up for reasons of simplicity while not being too unrealistic.

allowed to seize the remains of the firm in case the repayment cannot be guaranteed.[17]

With the knowledge about the optimal contract between the enterprise and its bank, the condition for bankruptcy and its probability can be derived. The optimal contract is characterized by the gross non-default loan rate $(1 + r_t^i)$ on the amount of debt B_t^i, and by the threshold value $\bar{\omega}_t^i$ of the firm-specific shock ω_t^i. In case the shock exceeds its threshold value, the bank will receive the contracted interest payments and the granted loan. In case of a negative shock, the bank will receive the remains of the firm and thus less than the contracted amount. Following Alessandrini (2003), the firm-specific shock will affect the earnings before interest and taxes and the capital stock after depreciation. If the earning before interest and taxes as well as the remaining capital stock are not large enough to satisfy the repayment obligation of the company, it will declare bankrupt. The condition for default thus can be written as[18]

$$\omega_t^i \left[EBIT_t^i + K_t^i(1 - \delta) \right] < (1 + r_t^i)B_t^i. \tag{4}$$

Hence, the bankruptcy threshold for the specific firm is that value of ω_t^i below which the firm's profits and its residual capital are too small to pay back wages and debt. Rearranging equation (4) with regard to the threshold value then yields

$$\bar{\omega}_t^i = \frac{(1 + r_t^i)B_t^i}{p_t F(K_t^i, L_t^i) - w_t L_t^i - p_t G(I_t^i, K_t^i) + K_t^i(1 - \delta)}. \tag{5}$$

It is obvious that the bankruptcy threshold is increasing in the amount of debt and, if the adjustment of the capital stock is assumed to be costless, decreasing in the amount of capital. The same holds true for the latter in case of a costly adjustment process if $p_t F_K(K_t^i, L_t^i) + (1 - \delta) > p_t G_K(I_t^i, K_t^i)$. To summarize, a rising level of debt as well as a declining capital stock will augment the firm's bankruptcy threshold. As the insolvency threshold rises, the probability of being solvent in the next period decreases, since the range of negative shocks that may render the firm insolvent grows. Therefore, the enterprise's survival probability can be written as follows:[19]

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[17]See Gale-Hellwig (1985), 654.

[18]Bernanke-Gertler-Gilchrist (1999) assume that the firm-specific shock only takes effect on the gross return on capital. However, the modification of Alessandrini (2003) adds a more realistic dimension to the model. First, by striking the firm at the EBIT level, the firm is allowed to pay wages even in the case of bankruptcy. Furthermore, by affecting the firm's level of capital, the firm cannot easily pay its debt by selling parts of its capital stock. In the model of Bernanke-Gertler-Gilchrist (1999), the firm would be able to sell a fraction of its capital in order to meet its repayment obligations in case of a negative shock, and, as a consequence, the risk of bankruptcy would nearly disappear.

[19]For reasons of simplicity, the influence of labor outlays on the bankruptcy threshold is ignored, even though it is obviously positive.

$$\Pr(no\ default) = P^i(B_t^i, K_t^i). \tag{6}$$

Naturally, the probability of bankruptcy is $\Pr(default) = 1 - P^i(B_t^i, K_t^i)$. As derived above, the probability of survival increases with the level of capital, and decreases with the level of debt, i.e. $P_K(B_t^i, K_t^i) > 0$, and $P_B(B_t^i, K_t^i) < 0$.

3.3 The Lending Behavior of the Bank

By lending funds to the enterprise, the bank faces opportunity costs equal to the economy's riskless gross rate of return, $(1 + r)$, since this is the rate the bank can serve to agends holding bonds due to its perfect diversification.[20] Without doubt, the lending activity of the bank must yield at least its opportunity costs. The only uncertainty about the return is still idiosyncratic to the firm. If the firm cannot repay its contractuary repayment and thus defaults, the bank will monitor the firm and seize everything it finds. However, the bank has to pay the auditing fee, μ, and only receives $(1 - \mu)$ of the remaining firm value. Accounting for the bankruptcy threshold, $\bar{\omega}_t^i$, the return of the bank is as follows:

$$\begin{array}{lcl} (1 + r_t^i)B_t^i & \multirow{2}{*}{if} & \omega_t^i \geq \bar{\omega}_t^i, \\ (1 - \mu)\omega_t^i \left[EBIT_t^i + K_t^i(1 - \delta)\right] & & \omega_t^i < \bar{\omega}_t^i. \end{array} \tag{7}$$

In equilibrium, lending to firms with their firm-speficic interest rate has to be at least as profitable for the bank as lending to others imposing the risk-free market interest rate. Thus, the risk-free return $(1 + r)B_t^i$ must equal the return from lending B_t^i to firm i, with both the case of default and the case of non-default necessarily entering this calculation:[21]

$$(1 + r)B_t^i = \int_0^{\bar{\omega}_t^i} \left[(1 - \mu)\omega_t^i \left(EBIT_t^i + K_t^i(1 - \delta)\right)\right] dF(\omega_t^i) + \int_{\bar{\omega}_t^i}^{\infty} \left[(1 + r_t^i)B_t^i\right] dF(\omega_t^i). \tag{8}$$

With $\lim_{\omega_t^i \to \infty} F(\omega_t^i) = 1$, and $P^i(B_t^i, K_t^i) = 1 - F(\bar{\omega}_t^i)$, the firm-specific interest rate can be written,

[20] Since the bank is assumed to hold sufficiently large and diversified portfolios to achieve perfect risk-pooling, it behaves as if it was risk-neutral, see Gale-Hellwig (1985), 650. Note that for reasons of simplicity this risk-free interest rate is equal across firms and constant over time.

[21] See Groessl-Hauenschild-Stahlecker (2000) or Bernanke-Gertler-Gilchrist (1999), 1351.

after rearrangement, as

$$1 + r_t^i = \frac{(1+r)B_t^i}{P^i(B_t^i, K_t^i)B_t^i} - \frac{\int_0^{\bar{\omega}_t^i} \left[(1-\mu)\omega_t^i \left(EBIT_t^i + K_t^i(1-\delta)\right)\right] dF(\omega_t^i)}{P^i(B_t^i, K_t^i)B_t^i}. \tag{9}$$

This interest rate will be higher than the market interest rate, since the bank needs to be compensated for the firm's risk of bankruptcy and the resulting uncertain repayment of the borrowerd funds. Equation (9) shows this mark-up that reflects the firm's probability of default. This risk premium is a decreasing function of the survival probability and thus an increasing function of the default probability.[22] A decreasing level of debt as well as a rising capital stock reduce the default probability and thus the risk premium, since a lower compensation of the bank for a potential default is needed. Thus, for reasons of simplicity, it is assumed that the idiosyncratic interest rate only depends on the firm's level of debt and its capital stock,

$$r_t^i = r^i(B_t^i, K_t^i), \tag{10}$$

with $r_B^i(B_t^i, K_t^i) > 0$ and $r_K^i(B_t^i, K_t^i) < 0$.

3.4 The Profit Maximization of the Firm

As derived in the previous sections, the investment decision of the firm has to take place simultaneously with the decison about its financing. In doing so, the firm is aware of its risk of default and thus the risk of the firm value falling to zero in any future period. Therefore, future values of the firm have to be weighted with the probability to survive. Both the amount of capital and debt will have an impact on this probability, and thus real and financial decisions will interact.

The time schedule of the investment decision is as follows: After the firm decides on its desired level of new capital and the required amount of debt, the bank fixes the interest rate for the demanded borrowed funds with the latter being transferred to the firm. Now, the bankruptcy threshold can be calculated, before the firm-specific shock is realized, and the output good is produced and sold. Hereafter, bankruptcies are determined. Surviving com-

[22] If the latter is zero and survival thus is guaranteed, the firm's interest rate equals the economy wide riskless rate of return.

panies calculate their profits, pay back their borrowed funds and their interest obligations, before paying out the entrepreneurial profits to their owners. Bankrupt companies will be liquidated, with the banks seizing the remains and paying the monitoring costs.

Recapitulating the explications about the decisions of the firm, its maximization problem can now be determined within the above described neoclassical model of capital accumulation in the presence of adjustment costs and bankruptcy risks. Assuming a finite time horizon and no agency problems between managers and owners of a firm, the management's aim is to maximize the value of the enterprise over the given time horizon, with the firm value being

$$V^i_{t_0} = E^i_{t_0}\left\{\sum_{t=t_0}^{T}\beta^t\left(\prod_{u=t_0}^{t}P^i(B^i_u, K^i_u)\right)D^i_t\right\}, \tag{11}$$

where $\beta = \frac{1}{1+r}$ is the discount factor equal to all firms.[23] Hence, the maximization of the expected firm value equals the maximization of all expected future entrepreneurial profits discounted with β and $P^i(B^i_t, K^i_t)$. While maximizing the value of the firm, the entrepreneur has to take into account several constraints.

The first constraint is the flow of funds constraint that defines the composition of the entrepreneurial profits which add up to the firm value. As already derived in equation (3), these profits are defined as the difference between total revenue and total costs,

$$D^i_t = (1-\tau)\left[p_tF(K^i_t, L^i_t) - w_tL^i_t - p_tG(I^i_t, K^i_t) - r^i(B^i_t, K^i_t)B^i_t\right] - p^I_tI^i_t. \tag{12}$$

The second constraint is the usual capital stock accounting identity. The capital stock of firm i at period t is formed by the existing capital stock from the last time period, K^i_{t-1}, which is subject to depreciation with rate δ, and the sum of the capital acquired in the present period, I^i_t. Note again that newly invested capital becomes productive immediatly:

$$K^i_t = I^i_t + K^i_{t-1}(1-\delta). \tag{13}$$

[23] The value V^i_t of firm i can be derived from the arbitrage condition which must hold when investors are risk-neutral and capital markets are in equilibrium, $rV^i_t = D^i_t + E^i_t\left\{P^i(B^i_{t+1}, K^i_{t+1})V^i_{t+1}\right\} - V^i_t$, see, for example, Whited (1992), 1430. Remember that no dividends are paid to shareholders, as commonly assumed in the context of this arbitrage condition, but rather the revenue to the entrepreneur from operating his business. This revenue is composed of current entrepreneurial profits, D^i_t, and the value added of the enterprise in future periods, $E^i_t\left\{P^i_{t+1}V^i_{t+1}\right\} - V^i_t$. Hereby, E^i_t is the expectation operator conditional on all relevant information which is available at time t. Solving this stochastic difference equation forward to find the time path for the value of the firm, and taking into account the transversality condition which prevents this value from becoming infinite in finite time yields the above expression for the value of the firm at time t_0, see, for example, Poterba-Summers (1983), 142.

The next two constraints recall that the interest rate which firm i has to pay for its borrowed funds, as well as its survival probability depend on the levels of capital and debt, as was derived before:

$$r^i = r^i(B_t^i, K_t^i), \tag{14}$$

$$P^i = P^i(B_t^i, K_t^i). \tag{15}$$

The last constraints specify the starting values for both the capital stock and the debt level:

$$K_{t-1} = \bar{K} \geq 0, \tag{16}$$

$$B_{t-1} = \bar{B} \geq 0. \tag{17}$$

In every period, the enterprise has to decide about the level of investment, I_t^i, and labor, L_t^i, knowing about its level of capital, K_{t-1}^i.[24] After substituting the entrepreneurial profits in the objective function (11) with equation (12), and taking into account equations (14) - (17), the discrete Hamiltonian at time t for the optimization problem of the profit maximizing enterprise can be written as

$$\begin{aligned}
&\mathcal{H}_t^i(L_t^i, I_t^i, K_t^i, B_t^i, \lambda_t^i) = \\
&\quad = E_t^i\{\beta^t P^i(B_t^i, K_t^i)[(1-\tau)(p_t F(K_t^i, L_t^i) - w_t L_t^i - p_t G(I_t^i, K_t^i) - \\
&\quad - r^i(B_t^i, K_t^i)B_t) - p_t^I I_t^i] + \lambda_t^i \left[I_t^i - \delta K_{t-1}^i\right]\} \text{ for } t = t_0, ..., T.
\end{aligned} \tag{18}$$

In the following, the expected value of the shadow price for capital, λ_t^i, will be inserted for the periods t and $t+1$ into the first order condition for capital in order to derive the investment equation.[25] Note that, when setting up its expectations about its firm value in period t, the firm faces a zero probability of default in this period, and thus $P(B_t, K_t) = 1$. Likewise, there is no discounting in the current period, and thus $\beta^t = 1$ for period t. Assuming the existence and optimality of the derived solution, the rearranged first-order condition for capital thus can be written as

---

[24]Since debt is completely repaid at the end of each period, B_{t-1}^i is known to be zero in the present case.

[25]For a description of the stochastic maximum principle in discrete time, see for example Bertsekas-Shreve (1978), Whittle (1982), Arkin-Evstigneev (1987). For a more detailed derivation of the investment equation, see Appendix A.

$$
\begin{aligned}
&E_t^i\left\{p_t G_I(I_t^i, K_t^i) + \frac{p_t^I}{(1-\tau)}\right\} \\
&= E_t^i\left\{\beta P^i(B_{t+1}^i, K_{t+1}^i)(1-\delta)\left[p_{t+1} G_I(I_{t+1}^i, K_{t+1}^i) + \frac{p_{t+1}^I}{(1-\tau)}\right]\right\} + \\
&+ E_t^i\left\{p_t F_K(K_t^i, L_t^i) - p_t G_K(I_t^i, K_t^i) - r_K^i(B_t^i, K_t^i) B_t^i\right\} \\
&+ E_t^i\left\{\frac{1}{(1-\tau)} P_K^i(B_t^i, K_t^i) D_t^i\right\},
\end{aligned}
\tag{19}
$$

while the rearranged debt function takes the following form:

$$
\begin{aligned}
&E_t^i\left\{\tau\left[r_B^i(B_t^i, K_t^i) B_t^i + r_t^i(B_t^i, K_t^i)\right]\right\} = \\
&= E_t^i\left\{P^i(B_t^i, K_t^i)\left[r_B^i(B_t^i, K_t^i) B_t^i + r_t^i(B_t^i, K_t^i)\right] - P_B^i(B_t^i, K_t^i) D_t^i\right\}.
\end{aligned}
\tag{20}
$$

3.5 The Investment and Financing Decision of the Firm

The rearranged first order condition for capital, equation (19), relates the costs of investing today to the costs of postponing the investment until tomorrow, and thus shows the optimal capital allocation path. As can easily be seen, the standard Euler equation for capital is subject to some important extensions due to the introduction of taxes, adjustment costs, and the possibility of default.

The left hand side of equation (19) shows the marginal installation and purchasing costs of investing today, with the latter being tax-adjusted. The right hand side presents the opportunity costs of delaying the investment until tomorrow. These costs include the expected discounted value of the costs for purchasing and installing the new capital, with the former again being tax-adjusted, as well as the foregone change in production less the marginal change of the installation costs due to the change in the capital stock.

Additionally, the firm has to take into account the changes of its bankruptcy risk due to changes in the level of capital and debt. Thus, the opportunity costs of postponing the investment decision are weighted by the probability of survival. Since capital becomes productive immediately, only the costs for the delayed investment project have to be weighted. While the firm has to bear the opportunity costs of not earning the revenue from today's investment in any case, it needs to pay the postponed investment project only in case of survival. Together with the corporate tax rate, this weighting reduces the present value of an additional unit of tomorrow's capital.

Two additional consequences of a potential default have to be taken into account both of which offer an incentive to invest rather today than tomorrow. Firstly, such a change in the capital stock increases the chance of future profits by lowering the default probability. As a consequence, the probability of receiving entrepreneurial profits in the future and thus the present discounted value of an additional unit of today's capital increases. Secondly, this investment lowers interest rates and thus interest payments for the necessary borrowed funds. With the newly invested capital becoming productive immediately, and interest rates being fixed after its installation, the costs of capital decrease in the present period.

The rearranged first order condition for debt, equation (20), presents the optimal decision of the firm concerning its level of borrowed funds, saying that the firm should take on debts until it is indifferent between the tax advantages of an additional unit of debt and its associated costs. Regarding the right hand side, the first term of equation (20) captures the aggravated credit conditions in the present period as a consequence of the higher debt level. Since the bank includes the new debt into its calculation, it will charge the risk premium according to the present financial indicators of the firm. Hence, the higher level of debt will increase the probability of not being able to repay the borrowed funds at the end of the period which results in higher interest rates and thus dearer credits on the part of the bank. The second term takes into account that a rising debt level will decrease the survival probability and thus the chance to receive entrepreneurial profits at the end of the period. The left hand side of the debt equation shows the discounted present value of the tax advantages of the additional unit of debt weighted with the survival probability. This is the amount of tax relief that stems from the higher costs of borrowing as described on the right hand side.

3.6 Econometric Specification of the Investment Function

The econometric estimation of the rearranged first order condition for capital, equation (19) is not possible. In order to derive the investment equation explicitly, it is necessary to specify the production function and the adjustment cost function. In the present case, the default probability and the external finance premium also have to be specified. Following Bond-Meghir (1994), an explicit specification of the production function can be avoided by assuming that it is linear homogenous in capital and labor. Under this assumption, the following equality, achieved by total differentiation, holds:

$$F(K_t^i, L_t^i) = F_K(K_t^i, L_t^i)K_t^i + F_L(K_t^i, L_t^i)L_t^i. \tag{21}$$

Substituting the marginal productivity of labor by the real wage, and rearranging the production function produces the following expression for the marginal productivity of capital:[26]

$$F_K(K_t^i, L_t^i) = \frac{F(K_t^i, L_t^i) - \frac{w_t}{p_t} L_t^i}{K_t^i} = \frac{Y_t - \frac{w_t}{p_t} L_t^i}{K_t^i}. \tag{22}$$

Since it is not possible to replace the adjustment costs of investment in a way similar to the marginal costs of labor, an adjustment cost function has to be explicitly specified. In the present case, a standard quadratic adjustment cost function of the Summers (1981) type that is linear homogenous in its arguments is introduced into the model as follows:[27]

$$G(I_t^i, K_t^i) = \frac{b}{2} \left(\frac{I_t^i}{K_t^i} - a \right)^2 K_t^i, \tag{23}$$

where a and b are finite constants with $b > 0$. The constant term a denotes some rate of investment that can be undertaken without facing adjustment costs, and thus can be interpreted as a 'normal' rate or a target rate of investment. Otherwise, adjustment costs rise quadratically in the investment ratio.[28] The premium on external finance, $r^i(B_t^i, K_t^i)$, will be specified by the following financial distress function:

$$r^i(B_t^i, K_t^i) = c \frac{B_t^i}{K_t^i}, \tag{24}$$

where $c > 0$. Thus, the interest rate on debt that a firm has to pay, consists of the riskless market rate plus an external finance premium that is linear in the degree of the debt-to-capital ratio. The parameter c displays the extent to which a deterioration of the firm's creditworthiness is transferred into a higher firm-specific interest rate. For reasons of simplicity, the financial distress function is assumed to be linear in the debt-to-capital ratio. [29] This specification meets the requirements for the external finance premium, as derived before. A higher level of debt will increase the external finance premium, and a larger capital stock will decrease this premium. The default probability will be set up in a comparable way by

[26]See Bond-Meghir (1994), 207. The real wage equation is derived in equation A.2 in appendix A.
[27]See Summers (1981), 95.
[28]See equation (A.10) in appendix A for the first derivatives of this adjustment cost function.
[29]See equation (A.11) in appendix A for the first derivatives. Note that the existing literature mostly introduces some sort of financial distress function that is assumed to be quadratic and homogenous of degree one in debt and capital, see Hansen-Lindberg (1997), 17, for example. However, in the present case, default probabilities rather than external finance premia are the crucial element of the investment function. Hence, the agency cost function will be held as simple as possible which also holds true for the bankruptcy cost function. In any case, different specifications do not alter the results significantly.

$$P_t^i(B_t^i, K_t^i) = 1 - d\frac{B_t^i}{K_t^i}, \tag{25}$$

where $d > 0$.[30] Analogous to the financial distress function, the parameter d specifies the transformation of a higher debt-to-assets ratio into a higher bankruptcy probability.

Additionally, the expectations of the managers who decide about the investment projects are assumed to be rational which means that mistakes will not be made systematically as concerns the managers' formation of expectations. Formally, the forecast error is white noise and thus serially uncorrelated, Hence, the unobserved terms in the first order condition for capital, equation (19), can be substituted by their realizations plus an error term, ε_{t+1}^i, with zero mean, $E_t^i\left\{\varepsilon_{t+1}^i\right\} = 0$, and no correlation with the information set available to the firm at time t, i.e. $E_t^i\left\{\varepsilon_{t+1}^i\varepsilon_t^i\right\} = 0$ for $t \neq t+1$. Including the specifications for the adjustment costs, the external finance premium, and the default probabilites as well as the manager's rational expectations, equation (19) can be written as

$$\begin{aligned} P_{t+1}^i\frac{I_{t+1}^i}{K_{t+1}^i} = \alpha_0 + \alpha_1\frac{I_t^i}{K_t^i} + \alpha_2\left(\frac{I_t^i}{K_t^i}\right)^2 + \alpha_3\frac{Y_t^i}{K_t^i} + \alpha_4\frac{w_tL_t^i}{K_t^i} + \\ + \alpha_5\left(\frac{B_t^i}{K_t^i}\right) + \alpha_6\left(\frac{B_t^i}{K_t^i}\frac{D_t^i}{K_t^i}\right) + \alpha_7P_{t+1}^i + f_i + \eta_{t+1} + \varepsilon_{t+1}^i, \end{aligned} \tag{26}$$

where the coefficients are the following:

$$\begin{aligned} &\alpha_0 = \left(\tfrac{a^2}{2} - a + \tfrac{1}{b(1-\tau)}\tfrac{p_t^I}{p_t}\right)\phi_{t+1}, && \alpha_1 = \phi_{t+1}, && \alpha_2 = -\tfrac{1}{2}\phi_{t+1}, \\ &\alpha_3 = -\tfrac{1}{b}\phi_{t+1}, && \alpha_4 = \tfrac{1}{bp_t}\phi_{t+1}, && \alpha_5 = -\tfrac{c}{bp_t}\phi_{t+1}, \\ &\alpha_6 = -\tfrac{d}{bp_t(1-\tau)}\phi_{t+1}, && \alpha_7 = a - \tfrac{1}{b(1-\tau)}\tfrac{p_{t+1}^I}{p_{t+1}}, && \phi_{t+1} = \tfrac{1}{(1-\delta)\beta}\tfrac{p_t}{p_{t+1}}. \end{aligned}$$

Analogous to Bond-Meghir (1994), ϕ_{t+1} is defined as the real discount rate. As is common practice in studies that deal with neoclassical investment functions, the rate of inflation is assumed to be constant over time and across firms for the output prices and the price of the capital good.[31] Consequently, the real discount rate ϕ_{t+1} and the coefficients $\alpha_0, ..., \alpha_7$ do not vary

---

[30]The default probability is $1 - P_t^i(B_t^i, K_t^i) = d\frac{B_t^i}{K_t^i}$, and the survival probability hence is $1 - P_t^i(B_t^i, K_t^i)$. The first derivative can be seen in equation (A.12) in appendix A.

[31]See Bond-Meghir (1994), 208, Janz (1997a), 31, or Whited-Wu (2003), 9.

over time which permits an estimation of equation (26). In any case, the neoclassical model assumes that firms face identical prices due to perfect competition, with the consequence of no variation of prices accross firms within one year. Hence, even if there are changes in the price level, these changes may be captured by the inclusion of the time-specific term η_{t+1}, which may additionally account for changes in macroeconomic conditions. The term f_i captures firm-specific effects, while the disturbance term ε^i_{t+1} reflects forecast errors, as discussed earlier.

The coefficient on the lagged investment ratio, α_1, is positive and greater than one, while α_2 as the coefficient on the lagged squared investment ratio is negative. With $b > 0$, the output coefficient, α_3, is negative, while the coefficient on the labor outlays, α_4, is positive. Note that both coefficients depend on the magnitude of the adjustment costs. The coefficients on both debt-to-assets ratios, α_5 and α_6, control for "the non-separability between investment and borrowing decisions."[32] Like the output and labor costs coefficients, they depend on the adjustment costs parameter, and additionally on the magnitude of the financial distress respective bankruptcy probability parameters c and d. Both coefficients have a negative sign. Interestingly, the coefficient of the survival probability, α_7, merely depends on the adjustment cost parameters a and b, but not on the parameter of the survival probability function. Yet, the coefficient in the theoretical model does not point in one specific direction.

4 The Data

The empirical analysis was performed with firm-level data stemming from the corporate balance sheet database of the Deutsche Bundesbank. It constitutes the largest source of accounting data for non-financial enterprises in Germany. An extensive description is provided by Deutsche Bundesbank (1998) or Stoess (2001). The dataset is based on the financial statements that enterprises submitted to the German central bank in connection with bill-based rediscount and lending operations. With the beginning of the Euopean Monetary Union in the year 1999, the Bundesbank discontinued its rediscount lending operations which is the reason for the year 1998 being the last year of the covered period. Due to accounting regulatory changes in German corporate law in line with the harmonization of national requirements to financial statements in the mid 1980's, the use of data prior to the year 1987 is not possible for reasons of comparability. Thus, a period of 12 years ranging from 1987 to 1998 is available for the present investigation. Since the coverage of the Eastern part of Germany being rather unsatisfactory, and no data being available for the years prior to the German unifica-

[32] Bond-Meghir (1994), 208.

tion, the analysis will be restricted to enterprises having their principle office in the Western part of Germany.

The balance sheet statistic includes between 50000 and 70000 enterprises for each year most of which are part of the industrial sector or the sectors of construction and commerce. After balancing as well as controlling for outliers and plausibility, 6238 enterprises remain in the dataset.[33] Note that enterprises that do not make it into this sample may have ended or interrupted their participation in bill transactions for different reasons. Hence, no information about bankruptcies is available. Yet, the chance of leaving the sample of reporting enterprises is considerably higher for small and medium-sized enterprises which causes a potential survivor bias in favor of larger firms. Nevertheless, the firms included in the dataset are only to a small extent large incorporated or even stock quoted firms as in many other investigations. More than 80 % of the included enterprises are small and medium-sized enterprises with an annual turnover less than 100 Mill. DM, and more than half of the dataset consists of unincorporated enterprises, as can be seen in table 1.

Table 1:
Turnover Size Classes

Class	Turnover	Firms	%	Inc.	%	Uninc.	%
SE	less than 10 Mill. DM	1154	*18.5*	474	*16.3*	680	*20.4*
ME	10 - 100 Mill. DM	3873	*62.1*	1761	*60.6*	2112	*63.4*
LE	100 Mill. DM and more	1211	*19.4*	671	*23.1*	540	*16.2*
ALL	All enteprises	6238	*100.0*	2906	*100.0*	3332	*100.0*

In order to classify the included firms, the size of these firms measured by their turnover will be employed as the main classification criterion.[34] Yet, the method of classification is subject to a broad discussion. This debate is reflected in the wide variety of classification methods that are used in empirical investigations.[35] Without doubt, since all these criteria divide the

[33] In order to control for outliers, the upper and lower 1 % tail of the investment-capital ratio, I_t^i/K_t^i, the cash flow-capital ratio, CF_t^i/K_t^i, and the sales-capital ratio, Y_t^i/K_t^i, were discarded, as well as enterprises with implausible observations. Missing values have been deleted in advance.

[34] The number of employees is not considered to be a completely reliable information in the present case, since it is an optional declaration for the firms undertaking rediscount operations and thus may be subject to misrepresentations.

[35] The classification criteria range from the age and the size of the firms measured by their turnover, total assets, or number of employees, to their debt-to-assets-ratios, coverage ratios, dividend payouts, bond ratings, and ownership structure.

sample a priori into different subgroups of enterprises, they all may be subject to the criticism put forward by Kaplan-Zingales (1997).

In the present case, the size of the firm is regarded to be a qualified approximation for the degree of financial risks the firms are exposed to, apart from the fact that this is the most commonly used classification if economic problems are adressed in the context of different groups of enterprises. The descriptive analysis will reveal that the risk position of the included enterprises decreases with the size of the firm. Additionally, as derived before, bankruptcies rise with decreasing firm size, as can be seen in table 2 which presents the number of German enterprises that declared bankrupt in the year 2002. It is obvious that smaller enterprises, measured either by the number of employees or the level of outstanding debt, account for a disproportionate share of insolvencies in Germany.[36]

Table 2:
Insolvencies in Germany (2002)

Level of debt	Firms	%	Employees	Firms	%
< 50000 Euro	7562	*20.1*	no employees	12935	*34.4*
50000 - 250000 Euro	14307	*38.1*	1 employee	4182	*11.1*
250000 - 500000 Euro	5838	*15.5*	2 - 5 employees	6481	*17.2*
500000 - 1 Mill. Euro	3958	*10.5*	6 - 10 employees	2806	*7.5*
1 Mill. - 5 Mill. Euro	3935	*10.5*	11 - 100 employees	4237	*11.3*
> 5 Mill. Euro	1057	*2.8*	> 100 employees	373	*1.0*
unknown	922	*2.5*	unknown	6565	*17.5*

Source: Federal Statistical Office of Germany.

Table 3 presents the summary statistics of the ratios that will be employed in the estimation of the investment function as well as selected indicators for the risk position of the incliuded enterprises.[37] Note that the median values of the variables are all well below their means which indicates that the distributions of the variables are skewed, with the longer tail for larger values. Groessl-Stahlecker-Wohlers (2001) as well as Kirchesch-Sommer-Stahlecker

[36] In the course of the empirical analysis, other classification criteria were applied to confirm the obtained results. These criteria included the level of total assets as another measure for firm size, as well as the debt-to-assets ratio and the bankruptcy probabilities as measures for the firms' financial strength. Since the different measures of firm size did not yield significantly different results, which also holds true for the classification according to the firms' financial risk position, the presentation of the empirical results from estimating the investment function will be restricted to the turnover size classes.

[37] The variables that will be employed in the course of the present analysis will be described in detail in appendix B.

(2001) find out that the risk position of small and medium-sized enterprises has undergone a significant deterioration during the observation period, with unincorporated enterprises being concerned even more severe. While all firms shifted their assets from non-financial towards financial assets, the latter enterprises faced a significant reduction of their own funds and an increase in their borrowed funds ratio. Additionally, the whole group of small and medium-sized enterprises expanded its long-run debt, and unincorporated enterprises even increased their short-run debt, while nearly all groups relied to a greater extent on bank loans. Splitting the mean and median values of these variables according to the different turnover size classes shows that these size classes prove to be rather homogenous. The main point of difference is certainly the borrowing behavior of enterprises. With decreasing size, firms depend to a rising extent on external funds which holds true for short-run and long-run liabilities as well as bank liabilities.

Since the empirical investment equation contains the financial risk of enterprises in terms of their default probability, the rather arbitrary inclusion of selected single indicators is not sufficient to describe the financial situation of the enterprises comprehensively. The most widely-used measures of bankruptcy probability will serve as the measure for these financial risks, namely the Z-score of Altman (1968) and the O-score of Ohlson (1980). As Dichev notes, these models are likely to complement each other, since they are derived in different time periods, using different samples, variables, and methods.[38] Concerning the latter, these models employ the multivariate discriminant analysis in case of the Z-score and the logit analysis in case of the O-score.

The final discriminant function that is employed to calculates Altman's Z-score contains five financial ratios and takes the following form:[39]

$$\begin{aligned} Z_t^i(Altman) = {} & 1.2WCTA_t^i + 1.4RETA_t^i + 3.3EBITTA_t^i + \\ & + 0.6EQTL_t^i + 0.99YTA_t^i, \end{aligned} \tag{27}$$

Appendix B gives a brief description of the included variables. The variable $WCTA_t^i$ serves as a measure for the firm's liquidity, while $RETA_t^i$ can be regarded as a measure for leverage. According to Altman, $EBITTA_t^i$ serves as a measure of the true productivity of the enterprise's assets. Additionally, $EQTL_t^i$ can be considered as the second part of the bankruptcy condition described in the theoretical model, and YTA_t^i serves as a measure of productivity. Begley-Ming-Watts (1996) re-estimate the model of Altman with more recent data and obtain

[38]See Dichev (1998), 1133.
[39]See Altman (1980), 594.

Table 3:
Summary Statistics

Variable	Code	Mean	Std.Dev.	0.25	Median	0.75	Obs.
Investment capital ratio	IK	0.26	0.17	0.12	0.22	0.36	68618
Output capital ratio	YK	15.50	24.68	4.50	7.95	16.92	74856
Labor cost capital ratio	LCK	2.56	3.16	0.95	1.64	2.97	74856
Cash flow capital ratio	CFK	0.37	0.79	0.03	0.17	0.46	68618
Debt capital ratio	BK	4.12	7.26	1.35	2.27	4.41	74856
Entr. Profits to capital ratio	DK	0.09	1.05	-0.16	0.07	0.32	74856
Non financial assets ratio	NFATA	0.60	0.18	0.48	0.61	0.73	74856
Financial assets ratio	FINTA	0.40	0.18	0.27	0.38	0.51	74856
Own funds ratio	OFTA	0.16	0.19	0.06	0.13	0.25	74856
Borrowed funds ratio	BFTA	0.84	0.19	0.75	0.87	0.94	74856
Total liabilities ratio	TLTA	0.69	0.26	0.54	0.72	0.86	74856
Current liabilities ratio	CLTA	0.48	0.24	0.29	0.47	0.64	74856
Long-term liabilities ratio	LLTA	0.21	0.20	0.04	0.17	0.33	74856
Total bank liabilities ratio	BTLTA	0.26	0.22	0.07	0.22	0.41	74856
Current bank liabilities ratio	BCLTA	0.14	0.16	0.01	0.08	0.21	74856
Long-term bank liabilities rati	BLLTA	0.12	0.15	0.00	0.07	0.20	74856
Debt coverage ratio	CFTL	0.16	0.55	0.01	0.07	0.19	68618
Short-term debt coverage rat	CFCL	0.27	0.84	0.02	0.10	0.30	68618
Long-term debt coverage rat	CFLL	0.99	5.44	0.00	0.15	0.54	68618
Interest coverage ratio	I_COV	8.69	43.88	0.21	1.48	4.84	68618
Wage coverage ratio	W_COV	0.19	1.62	0.02	0.11	0.26	68618
Tax coverage ratio	T_COV	3.52	52.39	0.07	2.28	5.68	68618
Interest rate	i	0.05	0.5	0.03	0.05	0.06	74856

the following discriminant coefficients:

$$Z_t^i(Begley) = 10.40WCTA_t^i + 1.01RETA_t^i + 10.60EBITTA_t^i + \\ + 0.30EQTL_t^i + 0.17YTA_t^i. \tag{28}$$

The O-score model of Ohlson (1980) was derived in order to overcome the restrictive assumptions and the resulting problems of the multivariate discriminant analysis by applying the conditional logit analysis, and to obtain a measure with more intuitive appeal than the Z-score. The derived probability function is defined as follows:[40]

[40]See Ohlson (1980), 121.

$$O = P(default) = \frac{1}{1 + e^{-y_t^i}}, \tag{29}$$

where y_t^i is given by:

$$\begin{aligned} y_{it} = &-1.32 - 0.407SIZE_t^i + 6.03TLTA_t^i - 1.43WCTA_t^i + \\ &+ 0.0757CLCA_t^i - 2.37NITA_t^i - 1.83CFTL_t^i + \\ &+ 0.285INTWO_t^i - 1.72OENEG_t^i - 0.521CHIN_t^i. \end{aligned} \tag{30}$$

Again, the O-score model is re-estimated by Begley-Ming-Watts (1996) which yields the following coefficients:

$$\begin{aligned} y_{it} = &-1.249 - 0.211SIZE_t^i + 2.262TLTA_t^i - 3.451WCTA_t^i - \\ &- 0.293CLCA_t^i + 1.080NITA_t^i - 0.838CFTL_t^i + \\ &+ 1.266INTWO_t^i - 0.907OENEG_t^i - 0.960CHIN_t^i. \end{aligned} \tag{31}$$

In order to provide an overview, table 4 presents some overall descriptive statistics for these bankruptcy probabilities that serve as indicators for financial distress, with the 25 %- and the 75 %-quartiles serving as cut-off values for the distinction between financially distressed, indeterminate and financially healthy enterprises.

Table 4:
Summary Statistics for the Bankruptcy Probabilities

Variable	Code	Mean	Std.Dev.	0.25	Median	0.75	Obs.
Z-Score (Altman)	P_Z_ALTMAN	3.40	1.94	2.29	3.10	4.11	74856
Z-Score (Begley)	P_Z_BEGLEY	2.95	3.20	0.89	2.74	4.89	74856
O-Score (Ohlson)	P_O_OHLSON	0.28	0.26	0.50	0.21	0.47	68618
O-Score (Begley)	P_O_BEGLEY	0.11	0.13	0.03	0.07	0.15	68618

Yet, the implementation of bankruptcy prediction models like Altman's Z-score or Ohlson's O-score on recent data may be problematic, as regards the different time periods and different samples. Tests to assess the applicability of these models on datasets other than they were developed with, should include tests concerning the actual error rates of these models with different data, as in the case of Begley-Ming-Watts (1996). Yet, in the Bundesbank dataset, no bankruptcies can be detected. Therefore, the applicability of both bankruptcy prediction models can only be tested by comparing the mean values of the different samples, as put forward by Bhagat-Moyen-Suh (2003), in order to assess whether significant structural breaks occured in the meantime, or whether fundamental differences can be detected between the differnt countries of the datasets. Note that, in the present case, bankruptcy probabilities are employed to describe the enterprises' degree of financial distress rather than their default probability. Hence, the predictive ability with regard to the firm's bankruptcy is not the crucial requirement.

Table 5:
Applicability of the Bankruptcy Probabilities

	Reference Studies								Deutsche Bundesbank Balance Sheet Statistic					
Ratio	**Altman (1968)**		**Ohlson (1980)**		**Begley et al. (1996)**		**Bhagat et al. (2003)[1]**		**Turnover Classes**			**O-Score Classes**		
	bankr.	**non-bankr.**	**bankr.**	**non-bankr.**	**bankr.**	**non-bankr.**	**fin. distr.**	**not distr.**	**small**	**me-dium**	**large**	**fin. distr.**	**inde-term.**	**not distr,**
WCTA	-0.061	0.414					0.178	0.321	0.170	0.223	0.276	0.059	0.231	0.400
RETA	-0.626	0.355					-1.110	0.030	0.012	0.041	0.076	-0.012	0.034	0.123
EBITTA	-0.318	0.153					-0.137	0.070	0.094	0.085	0.087	0.051	0.084	0.136
EQTL	0.401	2.477					7.845	5.029	0.228	0.287	0.432	0.070	0.211	0.769
YTA	1.500	1.900					0.619	1.558	2.517	2.617	2.540	2.738	2.634	2.299
SIZE			12.134	13.260	12.210	12.740	11.168	13.201	7.487	9.126	11.380	8.247	9.282	10.390
TLTA			0.905	0.488	0.810	0.500	0.764	0.430	0.808	0.697	0.544	0.914	0.703	0.393
WCTA			0.041	0.310	0.030	0.310	0.156	0.375	0.170	0.223	0.276	0.059	0.231	0.400
CLCA			1.320	0.525	0.781	0.350	1.057	0.418	0.808	0.711	0.645	0.967	0.697	0.466
NITA			-0.208	0.053	-0.170	0.030	-0.222	0.068	0.072	0.060	0.062	0.039	0.061	0.093
CFTL			-0.117	0.281	-0.070	0.250	-0.254	0.342	0.137	0.142	0.225	0.050	0.105	0.391
INTWO			0.390	0.043	0.500	0.110	0.427	0.030	0.051	0.051	0.047	0.075	0.043	0.038
OENEG			0.180	0.004	0.180	0.010	0.092	0.0005	0.132	0.024	0.004	0.131	0.009	0.000
CHIN			-0.322	0.038	-0.340	0.010	-0.256	0.081	-0.007	0.007	0.021	-0.005	0.009	0.016
Firms	33	33	105	2058	165	3300			1154	3873	1211	1712	3051	1475
Period	1946-1965		1970-1976		1980-1989		1979-1996		1987-1998			1987-1998		

[1] Bhagat-Moyen-Suh (2003) only state the sample size of their unbalanced sample. For the estimation of Altman's model, 9123 (27273) observations for (not) financially distressed firms were incuded, for Ohlson's model 4320 (12961).

In order to assess the applicability of the bankruptcy prediction models to the balance sheet data of the Deutsche Bundesbank, table 5 presents the descriptive statistics of the original studies of Altman and Ohlson first. Since the empirical implementation of the investment function will additionally be tested with the re-estimated bankruptcy prediction models of Begley-Ming-Watts, they will also be considered in the table. Unfortunately, they only display the means of the variables that are part of Ohlson's O-score model. The descriptive statistics of Bhagat-Moyen-Suh (2003) complete the reference studies in the table.[41]

[41] Grice-Ingram (2001) and Grice-Dugan (2001) test both the Z-score and the O-score model to assess their generalizability. To keep the table as simple as possible, their results will not be included. Both studies draw the conclusion that these models are more appropriate to predict financial distress than bankruptcies.

On the right hand side of table 5, the mean values of the current sample are presented for the different turnover size classes. Even though the variation between the groups is considerably smaller for the Bundesbank sample, the differnces between the size classes point in the same direction. Consistent with the conclusions of Begley-Ming-Watts and Bhagat-Moyen-Suh, Ohlson's O-score model will be regarded subsequently as an appropriate model to assess the risk of financial distress, since possible structural changes that could distort the prediction of financial distress for the dataset of the Bundesbank cannot be detected. The generalizability of Altman's Z-score turns out to be more problematic, since the variable means of the current dataset partly differ fundamentally from the original data of the Altman study. In addition, the variation between the size classes is very low. Therefore, in line with the Bhagat-Moyen-Suh findings, caution is indicated for the prediction even of financial distress if the Z-score is used.[42]

5 Empirical Results

In this chapter, the above derived model of investment behaviour will be estimated using the balance sheet statistic of the Deutsche Bundesbank. The included enterprises will be classified according to their size measured by their turnover. Additionally, the sample is split according to the legal form of the enterprises. The investment function takes the form of a linear fixed effects model, with the transformed investment-to-capital ratio as dependent variable and the above described ratios as regressors, as captured by equation (26). Prices are, as discussed earlier, not explicitly included in the investment equation, since they do not display any cross-sectional variation. This also holds true for macroeconomic variables such as the sectoral capacity utilization. In order to capture the influence of these determinants, time dummies are included in the regression equation.

The investment equation will be estimated using Ordinary Least Square (OLS), Fixed Effects (FE) respective Within Group (WITHIN), and Generalized Method of Moments (GMM) as developed by Arellano-Bond (1991). The OLS level estimator is known to be upward biased, since it does not control for the possibility of unobserved firm-specific effects, while the WITHIN estimator may produce rather downward biased paramter values in finite samples. Consequently, the GMM estimator will serve as some sort of compromise between these two approaches. Yet, in case of weak instruments it may likewise be biased. Hence, the strategy will be to account for all three estimators. Referring to the severe finite sample biases in the presence of weak instruments, Bond (2002) concludes that the comparison of these estimators

[42] It is noteworthy that these results also apply for the tests performed by Grice-Ingram and Grice-Dugan.

may help detecting and avoiding the above mentioned biases.[43]

The reported GMM estimates are two-step estimates. Although the standard errors of two-step GMM estimations are more efficient than the one-step estimators, they tend to be biased downwards in small samples. For reasons of inference, the one-step standard errors that are asymptotically robust to heteroscedasticity of arbitrary form will be reported. Additionally, Wald tests regarding the joint significance of all regressors and the dummy variables are included in terms of their p-values. In case of the OLS and WITHIN estimations, the adjusted R-squared statistic is reported. Instruments that are used for estimation include the undifferenced values of all regressors, lagged two periods and earlier.[44] In order to verify that the error term is not serially correlated beyond first-order correlation, m1 and m2 are included as tests for first- and second-order serial correlation. Additionally, the validity of the included instruments will be tested using the Sargan test of overidentifying restrictions. For all of the validity tests, p-values will be reported in the included tables.

Table C.1 in appendix C shows the estimation results of equation (26) for the different size classes and legal forms with the financial risk position of the included enterprises being measured by Ohlson's O-score. Note that the performance of the GMM regressions in terms of the second-order serial correlation and the Sargan test statistic is rather unsatisfactory for medium-sized and large enterprises, whereas the performance of the OLS and WITHIN estimations can be regarded as satisfactory. Hence, caution is advisable for the valuation of the GMM results in all of the cases, and OLS respective WITHIN estimates will always be taken into account for inference.[45]

Turning to the estimated parameters, the coefficients of the investment ratio, β_1, and the squared investment ratio, β_2, have their expected signs. The values of these coefficients are furthermore reasonable and in line with earlier studies. The higher parameter values of the lagged investment ratio of larger enterprises may be an indicator for the fact that enterprises invest more continuously with rising size, while small firms tend to invest more intermittently. The test statistics concerning the second-order serial correlation may point in the same direc-

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[43] See Bond (2002), 26-27.

[44] Additionally, four lags were added to the investment function in order to capture the dynamics of the investment decision. Including these lags does not change the results significantly, but improves the performance of the regressions. Only the magnitude of the lagged investment ratio and the lagged squared investment ratio increases slightly.

[45] The estimations of medium and large enterprises may suffer from the finite sample bias as a consequence of weak instruments in terms of Blundell-Bond (1998). However, the standard errors of the GMM estimates appear to be not too large, even though they exceed the OLS and WITHIN standard errors. Consequently. if the estimated GMM coefficients turn out to be significant, have the expected signs, and do not diverge fundamentally from both the OLS and the WITHIN estimates, then the results may nevertheless suggest some validity of the derived investment function despite of the rather low performance of the GMM regressions.

tion, as they are lower for larger and incorporated enterprises. In contrast to the theoretical model, but consistent with other studies, β_3 as the coefficient of the output ratio displays positive values for all groups of enterprises, yet insignificant for large unincorporated enterprises. The influence of labor outlays on investment, captured by the coefficient, β_4, match with theory, as all enterprises display positive values which prove to be significant and higher for larger enterprises. This confirms the assumption about large enterprises producing more capital intensive than their smaller counterparts. The difference between smaller and larger firms is even higher for unincorporated enterprises. The GMM estimates appear to overestimate the influence of labor costs, regardless of the size and legal form. Yet, the increase of their influence with the size of the firm can be found in these estimates, too.

As could be expected, and in line with the predictions from the model, the coefficients of the debt-to-capital ratio, β_5, display a negative relation between external finance and investment. Usually, higher parameter values or a higher significance of the debt-to-assets ratio of smaller enterprises are interpreted as indication for informational problems on capital markets being more severe for these firms. Yet, no unambiguous conclusion can be drawn for the debt-to-assets ratio concerning the different size classes. Medium-sized unincorporated enterprises display the closest negative relation between debt and investment, while their incorporated counterparts show the opposite behavior. Large unincorporated enterprises even display positive values of their debt coefficient if estimated with OLS or WITHIN regressions. The second debt term which is composed of the debt-to-capital ratio times the entrepreneurial profits ratio, is a rather technical term stemming from the profit maximization of the firm associated with the bankruptcy probability, and is not easy to interpret. Anyhow, its coefficient, β_6, proves to be very small and furthermore insignificant. The reason for the low performance of this debt indicator is presumably the debt-to-assets ratio which already captures the influence of external funds on the investment decision of the firm.

The remaining coefficient, β_7, belongs to the variable that accounts for the influence of financial risks in terms of the bankruptcy probability. While the model does not provide an unambiguous relation between the bankruptcy probability of an enterprise and its level of investment, one would rather assume this relation to be negative which corresponds to a positive influence of the survival probability on the company's investment. The few existing studies dealing with the link between investment and bankruptcy risk confirm this view.[46] The same holds true for the results obtained with the Bundesbank's balance sheet statistics. Without exception, all size classes display rather high positive correlations between their investment and their financial healthiness in terms of survival probabilities. These correlations

[46] See Frisse-Funke-Lankes (1993) and Wald (2003).

are throughout significant at the 1 % level. According to the theory of asymmetric information and in line with the financial constraints literature, smaller enterprises should exhibit a rather high sensitivity of their investment with regards to their financial risks. This can be observed for incorporated enterprises, while the opposite holds true for unincorporated enterprises. Additionally, the latter surprisingly display lower sensitivities than corporations, even though incorporated enterprises are assumed to have easier access to the capital market than unincorporated firms.

In order to verify whether the obtained results are due to the specific calculation of Ohlson's O-score with the original parameters, Tables C.2-C.4 in appendix C provide estimation results for the same investment function, yet with bankruptcy probabilities calculated with, in order of their appearence, the O-score as calculated by Begley-Ming-Watts, the Z-score of Altman, and the Z-score of Begley-Ming-Watts. The modified calculation of the O-score in table C.2 yields almost the same results as the original O-score, with the parameter values being slightly smaller. Yet, the relation between firm size and the influence of financial risks on the firm's investment decision is more ambiguous in case of the modified O-score. The GMM estimates provide evidence for a decline of this influence with firm size for both incorporated and unincorporated enterprises, while OLS and WITHIN estimates do not point in this direction.

Even though Altman's Z-score is calculated completely different from the O-score, it is evident that its inclusion instead of the O-score does not change the obtained results in a fundamental way, as can be seen in tables C.3 and C.4.[47] Yet, it is not clear whether the influence of financial risks rises with the size of the firm or not. If the Z-score is calculated by the method of Begley-Ming-Watts, this correlation is again decreasing with the size of the firm in case of incorporated enterprises, and rising with firm size in case of their unincorporated counterparts. Note that the estimations were additionaly performed with other classification criteria such as Ohlson's O-score. Yet, the results remain almost unchanged.

6 Conclusion

Financial risks traditionally enter the theoretical models of investment such as the q model or the Euler equation model in the form of financial constraints that enterprises are facing as a consequence of informational asymmetries while deciding on the level of their investment. In this context, financial constraints are unanimously defined as the risk premium that enterprises have to bear in order to raise external funds, or as a limited access to borrowed funds.

[47] Note that, with a rising value being equal to declining financial risks, it is not necessary to transform the Z-score into a survival probability as in the case of the O-score.

Tests for financial constraints are performed by estimating excess sensitivities of investment with regard to financial indicators concerning the enterprises' internal or external funds that are assumed to best approximate these constraints.

However, the impact of financial risks as a whole rather than merely financial constraints has rarely been implemented explicitly in theoretical or empirical investigations dealing with the interaction of the firms' financial sphere with their investment decisions. While financial risks contain the wedge in the costs between internal and external funds and therewith financial constraints, they furthermore account for the possibility of the firm loosing its ability to repay its borrowed funds and thus being subject to potential bankruptcy. Beyond doubt, both kinds of risks point in the same direction. The external finance premium will cause the investment costs to rise directly which lowers the firm's demand for new capital. The probability of bankruptcy lowers expected future profits and thus dampens the enterprises' demand for investment, too.

The inclusion of the bankruptcy probabilities has to take place by weighting the future revenues of the company with the probability of actually earning these revenues, and thus the probability of survival. As a consequence, the resulting specification of the investment function explicitly includes this survival probability as an additional explanatory variable. The advantage of this variable is a rather high degree of freedom for the researcher to understand and to model this survival probability. Whether one may understand this probability in the original sense or in the sense of financial distress, one may employ bankruptcy prediction models to calculate the degree of financial distres the enterprises may face. It is even possible to understand these probabilities as a proxy for financial constraints, since these constraints represent one case of financial risks, namely the case of firms facing higher costs for external finance without being endangered by the risk of bankruptcy.

The empirical analysis performed with the balance sheet data of the Deutsche Bundesbank confirms the position that the survival probabilities as measured by the different bankruptcy prediction models are appropriate to account for the link between the investment and the financial risks of enterprises. As the reuslts show, some groups of enterprises turned out to display a higher sensitivity of their investment with regard to their survival probabilities than others. Thus, apart from the debate about the usefulness of the analysis of single internal or external financial indicators to proxy for financial constraints, the results of both methods undisputedly point in the same direction, independent of whether one tests for financial constraints or financial risks as a whole.

A Mathematical Appendix

The Hamiltonian for the profit maximizing firm which faces an external finance premium and the risk of bankruptcy can be written as

$$\begin{aligned}\mathcal{H}_t^i(L_t^i, I_t^i, K_1^i, B_t^i, \lambda_t^i) = E_t^i\{\beta^t P^i(B_t^i, K_t^i)[(1-\tau)(p_t F(K_t^i, L_t^i) - \\ - w_t L_t^i - p_t G(I_t^i, K_t^i) - r^i(B_t^i, K_t^i)B_t) - p_t^I I_t^i] + \lambda_t^i \left[I_t^i - \delta K_{t-1}^i\right]\}.\end{aligned} \tag{A.1}$$

Since the enterprise has to survive up to time t to calculate the Hamiltonian at time t, the probabilities of survival are equal to 1 for $s = t_0, ..., t-1$. The necessary conditions of the maximum principle for the present problem involve three first order difference equations in the state variables, K_t^i and B_t^i, and the costate variable, λ_t^i, with the latter denoting the shadow price of capital. Besides these necessary conditions, the maximum principle requires the maximization of the Hamiltonian with respect to the control variable, I_t^i, at every point of time. The first order condition of the Hamiltonian with respect to labor, L_t^i, leads to the usual marginal productivity rule for labor:

$$\begin{aligned}\frac{\partial \mathcal{H}_t^i}{\partial L_t^i} &= E_t^i\left\{\beta^t P^i(B_t^i, K_t^i)(1-\tau)\left[p_t F_L(K_t^i, L_t^i) - w_t\right]\right\} = 0 \\ \Longleftrightarrow \quad & F_L(K_t^i, L_t^i) = \frac{w_t}{p_t}.\end{aligned} \tag{A.2}$$

The first order condition for investment, I_t^i, gives:

$$\begin{aligned}\frac{\partial \mathcal{H}_t^i}{\partial I_t^i} &= E_t^i\left\{-\beta^t P^i(B_t^i, K_t^i)\left((1-\tau)p_t G_I(I_t^i, K_t^i) + p_t^I\right)\right\} - E_t^i\left\{\lambda_t^i\right\} \\ \Longleftrightarrow \quad & E_t^i\left\{\beta^t P^i(B_t^i, K_t^i)\left[(1-\tau)p_t G_I(I_t^i, K_t^i) + p_t^I\right]\right\} = E_t^i\left\{\lambda_t^i\right\}.\end{aligned} \tag{A.3}$$

For capital, K_t^i, the necessary condition reads:

$$\frac{\partial \mathcal{H}_t^i}{\partial K_t^i} = -E_t^i\left\{\lambda_{t+1}^i - \lambda_t^i\right\} \tag{A.4}$$

$$\Longleftrightarrow -E_t^i\left\{\lambda_{t+1}^i - \lambda_t^i\right\} = E_t^i\left\{\begin{array}{c}\beta^t P_K^i(B_t^i, K_t^i)D_t^i + \\ +\beta^t P^i(B_t^i, K_t^i)(1-\tau)[p_t F_K(K_t^i, L_t^i) - \\ -p_t G_K(I_t^i, K_t^i) - r_k^i(B_t^i, K_t^i)B_t^i] - \delta\lambda_{t+1}^i\end{array}\right\}$$

$$\Longleftrightarrow E_t^i\left\{\lambda_t^i\right\} = E_t^i\left\{\begin{array}{c}\beta^t P_K^i(B_t^i, K_t^i)D_t^i + \\ +\beta^t P^i(B_t^i, K_t^i)(1-\tau)[p_t F_K(K_t^i, L_t^i) - \\ -p_t G_K(I_t^i, K_t^i) - r_K^i(B_t^i, K_t^i)B_t^i] + (1-\delta)\lambda_{t+1}^i\end{array}\right\}.$$

The necessary condition with respect to debt, B_t^i, is as follows:

$$\frac{\partial \mathcal{H}_t^i}{\partial B_t^i} = E_t^i \left\{ \begin{array}{c} \beta^t P_B^i(B_t^i, K_t^i) D_t^i - \beta^t P^i(B_t^i, K_t^i)(1-\tau) \times \\ \times \left[r_B^i(B_t^i, K_t^i) B_t^i + r^i(B_t^i, K_t^i) \right] \end{array} \right\} = 0 \tag{A.5}$$

$$\iff \quad E_t^i \left\{ \tau \left[r_B^i(B_t^i, K_t^i) B_t^i + r^i(B_t^i, K_t^i) \right] \right\} =$$
$$E_t^i \left\{ P^i(B_t^i, K_t^i) \left[r_B^i(B_t^i, K_t^i) B_t^i + r^i(B_t^i, K_t^i) \right] - P_B^i(B_t^i, K_t^i) D_t^i \right\}.$$

To be complete, the first partial derivative with respect λ_t^i, as well as the necessary transversality condition are

$$E_t^i \left\{ K_t^i - K_{t-1}^i \right\} = E_t^i \left\{ I_t^i + -\delta) K_{t-1}^i \right\}, \tag{A.6}$$

$$E_t^i \left\{ \lambda_T^i \right\} = 0. \tag{A.7}$$

In order to derive the empirical investment equation, the expected shadow price of capital, $E_t^i \left\{ \lambda_t^i \right\}$, from the first order condition with respect to investment, equation (A.3), is substituted into the first order condition for capital, equation (A.4). Rearranging yields the following equation:

$$E_t^i \left\{ P^i(B_t^i, K_t^i) \left[p_t G_I(I_t^i, K_t^i) + \frac{p_t^I}{(1-\tau)} \right] \right\} = \tag{A.8}$$
$$= E_t^i \left\{ \beta P^i(B_{t+1}^i, K_{t+1}^i)(1-\delta) \left[p_{t+1} G_I(I_{t+1}^i, K_{t+1}^i) + \frac{p_{t+1}^I}{(1-\tau)} \right] \right\} +$$
$$+ E_t \left\{ \beta P^i(B_t^i, K_t^i) \left[p_t F_K(K_t^i, L_t^i) - p_t G_K(I_t^i, K_t^i) - r_K^i(B_t^i, K_t^i) B_t^i \right] \right\} +$$
$$+ E_t \left\{ \frac{\beta}{(1-\tau)} P_K^i(B_t^i, K_t^i) D_t^i \right\}.$$

Since $\beta^t = P(B_t, K_t) = 1$ for period t, and the expected values of period t are the realized values, equation (A.8) can be written as follows:

$$p_t G_I(I_t^i, K_t^i) + \frac{p_t^I}{(1-\tau)} = \tag{A.9}$$
$$= E_t \left\{ \beta P^i(B_{t+1}^i, K_{t+1}^i)(1-\delta) \left[p_{t+1} G_I(I_{t+1}^i, K_{t+1}^i) + \frac{p_{t+1}^I}{(1-\tau)} \right] \right\} +$$
$$+ p_t F_K(K_t^i, L_t^i) - p_t G_K(I_t^i, K_t^i) - r_K^i(B_t^i, K_t^i) B_t^i + \frac{1}{(1-\tau)} P_K^i(B_t^i, K_t^i) D_t^i.$$

The first derivatives of the adjustment cost function with respect to new and old capital are

$$G_I(I_t^i, K_t^i) = b\left(\frac{I_t^i}{K_t^i} - a\right), \qquad G_K(I_t^i, K_t^i) = -\frac{b}{2}\left(\frac{I_t^i}{K_t^i}\right)^2 + \frac{b}{2}a^2. \tag{A.10}$$

Additionally, the first derivatives of the interest premium function as well as the survival probablity function read

$$r_B^i(B_t^i, K_t^i) = c\frac{1}{K_t^i}, \qquad r_K^i(B_t^i, K_t^i) = -c\frac{B_t^i}{(K_t^i)^2}, \tag{A.11}$$

and

$$P_B^i(B_t^i, K_t^i) = -d\frac{1}{K_t^i}, \qquad P_K^i(B_t^i, K_t^i) = d\frac{B_t^i}{(K_t^i)^2}. \tag{A.12}$$

Substituting these derivatives into equation (A.9), assuming rational expectations, and denoting the survival probability in period $t+1$ with P_{t+1}^i yields:

$$\begin{aligned} p_t b\left(\frac{I_t^i}{K_t^i} - a\right) + \frac{p_t^I}{(1-\tau)} = \\ = \beta P_{t+1}^i(1-\delta)\left[p_{t+1}b\left(\frac{I_{t+i1}^i}{K_{t+1}^i} - a\right) + \frac{p_{t+1}^I}{(1-\tau)}\right] + p_t\frac{Y_t^i - \frac{w_t}{p_t}L_t^i}{K_t^i} - \\ - p_t\left[-\frac{b}{2}\left(\frac{I_t^i}{K_t^i}\right)^2 + \frac{b}{2}a^2\right] - c\frac{B_t^i}{(K_t^i)^2}B_t^i + \frac{d}{(1-\tau)}\frac{B_t^i}{(K_t^i)^2}D_t^i + \varepsilon_{t+1}^i. \end{aligned} \tag{A.13}$$

This equation can be written after rearranging and dividing by $\beta(1-\delta)bp_{t+1}$:

$$\begin{aligned} P_{t+1}^i\frac{I_{t+1}^i}{K_{t+1}^i} &= \frac{1}{\beta(1-\delta)}\frac{p_t}{p_{t+1}}\frac{I_t^i}{K_t^i} - \frac{1}{2\beta(1-\delta)}\frac{p_t}{p_{t+1}}\left(\frac{I_t^i}{K_t^i}\right)^2 - \\ &- \frac{1}{\beta(1-\delta)b}\frac{p_t}{p_{t+1}}\frac{Y_t^i}{K_t^i} + \frac{1}{\beta(1-\delta)b}\frac{p_t}{p_{t+1}}\frac{w_t L_t^i}{K_t^i} + \\ &+ \frac{c}{\beta(1-\delta)b}\frac{p_t}{p_{t+1}}\frac{1}{p_t}\left(\frac{B_t^i}{K_t^{i2}}\right)^2 - -\frac{d}{(1-\tau)}\frac{1}{\beta(1-\delta)b}\frac{p_t}{p_{t+1}}\frac{1}{p_t}\frac{B_t^i}{(K_t^i)^2}D_t^i + \\ &+ \left(a - \frac{b}{(1-\tau)}\frac{p_{t+1}^I}{p_{t+1}}\right)P_{t+1}^i + +\frac{a^2}{2\beta(1-\delta)}\frac{p_t}{p_{t+1}} - \frac{a}{\beta(1-\delta)}\frac{p_t}{p_{t+1}} + \\ &+ \frac{p_t^I}{b(1-\tau)\beta(1-\delta)p_{t+1}}. \end{aligned} \tag{A.14}$$

Substituting $\phi_{t+1} = \frac{1}{(1-\delta)\beta}\frac{p_t}{p_{t+1}}$ yields the investment equation

$$\begin{aligned} P^i_{t+1}\frac{I^i_{t+1}}{K^i_{t+1}} = {} & \phi_{t+1}\frac{I^i_t}{K^i_t} - \frac{1}{2}\phi_{t+1}\left(\frac{I^i_t}{K^i_t}\right)^2 - \frac{1}{b}\phi_{t+1}\frac{Y^i_t}{K^i_t} + \frac{1}{b}\phi_{t+1}\frac{w_t L^i_t}{K^i_t} + \\ & + \frac{c}{bp_t}\phi_{t+1}\left(\frac{B^i_t}{K^{i2}_t}\right)^2 - \frac{d}{bp_t(1-\tau)}\phi_{t+1}\frac{B^i_t}{K^i_t}\frac{D^i_t}{K^i_t} + \\ & + \left(a - \frac{b}{(1-\tau)}\frac{p^I_{t+1}}{p_{t+1}}\right)P^i_{t+1} + \left(\frac{a^2-2}{2} + \frac{1}{b(1-\tau)}\frac{p^I_t}{p_t}\right)\phi_{t+1}, \end{aligned} \tag{A.15}$$

with the following coefficients:

$$\begin{aligned} &\alpha_0 = \left(\tfrac{a^2}{2} - a + \tfrac{1}{b(1-\tau)}\tfrac{p^I_t}{p_t}\right)\phi_{t+1}, && \alpha_1 = \phi_{t+1}, && \alpha_2 = -\tfrac{1}{2}\phi_{t+1}, \\ &\alpha_3 = -\tfrac{1}{b}\phi_{t+1}, && \alpha_4 = \tfrac{1}{bp_t}\phi_{t+1}, && \alpha_5 = -\tfrac{c}{bp_t}\phi_{t+1}, \\ &\alpha_6 = -\tfrac{d}{bp_t(1-\tau)}\phi_{t+1}, && \alpha_7 = a - \tfrac{1}{b(1-\tau)}\tfrac{p^I_{t+1}}{p_{t+1}}, && \phi_{t+1} = \tfrac{1}{(1-\delta)\beta}\tfrac{p_t}{p_{t+1}}. \end{aligned}$$

B Definition of the Variables

The variables that are included in the empirical analysis are derived from the balance sheets and the profit and loss accounts included in the balance sheet statistic of the Deutsche Bundesbank. Albeit all variables are measured in thousands of Deutsche Mark, the dimension is not of importance, since the empirical analysis will rely on financial ratios composed of these variables.[48]

- The level of the *capital stock*, K, of the included enterprises is defined as the level of gross tangible fixed assets of firm i in period t. These tangible fixed assets include assets that are used in production longer than one year, comprising land, buildings, machinery, technical plant, as well as furniture and equipment. They include assets under construction and payments made on account of such assets.
- The level of *investment*, I, of an enterprise thus is calculated as additions to the gross tangible fixed assets in one year. Note that both the capital stock and the level of investment are not derived from the detailed schedule of fixed asset movements.
- Output, Y, is the level of turnover achieved by the particular enterprise.
- *Cash flow*, CF, as a measure of the internally generated funds is calculated from the profit for the year plus write-downs and changes in provisions, special reserves and deferred income, less write-ups of tangible fixed assets and changes in prepayments.
- *Total assets*, TA, as the sum of all property owned by the business is calculated as *current assets*, CA, plus *long-term assets*, LA. The former include all property the business ownes for short-term use, and include particularly cash, securities, bank accounts, and business equipment. Besides the tangible fixed assets, long-term assets particularly include intangible assets and financial assets.
- *Non-financial assets*, NFA, encompass tangible fixed assets and inventories, while *financial assets*, FIN, are composed of cash holdings, short- and long-term outstanding accounts, securities, and shareholdings.
- *Own funds*, OF, consist of the firm's equity and reserves, while *borrowed funds*, BF, are composed of short- and long-term liabilities, trade credits, and provisions. Own funds and borrowed funds sum up to *total assets*, TA if deferrals are ignored.

[48] For a detailed description of all variables contained in the Bundesbank's balance sheet statistics, see Deutsche Bundesbank (1999b), 10-14.

- *Total liabilities*, TL, are composed of *current liabilities*, CL, and *long-term liabilities*, LL, The Bundesbank classifies the former by short-run liabilities not exceeding a maturity of one year, including among others trade creditors, liabilities on bills, and payments received on account. Long-term liabilities include debt with a residual maturity of at least one year. The same classification with respect to the maturity holds true for *total bank liabilities*, BTL, which are part of total liabilities and thus consist of current *bank liabilities*, BCL, and *long-term bank liabilities*, BLL.

- *Working capital*, WC, is defined as current assets minus current liabilities and thus includes the accessible resources needed to support the day-to-day operations of an organization.

- Besides wages and salaries, *labor cost*, LC, consit of social security contributions, voluntary social security expenses and transfers to provisions for pensions. *Interest paid*, IC, are made of interest payments as well as discount expenditures, loan and overdraft commissions and write-downs of discounts shown on the asset side. *Taxes*, TC, include among others taxes on income and earnings, corporation taxes and operating taxes.

- *Net income*, NI, is the amount of profit a company realizes after all costs, expenses and taxes have been paid. It is calculated by subtracting business, depreciation, interest and tax costs from revenues. In order to asses the financial performance of companies with high levels of debt and interest expenses, *net income before interest and taxes,* $EBIT$, is often used rather than the net income after interst and taxes.

- *Entrepreneurial profits*, D, are defined as that part of net income that is not used as r*etained earnings*, RE, and thus can be distributed to the owners of the enterprise.

The definitions of the variables that are included in the Z-score model of Altman (1968) are as follows:

Z_t^i	=	Overall index,
$WCTA_t^i$	=	Working Capital / Total assets,
$RETA_t^i$	=	Retained earnings / Total assets,
$EBITTA_t^i$	=	Earnings before interest and taxes / Total assets,
$EQTL_t^i$	=	Market value equity / Book value of total debt,
YTA_t^i	=	Sales / Total assets.

The variables that are included in the O-score model of Ohlson (1980) are defined in the following way:

$SIZE_t^i$	=	Log (Total assets / GNP price level)[49],
$TLTA_t^i$	=	Total liabilities / Total assets,
$WCTA_t^i$	=	Working capital / Total assets,
$CLCA_t^i$	=	Current liabilities / Current assets,
$NITA_t^i$	=	Net income / Total assets,
$CFTL_t^i$	=	Funds provided by operations / Total liabilities,
$INTWO_t^i$	=	1 if net income was negative for the last two years,
	=	0 otherwise,
$OENEG_t^i$	=	1 if total liabilities exceed total assets,
	=	0 otherwise,
$CHIN_t^i$	=	$(NI_t^i - NI_{t-1}^i)/(\lvert NI_t^i\rvert + \lvert NI_{t-1}^i\rvert)$,
		where NI_t^i is net income in the most recent period.

C Tables

Table C.1:
Investment Function with Financial Risks
Bankruptcy Probability: O-Score (Ohlson)

Incorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	**FE**	**GMM**	**OLS**	**FE**	**GMM**	**OLS**	**FE**	**GMM**
IK_{t-1}	0.266***	0.009	0.116	0.487***	0.158***	0.210***	0.734***	0.391***	0.431***
	(0.0278)	(0.0301)	(0.1230)	(0.0168)	(0.0181)	(0.0752)	(0.0294)	(0.0323)	(0.0900)
IK^2_{t-1}	-0.255***	-0.012	-0.140	-0.421***	-0.150***	-0.217***	-0.603***	-0.361***	-0.322***
	(0.0368)	(0.0387)	(0.1569)	(0.0227)	(0.0238)	(0.0960)	(0.0430)	(0.0458)	(0.1257)
YK_{t-1}	0.001***	0.001***	0.001	0.001***	0.001***	0.003***	0.000***	0.002***	0.002**
	(0.0001)	(0.0002)	(0.0009)	(0.0000)	(0.0001)	(0.0006)	(0.0001)	(0.0002)	(0.0012)
LCK_{t-1}	0.006***	0.014***	0.043***	0.009***	0.014***	0.032***	0.015***	0.035***	0.130***
	(0.0006)	(0.0012)	(0.0052)	(0.0003)	(0.0007)	(0.0090)	(0.0009)	(0.0021)	(0.0165)
BK^2_{t-1}	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$BKDK_{t-1}$	-0.000	-0.000	0.000	-0.000***	-0.000	-0.000	-0.000	-0.000	0.001***
	(0.0001)	(0.0001)	(0.0004)	(0.0000)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0004)
P_t	0.273***	0.277***	0.266***	0.265***	0.260***	0.228***	0.235***	0.211***	0.201***
	(0.0060)	(0.0098)	(0.0141)	(0.0040)	(0.0066)	(0.0092)	(0.0114)	(0.0187)	(0.0241)
Wald1	208.05	109.12	34.63	628.08	303.99	51.90	201.05	100.08	44.73
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	8.20	13.07	1.20	46.33	68.06	22.01	23.58	33.81	21.18
p-Value	0.000	0.000	0.306	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.396	0.278		0.348	0.224		0.309	0.200	
m1			0.000			0.000			0.000
m2			0.830			0.006			0.391
Sargan			0.829			0.100			0.018

Unincorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	**FE**	**GMM**	**OLS**	**FE**	**GMM**	**OLS**	**FE**	**GMM**
IK_{t-1}	0.250***	0.029	0.074	0.457***	0.158***	0.326***	0.576***	0.335***	0.304***
	(0.0196)	(0.0210)	(0.0941)	(0.0133)	(0.0144)	(0.0651)	(0.0329)	(0.0352)	(0.1083)
IK^2_{t-1}	-0.252***	-0.035	-0.134	-0.418***	-0.154***	-0.285***	-0.388***	-0.267***	-0.227**
	(0.0286)	(0.0298)	(0.1214)	(0.0198)	(0.0208)	(0.0928)	(0.0470)	(0.0495)	(0.1352)
YK_{t-1}	0.001***	0.003***	0.005***	0.001***	0.003***	0.005***	0.000	-0.000	-0.001
	(0.0001)	(0.0003)	(0.0010)	(0.0001)	(0.0002)	(0.0011)	(0.0001)	(0.0001)	(0.0007)
LCK_{t-1}	0.004***	0.009***	0.014**	0.009***	0.022***	0.076***	0.020***	0.061***	0.177***
	(0.0006)	(0.0014)	(0.0082)	(0.0004)	(0.0011)	(0.0099)	(0.0011)	(0.0027)	(0.0150)
BK^2_{t-1}	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	0.000	0.000	-0.000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$BKDK_{t-1}$	0.000***	0.000	-0.000	0.000***	0.000	-0.000	0.000	0.000	0.000
	(0.0000)	(0.0001)	(0.0002)	(0.0000)	(0.0000)	(0.0001)	(0.0002)	(0.0002)	(0.0007)
P_t	0.219***	0.213***	0.192***	0.236***	0.217***	0.191***	0.273***	0.247***	0.210***
	(0.0041)	(0.0072)	(0.0123)	(0.0029)	(0.0049)	(0.0078)	(0.0093)	(0.0152)	(0.0246)
Wald1	276.44	128.69	35.29	879.56	353.14	50.34	199.85	95.12	43.03
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	9.70	17.23	2.70	46.69	84.84	28.19	17.03	26.53	15.36
p-Value	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.378	0.240		0.384	0.218		0.356	0.228	
m1			0.000			0.000			0.000
m2			0.933			0.924			0.543
Sargan			0.334			0.001			0.271

Notes: $P{\cdot}IK_t$ is the dependent variable. Constants and time dummies are included in the regression, but not reported. Parameter estimates are from the two-step estimation. One-step standard errors are given in parentheses. *** / ** / * denotes significance at the 1% / 5% / 10% level. Wald1 is the Wald test for joint significance of all regressors, Wald2 for all time dummies. m1 and m2 are tests for first- and second-order serial correlation based on residuals from the first-differenced equation. These tests are asymptotically distributed as N(0,1) under the null of no serial correlation. Sargan is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of valid instruments.

Table C.2:
Investment Function with Financial Risks
Bankruptcy Probability: O-Score (Begley)

Incorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	FE	GMM	OLS	FE	GMM	OLS	FE	GMM
IK_{t-1}	0.373***	0.022	0.149*	0.556***	0.170***	0.162***	0.757***	0.398***	0.375***
	(0.0369)	(0.0402)	(0.1071)	(0.0195)	(0.0211)	(0.0640)	(0.0306)	(0.0336)	(0.0772)
IK^2_{t-1}	-0.355***	-0.021	-0.212**	-0.480***	-0.160***	-0.135**	-0.620***	-0.368***	-0.181**
	(0.0489)	(0.0517)	(0.1300)	(0.0263)	(0.0277)	(0.0812)	(0.0447)	(0.0476)	(0.1162)
YK_{t-1}	0.002***	0.002***	0.002**	0.001***	0.002***	0.003***	0.000***	0.002***	0.001*
	(0.0002)	(0.0003)	(0.0011)	(0.0000)	(0.0001)	(0.0007)	(0.0001)	(0.0002)	(0.0012)
LCK_{t-1}	0.008***	0.021***	0.057***	0.010***	0.017***	0.047***	0.015***	0.037***	0.143***
	(0.0007)	(0.0016)	(0.0063)	(0.0004)	(0.0008)	(0.0112)	(0.0009)	(0.0022)	(0.0171)
BK^2_{t-1}	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$BKDK_{t-1}$	0.000	0.000	0.000	-0.000**	0.000	-0.000	-0.000	-0.000	0.001***
	(0.0001)	(0.0002)	(0.0005)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0004)
P_t	0.226***	0.229***	0.225***	0.220***	0.181***	0.200***	0.169***	0.099***	0.170***
	(0.0149)	(0.0197)	(0.0236)	(0.0098)	(0.0128)	(0.0176)	(0.0226)	(0.0294)	(0.0417)
Wald1	93.81	74.81	21.46	417.81	234.85	46.74	185.34	96.11	41.82
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	11.85	18.07	1.29	53.06	75.35	22.50	23.17	34.11	19.07
p-Value	0.000	0.000	0.267	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.227	0.209		0.262	0.182		0.292	0.193	
m1			0.000			0.000			0.000
m2			0.908			0.020			0.173
Sargan			0.911			0.145			0.037

Unincorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	FE	GMM	OLS	FE	GMM	OLS	FE	GMM
IK_{t-1}	0.404***	0.065**	0.058	0.600***	0.199***	0.283***	0.629***	0.348***	0.216***
	(0.0269)	(0.0288)	(0.0899)	(0.0164)	(0.0179)	(0.0534)	(0.0353)	(0.0381)	(0.1151)
IK^2_{t-1}	-0.412***	-0.074*	-0.070	-0.550***	-0.190***	-0.127**	-0.439***	-0.275***	-0.064
	(0.0393)	(0.0407)	(0.1113)	(0.0246)	(0.0258)	(0.0750)	(0.0505)	(0.0535)	(0.1427)
YK_{t-1}	0.002***	0.004***	0.008***	0.001***	0.004***	0.008***	0.000	0.000	-0.000
	(0.0002)	(0.0004)	(0.0014)	(0.0001)	(0.0002)	(0.0013)	(0.0001)	(0.0001)	(0.0009)
LCK_{t-1}	0.007***	0.018***	0.032***	0.011***	0.028***	0.100***	0.022***	0.067***	0.191***
	(0.0008)	(0.0019)	(0.0119)	(0.0005)	(0.0013)	(0.0129)	(0.0012)	(0.0030)	(0.0168)
BK^2_{t-1}	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	0.000	0.000	-0.000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
$BKDK_{t-1}$	0.000***	0.000	-0.000	0.000***	-0.000	-0.000	0.000	-0.000	0.000
	(0.0001)	(0.0001)	(0.0003)	(0.0000)	(0.0000)	(0.0001)	(0.0002)	(0.0002)	(0.0008)
P_t	0.199***	0.158***	0.154***	0.191***	0.116***	0.137***	0.230***	0.151***	0.137***
	(0.0077)	(0.0133)	(0.0171)	(0.0074)	(0.0099)	(0.0144)	(0.0200)	(0.0280)	(0.0431)
Wald1	143.83	90.18	35.31	511.00	242.41	34.51	155.11	82.26	33.82
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	12.86	24.17	2.95	53.64	96.75	27.75	16.97	26.55	15.11
p-Value	0.000	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.240	0.181		0.266	0.161		0.300	0.203	
m1			0.000			0.000			0.000
m2			0.967			0.676			0.498
Sargan			0.020			0.002			0.107

Notes: $P{\cdot}IK_t$ is the dependent variable. Constants and time dummies are included in the regression, but not reported. Parameter estimates are from the two-step estimation. One-step standard errors are given in parentheses. *** / ** / * denotes significance at the 1% / 5% / 10% level. Wald1 is the Wald test for joint significance of all regressors, Wald2 for all time dummies. m1 and m2 are tests for first- and second-order serial correlation based on residuals from the first-differenced equation. These tests are asymptotically distributed as N(0,1) under the null of no serial correlation. Sargan is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of valid instruments.

Table C.3:
Investment Function with Financial Risks
Bankruptcy Probability: Z-Score (Altman)

Incorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	**FE**	**GMM**	**OLS**	**FE**	**GMM**	**OLS**	**FE**	**GMM**
IK_{t-1}	1.204***	-0.035	2.871***	2.083***	0.476***	3.344	2.865***	1.084***	-1.460**
	(0.1501)	(0.1625)	(1.1249)	(0.0938)	(0.0972)	(5.6649)	(0.1387)	(0.1437)	(0.9927)
IK^2_{t-1}	-1.106***	0.059	-3.389***	-1.795***	-0.482***	-4.335*	-2.299***	-0.900***	2.732***
	(0.1989)	(0.2089)	(1.3846)	(0.1266)	(0.1274)	(7.3429)	(0.2021)	(0.2034)	(1.2844)
YK_{t-1}	0.008***	0.012***	0.013***	0.008***	0.014***	0.024***	0.006***	0.016***	0.024***
	(0.0007)	(0.0013)	(0.0062)	(0.0002)	(0.0005)	(0.0100)	(0.0004)	(0.0008)	(0.0074)
LCK_{t-1}	0.023***	0.061***	0.207***	0.026***	0.050***	0.115***	0.063***	0.117***	0.500***
	(0.0030)	(0.0064)	(0.0294)	(0.0018)	(0.0037)	(0.0629)	(0.0040)	(0.0096)	(0.0688)
BK^2_{t-1}	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.001***	-0.001***	-0.001*
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0004)
$BKDK_{t-1}$	-0.000	-0.001	0.001	0.001**	0.001***	0.001	-0.001	-0.000	0.007***
	(0.0006)	(0.0007)	(0.0019)	(0.0002)	(0.0003)	(0.0021)	(0.0005)	(0.0007)	(0.0018)
P_t	0.254***	0.214***	0.200***	0.168***	0.150***	0.119***	0.234***	0.187***	0.112***
	(0.0067)	(0.0117)	(0.0334)	(0.0022)	(0.0039)	(0.1340)	(0.0042)	(0.0086)	(0.0258)
Wald1	221.06	98.23	28.45	927.69	348.89	146.99	573.76	155.44	43.25
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	9.32	14.00	4.03	34.78	56.50	27.28	12.74	24.23	25.53
p-Value	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.411	0.257		0.441	0.248		0.562	0.279	
m1			0.000			0.000			0.000
m2			0.520			0.576			0.642
Sargan			0.629			0.000			0.179

Unincorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	**FE**	**GMM**	**OLS**	**FE**	**GMM**	**OLS**	**FE**	**GMM**
IK_{t-1}	1.374***	0.118	0.309	2.066***	0.583***	0.579	2.031***	0.854***	4.791***
	(0.1242)	(0.1328)	(0.7269)	(0.0671)	(0.0714)	(0.4894)	(0.1694)	(0.1744)	(3.9797)
IK^2_{t-1}	-1.303***	-0.066	-0.411	-1.829***	-0.557***	0.048	-1.028***	-0.412*	-5.285***
	(0.1811)	(0.1880)	(0.8690)	(0.1003)	(0.1031)	(0.6423)	(0.2424)	(0.2449)	(4.9510)
YK_{t-1}	0.012***	0.028***	0.049***	0.009***	0.023***	0.040***	0.003***	0.008***	-0.001
	(0.0008)	(0.0017)	(0.0081)	(0.0004)	(0.0008)	(0.0053)	(0.0003)	(0.0007)	(0.0249)
LCK_{t-1}	0.017***	0.037***	0.071**	0.037***	0.073***	0.285***	0.091***	0.224***	0.688***
	(0.0037)	(0.0090)	(0.0550)	(0.0020)	(0.0053)	(0.0392)	(0.0055)	(0.0136)	(0.2070)
BK^2_{t-1}	-0.000**	-0.000***	-0.000***	-0.000***	-0.001***	-0.001***	-0.000	-0.000	-0.001**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0015)
$BKDK_{t-1}$	0.000	-0.000	0.001	0.001***	0.000	-0.000	0.001	-0.002	0.009
	(0.0003)	(0.0003)	(0.0014)	(0.0002)	(0.0002)	(0.0006)	(0.0009)	(0.0011)	(0.0194)
P_t	0.221***	0.189***	0.142***	0.228***	0.156***	0.103***	0.259***	0.225***	0.115***
	(0.0048)	(0.0084)	(0.0330)	(0.0027)	(0.0049)	(0.0167)	(0.0050)	(0.0093)	(0.1176)
Wald1	312.86	130.20	220.04	1'341.45	386.62	46.24	579.25	129.43	140.93
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	7.06	12.66	3.23	41.15	84.46	33.66	8.26	15.32	14.81
p-Value	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.408	0.242		0.488	0.234		0.616	0.286	
m1			0.000			0.000			0.000
m2			0.969			0.682			0.968
Sargan			0.673			0.092			0.166

Notes: $P{\cdot}IK_t$ is the dependent variable. Constants and time dummies are included in the regression, but not reported. Parameter estimates are from the two-step estimation. One-step standard errors are given in parentheses. *** / ** / * denotes significance at the 1% / 5% / 10% level. Wald1 is the Wald test for joint significance of all regressors, Wald2 for all time dummies. m1 and m2 are tests for first- and second-order serial correlation based on residuals from the first-differenced equation. These tests are asymptotically distributed as N(0,1) under the null of no serial correlation. Sargan is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of valid instruments.

Table C.4:
Investment Function with Financial Risks
Bankruptcy Probability: Z-Score (Begley)

Incorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	FE	GMM	OLS	FE	GMM	OLS	FE	GMM
IK_{t-1}	0.992***	-0.064	1.356	2.037***	0.788***	3.264	2.821***	1.409***	3.889*
	(0.1816)	(0.2018)	(3.1671)	(0.1012)	(0.1052)	(6.8789)	(0.1526)	(0.1605)	(3.7811)
IK^2_{t-1}	-0.954***	0.039	-1.753	-1.753***	-0.810***	-4.221	-2.282***	-1.226***	-4.485*
	(0.2407)	(0.2594)	(3.8936)	(0.1366)	(0.1378)	(8.3718)	(0.2225)	(0.2269)	(4.8786)
YK_{t-1}	0.006***	0.009***	0.020***	0.002***	0.007***	0.009	0.002***	0.006***	-0.001
	(0.0008)	(0.0016)	(0.0116)	(0.0003)	(0.0005)	(0.0069)	(0.0004)	(0.0009)	(0.0072)
LCK_{t-1}	0.030***	0.062***	0.153***	0.048***	0.078***	0.181***	0.082***	0.200***	0.542***
	(0.0037)	(0.0079)	(0.0581)	(0.0019)	(0.0040)	(0.0677)	(0.0046)	(0.0107)	(0.1812)
BK^2_{t-1}	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000*	-0.000***	-0.001***	-0.000
	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0006)
$BKDK_{t-1}$	-0.001	-0.002**	0.000	-0.001**	0.000	0.000	-0.000	0.001	0.002
	(0.0007)	(0.0008)	(0.0032)	(0.0003)	(0.0003)	(0.0026)	(0.0005)	(0.0008)	(0.0053)
P_t	0.273***	0.272***	0.241***	0.255***	0.250***	0.221***	0.245***	0.228***	0.183***
	(0.0035)	(0.0058)	(0.0265)	(0.0018)	(0.0030)	(0.0330)	(0.0025)	(0.0045)	(0.0288)
Wald1	498.81	182.63	39.53	1'815.03	670.84	67.44	877.48	277.00	55.13
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	3.78	5.18	2.40	21.16	33.46	8.56	16.58	24.52	13.97
p-Value	0.000	0.000	0.035	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R²	0.612	0.392		0.607	0.389		0.662	0.408	
m1			0.000			0.000			0.000
m2			0.606			0.328			0.239
Sargan			0.541			0.001			0.086

Unincorporated enterprises

	Small Enterprises			Medium Enterprises			Large Enterprises		
	OLS	FE	GMM	OLS	FE	GMM	OLS	FE	GMM
IK_{t-1}	0.868***	-0.179	-4.955***	1.624***	0.460***	0.908	1.467***	0.999***	2.824
	(0.1684)	(0.1795)	(3.3644)	(0.0810)	(0.0866)	(2.0577)	(0.1812)	(0.1827)	(4.2055)
IK^2_{t-1}	-0.835***	0.356	6.187***	-1.358***	-0.411***	-0.305	-0.272	-0.644**	-3.269
	(0.2459)	(0.2542)	(4.7064)	(0.1210)	(0.1249)	(2.7359)	(0.2592)	(0.2564)	(5.7154)
YK_{t-1}	0.006***	0.020***	0.028***	0.005***	0.013***	0.026***	0.000	-0.001	-0.003
	(0.0010)	(0.0023)	(0.0074)	(0.0004)	(0.0009)	(0.0087)	(0.0003)	(0.0007)	(0.0067)
LCK_{t-1}	0.025***	0.038***	0.086*	0.049***	0.089***	0.303***	0.120***	0.269***	0.618***
	(0.0050)	(0.0122)	(0.0590)	(0.0025)	(0.0064)	(0.0633)	(0.0060)	(0.0143)	(0.2014)
BK^2_{t-1}	-0.000***	-0.000*	-0.000***	-0.000***	-0.001***	-0.001***	-0.000***	-0.000**	-0.001
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0001)	(0.0001)	(0.0011)
$BKDK_{t-1}$	0.000	-0.001**	-0.001	0.001***	0.000	0.002	0.001	0.002	0.009
	(0.0004)	(0.0005)	(0.0017)	(0.0002)	(0.0002)	(0.0015)	(0.0010)	(0.0012)	(0.0123)
P_t	0.222***	0.205***	0.213***	0.243***	0.230***	0.209***	0.276***	0.242***	0.230***
	(0.0026)	(0.0046)	(0.0132)	(0.0014)	(0.0024)	(0.0126)	(0.0027)	(0.0046)	(0.0311)
Wald1	563.26	173.21	1'001.45	2'547.71	801.52	68.14	899.51	250.09	65.08
p-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald2	4.27	7.05	2.07	19.47	36.74	13.31	9.20	16.05	7.59
p-Value	0.000	0.000	0.066	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R²	0.554	0.299		0.644	0.388		0.714	0.436	
m1			0.000			0.000			0.000
m2			0.202			0.991			0.463
Sargan			0.223			0.016			0.047

Notes: $P \cdot IK_t$ is the dependent variable. Constants and time dummies are included in the regression, but not reported. Parameter estimates are from the two-step estimation. One-step standard errors are given in parentheses. *** / ** / * denotes significance at the 1% / 5% / 10% level. Wald1 is the Wald test for joint significance of all regressors, Wald2 for all time dummies. m1 and m2 are tests for first- and second-order serial correlation based on residuals from the first-differenced equation. These tests are asymptotically distributed as N(0,1) under the null of no serial correlation. Sargan is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of valid instruments.

References

[1] Akerlof, George A. (1970): The Market for Lemons: Quality Uncertainty and the Market Mechanism. In: Quarterly Journal of Economics 84, 488-500.

[2] Alessandrini, Fabio (2003): Introducing Capital Structure in a Production Economy: Implications for Investment, Debt and Dividends. Mimeo.

[3] Altman, Edward I. (1968): Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. In: Journal of Finance 23, 589-609.

[4] Arellano, Manuel / Bond, Stephen (1991): Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. In: The Review of Economic Studies 58, 277-297.

[5] Arkin, Vadim / Evstigneev, Igor V. (1987): Stochastic Models of Control and Economic Dynamics. London.

[6] Begley, Joy / Ming, Jin / Watts, Susan G. (1996): Bankruptcy Classification Errors in the 1980s: An Empirical Analysis of Altman and Ohlson's Models. In: Review of Accounting Studies 1, 267-284.

[7] Behr, Andreas / Bellgardt, Egon (2000): Investitionsverhalten unter Liquiditätsrestringiertheit. Eine Sensitivitätsanalyse. In: Jahrbücher für Nationalökonomie und Statistik 220, 257-283.

[8] Bernanke, Ben S. / Gertler, Mark / Gilchrist, Simon (1999): The Financial Accelerator in a Quantitative Business Cycle Framework. In: Taylor, John B. / Woodford, Michael (eds.): Handbook of Macroeconomics, Amsterdam, 1341-1396.

[9] Bertsekas, Dimitri P. / Shreve, Stephen E. (1978): Stochastic Optimal Control: The Discrete Case. New York.

[10] Blundell, Richard / Bond, Stephen (1998): Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. In: Journal of Econometrics 87, 115-143.

[11] Bond, Steven / Meghir, Costas (1994): Dynamic Investment Models and the Firm's Financial Policy. In: Review of Economic Studies 61, 197-222.

[12] Chatelain, Jean-Bernard (1998): Investment Facing Credit Rationing. In: The Manchester School 66 (Supplement), 102-115.

[13] Cleary, Sean (1999): The Relationship between Firm Investment and Financial Status. In: Journal of Finance 54, 673-692.

[14] Deutsche Bundesbank (1998): The Methodological Basis of the Deutsche Bundesbank's Corporate Balance Sheet Statistics. Monthly Report October 1998, 51-67.

[15] Deutsche Bundesbank (1999a): The Bundesbank's Method of Assesing the Creditworthiness of Business Enterprises. Monthly Report January 1999.

[16] Deutsche Bundesbank (1999b): Annual Accounts of West German Enterprises 1971 to 1996. Special Statistical Publication 5.

[17] Dichev, Ilia D. (1998): Is the Risk of Bankruptcy a Systematic Risk? In: Journal of Finance 53, 1131-1147.

[18] Fazzari, Steven M. / Hubbard, R. Glenn / Petersen, Bruce C. (1988): Finance Constraints and Corporate Investment. In: Brookings Papers on Economic Activity 1, 141-206.

[19] Frisse, Kenneth / Funke, Michael / Lankes, Fidelis (1993): An empirical analysis of West German corporate investment decisions using company-level panel data. In: Zeitschrift für Wirtschafts- und Sozialwissenschaften 113, 579-595.

[20] Gertler, Mark (1992): Financial Capacity and Output Fluctuations in an Economy with Multiperiod Financial Relationships. In: Review of Economic Studies 59, 455-472.

[21] Greenwald, Bruce C. / Stiglitz, Joseph E. (1988a): Imperfect Information, Finance Constraints, and Business Fluctuations. In: Kohn, Meir / Tsiang, Sho-chieh (eds.): Financial Constraints, Expectations and Macroeconomics, Oxford, 103-140.

[22] Greenwald, Bruce C. / Stiglitz, Joseph E. (1988b): Money, Imperfect Information, and Economic Fluctuations. In: Kohn, Meir / Tsiang, Sho-chieh (eds.): Financial Constraints, Expectations and Macroeconomics, Oxford, 141-165.

[23] Größl, Ingrid / Hauenschild, Nils / Stahlecker, Peter (2000): Individual and Aggregate Supply Behaviour with Bankruptcy Risks. Beiträge aus dem Institut für Statistik und Ökonometrie der Universität Hamburg Diskussionspapier Nr. 49.

[24] Groessl, Ingrid / Stahlecker, Peter / Wohlers, Eckhard (2001): An Empirical Investigation of German Firms' Financial Structure and Ensuing Risks. In: Jahrbücher für Nationalökonomie und Statistik 221, 491-521.

[25] Hansen, Sten (1999): Agency Costs, Credit Constraints and Corporate Investment. Central Bank of Sweden Working Paper No. 79.

[26] Hansen, Sten / Lindberg, Sara (1997): Agency Costs, Financial Deregulation, and Corporate Investment. An Euler Equation Approach to Panel Data for Swedish Firms. Uppsala University Department of Economics Working Paper Series 1997-20.

[27] Hsiao, Cheng / Tahmiscioglu, A. Kamil (1997): A Panel Analysis of Liquidity Constraints and Firm Investment. In: Journal of the American Statistical Assiciation 92, 455-465.

[28] Hubbard, R. Glenn (1998): Capital-Market Imperfections and Investment. Journal of Economic Literature 36, 193-225.

[29] Janz, Norbert (1997): Ökonometrische Panelanalysen des Investitionsverhaltens deutscher Aktiengesellschaften. Baden-Baden.

[30] Kalkreuth, Ulf von (2001): Monetary Transmission in Germany: New Perspectives on Financial Constraints and Investment Spending. ECB Working Paper No. 109.

[31] Kaplan, Steven N. / Zingales, Luigi: Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints? In: Quarterly Journal of Economics 112, 169-215.

[32] Kirchesch, Kai / Sommer, Marc / Stahlecker, Peter (2001): A Further Empirical Investigation of German Firms' Financial Structure and Ensuing Risks. In: Jahrbücher für Nationalökonomie und Statistik 221, 530-555.

[33] Kirchesch, Kai: The Influence of Financial Risks on the Investment Decision of Enterprises. Baden Baden, forthcoming.

[34] Leith, Campbell (1999): Aggregate Investment, Tobin's Q and Insolvency Risk. University of Exeter Discussion Paper No. 99/11.

[35] Miller, Merton H. (1977): Debt and Taxes. In: Journal of Finance 32, 261-275.

[36] Modigliani, Franco / Miller, Merton H. (1958): The Cost of Capital, Corporate Finance, and the Theory of Investment. In: American Economic Review 48, 261-297.

[37] Myers, Steward C.: The Capital Structure Puzzle. In: Journal of Finance 39, 575-592.

[38] Ohlson, James A. (1980): Financial Ratios and the Probabilistic Prediction of Bankruptcy. In: Journal of Accounting Research 18, 109-131.

[39] Poterba, James M / Summers, Lawrence H.: Dividend Taxes, Corporate Investment and Q. In: Journal of Public Economics 22, 135-167.

[40] Pratap, Sangeeta / Rendón, Silvio (2003): Firm Investment in Imperfect Capital Markets: A Structural Estimation. In: Review of Economic Dynamics 6, 513-545.

[41] Siegfried, Nikolaus A. (2000): Microeconomic Evidence for a German Credit Channel. University of Hamburg Quantitative Macroeconomics Working Paper Series No. 1/2000.

[42] Stoess, Elmar (2001): Deutsche Bundesbank's Corporate Balance Sheet Statistics and Areas of Application. In: Schmollers Jahrbuch: Zeitschrift für Wirtschafts- und Sozialwissenschaften (Journal of Applied Social Science Studies) 121, 131-137.

[43] Summers, Lawrence H. (1981): Taxation and Corporate Investment: A Q-Theory Approach. In: Brookings Papers on Economic Activity 1, 67-127.

[44] Wald, John K. (2003): Adding Bankruptcy to Models of Investment. Mimeo.

[45] Whited, Toni (1992): Debt, Liquidity Constraints and Corporate Investment. In: Journal of Finance 47, 1425-1460.

[46] Whited, Toni / Wu, Guojun (2003): Financial Constraints Risk. Mimeo.

[47] Whittle, Peter (1982): Optimization over Time, Dynamic Programming and Stochastic Control Vol. 1. Chichester.

[48] Williamson, Stephen D. (1987): Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing. In: Quarterly Journal of Economics 102, 135-145.