Further Evidence On The Relationship Between Firm Investment And Financial Status

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Summary

The interpretation of the significant relation between business investment spending and cash flow has been controversial. A large body of research has found that investment/cash flow sensitivities are higher for financially constrained firms. This fundamental result underlying the finance constraints hypothesis has been challenged recently by Kaplan, Zingales, and Cleary. The latter author introduces an important new element to this debate by using discriminant analysis, which allows creditworthy firms to be identified using an objective ex-ante criterion based on dividend payouts. Consistent with the Kaplan and Zingales critique, investment/cash flow sensitivities are lower for financially constrained firms. This short paper documents that the use of discriminant analysis does not necessarily lead to lower sensitivities. Our contrasting results are traceable to the use of the firm's creditworthiness as the discriminating variable and appropriate adjustments for endogenous regressors and serially correlated residuals. We document that the investment/cash flow sensitivity is higher for financially constrained firms.

JEL Codes: G32, E22

Zusammenfassung

Die Interpretation der signifikanten Beziehung zwischen unternehmerischen Investitionsausgaben und dem Cash-Flow ist umstritten. Eine größere Anzahl von Forschungsarbeiten kommt zu dem Ergebnis, dass die Sensitivität der Investitionen bezüglich des Cash-Flow bei finanziell beschränkten Unternehmen höher liegt. Dieses für die Theorie finanzieller Beschränkungen grundlegende Resultat wurde in jüngerer Zeit von Kaplan, Zingales und Cleary in Zweifel gezogen. Der letztgenannte Autor führte ein wichtiges neues Element in die Debatte ein: Finanziell beschränkte Unternehmen werden von ihm mit Hilfe eines diskriminanzanalytischen Verfahrens identifiziert, also eines objektiven ex-ante Kriteriums. Im Einklang mit der Kritik von Kaplan und Zingales findet er bei finanziell beschränkten Unternehmen eine geringere Cash-Flow-Sensitivität. Dieses kurze Papier dokumentiert, dass eine diskriminanzanalytische Vorgehensweise nicht notwendigerweise zu einem derartigen Resultat führt. Unsere abweichenden Ergebnisse basieren einerseits auf der Identifikation finanziell beschränkter Unternehmen auf der Basis ihrer Kreditwürdigkeit, andererseits aber auf der Berücksichtigung endogener Regressoren und seriell korrelierter Residuen bei der Schätzung. Wir zeigen auf, dass die Cash-Flow-Sensitivität der Investitionsausgaben bei finanziell beschränkten Unternehmen höher ist.

JEL Klassifikation: G32, E22

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Introduction

The impact of finance on firm's investment decisions has been a hotly contested research issue for decades. Since the earliest econometric studies by Tinbergen (1939), Klein (1951), and Meyer and Kuh (1957), investment equations have frequently contained liquidity variables, and these regressors have usually been statistically significant. Despite this and other empirical evidence, the framework of Modigliani and Miller (1958) that was prominent through the mid-1980's questioned the role and interpretation of such financial variables. However, over the past 15 years, work on asymmetric information, costly monitoring, and transactions costs have provided a theoretical basis for the role of finance constraints.[1]

A flurry of empirical work has followed on these theoretical developments. In an important paper, Fazzari, Hubbard, and Petersen (FHP, 1988) assess the finance constraints hypothesis in terms of an investment equation that relates investment opportunities ($X_{i,t}$) and an indicator of finance constraints ($LIQ_{i,t}$) in the following equation,[2]

$$I_{i,t}/K_{i,t-1} = F[X_{i,t}] + G[LIQ_{i,t}] + u_{i,t}, \qquad (1)$$

where $I_{i,t}/K_{i,t-1}$ is the investment/capital ratio for firm i at time t, F[.] and G[.] are functions increasing in their arguments, and $u_{i,t}$ is a stochastic error term. FHP measure $X_{i,t}$ by the Brainard-Tobin's Q ($Q_{i,t}$) and $LIQ_{i,t}$ by the ratio of cash flow to the capital stock ($CF_{i,t}/K_{i,t-1}$), and estimate the following model,

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* We gratefully acknowledge the comments of Heinz Herrmann, and the invaluable contribution of Fred Ramb with respect to the construction of our user cost variable. The views expressed in this paper do not necessarily reflect those of the Deutsche Bundesbank or CESifo. All errors, omissions, and conclusions remain the sole responsibility of the authors. Contact: Robert S. Chirinko, Emory University and CESifo, Department of Economics, Emory University, 1602 Mizell Drive, Atlanta, Georgia 30322-2240 USA, PH: 1-404-727-6645, FX: 1-404-727-4639, EM: rchirin@emory.edu; Ulf von Kalckreuth: Deutsche Bundesbank, Economic Research Centre, P.O. Box 100602, Wilhelm-Epstein Strasse 14, D-60006 Frankfurt, Germany, PH: 49-69-9566-2217, FX: 49-69-9566-4317, EM: ulf.von-kalckreuth@bundesbank.de.

1 See the reviews of the finance constraint literature by Gertler (1988), Schiantarelli (1995), and Hubbard (1998).

2 See, for example, FHP (1988, equation 3) and Cleary (1999, equation 1).

$$I_{i,t}/K_{i,t-1} = \alpha_i + \beta\, Q_{i,t} + \gamma\, CF_{i,t}/K_{i,t-1} + u_{i,t}, \qquad (2)$$

where α_i, β, and γ are estimated coefficients. There is some evidence of serial correlation in the residuals from this specification.[3]

An important innovation in the FHP study was assessing the finance constraints hypothesis in terms of the *pattern* of estimated coefficients across classes of firms. In their paper, firms are sorted by the dividend payout ratio under the hypothesis that firms paying-out a lower percentage of their equity income as dividends must face higher costs for external funds. Thus, the γ for low dividend payout firms should be statistically different from zero and *higher than* the γ for the high dividend payout and presumably unconstrained firms. This approach, which has spawned a huge literature with data from different countries and different sortings, tests the null hypothesis of a financially frictionless firm by the significance of the γ's, and uses their pattern across firms to suggest the alternative of finance constraints.

The FHP paper has been recently criticized in a lively intellectual exchange. Kaplan and Zingales (KZ, 1997) argue that the sorting criterion used by FHP was inappropriate, and misclassified firms' ability to obtain financing. They expand the information for classifying firms by using annual and 10-K reports, public news, and management's discussion of liquidity needs. With their classification, KZ rerun equation (2), and find the opposite result from FHP for investment/cash flow sensitivities – the γ for constrained firms is less than the γ for unconstrained firms. Schiantarelli (1995), Hubbard (1998), and FHP (2000) have offered several arguments against the KZ approach. Chief among these are that some of the additional information used by KZ is highly subjective and that the sample size of constrained firms is too small to support accurate inference. KZ (2000) offer a rejoinder.

Cleary (1999) introduces an important new element into this debate by using discriminant analysis. He defines his reference groups as those firms that either increase or decrease dividend payments. Firms that do not change their dividend payment are excluded. He then computes a discriminant function based on several financial ratios, and uses this function to divide his sample into three mutually exhaustive and exclusive classes – financially constrained, partially financially constrained, and not financially constrained. Cleary has a large sample of 9,219 firm/year observations and, coupled with the use of objective ex-ante

[3] FHP (1988, Table 6) find that lags of $Q_{i,t}$ and $CF_{i,t}/K_{i,t-1}$ are statistically significant. Based on formal tests, Blundell, Bond, Devereux, and Schiantarelli (1992) conclude that their residuals are serially correlated and that lagged dependent and independent variables are important in their Q model.

measures generated by the discriminant function, his study addresses the above two criticisms of the KZ analysis. He estimates equation (2) by OLS, and his coefficient estimates support the KZ finding that investment/cash flow sensitivities are lower for financially constrained firms.

This short paper documents that the use of discriminant analysis does not necessarily lead to the Cleary/Kaplan/Zingales (CKZ) finding; the initial FHP result concerning higher cash flow sensitivity for financially constrained firms holds when these firms are identified by means of a discriminant analysis. The differing results are traceable to three factors. First, we use the firm's creditworthiness in place of dividend payments as the discriminant variable. There is rather broad agreement that variations in firm creditworthiness and the resulting wedge between internal and external finance are the key elements in finance constraints models.[4] We have available unique and confidential data from the Deutsche Bundesbank that allows us to generate a precise indicator of those firms that will face a premium on external finance. We believe that our creditworthiness measure allows for more accurate inferences than is possible with the indirect measures used previously in the literature.[5] Second, since the right-side variables in (1) or (2) are endogenous, obtaining consistent coefficients requires the use of an instrumental variable estimator. Third, serially correlated residuals may adversely affect inferences. We show that, relative to the preferred Generalized Method Of Moments (GMM) estimator that adjusts for endogenous regressors and serially correlated residuals, OLS biases the results toward the CKZ conclusion of lower cash flow sensitivities for financially constrained firms.

In considering our contribution to the finance constraints debate, we believe it is important to emphasize that, relative to Cleary, our OLS coefficient estimates are based on a different specification with different data. We use data on German firms rather than US firms because of the availability of a creditworthiness measure that has been tested and developed over several years. The econometric specification follows from equation (1) but, since we wish to work with a very large sample in order to amplify the creditworthiness distinctions, we need to include firms not listed on stock exchanges. Hence, a Q model is not feasible. Nonetheless, despite these differences, we are able to reproduce the pattern and magnitude of γ's obtained by Cleary with OLS. Our study proceeds as follows. Section I discusses the

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4 For example, FHP (1988, p. 183), KZ (1997, p., 172-173), Bernanke and Gertler (1990, p. 88-89), and Cleary (1999, Abstract).

5 Identifying finance constrained firms by their dividend payout behavior was used in the original FHP study. This classification scheme has been controversial because dividend policy may be associated with factors not directly related to creditworthiness, such as investor taxation (Allen, Bernardo, and Welch, 2000), firm maturity (Grullon, Michaely, and Swaminathan, 2002), or corporate governance (Easterbrook, 1984).

model specification and several econometric issues. We estimate a distributed lag (DL) model that includes current and lagged percentage changes in sales and user cost and the current and lagged cash flow/capital ratio. Section II discusses the unique dataset available for this study, and the discriminant analysis that allows us to sort the data to assess the finance constraints hypothesis. Section III contains our OLS results for the creditworthiness ratio and, like CKZ, we find that investment/cash flow sensitivities are lower for financially constrained firms. However, given the endogeneity of the regressors, these OLS results may be biased, and Section IV presents GMM results for the exact same distributed lag model used in Section III. In this case, the cash flow coefficients for constrained and unconstrained firms are not significantly different. Both the GMM and OLS estimates of this DL model appear to be questionable because serial correlation tests suggest that the econometric specification does not provide a satisfactory representation of the dynamic structure of investment. We thus add lagged dependent variables. In this autoregressive distributed lag (ADL) model, we find a marked improvement in model specification and, as in the initial FHP analysis, that investment/cash flow sensitivities are higher for financially constrained firms. Section V contains conclusions.

I. Estimating Equation

Our econometric equation is similar to the model (equation (1)) used frequently in the literature examining finance constraints, and contains separate terms capturing investment opportunities and financial effects. Investment opportunities are measured by Cleary by the market-to-book ratio, a procedure requiring that all firms are listed on a stock exchange. However, to expand the coverage of firms, our dataset also includes non-listed firms. Investment opportunities are specified using the neoclassical theory of capital accumulation, which excludes financing effects. In this model, the desired capital stock is related to a quantity variable (sales, S) and a price variable (the user cost of capital, UC, discussed in Section II.B). This demand for the stock of capital is translated into a demand for the flow of investment by relating the percentage change in capital (or the investment/capital ratio less depreciation, $I/K - \delta$) to current and lagged percentage changes in S and UC. These lag coefficients represent in an unrestricted manner expectations formation and adjustment frictions. (The model can be further generalized by including lagged dependent variables; this extension will be considered in Section IV.B.) The second element in equation (1) concerns the specification of the liquidity variable. As in many studies, we measure financing effects by the ratio of cash flow to the capital stock (CF/K), and capture fixed firm and time effects with firm-specific (α_i) and time-specific (α_t) intercepts. These considerations give rise to the following distributed lag investment specification (DL(H)) of lag length H:

$$I_{i,t}/K_{i,t-1} = \alpha_i + \alpha_t - \sum_{h=0}^{H} \beta_{uc,h} \Delta logUC_{i,t-h} + \sum_{h=0}^{H} \beta_{s,h} \Delta logS_{i,t-h} + \sum_{h=0}^{H} \gamma_h (CF_{i,t-h} / K_{i,t-1-h}) + u_{i,t} , \qquad (3)$$

where the α's, β's, and γ's are estimated coefficients, $u_{i,t}$ is a stochastic error term, i indexes firms, and t indexes time. The other coefficients do not vary across firms. Equation (3) is derived in Appendix A.[6]

The key test for assessing the importance of finance constraints is whether there exists a *differential effect* of cash flow on investment for constrained firms relative to unconstrained firms. We evaluate this test by estimating jointly a set of coefficients for unconstrained firms and a set of differential coefficients between contrasting classes of firms.[7] For example, consider the coefficient on the contemporaneous cash flow term. In our estimating equation, we replace γ_0 in (3) by $\gamma_0 + \gamma_{\Delta,0} * DFC_i$, where the latter term is an indicator variable equaling one for firms classified as financially constrained and zero for the contrasting class of unconstrained firms. The estimating equation used in this study is as follows,

$$I_{i,t}/K_{i,t-1} = \alpha_i + \alpha_t - \sum_{h=0}^{H} (\beta_{uc,h} + \beta_{\Delta,uc,h}*DFC_i) * \Delta logUC_{i,t-h} + \sum_{h=0}^{H} (\beta_{s,h} + \beta_{\Delta,s,h}*DFC_i) * \Delta logS_{i,t-h} + \sum_{h=0}^{H} (\gamma_h + \gamma_{\Delta,h}*DFC_i) * (CF_{i,t-h} / K_{i,t-1-h}) + u_{i,t} . \qquad (4)$$

This joint approach with the full sample allows us to evaluate in a relatively straightforward manner the differential effect of cash flow in terms of a t-test on the estimated $\gamma_{\Delta,h}$'s. Furthermore, these tests incorporate the covariances among coefficients for constrained and unconstrained firms (e.g., the covariance between γ_0 and $\gamma_{\Delta,0}$). Since our estimating equa-

[6] See Chirinko (1993, Section II) for a survey of the extensive literature related to the development of this model.

[7] A similar approach has been used by Oliner and Rudebusch (1992) and Chirinko and Schaller (1995).

tion contains both current and lagged values of cash flow, the test is based on the sum of the differential coefficients,

$$\eta = \sum_{h=0}^{H} \gamma_{\Delta,h} . \qquad (5)$$

If η is negative and statistically significant, we obtain the CKZ result that financially constrained firms are less sensitive to cash flow. By contrast, a value of η that is positive and statistically significant is consistent with the original FHP finding that financially constrained firms are more sensitive to cash flow.

II. Datasets

A. Creditworthiness Ratio (CWR)

A unique element in this study is the set of creditworthiness ratios (CWR's) generated by the Bundesbank in performing its rediscounting and lending operations. Bills of exchange are issued by nonfinancial firms, and were frequently presented to the Bundesbank by credit institutions.[8] When a bill was presented for discounting, the creditworthiness of the issuing firm, as well as all other firms that have held this bill, needed to be determined. In the case of default, liability for payment of the bill falls on any firm that has held the bill. By law, the Bundesbank could only accept bills backed by three parties known to be creditworthy.

The Bundesbank evaluates firms by undertaking a massive effort at collecting financial statement data (discussed in Section II.C) and computing CWR's (*Gesamtkennzahl*) using discriminant analysis.[9] The two underlying populations are solvent and insolvent firms, where insolvency is indicated by a legal application for bankruptcy. The sample is constructed by first identifying the relatively scarce insolvent firms, and then adding a solvent firm from the same sector. To enhance the statistical properties of the discriminant function, the sample contains an equal number of solvent and insolvent firms. The following information is used to compute the discriminant function: 1) equity/pension provision ratio

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[8] Since the implementation of the Monetary Union on January 1, 1999, the Bundesbank continues to assess creditworthiness in the course of the Eurosystem monetary policy operations, but it no longer rediscounts trade bills.

[9] See Deutsche Bundesbank (1999) for further details about the construction of the CWR's and the credit evaluation process.

(adjusted equity capital and pension provisions as a percentage of total capital employed; 2) return on total capital employed (profit before income taxes and before interest payments as a percentage of total capital employed); 3) return on equity (profit before income taxes as a percentage of adjusted equity income); 4) capital recovery rate (net receipts as a percentage of capital invested); 5) net interest payment ratio (net interest as a percentage of turnover); 6) accounting practice (which affects available valuation methods). The weights assigned to these categories are confidential. These ratios are examined by the Bundesbank's Department of Credit, Foreign Exchange, and Financial Markets for outliers. The original CWR's range between -99.9 and 99.9, and have been transformed for this study to vary between 0 and 1.

The discriminant analysis determines two critical values of the CWR that classifies firms into one of three categories: high degree of creditworthiness (Good), low degree of creditworthiness (Endangered), or indeterminate. The proportion of distressed firms in the data used in the discriminant analysis appears representative, and compares favorably to the percentage of failed firms in the overall economy (Deutsche Bundesbank, 1998; Stoess, 2001).

B. User Cost (UC)

The user cost of capital (UC) measures the price of capital, and is comprised of three components,

$$UC = R * P * T, \qquad (6)$$

where R, P, and T represent rental, price, and tax terms, respectively. The rental term contains two components, the opportunity cost of funds measured by the real long-term interest rate ($r = i - \pi$, the nominal discount rate (i) less the expected rate of inflation (π) in the price of investment goods) and the economic rate of depreciation (δ). The P term is the price of investment goods relative to the price of output. The two key taxes are the rate of income taxation (reflecting both federal and Länder rates, as well as the "solidarity surcharge") and the present value of the stream of current and future tax depreciation deductions. The user cost variable used in this study is much more complicated than this discussion reveals, and these important details are discussed in Appendix B.

C. Financial Statements (UBS)

The Bundesbank's financial statement database (Unternehmensbilanzstatistik, UBS) constitutes the largest source of accounting data for nonfinancial firms in Germany.[10] About 70,000 annual accounts were collected per year on a strictly confidential basis by the Bundesbank's branch offices. These data were initially subjected to a computer check for logical errors and missing data. Approximately 15,000 accounts had to be excluded because they were incomplete, represented consolidated accounts, or were for firms in sectors (e.g., agriculture) for which no meaningful results could be generated owing to the small amount of available data. Additional checks and corrections for errors were undertaken in the Statistical Department at the Bundesbank's Central Office in Frankfurt before finalizing the UBS database.

The dataset used in estimation is smaller for several reasons. We use data only for firms located in the manufacturing sector of West Germany to avoid any issues of comparability between the western and eastern sections of the country. Sole proprietorships and private partnerships are excluded because their tax treatment depends on personal characteristics that are very difficult to quantify. State dominated corporations are also excluded. The dataset is further reduced by missing values, data cleaning, variable construction involving lags, and outlier control.[11] The data extend from 1988 to 1997.[12] We thus have available for our preferred econometric specification containing three lags (equation (4) with H=3) 44,345 datapoints for 6,408 firms. For 1996, these data represent 42% of the total turnover of the West German manufacturing sector and 61% of the total turnover of incorporated firms in all German manufacturing.

D. Summary Statistics

Table 1 contains summary statistics for the variables that will enter the econometric specification; variable definitions are displayed in the table note. In addition, the variable means for the sub-sample defined by CWR are presented in columns 6-8. A noteworthy feature of

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[10] This discussion draws on the Deutsche Bundesbank (1998) and Stoess (2001), which contain more detailed descriptions of the UBS data.

[11] We control for outliers by discarding the upper and lower 1% tails of sales growth, cash flow divided by the capital stock, and the CWR, and the upper 2% tail of the investment capital ratio.

[12] The beginning year of 1988 is chosen because the definitions of many important financial statement variables were changed in 1986 by the directive harmonizing financial statements in the European Union. For many firms, the changes were not instituted in 1987, and the amount of data available in the UBS is unacceptably low in that year.

the UBS dataset is the extensive coverage of small firms. Nearly one-half of the observations in the full sample are for firms with 100 employees or fewer.

III. OLS Estimates

This section presents results with the OLS estimation strategy used by Cleary. Firm fixed-effects are removed by first-differencing.[13] Since the focus of the analysis is on the sensitivity of investment to cash flow, only the cash flow coefficients and standard errors are presented in the tables. (Complete tables of the estimated coefficients are presented in Appendix C.) The first column of Table II contains results for the full sample and, as in virtually all investment equations, cash flows is statistically significant. Our sum of the cash flow coefficients η equals 0.137 with a standard error of 0.013.

The important issue dividing CKZ and FHP is the differential sensitivity of cash flow coefficients. Rather than sorting firms by their predicted dividend payout policy as in Cleary, we form sub-samples with a direct measure of the external finance premium, CWR. Firms are sorted into three categories of creditworthiness – Endangered, Good, and Indeterminate – depending on the state in the year before the investment/capital ratio first enters the regression model as a dependent variable. Our large sample permits us to discard the middle group to in order to sharpen the tests between the Endangered and Good firms.

The CWR split sample results confirm CKZ's findings. Estimates for the Good class of firms and the differential between the Endangered and Good classes are presented in columns 2 and 3 of Table II. The sum of coefficient differences between the Endangered and Good firms is -0.066. This η has a p-value of 0.059. Based on these OLS results, financially constrained firms are less sensitive to cash flow, a result that contradicts the findings of FHP and many other published studies.

Our distributed lag model contains several insignificant coefficients that may affect the reported standard errors and p-values for the estimated coefficient sums. To obtain more precise estimates, we retain only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10. This trimmed specification includes the current and once lagged value of cash flow, the current and twice lagged value of the user cost, and the current and thrice lagged values of sales. These trimmed estimates are presented in columns 4 and 5 of

[13] In Cleary's estimated models, the results are robust to whether firm fixed-effects are removed by mean-differencing or first-differencing (Cleary, fn. 13). We choose the latter method because only a first-difference transformation is appropriate for the GMM estimates to be presented in Section IV.

Table II. For cash flow, the current and once lagged coefficient differences are each negative and statistically significant. Relative to the results in column 3, the key η statistic rises (in absolute value), and has a lower standard error. The null hypothesis of equality between the sum of cash flow coefficient differences has a p-value of 0.000, again confirming the CKZ finding. Interestingly, our η of -0.082 is very similar to the comparable differential of -0.089 reported in Cleary's Table IV.

IV. GMM Estimates

The OLS estimates reported in Table II are subject to two potential problems concerning the error term. First, there is a possible correlation between the error term and the regressors.[14] This endogeneity problem will lead to inconsistent coefficient estimates, and needs to be addressed with an instrumental variables technique. Second, there is some evidence that the residuals are serially correlated. With the First-Difference estimator, white noise errors imply that the residuals for periods t and t-2 will be uncorrelated. We use the Lagrangian Multiplier statistic (LM(2)) proposed by Arellano and Bond (1991) for assessing second-order residual serial correlation. If the model is correctly specified and serially correlated residuals are absent, the p-value for LM(2) should be large. However, as indicated in the bottom row of Table II, serial correlation is evident, and the specification may be suspect. Moreover, serially correlated residuals will make it difficult to find appropriate instruments to correct the endogeneity problem. This section explores the impacts of endogeneity and serial correlation on the estimated coefficients and the inferences about finance constraints.

A. Distributed Lag (DL) Specification

We begin by addressing the issue of endogeneity, but maintain the distributed lag specification (equation 4). The standard approach to addressing endogeneity is to replace OLS with an instrumental variables technique. We use the Generalized Method of Moments (GMM) technique developed by Hansen (1982) and applied to panel data by Arellano and Bond (1991). Apart from controlling for the distorting effects of endogeneity, the GMM estimates also correct for conditional heteroscedasticity. We choose appropriately lagged values of the right-hand variables as instruments: $CF_{i,t-m(t)}/K_{i,t-1-m(t)}$, $\Delta logUC_{i,t-m(t)}$, and $\Delta logS_{i,t-m(t)}$ for $m_t \geq 2$, where m_t is as large as possible given data availability and increases over the sample. A constant and the time dummies are also in the instrument set.

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[14] This problem is addressed by Clearly, FHP, and other authors by using the beginning-of-period value of Q. However, the key cash flow variable is defined over period t, and hence is likely to be endogenous.

GMM estimates are presented in Table III, which has the exact same format as Table II. As with OLS, the full sample results in column 1 indicate that cash flow is statistically significant. However, each GMM cash flow coefficient is lower than its OLS counterpart. This result suggests that the OLS results may be adversely affected by a positive correlation between cash flow and shocks to investment spending, the latter captured in the error term. The important change is that the η's in columns 3 and 5 are now positive. These results imply that investment spending by Endangered firms is more sensitive to cash flow than Good firms. However, the t-statistics are approximately one, and thus there is no statistical grounds for rejecting the hypothesis of equality between the cash flow coefficients for firms sorted by creditworthiness.

The specification of the DL model estimated by GMM is satisfactory in one dimension, but remains unsatisfactory in another. For GMM estimation, Sargan (1958) and Hansen (1982) propose a statistic (SH) for testing overidentifying restrictions. If these restrictions on the instruments are rejected, the p-value for the SH statistic will be small. For the split-sample results, the p-values are in excess of 0.250, and the instruments appear to be valid. However, as in the OLS specification, the p-values for the LM(2) statistics are very close to zero, thus indicating that serial correlation continues to be a problem.

B. Autoregressive Distributed Lag (ADL) Specification

Serially correlated residuals are not uncommon in investment studies (cf. fn. 3), and may reflect misspecified dynamics. In panel models using lagged endogenous regressors as instruments, serially correlated residuals will lead to inconsistent coefficient estimates. In general, coefficients of lagged variables represent in an unrestricted manner expectations formation and adjustment frictions, and including lags of the dependent variable is recommended by the derivation in Appendix A to capture these dynamic effects. The ADL specification follows from equation (4) with the inclusion of an additional sum of lags of the dependent variable – $\Sigma_h (\lambda_h + \lambda_{\Delta,h}*DFC_i) * (I_{i,t-h} / K_{i,t-1-h})$, h=1,...,H. With these additional terms, the η statistic capturing the long-run impact of cash flow on investment equals the formula in equation (5) divided by $(1-\Sigma \lambda_h)$; standard errors for this nonlinear combination of coefficients are computed by the delta method. Lastly, the instrument list now includes lags of the dependent variable.

GMM estimates of the ADL specification are presented in Table IV. The inclusion of lags of the dependent variable eliminates the serial correlation problem, as the p-values for the LM(2) statistics rise sharply. The p-values for the SH statistic continue to exceed conventional levels of significance. The ADL specification has important implications for cash flow sensitivities. As indicated in column 3, η is positive with a p-value of 0.061.[15] When we remove the insignificant coefficients, η does not change, but the standard error declines. The resulting p-value falls to 0.032. Thus, the null hypothesis that the cash flow coefficients are equal for financially constrained and unconstrained firms is rejected, and the original FHP result is confirmed.

V. Summary And Conclusions

That financial factors are related to business fixed investment is not in question. In many investment equations for many different countries, cash flow and other variables representing financial structure are statistically and economically important. However, the interpretation of this significant relation remains controversial. Fazzari, Hubbard, and Petersen (1998) ignited recent interest by introducing an innovative test that assessed the finance constraints hypothesis in terms of the pattern of estimated coefficients across classes of firms. The FHP paper has been the subject of recent criticisms by Kaplan and Zingales (1997) that, in turn, has led to a series of counter-criticisms. Cleary (1999) addresses some of the important concerns that have been raised by using discriminant analysis on a large dataset.

This short paper presents evidence that the use of discriminant analysis does not necessarily lead to the CKZ finding that cash flow sensitivities are lower for financially constrained firms. Rather than using dividend payouts, we are able to base our discriminant analysis directly on the firm's creditworthiness because of unique and confidential rating data at our disposal. Furthermore, we account for the distorting effects on inferences due to endogenous regressors and serially correlated residuals. Consistent with FHP's original conclusion, we find that firms that are financially constrained, as indicated by their creditworthiness, have higher investment/cash flow sensitivities.

Our results confirm the benefits of using discriminant analysis or other formal techniques for generating objective ex-ante measures for classifying financially constrained firms. The econometric evidence presented here demonstrates the sensitivity of economic inferences to econometric specifications. Additional empirical work is needed to pin-down the proper conclusions to be drawn from investment/cash flow correlations.

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[15] This η statistic is appropriate if, as we believe, misspecified dynamics are the source of serial correlation in the residuals. If the serial correlation is due to serial correlation in the error term, then the original formulation of η in equation (5) would be appropriate.

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Table I
Summary Statistics For The Full And Split Samples

	Full Sample					Split By Creditworthiness		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**Mean**	**Std. Dev.**	**25%**	**Median**	**75%**	**Endan-gered**	**Indeter-minate**	**Good**
I_t / K_{t-1}	0.1813	0.220	0.0585	0.1161	0.2157	0.1776	0.1891	0.1806
$\Delta logUC_t$	0.0222	0.0717	-0.0178	0.0094	0.0644	0.0217	0.0228	0.0222
UC_t	0.1587	0.0183	0.1457	0.1572	0.1697	0.1584	0.1579	0.1589
$\Delta logS_t$	0.0206	0.1597	-0.0654	0.0214	0.1068	0.0111	0.0265	0.0218
S_t	173.15	1455.12	9.94	26.13	71.25	51.16	57.98	225.31
CF_t / K_{t-1}	0.2843	0.4941	0.1091	0.1887	0.3308	0.1563	0.2262	0.3267
ΔCWR_t	0.0004	0.0427	-0.0210	0.005	0.0220	-0.0005	-0.0001	0.0007
CWR_t	0.5736	0.0618	0.5355	0.5735	0.6150	0.5147	0.5399	0.5946

Notes To Table I:

The sample contains 44,345 datapoints for 6,408 firms for 1988-1997. The Endangered, Indeterminate, and Good sub-samples contain 18%, 14%, and 68%, respectively, of the total firms in the sample. I_t/K_{t-1} is the investment/capital ratio; UC_t is the user cost of capital; S_t is real sales in millions of Deutschmarks; CF_t/K_{t-1} is the cash flow/capital ratio; CWR_t is the creditworthiness ratio; Δ is the first-difference operator. See Section II and Appendix B for more details about the variables. The sub-sample results in columns 1-3 are sorted by CWR_t: Endangered [Good] represents those datapoints below [above] the lower [higher] critical value of CWR; Indeterminate represents those datapoints between the two critical values.

Table II

OLS Parameter Estimates Of Equation (4)

Dependent Variable: I_t / K_{t-1}

Split Sub-Samples Defined By The Creditworthiness Ratio

Variable	FULL SAMPLE **(1)**	SPLIT SAMPLE Good **(2)**	Differential **(3)**	Good **(4)**	Differential **(5)**
$\mathbf{CF_{i,t}/K_{i,t-1}}$	0.083 (0.006)	0.100 (0.007)	-0.057 (0.014)	0.099 (0.007)	-0.060 (0.014)
$\mathbf{CF_{i,t-1}/K_{i,t-2}}$	0.036 (0.005)	0.038 (0.007)	-0.012 (0.014)	0.036 (0.006)	-0.021 (0.013)
$\mathbf{CF_{i,t-2}/K_{i,t-3}}$	0.014 (0.005)	0.008 (0.006)	0.012 (0.012)		
$\mathbf{CF_{i,t-3}/K_{i,t-4}}$	0.004 (0.004)	0.005 (0.005)	-0.008 (0.010)		
η	0.137 (0.013)	0.151 (0.015)	-0.066 (0.035)	0.135 (0.010)	-0.082 (0.022)
$\mathbf{R^2}$	0.028	0.032		0.031	
LM(2) p-value	0.000	0.000		0.000	

Notes To Table II:

See the note to Table I for variable definitions. Firm-specific (α_i) and time-specific (α_t) intercepts are also included in the regression equation. Standard errors are in parentheses. The estimates in column 1 are for the full sample. The estimates in columns 2 and 3 are sorted by CWR_t: Good represents coefficients for observations above the higher critical value of CWR; Differential represents coefficients for the difference between the coefficients for Endangered and Good firms, where Endangered firms are those below the lower critical value of CWR. Indeterminate observations have been excluded. The estimates in columns 4 and 5 include only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10. η measures the long-run impact of cash flow on investment; see equation (5). LM(2) is the p-value for the Lagrange Multiplier statistic testing for second-order autocorrelation. Section IV contains a further discussion of this statistic. A complete set of estimated coefficients is contained in Appendix C.

Table III
GMM Parameter Estimates Of Equation (4)
Dependent Variable: I_t / K_{t-1}
Split Sub-Samples Defined By The Creditworthiness Ratio

Variable	FULL SAMPLE (1)	SPLIT SAMPLE Good (2)	Differential (3)	Good (4)	Differential (5)
$CF_{i,t}/K_{i,t-t}$	0.073 (0.037)	0.114 (0.041)	0.014 (0.050)	0.107 (0.026)	0.038 (0.039)
$CF_{i,t-1}/K_{i,t-2}$	0.019 (0.014)	-0.000 (0.017)	0.025 (0.022)		
$CF_{i,t-2}/K_{i,t-3}$	0.011 (0.005)	0.005 (0.006)	0.012 (0.010)		
$CF_{i,t-3}/K_{i,t-4}$	0.008 (0.004)	0.006 (0.005)	-0.001 (0.007)		
η	0.110 (0.027)	0.125 (0.031)	0.050 (0.046)	0.107 (0.026)	0.038 (0.039)
SH p-value	0.017	0.252		0.270	
LM(2) p-value	0.000	0.000		0.000	

<u>Notes To Table III:</u>

See the note to Table I for variable definitions. Firm-specific (α_i) and time-specific (α_t) intercepts are also included in the regression equation. Standard errors are in parentheses. The instruments are $CF_{i,t-m(t)}/K_{i,t-1-m(t)}$, $\Delta logUC_{i,t-m(t)}$, and $\Delta logS_{i,t-m(t)}$ for $m_t > 2$, where m_t is as large as possible given data availability and increases over the sample; a constant and α_τ are also in the instrument set. The estimates in column 1 are for the full sample. The estimates in columns 2 and 3 are sorted by CWR_t: Good represents coefficients for observations above the higher critical value of CWR; Differential represents coefficients for the difference between the coefficients for Endangered and Good firms, where Endangered firms are those below the lower critical value of CWR. The estimates in columns 4 and 5 include only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10. η measures the long-run impact of cash flow on investment; see equation (5). SH is the p-value for the Sargan-Hansen statistic testing overidentifying restrictions. LM(2) is the p-value for the Lagrange Multiplier statistic testing for second-order autocorrelation. Sections I and IV contain further discussion of these statistics. A complete set of estimated coefficients is contained in Appendix C.

Table IV
GMM Parameter Estimates Of Equation (4)
Augmented With Lags Of The Dependent Variable
Dependent Variable: I_t / K_{t-1}
Split Sub-Samples Defined By The Creditworthiness Ratio

Variable	**FULL SAMPLE (1)**	**SPLIT SAMPLE** Good **(2)**	Differential **(3)**	Good **(4)**	Differential **(5)**
$\mathbf{CF_{i,t}/K_{i,t-1}}$	0.070 (0.034)	0.071 (0.034)	0.072 (0.045)	0.075 (0.023)	0.079 (0.036)
$\mathbf{CF_{i,t-1}/K_{i,t-2}}$	0.013 (0.014)	0.005 (0.016)	0.013 (0.020)		
$\mathbf{CF_{i,t-2}/K_{i,t-3}}$	0.005 (0.005)	0.005 (0.006)	0.006 (0.010)		
$\mathbf{CF_{i,t-3}/K_{i,t-4}}$	0.005 (0.004)	0.003 (0.005)	-0.010 (0.007)		
η	0.108 (0.029)	0.092 (0.029)	0.090 (0.048)	0.086 (0.026)	0.090 (0.042)
SH p-value	0.075	0.239		0.326	
LM(2) p-value	0.165	0.132		0.042	

Notes To Table IV:

See the note to Table I for variable definitions. Firm-specific (α_i) and time-specific (α_t) intercepts are also included in the regression equation. Standard errors are in parentheses. The instruments are $CF_{i,t-m(t)}/K_{i,t-1-m(t)}$, $\Delta logUC_{i,t-m(t)}$, $\Delta logS_{i,t-m(t)}$, and $I_{i,t-m(t)}/K_{i,t-1-m(t)}$ for $m_t > 2$, where m_t is as large as possible given data availability and increases over the sample; a constant and α_t are also in the instrument set. The estimates in column 1 are for the full sample. The estimates in columns 2 and 3 are sorted by CWR_t: Good represents coefficients for observations above the higher critical value of CWR; Differential represents coefficients for the difference between the coefficients for Endangered and Good firms, where Endangered firms are those below the lower critical value of CWR. Indeterminate observations have been excluded. The estimates in columns 4 and 5 include only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10. η measures the long-run impact of cash flow on investment, and equals the formula in equation (5) divided by $(1-\Sigma\ \lambda_h)$, where the λ_h's are the coefficients on the lags of the dependent variable; standard errors are computed by the delta method. SH is the p-value for the Sargan-Hansen statistic testing overidentifying restrictions. LM(2) is the p-value for the Lagrange Multiplier statistic testing for second-order autocorrelation. Sections I and IV contain further discussion of these statistics. A complete set of estimated coefficients is contained in Appendix C.

Appendix A: Derivations Of The Distributed Lag (DL) And Autoregressive Distributed Lag (ADL) Estimating Equations

This appendix contains a derivation of the DL and ADL estimating equations. The DL is a special case of the ADL with the lags of the dependent variable suppressed. We first derive the ADL equation, and then show how the DL follows with appropriate restrictions on the coefficients.

The ADL takes as its starting point the demand for the desired capital stock,

$$k^*_t = \sigma\, uc^*_t + \xi\, s^*_t, \tag{A-1}$$

where k^*_t is the log of the desired (or long-run) stock of capital, s^*_t is the log of desired output measured by sales, uc^*_t is the log of the long-run user cost, ξ and σ are long-run elasticities representing the technology, and the t subscript indexes time. For expositional simplicity, we do not include firm-specific subscripts in this derivation. Equation (A-1) follows from a CES production function containing capital and any number of additional factors of production. Note that σ is the elasticity of substitution between labor and capital, and is a key parameter in determining the strength of the interest rate channel of monetary policy on capital formation.

The challenge facing the applied econometrician is to translate the above demand for a stock of capital into the demand for the flow of investment. We begin this translation by assuming that investment equals the change in the desired capital stock,

$$\Delta k_t = \Delta k^*_t, \tag{A-2}$$

where Δ is the first difference operator and k_t is the log of the capital stock. Equation (A-2) is not a satisfactory investment equation because it assumes that the actual capital stock adjusts instantaneously to changes in the desired capital stock. Furthermore, k^*_t is unobservable. To derive a useful econometric specification, we introduce dynamics with three assumptions. First, we assume that the adjustment of the actual capital stock (or the investment-capital ratio less depreciation) to its desired level is distributed over time according to the following distributed lag,

$$\Delta k_t = I_t/K_{t-1} - \delta = a(L)\, \Delta k^*_t, \tag{A-3}$$

where a(L) is a polynomial in the lag operator representing technological constraints such as delivery lags and other adjustment frictions.

Second, following Jorgenson (1966), we assume that a(L) can be approximated by a rational lag, b(L)/(1-c(L)), and rewrite (A-3) as follows,

$$I_t/K_{t-1} - \delta = b(L)/(1-c(L))\ \Delta k^*_t, \qquad \text{(A-4)}$$

$$= \alpha + b(L)\ \Delta k^*_t + c(L)\ I_{t-1}/K_{t-2},$$

where $\alpha = \delta\ c(1)$. The b(L)'s, c(L)'s, and α contain technology parameters.

Third, at time t, one can consider the long-run values defining k^*_t in (A-1) as expected values based on current information. We assume that these expectations are determined by the following univariate autoregressions specified as first differences,

$$\Delta uc^*_t = d_{uc}(L)\ \Delta uc_t, \qquad \text{(A-5a)}$$

$$\Delta s^*_t = d_s(L)\ \Delta s_t, \qquad \text{(A-5b)}$$

where the $d_{uc}(L)$'s and $d_s(L)$'s are expectation parameters whose lag lengths need not be equal. Consequently, (A-5) provides a good reason why the length of the distributed lag for user cost and sales variables in our investment equation may not be equal. A disadvantage of (A-5) is that it uses a narrow information set, a point to which we return below.

Combining (A-1)-(A-5) and appending an error term (e_t), we obtain the following investment equation,

$$I_t/K_{t-1} = \alpha + \sigma\ b(L)\ d_{uc}(L)\ \Delta uc_t + \xi\ b(L)\ d_s(L)\ \Delta s_t + c(L)\ I_{t-1}/K_{t-2} + e_t, \qquad \text{(A-6a)}$$

$$I_t/K_{t-1} = \alpha + f_{uc}(L)\ \Delta uc_t + f_s(L)\ \Delta s_t + f_{I/K}(L)\ I_{t-1}/K_{t-2} + e_t, \qquad \text{(A-6b)}$$

where $f_{uc}(L) = \sigma\ b(L)\ d_{uc}(L)$, $f_s(L) = \xi\ b(L)\ d_s(L)$, and $f_{I/K}(L) = c(L)$. The f(L)'s represent estimated coefficients, and are a mixture of technology and expectation parameters.

The long-run impacts of changes in the user cost and sales are assessed with the following transformed set of coefficients,

$$\eta_{uc} = f_{uc}(1) / (1 - f_{I/K}(1)), \qquad \text{(A-7a)}$$

$$\eta_s = f_s(1) / (1 - f_{I/K}(1)). \qquad \text{(A-7b)}$$

These long-run elasticities can have a structural interpretation in terms of the technology parameters – σ and ξ – if we impose the following restrictions,

$$b(1) / (1-c(1)) = 1, \quad \text{(A-8a)}$$

$$d_{uc}(1) = 1, \quad \text{(A-8b)}$$

$$d_s(1) = 1. \quad \text{(A-8c)}$$

Equation (A-8a) implies that all orders for capital goods are ultimately delivered. Equations (A-8b) and (A-8c) imply that expected values ultimately move one-for-one with changes in actual values in the information set. Note that the validity of the η's as long-run elasticities is not dependent on the validity of these assumptions used to identify the structural parameters. However, if we wish to separate technology and expectation parameters and thus, in principle, conduct policy experiments that adhere to the strictures of the Lucas Critique, such identification is essential. The quantitative importance of the Lucas Critique and hence the need to achieve identification has been questioned.

The information set used to form expectations of Δuc^*_t and Δs^*_t can be expanded to include additional variables (z_t's), and (A-5) is can be generalized as follows,

$$\Delta uc^*_t = d_{uc,uc}(L)\, \Delta uc_t + d_{uc,z}(L)\, z_t, \quad \text{(A-5a')}$$

$$\Delta s^*_t = d_{s,s}(L)\, \Delta s_t + d_{s,z}(L)\, z_t. \quad \text{(A-5b')}$$

If the z's are variables already appearing as arguments in the investment equation (i.e., Δuc_t, Δs_t, and I_t/K_{t-1}), then the estimating equation is not altered,

$$I_t/K_{t-1} = \alpha + \{\sigma\, b(L)\, d_{uc,uc}(L) + \xi\, b(L)\, d_{s,uc}(L)\}\Delta uc_t \quad \text{(A-6a')}$$

$$+ \{\xi\, b(L)\, d_{s,s}(L) + \sigma\, b(L)\, d_{uc,,s}(L)\}\, \Delta s_t$$

$$+ \{c(L) + \sigma\, b(L)\, d_{uc,I/K}(L) + \xi\, b(L)\, d_{s,I/K}(L)\}\, I_{t-1}/K_{t-2} + e_t,$$

$$I_t/K_{t-1} = \alpha + \beta_{uc}(L)\, \Delta uc_t + \beta_s(L)\, \Delta s_t + \lambda(L)\, I_{t-1}/K_{t-2} + e_t, \quad \text{(A-6b')}$$

where the $\beta(L)$'s and $\lambda(L)$'s are defined by the terms in braces in (A-6a'). In this case with more a more general information set, identification of the σ and ξ technology parameters becomes more difficult.

The estimating equation recognizes the possibility that cash flow may also enter as an argument to capture short-term credit constraints (i.e., entering

(A-4)) and/or as an element of the information set used to form expectations of Δuc_t and Δs_t (i.e., as another z entering (A-5)). In either case, current and lagged values of cash flow (scaled by the lagged capital stock) enters as additional regressors. Defining the cash flow coefficients – representing short-term credit constraints – as $\gamma(L)$, we obtain the following equation that is the basis for all of the estimates presented in this paper,

$$I_t/K_{t-1} = \alpha + \beta_{uc}(L)\,\Delta uc_t + \beta_s(L)\,\Delta s_t + \gamma(L)\,CF_t/K_{t-1} \qquad \text{(A-7)}$$

$$+ \ \lambda(L)\, I_{t-1}/K_{t-2} \ + \ e_{t.}.$$

The long-run impacts of user cost, sales, and cash flow are defined as follow,

$$\eta_{uc} = \beta_{uc}(1) / (1-\lambda(1)), \qquad \text{(A-8a)}$$

$$\eta_s = \beta_s(1) / (1-\lambda(1)), \qquad \text{(A-8b)}$$

$$\eta_{cf} = \gamma(1) / (1-\lambda(1)), \qquad \text{(A-8c)}$$

where η_{uc} and η_s are elasticities and η_{cf} is a semi-elasticity.

The DL model excludes the effect of lags of the dependent variable on the adjustment of the desired capital stock (A-4) and expectations formation (A-5’). Excluding these effects in the above derivation implies the following coefficient restrictions: C(L) = 0, $d_{uc,I/K} = 0$, and $d_{s,I/K} = 0$. With these restrictions, $\lambda(L) = 0$ in equation (A-7). The only differences between this restricted version of equation (A-7) and equation (4) in the text is the inclusion of time-specific intercepts (α_t) and firm-specific subscripts on α_i and the variables.

Appendix B: The Construction Of User Costs Of Capital For Germany[16]

The Jorgensonian user cost of capital (see Auerbach (1983) for a derivation) is given by the following formula,

$$UC = \frac{p^I}{p} \frac{(1-A)\left(\rho - \pi^I + \delta^e\right)}{(1-\tau)} , \qquad \text{(B-1)}$$

where p is the output price level, p^I is the price of investment goods, A is the present value of depreciation allowances, ρ is the nominal discount rate, π^I is the expected rate of investment goods price inflation, δ^e is the economic depreciation rate, and τ is the basic corporate tax rate (the rate of tax paid if no profits are distributed). The user cost formula usually reflects investment tax credits determined as a percentage of the price of a purchased asset. During our sample period, no such credits were granted to German firms.

Our construction of user costs takes into account multiple assets, multiple sources of funds, and individual taxation following the approach developed by King and Fullerton (1984), extended by the OECD (1991) and Chenells and Griffith (1997), and applied to the German data by Harhoff and Ramb (2001) and Ramb (2003).

If we distinguish as sources of finance between debt finance, new share issues, and retained earnings, the respective discount rates are given by

$$\rho = \begin{cases} i \cdot (1-\tau) & \text{for debt} \\ i/\theta & \text{for new shares} \\ i \cdot \dfrac{1-m}{1-z} & \text{for retained earnings} \end{cases} \qquad \text{(B-2)}$$

In this expression, the variable θ measures the degree of discrimination between retentions and distributions. It is the opportunity costs of retained earnings in terms of gross dividends forgone; θ equals the additional dividend shareholders would receive if one unit of post-corporate tax earnings were distributed. Furthermore, i is the nominal interest rate, m is the

16 The user cost of capital for our sample have been constructed on the basis of the computer routines provided by Fred Ramb, who also allowed us to use his tax and depreciation data. Fred's help was crucial and decisive. As we made several changes, however, we have to bear responsibility for the user costs used in this study.

marginal personal tax rate on capital income, and z is the effective tax rate on accrued capital gains.

Between 1977 and 2000, the system of capital income taxation operating in Germany was a split rate system with full imputation. Shareholders who were residents of the Federal Republic received a tax credit in the amount of the corporation tax on distributed profits paid. Ultimately, the tax on capital income on distributed profits was equal to the marginal tax on capital income. For Germany, therefore, the variable θ assumes the value $1/(1-\tau)$. Furthermore, the effective tax rate on accrued capital gains was zero, as capital gains were not taxed after a holding period of one year or more. In this case, the expression for the discount rate reduces to

$$\rho = \begin{cases} i \cdot (1-\tau) & \text{for debt} \\ i \cdot (1-\tau) & \text{for new shares} \\ i \cdot (1-m) & \text{for retained earnings} \end{cases} \qquad \text{(B-3)}$$

In the system with full imputation that prevailed in Germany from 1977 to 2000, the two types of outside finance are equivalent (Sinn, 1984 and 1987).

To implement this framework and quantify (B-1), we use sector-specific (indexed by j) output price levels ($p_{j,t}$) and depreciation rate ($\delta^{e}_{j,t}$). Depreciation rates are calculated from a perpetual inventory equation for sectoral capital stocks and investment flows; rates for 1995-1997 are imputed. The price of capital goods (p^{I}_{t}) is an economy-wide deflator dated at the beginning of the year, and the expected inflation rate (π^{I}_{t}) measures the rate of growth of p^{I}_{t} between the beginning and the end of year t. $A_{a,t}$ is the present value of depreciation allowances as a firm-specific asset-weighted average for three different types of assets (indexed by a): building, machinery and equipment. In each case, finance-specific discount rates are used. ($A_{a,t}$ is computed with an optimal switch from accelerated to straight-line depreciation methods.) The rate of interest rate (i_t) is the average yield to maturity of domestic listed debt securities. The tax rate on retained earnings is calculated as a compound tax combining three different taxes of profits: the basic corporate tax on retained earnings (τ^{r}_{t}), the local tax (*Gewerbesteuer*, g_t, is deductible for corporate tax purposes), and the "solidarity surcharge" (s_t, which is levied on all corporate and personal tax payments),

$$\tau_t = (1+s_t)\tau_t^r(1-g_t)+g_t, \qquad \text{(B-4)}$$

As in King and Fullerton, we treat local taxes as a normal tax on profits, ignoring some of its special features.[17] As a marginal tax rate for the shareholder, we used the highest marginal income tax $m_t^{\max}$, again inflated by the solidarity surcharge,

$$m_t = (1 + s_t) m_t^{\max} . \qquad \text{(B-5)}$$

To combine the different user costs resulting from the three different sources of finance, we use a flow weights defined for the three sources of finance as follows: debt (with total liabilities including the share of borrowed funds in the reserve subject to future taxation), new shares (the first difference of the stock of subscribed capital augmented by share premium or paid-in surplus), and retained earnings (retained earnings with the earned surplus including the share of own funds in the reserves subject to future taxation). For increases of debt, new shares, or retained earnings, the corresponding weight is calculated as a ratio to the sum of *positive* sources of new finance in that year. If a particular weight assumes a negative value, it is set to zero for that year; in each year, the weights sum to unity. For the first year, the respective stock weights are used.

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[17] Interest payments are only partly deductible, and the Gewerbesteuer payments are not credited to the shareholders on distribution. The latter, strictly speaking, destroys the basic equivalence between sources of outside finance. The Gewerbesteuer is raised at the local level. Due to data limitations, however, we have to confine ourselves to the mean Gewerbesteuer rate for the whole sample.

Appendix C: Complete Tables of the Estimated Coefficients

Table C-II
OLS Parameter Estimates of Equation (4) - Complete Estimates
Dependent Variable: I_t / K_{t-1}
Split Sub-Samples Defined by the Creditworthiness Ratio

Variable	FULL SAMPLE (1)	SPLIT SAMPLE Good (2)	SPLIT SAMPLE Differential (3)	SPLIT SAMPLE Good (4)	SPLIT SAMPLE Differential (5)
$CF_{i,t}/K_{i,t-1}$	0.083 (0.006)	0.100 (0.007)	-0.057 (0.014)	0.099 (0.007)	-0.060 (0.014)
$CF_{i,t-1}/K_{i,t-2}$	0.036 (0.005)	0.038 (0.007)	-0.012 (0.014)	0.036 (0.006)	-0.021 (0.013)
$CF_{i,t-2}/K_{i,t-3}$	0.014 (0.005)	0.008 (0.006)	0.012 (0.012)		
$CF_{i,t-3}/K_{i,t-4}$	0.004 (0.004)	0.005 (0.005)	-0.008 (0.010)		
η_{cf}	0.137 (0.013)	0.151 (0.015)	-0.066 (0.035)	0.135 (0.010)	-0.082 (0.022)
$\Delta logUC_{i,t}$	-0.093 (0.031)	-0.016 (0.029)	-0.071 (0.057)	0.001 (0.026)	-0.062 (0.056)
$\Delta logUC_{i,t-1}$	-0.247 (0.038)	-0.195 (0.029)	0.043 (0.057)	-0.176 (0.026)	0.053 (0.054)
$\Delta logUC_{i,t-2}$	-0.091 (0.037)	-0.085 (0.031)	-0.051 (0.059)	-0.057 (0.023)	-0.013 (0.049)
$\Delta logUC_{i,t-3}$	0.001 (0.028)	-0.028 (0.023)	-0.053 (0.047)		
η_{uc}	-0.430 (0.110)	-0.324 (0.093)	-0.131 (0.170)	-0.232 (0.062)	-0.023 (0.128)
$\Delta logS_{i,t}$	0.080 (0.009)	0.089 (0.012)	-0.005 (0.023)	0.090 (0.012)	-0.002 (0.023)
$\Delta logS_{i,t-1}$	0.063 (0.011)	0.079 (0.014)	–0.021 (0.028)	0.080 (0.014)	-0.015 (0.028)
$\Delta logS_{i,t-2}$	0.039 (0.012)	0.048 (0.014)	–0.000 (0.028)	0.053 (0.014)	0.011 (0.027)
$\Delta logS_{i,t-3}$	0.013 (0.010)	0.016 (0.012)	0.039 (0.023)	0.019 (0.011)	0.039 (0.023)
η_s	0.195 (0.033)	0.233 (0.040)	0.012 (0.081)	0.243 (0.039)	0.034 (0.080)
R^2	0.028	0.032		0.031	
LM(2) p-value	0.000	0.000		0.000	

Notes to Table C-II:

See the note to Table I for variable definitions. Firm-specific (α_i) and time-specific (α_t) intercepts are also included in the regression equation. Standard errors are in parentheses. The estimates in column 1 are for the full sample. The estimates in columns 2 and 3 are sorted by CWR_t: Good represents coefficients for observations above the higher critical value of CWR; Differential represents coefficients for the difference between the coefficients for Endangered and Good firms, where Endangered firms are those below the lower critical value of CWR. Indeterminate observations have been excluded. The estimates in columns 4 and 5 include only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10 (the one exception to this trimming rule is for $\Delta logUC_{i,t}$ which has been included in columns 4 and 5 to preserve the continuity of the distributed lag). η_X measures the long-run impact of X (X={CF/K, ΔlogUC, ΔlogS}) on investment; see equation (5). (Note that the η in Table II is equivalent to the η_{cf} in Table C-II.) LM(2) is the p-value for the Lagrange Multiplier statistic testing for second-order autocorrelation. Section IV contains a further discussion of this statistic.

Table C-III

GMM Parameter Estimates of Equation (4) - Complete Estimates

Dependent Variable: I_t / K_{t-1}

Split Sub-Samples Defined by the Creditworthiness Ratio

Variable	FULL SAMPLE (1)	SPLIT SAMPLE Good (2)	Differential (3)	Good (4)	Differential (5)
$CF_{i,t}/K_{i,t-1}$	0.073 (0.037)	0.114 (0.041)	0.014 (0.050)	0.107 (0.026)	0.038 (0.039)
$CF_{i,t-1}/K_{i,t-2}$	0.019 (0.014)	-0.000 (0.017)	0.025 (0.022)		
$CF_{i,t-2}/K_{i,t-3}$	0.011 (0.005)	0.005 (0.006)	0.012 (0.010)		
$CF_{i,t-3}/K_{i,t-4}$	0.008 (0.004)	0.006 (0.005)	-0.001 (0.007)		
η_{cf}	0.110 (0.027)	0.125 (0.031)	0.050 (0.046)	0.107 (0.026)	0.038 (0.039)
$\Delta logUC_{i,t}$	-0.212 (0.068)	-0.335 (0.081)	0.360 (0.154)	-0.316 (0.079)	0.375 (0.147)
$\Delta logUC_{i,t-1}$	-0.182 (0.039)	-0.221 (0.044)	0.132 (0.093)	-0.187 (0.035)	0.143 (0.073)
$\Delta logUC_{i,t-2}$	-0.034 (0.033)	-0.059 (0.037)	-0.040 (0.081)		
$\Delta logUC_{i,t-3}$	0.023 (0.026)	-0.001 (0.029)	-0.004 (0.062)		
η_{uc}	-0.405 (0.123)	-0.616 (0.141)	0.448 (0.300)	-0.502 (0.099)	0.518 (0.196)
$\Delta logS_{i,t}$	0.156 (0.057)	0.233 (0.069)	-0.215 (0.094)	0.239 (0.066)	-0.245 (0.089)
$\Delta logS_{i,t-1}$	0.113 (0.014)	0.123 (0.018)	-0.065 (0.029)	0.122 (0.018)	-0.068 (0.029)
$\Delta logS_{i,t-2}$	0.079 (0.011)	0.072 (0.014)	-0.034 (0.023)	0.072 (0.014)	-0.036 (0.023)
$\Delta logS_{i,t-3}$	0.041 (0.009)	0.035 (0.011)	0.010 (0.019)	0.037 (0.011)	0.010 (0.019)
η_s	0.388 (0.069)	0.462 (0.081)	-0.303 (0.123)	0.469 (0.078)	-0.339 (0.118)
SH p-value	0.017	0.252		0.270	
LM(2) p-value	0.000	0.000		0.000	

Notes to Table C-III:

See the note to Table I for variable definitions. Firm-specific (α_i) and time-specific (α_t) intercepts are also included in the regression equation. Standard errors are in parentheses. The instruments are $CF_{i,t-m}/K_{i,t-1-m}$, $\Delta logUC_{i,t-m}$, and $\Delta logS_{i,t-m}$ for $m_t > 2$, where m_t is as large as possible given data availability and increases over the sample; a constant and α_t are also in the instrument set. The estimates in column 1 are for the full sample. The estimates in columns 2 and 3 are sorted by CWR_t: Good represents coefficients for observations above the higher critical value of CWR; Differential represents coefficients for the difference between the coefficients for Endangered and Good firms, where Endangered firms are those below the lower critical value of CWR. The estimates in columns 4 and 5 include only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10. η_X measures the long-run impact of X (X={CF/K, ΔlogUC, ΔlogS}) on investment; see equation (5). (Note that the η in Table III is equivalent to the η_{cf} in Table C-III). SH is the p-value for the Sargan-Hansen statistic testing overidentifying restrictions. LM(2) is the p-value for the Lagrange Multiplier statistic testing for second-order autocorrelation. Sections I and IV contain further discussion of these statistics.

Table C-IV
GMM Parameter Estimates Of Equation (4)
Augmented With Lags Of The Dependent Variable - Complete Estimates
Dependent Variable: I_t / K_{t-1}
Split Sub-Samples Defined By The Creditworthiness Ratio

Variable	**FULL SAMPLE**	**SPLIT SAMPLE**			
		Good	Differential	Good	Differential
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
$CF_{i,t}/K_{i,t-1}$	0.070 (0.034)	0.071 (0.034)	0.072 (0.045)	0.075 (0.023)	0.079 (0.036)
$CF_{i,t-1}/K_{i,t-2}$	0.013 (0.014)	0.005 (0.016)	0.013 (0.020)		
$CF_{i,t-2}/K_{i,t-3}$	0.005 (0.005)	0.005 (0.006)	0.006 (0.010)		
$CF_{i,t-3}/K_{i,t-4}$	0.005 (0.004)	0.003 (0.005)	-0.010 (0.007)		
η_{cf}	0.108 (0.029)	0.092 (0.029)	0.090 (0.048)	0.086 (0.026)	0.090 (0.042)
$\Delta logUC_{i,t}$	-0.207 (0.071)	-0.309 (0.082)	0.320 (0.154)	-0.288 (0.079)	0.323 (0.150)
$\Delta logUC_{i,t-1}$	-0.163 (0.038)	-0.193 (0.043)	0.089 (0.090)	-0.171 (0.036)	0.089 (0.073)
$\Delta logUC_{i,t-2}$	-0.014 (0.034)	-0.050 (0.036)	-0.037 (0.081)		
$\Delta logUC_{i,t-3}$	0.038 (0.027)	0.008 (0.030)	0.001 (0.062)		
η_{uc}	-0.401 (0.144)	-0.608 (0.157)	0.418 (0.324)	-0.524 (0.115)	0.470 (0.226)
$\Delta logS_{i,t}$	0.161 (0.055)	0.220 (0.065)	-0.176 (0.088)	0.209 (0.061)	-0.210 (0.082)
$\Delta logS_{i,t-1}$	0.095 (0.014)	0.112 (0.017)	-0.069 (0.028)	0.108 (0.017)	-0.066 (0.028)
$\Delta logS_{i,t-2}$	0.065 (0.011)	0.063 (0.014)	-0.042 (0.023)	0.060 (0.013)	-0.038 (0.022)
$\Delta logS_{i,t-3}$	0.033 (0.010)	0.031 (0.011)	0.000 (0.019)	0.030 (0.011)	-0.003 (0.018)
η_s	0.409 (0.077)	0.478 (0.085)	-0.321 (0.129)	0.466 (0.083)	-0.363 (0.126)

Table C-IV (continued)
GMM Parameter Estimates Of Equation (4)
Augmented With Lags Of The Dependent Variable - Complete Estimates
Dependent Variable: I_t / K_{t-1}
Split Sub-Samples Defined By The Creditworthiness Ratio

Variable	FULL SAMPLE (1)	SPLIT SAMPLE Good (2)	Differential (3)	Good (4)	Differential (5)
$I_{i,t-1}/K_{i,t-2}$	0.131 (0.016)	0.114 (0.017)	-0.010 (0.036)	0.125 (0.015)	-0.006 (0.028)
$I_{i,t-2}/K_{i,t-3}$	-0.002 (0.009)	-0.011 (0.010)	-0.002 (0.019)		
$I_{i,t-3}/K_{i,t-4}$	0.005 (0.007)	0.003 (0.008)	0.007 (0.014)		
$\Sigma_h I_{i,t-j}/K_{i,t-h-1}$	0.135 (0.025)	0.106 (0.027)	-0.006 (0.062)	0.125 (0.015)	-0.006 (0.028)
SH p-value	0.075	0.239		0.326	
LM(2) p-value	0.165	0.132		0.042	

Notes to Table C-IV:

See the note to Table I for variable definitions. Firm-specific (α_i) and time-specific (α_t) intercepts are also included in the regression equation. Standard errors are in parentheses. The instruments are $CF_{i,t-m}/K_{i,t-1-m}$, $\Delta logUC_{i,t-m}$, $\Delta logS_{i,t-m}$, and $I_{i,t-m}/K_{i,t-1-m}$ for $m_t > 2$, where m_t is as large as possible given data availability and increases over the sample; a constant and α_t are also in the instrument set. The estimates in column 1 are for the full sample. The estimates in columns 2 and 3 are sorted by CWR_t: Good represents coefficients for observations above the higher critical value of CWR; Differential represents coefficients for the difference between the coefficients for Endangered and Good firms, where Endangered firms are those below the lower critical value of CWR. Indeterminate observations have been excluded. The estimates in columns 4 and 5 include only those regressors in columns 2 or 3 with t-statistics whose p-values are less than 0.10. η_X measures the long-run impact of X (X={CF/K, ΔlogUC, ΔlogS}) on investment, and equals the formula in equation (5) divided by $(1-\Sigma \lambda_h)$, where the λ_h's are the coefficients on the lags of the dependent variable; standard errors are computed by the delta method. (Note that the η in Table IV is equivalent to the η_{cf} in Table C-IV). SH is the p-value for the Sargan-Hansen statistic testing overidentifying restrictions. LM(2) is the p-value for the Lagrange Multiplier statistic testing for second-order autocorrelation. Sections I and IV contain further discussion of these statistics.

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