Financial Constraints and Investment - Evidence from U.S. Companies

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Abstract

Using data for U.S. companies this study tests if imperfect information and agency problems are present in financial markets and if investment is affected by finance in the ways predicted by pecking-order theory. The traditionally used cash flow ratio is augmented by indicators for the accessibility (or costs) of credit and equity issues. While related studies only test one pecking-order hypotheses this methodology allows to discriminate between multiple theorems derived from the theory. This makes an analysis and evaluation of different individual agency problems possible which are all part of the pecking-order model. A two-step system-GMM estimator is used in a dynamic panel data model. One finding is that agency conflicts associated with issuing debt and new equity impede investment. Access to internal finance and risk free debt have positive effects especially when firms lack investment grade debt ratings. Small firms rely more on equity finance and less on internal cash flow or credit. This is interpreted as evidence for agency problems effecting investment and for structural constraints amplifying these negative effects. On the other hand it turns out that cyclical financial constraints do not effect agency problems systematically. Policy should thus rather focus on structural instead of cyclical constraints when addressing information and agency problems on financial markets to support investment and economic growth. (JEL G31, G32)

Keywords: Investment, information and agency problems, financial constraints, pecking-order theory, panel data, system-GMM

This study estimates investment equations and tests if different financial variables behave as predicted by pecking-order theory. Methodologically it is closely related to work on the cash flow sensitivity of investment while its motivation and results are also relevant for empirical research that tests pecking-order theory with different methodologies.[1]

A panel of 9,022 U.S. companies with 79,356 observations from S&P's Compustat North American Fundamentals data files is analyzed using a system-GMM or Arellano-Bover/Blundell-Bond estimator (Arellano & Bover, 1995; Blundell & Bond, 1998).

[1] An example are studies that follow Shyam-Sunder & Myers (1999) in testing if changes in leverage can be better explained by either financing deficits or by deviations of actual from estimated optimal leverage.

Pecking-order (PO in the following) theory is usually represented in investment equations by cash flow (an indicator for the availability of internal finance) and the prediction of a significant positive coefficient (see Fazzari et al., 1988, and subsequent studies). However, this tests only a single pecking-order hypothesis as the analysis of cash flow in an investment equation can at best just provide evidence on whether external finance sources (debt and equity) have higher agency costs than internal finance or not. It does not even accomplish this properly as significance of cash flow can simply mean that other agency problems, over-investment and empire-building, are indeed positively associated with cash flow as predicted by Jensen (1986). One innovation is to augment the investment equation by adding two additional financial indicators. The first one is the weighted cash commitment for debt servicing as an indicator for the ability to obtain additional risk free credit lines. This allows to test the predictions of the PO model that less risky debt involves lower agency costs and that the ability to issue risk free debt is of similar importance for the realization of investment projects as internal cash flow. The second variable is average Q, which reflects the values of existing assets in place and unrealized future investment opportunities. In agency theory these are major determinants of the agency cost of new equity issues (Myers, 1977). When marginal q is controlled for at the same time one can test the hypothesis that new equity finance involves such agency costs and that they are determined as PO theory predicts. Comparing the significance levels of the three financial variables that capture the agency costs or the availability of internal finance, debt and equity allows to test the prediction of a hierarchy of finance in a different way. The analysis of significance levels and coefficient magnitudes in different subsamples of firms that are likely to be financially constrained in different degrees provides additional insights.

High sensitivities of results and theoretical ambiguities of variables used to identify financially constrained firms are weaknesses that have been criticized most prominently by Kaplan & Zingales (1997). A second innovation is to meet this critique by applying grouping schemes in different ways. Firstly, four different classification schemes are used that are all based on exogeneous variables. This allows to test the sensitivity of results to the use of alternative classification schemes. It makes it also possible to differentiate between "cyclical financial constraints" and the more commonly applied "structural financial constraints" - allowing to investigate if fundamentally different constraints have different effects. Secondly, classification variables are used to not only form binary major groups (constrained, unconstrained) as this is usually done but also to compare the findings to those from narrower groups with multiple degrees of financial constraint. This represents a sensitivity test and allows to analyze the data in an alternative way.

The application of the two-step system-GMM estimator allows to sidestep the severe autocorrelation problems of static investment models, address endogeneity issues and produce an unbiased estimate of a dynamic specification using panel data. While its use is not new it is nevertheless a strength of the study since IV (Anderson & Hsiao, 1981; Almeida et al., 2010) or alternative GMM techniques (Erickson & Whited, 2000, 2002) are more commonly found in research on cash flow sensitivities of investment.

Indicators for the availability of internal credit and equity finance are all found to be significant. The signs and the relative significance levels are as expected by PO theory. With less favorable or a lack of any credit ratings the significance of the indicators for internal and credit finance increases. Internal and credit finance are more important for larger firms while equity is more relevant for smaller ones. Cyclical financial constraints have practically no systematic impact. These findings have several policy implications: 1. overcoming agency costs on financial markets is no argument for cyclical monetary interventions in an economic downturn; 2. policy should instead focus on structural constraints and e.g. attempt to make credit more available for small companies by facilitating institutions such that information asymmetries and agency conflicts are diminished.

Section 1 describes the hypotheses tested and the variables used; 2 discusses the estimation and the data; 3 presents the results; 4 concludes the study.

1 Financial Constraints and Investment

The most widely considered implication of PO theory for explaining investment is that access to internal funds as it can be captured by cash holdings or an internal cash flow ratio (CF) should have a significant positive impact.[2] A related hypothesis is that the cash flow sensitivity of investment should increase for firms that are financially constrained and that cannot issue debt which is free of default risk.

While internal finance does stand on top of the hierarchy, the PO model also implies that debt at low levels and with minor debt service and repayment burdens is not suffering from any major agency costs and incentive problems either. The ability to access credit which is free of default risk allows firms to carry out all investment projects with a NPV > 0. Risky debt with higher interest rates, leverage and cash commitment ratios (CC) involves higher costs of and limited access to finance as it produces agency problems where debtors have the incentive to shift to riskier investment projects, where only risky debtors apply for loans and where banks ration credit (Myers, 1977; Stiglitz & Weiss, 1981). The first additional prediction of PO theory is thus that CC over assets is an indicator for access to (low-cost) credit, which should be significant and negatively related to investment.[3]

New equity issues are the most expensive source in the PO and less likely to be used. However, with high leverage coordination problems and costs of debt become very large. Issuing new equity (to retire debt, accumulate financial slack or directly finance investments) can lower total capital costs and enable firms to undertake investments that would not be realized otherwise (Jensen & Meckling, 1976). In addition to that, higher net present values of available investment opportunities and lower values of existing assets reduce the

[2]Cash holdings represent an endogeneously determined variable that is subject to strategic choice in the short run. Holdings can be accumulated gradually or build up spontaneously through external finance if investments are planned for the near future. It is thus not a very suited variable for an econometric analysis. However, CF is suited as it is by definition internally generated and not subject to arbitrary choice.

[3]Leverage or CC/CF are similar but involve greater endogeneity problems: when credit is used to finance investment then leverage in period t is positively associated with investment in t (its estimated coefficient is biased upwards). However, the first interest payment is usually due within a year from which the credit line was set in place. For investments undertaken in period t, the upward bias will not occur for CC_t in the same annual accounting period. It would rather appear for CC_{t+1} (if this variable was used).

disadvantages from new equity issues (Myers & Majluf, 1984). Average Q (Q from thereon) captures the factors on which the viability of equity finance depends. A higher value of Q should be associated with low-cost access to new equity and higher investment.[4] The second additional PO prediction is thus that Q is an indicator for the cost of equity finance and significantly positively related to investment.

CC and Q are of course imperfect indicators and not the only factors that determine the accessibility and costs of new credit and equity finance respectively. Inferior or no ratings imply that greater information asymmetries are present and that the costs of external finance are higher. Adverse conditions in the economy and on financial markets mean that there will be more uncertainty and risks and a lower firm value. The latter is inversely related to the costs of external finance, amplifies agency costs through a "financial accelerator" effect and induces a "flight to quality" (Bernanke, 1981; Bernanke et al., 1996). Greater cyclical and structural constraints are thus likely to increase the sensitivity of investment with respect to CC and Q.

To form groups of firms that are likely to be either financially constrained or unconstrained four indicators are used. Long-term bond ratings discriminate between likelihoods of being "structurally constrained". The number of official recession months per year is used to identify firms that are probably "cyclically constrained". To test the sensitivity of results two alternative grouping indicators are applied: annual firm size percentiles for the former and PMI Manufacturing Composite Index percentiles for the latter.[5] All grouping schemes are largely insulated against endogeneity problems of other popular variables like leverage, cash holdings or dividend payouts (Kaplan & Zingales, 1997). The testable hypotheses implied by these ideas are:

PO1. CF, CC and Q are significant; CC is negative, the other positive;

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[4] This interpretation requires of course that marginal q is controlled for. Others such as Gugler et al. (2004) have used Q in a similar way.

[5] The two variables behind the grouping schemes that identify structural financial constraints have both been applied in related studies (Erickson & Whited, 2000; Gilchrist & Himmelberg, 1995). Using ratings is more common than size - which is besides the mentioned studies also used by Devereux & Schiantarelli, 1990; Athey & Laumas, 1994; Kadapakkam et al., 1998.

PO2. CF is more significant than CC and the latter more than Q; PO3. lower or no debt ratings and inferior economic conditions raise the significance and coefficient magnitudes of CF , CC and Q.

This can be contrasted with a largely frictionless and perfect MM world (Modigliani & Miller, 1958) where taxes and bankruptcy costs make finance also relevant. However, they imply a tradeoff (TO) model of debt where bankruptcy risk is positively associated with leverage and has to be weighted against tax benefits of debt finance (Modigliani & Miller, 1963). Since frictions like agency or information problems are absent funding can always be obtained for investment projects with a positive NPV. Costs of finance stay constant if the financial sources used do not move the capital structure of the firm away from its optimal level. An indicator for the availability of worthy future investments such as marginal q (q in the following) is thus the only variable required in a corresponding investment equation (Lucas & Prescott, 1971; Mussa, 1977).[6] The corresponding alternative TO hypotheses are[7]:

TO1. variables intended to capture the availability or agency costs of different sources of finance are largely insignificant;

TO2. grouping subsamples by recession occurrence or debt rating does not impact the effect of such variables systematically.

It is a stylized empirical fact that sales and capacity utilization variables have explanatory power in estimated investment equations - see e.g. Fazzari et al. (1988) or Blundell et al. (1992). The theoretical explanation is given by measurement errors of q (or Q) and accelerator effects. Thus, firm level sales growth, sg and estimated industry level capacity utilization, u are included as control variables. Table 1 summarizes all variables used.

Insert table 1 here.

[6] The formula used here to approximate q is identical to the one in Gugler et al. (2004).

[7] Both PO and TO theory predict a significant positive effect of q. Thus, this does not allow to discriminate between the models.

2 Econometric Methodology and Data

There is a clear pattern of autocorrelation in the dependent variable, the growth rate of the fixed capital stock (I_t), with a correlation coefficient of 0.535 for I_t and I_{t-1} (see table 2). This is not surprising since certain investment projects are implemented over periods that do not fall into a calendar year. Large expenditures are often also preceded and succeeded by complementary investments.

Insert table 2 here.

Adjustments of the actual to the desired capital stock can involve risks like when sunk costs and fundamental uncertainty about future demand conditions (that determine a changed level of the desired capital stock) are jointly present. In such a case gradual, not instantaneous adjustments of the actual capital/sales ratio to the desired one can be preferred. Highly significant test statistics from Wald tests for static panel-data model specifications in a preliminary analysis also clearly imply autocorrelation in the idiosyncratic errors. Including autoregressive (AR) terms is likely to solve this issue.

A second major problem is the highly probable presence of endogeneity in all firm level variables. sg is obviously simultaneously determined as increases in capacity due to investments enable higher sales. They are also likely to produce the required incentives when new equipment involves lower variable and higher fixed costs. CF is likely to be effected by investment as the latter alters the cost structure of the firm. CC is positively influenced by investment if it raises the leverage ratio (at a constant interest rate) or if the interest on new debt is sufficiently higher than before (in cases where leverage stays constant or does not decline too much). The numerators and denominators of Q and q are clearly both affected by changes in the capital stock. Instrumentalizing these variables can be a solution.

To address the autocorrelation and endogeneity issues a two-step system-GMM or Arellano-Bover/Blundell-Bond estimator (Arellano & Bover, 1995; Blundell & Bond, 1998) is applied. It yields unbiased estimates and is designed to fit dynamic panel models. The appendix

describes and compares it to the difference-GMM or Arellano-Bond estimator (Arellano & Bond, 1991) that is used more commonly in related studies (e.g. Blundell et al. , 1992; Bond & Meghir, 1994; Almeida & Campello, 2007) but likely to be inefficient and to have weaker instruments than the estimator applied here. Having also advantages over IV approaches (Anderson & Hsiao, 1981; Almeida et al., 2010) with respect to efficiency and the possible presence of heteroskedasticity, the system-GMM estimator seems to be the most appropriate one.

An alternative approach that is currently used in some studies (see e.g. A˘gca & Mozum-dar, 2008) and that follows Erickson & Whited (2000, 2002) focuses on the issue of measurement errors in q.[8] Applying GMM estimators it utilizes information in the higher order moments of the data. However, there are several reasons why another method is used here: 1. in the regular application it is used only in static models and does not account for the AR patterns in I that is shown to be substantial; 2. the identification of models following this approach has requirements that are often harder to satisfy; 3. Almeida et al. (2010) find that it is biased, inefficient and less robust in comparison to IV and Arellano/Bond GMM approaches.

The data used cover 9,022 firms, 79,356 observations and 60 years from 1950 to 2010. FIRE (SIC 6000-6999) and publicly dominated sectors (SIC 8000-8699, ≥8800) are excluded. Variables are winsorized at their 3rd and 97th percentiles. Observations with negative CAPX,

[8] This is widely discussed in literature and often used as an argument to explain the findings of significant CF coefficients in Fazzari et al. (1988) and subsequent studies. However, the idea is not convincing. Firstly, demand indicators like the two used here are used in most models and act as control variables that are known to raise the explanatory power of investment equations more than the inclusion of CF. It is very likely that they (and not CF) capture already most of the variations in investment opportunities that are unexplained by q. Secondly, the almost exclusive focus on q is exaggerated since other variables in investment equations are also known to suffer from measurement errors. The almost generally used Compustat data are e.g. reported by companies and designed to reflect accounting data. However, what is reported often does not reflect accounting information; reporting methodologies differ for firms and data contain numerous errors. The use of proper accounting data is problematic as well. Authors criticized the quality and usability of accounting data on the grounds of lacking reliability (e.g. with respect to depreciation) or systematic manipulation (to avoid taxes) (Fisher & McGowan, 1983; Dess & Jr., 1984; Powell & Dent-Micallef, 1997). However, if disturbances are randomly distributed (which seems to be the case) and if there is still a sufficiently high correlation between actual and measured variables then a sensible econometric analysis may have lower explanatory power but is still possible (Mueller, 1986, pp. 108-109).

SALE or XINT values are removed. Firms with acquisitions that amount to more than 25% of total assets are treated as new firms from the acquisition onwards. Table 3 illustrates medians of the regression variables. It reveals significant variations. Firms in the group with good ratings have e.g. an investment rate more than four (two) times that of firms with a bad (no) rating. A similar difference but with a smaller magnitude exists with respect to CF. Lower CC for the group with good ratings relative to the one with bad ratings might reflect lower leverage or lower interest rates. Small firms in this sample have on average a negative capital stock growth rate and are much less profitable.

Insert table 3 here.

3 Results

Table 4 summarizes the results for the entire sample (equation 1) and for different large subsamples (equations 2-10). Regressions 2-4 are based on subsamples of firms whose long-term bond ratings are "good" investment grade (A- or better), "junk" (BB+ or lower) or nonexistent. Equations 5 and 6 use firm size as the alternative way to identify firms that are likely to be financially constrained. The fixed assets of firms included are above the 70th percentile of the distribution of that year or below the 30th.

In equations 7 and 8 the sample is restricted to years without and with more than 6 recession months respectively. The alternative grouping variable is the PMI. Values above 50 imply expansion. The average of the sample is 52.5. Annual averages are computed from the raw monthly data. Firm years with values above 55 are classified as "high" and below 50 as "low" (equations 9 and 10).

Figure 1 illustrates in detail how significance levels and coefficients behave when firms are grouped into narrower classes using the same variables.

Equation 1 in table 4 shows that significance levels of CF, CC and Q and coefficient signs are as predicted by the first PO hypothesis, PO1. All other variables have the expected sign and are significant - with the exception of u. As predicted by PO2, CF is more significant than CC and CC more than Q when one looks at all regressions in table 4 and uses 1% or 5% significance as the criterion. This finding is confirmed by looking at the p-values shown in figure 1. The first alternative hypothesis TO1 of no significance of these financial indicators has to be rejected.

Insert table 4 here.

Insert figure 1 here.

Firms that are likely to suffer from structural financial constraints due to low or no ratings reveal higher significance levels for CF and CC but not for Q. The magnitudes of CF and Q (but not of CC) behave as predicted by PO3. Since figure 1 confirms these findings (with an exception of the behavior of the coefficient magnitude of Q) they are interpreted as weak partial evidence in support of PO3 and against TO2. This is opposed to the findings of Kaplan & Zingales (1997), Cleary (1999), Erickson & Whited (2000) that see the CF sensitivity of investment decline as financing constraints become greater but in line with the results from most other studies.

The application of the alternative grouping variable, firm size, does not confirm the identified rise in the coefficient magnitude of CF for structurally constrained firms. Magnitudes of CF and CC actually show the exact opposite of the expected behavior in table 4 and figure 1. This is also true for the p-values of CC in the figure. CC and CF seem to be less important and have a smaller impact for smaller firms - something that has been found before (Devereux & Schiantarelli, 1990; Athey & Laumas, 1994; Kadapakkam et al., 1998). P-values and coefficient magnitudes for Q are as expected, suggesting a greater importance of it for smaller firms and confirming the results from Devereux & Schiantarelli (1990).

While the PO3 is not confirmed, the alternative counter hypothesis TO2 is not supported either: there seem to be systematic relations for all three variables as illustrated by exceptionally smooth graphs for coefficient magnitudes in the second column of figure 1. Firms of different sizes appear to use different means of finance to different degrees: small ones rely

more on equity while larger ones rely more on credit and internal cash. Possible explanations are higher agency costs for larger firms due to a usually more diverse ownership structure (Devereux & Schiantarelli, 1990). This would make debt more expensive relative to equity. In addition smaller companies might also suffer from higher agency costs of debt which may be explained e.g. by a lack of specialization of the dominating large U.S. banks on small and medium companies. These effects appear to be more important than any possible reduction in information asymmetry because of greater size. Being based on agency theory and sup-ported by the results this calls for a refined PO model and a more careful formulation of PO3.

Using either one of the two groups that classify firms as cyclically constrained or unconstrained fails to produce the patterns predicted by PO3 for CC, CF and Q in a reasonably clear way. For the case of CF the findings of table 4 are as PO theory expects (for magnitude and p-value). However, a lot of creativity is required to confirm this from figure 1. The same is true for the recession months and PMI graphs for CC. This might imply at best an extremely weak support for PO3 but is more in favor of TO2. It casts doubt on theories of cyclical agency effects such as the financial accelerator. Results for Q using any classification system (except the one based on size) support TO2 (unsystematic pattern). Thus, evidence from business cycle based groups is split but slightly more on the side of TO theory.

The significance of the lagged dependent variable in all regressions in table 4 and the coefficient values of up 0.548 proof that its inclusion is necessary. The average length of consecutive observations that are used in the regression amounts to 8.8 for equation 1 in table 4 and is in this order in most other equations. Validity of the moment conditions and consistency of the estimators require the absence of autocorrelation in the idiosyncratic error term. The Arellano-Bond test fails to reject the null of no serial correlation at 5% for higher orders in all regressions reported in table 4, with an exception of equation 6 (which can be rejected at 1% nonetheless).[9]

[9] WC-robust standard errors do not allow to compute the Sargan or overidentifying restrictions test.

4 Conclusion

The presented analysis is based on dynamic panel models that divide the sample into firms, which are expected to suffer from different types of financial constraints in different degrees. This allows to test hypotheses derived from PO theory.

The first two are both clearly supported (significance, “correct” signs and significance differentials). Internal finance is the most important source. PO predictions perform very well with respect to the CF variable. Access to credit as captured by CC is also of considerable importance. It is the variable that behaves closest to predictions of the agency model when firms are classified as more or less cyclically financially constrained. An implication for empirical research on cash flow sensitivities of investment is that it should be augmented by an analysis of the sensitivity of investment to credit accessibility.

When classifications are based on credit ratings significance levels increase for CF and CC as predicted by PO. Surprisingly CF and CC sensitivities of investments increase with firm size. They decrease only for Q. However, an alternative agency theoretical explanation can explain this: greater costs due to more diverse ownership structure of larger firms (or greater agency costs of debt for smaller firms) make Q comparably more expensive.

Thus, when the PO model is placed into the larger framework of financial agency and information theory the approach performs very well - at least when “structural” financial constraints are analyzed. An implication for financial economic theory is thus that it might make sense to not think about “the pecking-order model” but more broadly “the agency theory” as the alternative approach to trade-o↵theory.

However, there is little evidence for a cyclical agency model like the financial accelerator. There is also only minimal support for pecking-order predictions when it comes to equity finance with low significance and unexpected or a lack of any clear patterns in Q in three out of four classification systems. The investigation thus reveals that the type of financial constraint matters. Structural ones appear to be generally more relevant for agency costs than cyclical ones. The fact that different grouping schemes produce differences in empirical findings does not necessarily imply an arbitrary coefficient behavior and a high sensitivity that is sometimes seen as a weakness of the classification methodology or of agency theory. Different grouping methods rather turn out to capture different types of financial frictions that show up in the data and that can be explained by theory. A policy implication is that cyclical monetary interventions in times of economic headwinds cannot be justified with by the argument that amplified agency costs or coordination problems on financial markets have to be lowered or lessened. Another implication is that it might make sense to deal more with structural constraints faced for example by small firms. Apparently existing higher coordination problems of debt finance for these companies could, e.g. be addressed by specialized financial institutions such as the German cooperative banks, which are known to successfully credit-finance small and medium companies.

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Appendix

The estimation of a dynamic model that results from the inclusion of an AR term with random and fixed effects is biased due to endogeneity. In equation

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it}' + u_i + \varepsilon_{it} \tag{1}$$

the lagged dependent variable, y_{it-1}, is always correlated with the time invariant individual error term, u_i (y_{it} is the regressand, x'_{it} a vector of regressors, ε_{it} the idiosyncratic error term, α and β a scalar and vector of parameters respectively). In the differentiated form of the equation,

$$(y_{it} - y_{i,t-1}) = \alpha(y_{i,t-1} - y_{i,t-2}) + \beta(x_{it} - x_{it-1}) + (\varepsilon_{it} - \varepsilon_{i,t-1}) \tag{2}$$

Or

$$y_{it} = \alpha \ y_{i,t-1} + \beta \ x_{it}' + \ \varepsilon_{it} \tag{3}$$

y_{it-1} and ε_{it-1} in $y_{i,t-1}$ and ε_{it} are obviously correlated too.[10]

A solution is the use of instrumental variables in a difference-GMM or Arellano-Bond estimator (Arellano & Bond, 1991). It estimates the parameters in equation 3 by using lagged levels as instruments for the differences of the AR term and for the endogenous variables in x'_{it} (exogenous variables remain in first differences).[11]

However, the performance of the Arellano-Bond estimator is undermined in cases of a too persistent AR process in the dependent variable. This causes the instruments (lagged levels) for the current changes to weaken. Besides the reported considerable magnitude of the correlation coefficient all preliminary regressions revealed very high degrees of significance

[10] u_{it} is the individual average or fixed effect and ε_{it} the idiosyncratic error term. i is the panel or firm identifier and t the time index. x_{it} is a vector of explanatory variables. α is a scalar and β a vector of coefficients.

[11] The assumption is that the used lagged levels of the dependent variable are orthogonal to the differenced disturbances.

for the autoregressive terms of y_{it}. Using only information from the time dimension of the panel to estimate the coefficients the difference-GMM estimator loses efficiency when the variation of variables in the between dimension is comparatively high. In the present case only two variables have larger standard deviations in their within than in their between dimension (see table 5). For the three variables that capture the availability of finance, the standard deviation "between" is roughly double than "within". The panel analyzed here is also relatively short and wide with many firms and relatively short spells of consecutive observations. Unsurprisingly, larger standard errors of equivalent regression specifications in a preliminary analysis reveal efficiency disadvantages of the difference-GMM estimator relative to the system-GMM or Arellano-Bover/Blundell-Bond estimator (described in the next paragraph). Another advantage of the latter estimator is that it does not suffer from the downward bias of the former that occurs in certain cases (Blundell & Bond, 1998).

Insert table 5 here.

Arellano & Bover (1995) and Blundell & Bond (1998) augment the difference-GMM estimator by using lagged differences as instruments in equation 1 for the levels of the autoregressive and endogenous variables.[12] This eliminates the problem of y_{it-1} being correlated with u_i and, in the case of endogeneity, x_{it} correlating with "$_{it}$. Adding moment conditions for the data in levels while retaining the original Arellano-Bond moments for the transformed equation produces a more efficient system-GMM estimator that exploits more information and that allows to include time-invariant regressors. The system of equations 1 and 3 can be treated as a single-equation estimation problem due to the fact that the same linear functional relationship is believed to apply in both the transformed and untransformed variables. Since the sample is large enough one can avoid additional assumptions by using a two-step GMM estimator that estimates the covariance matrix of moment conditions from the sample in the first step and applies its inverse as weights in calculating the estimators

[12] The lagged differences are assumed to be orthogonal to the levels.

in the second step. The bias it produces for finite samples can be corrected by using Windmejiers WC-robust standard errors (Windmeijer, 2005). This takes also care of potential heteroskedasticity and a non-identical distribution of disturbances.[13] In the technique used here the two-step procedure is combined with the WC-robust standard errors. All regressors but u are assumed to be endogenous.

[13] One lag that can be used as an instrument for the AR(1) term and the endogenous variables is chosen to avoid over-fitting problems that can result from the use of too many instruments. Changing the number of lags to 2 or 3 produces results very similar to the ones illustrated below.

Tables

Table 1: Variables Used

	Description	Computation & Data Source[a]
Regression Variables		
I	net investment / fixed assets	$[CAPX - DP]_t / PPENT_{t-1}$
Q	average Q	$[CSHO$ ⇤ $PRCC + DLC + DLTT]_t$ $/PPENT_t$
q	marginal Q	$([CSHO$ ⇤ $PRCC + DLC + DLTT]_t -$ $[CSHO$ ⇤ $PRCC + DLC + DLTT]_{t-1}$ ⇤ $[1 - DP/PPENT]_t)/[CAPX - DP]_t$
CC	cash commitment / fixed assets	$XINT_t / PPENT_t$
CF	cash flow rate	$[PI_t + DP_t]/PPENT_t$
sg	sales growth	$[SALE_t - SALE_{t-1}]/SALE_{t-1}$
u	capacity utilization (lowest available industry aggregate)	$utilization_t / (\sum_{i=0}^{4} utilization_{t-i}/5)$ Federal Reserve Bank
Grouping Variables		
1	S&P long-term credit rating	$SPLTICRM_t$ (item 280)
2	annual percentiles of total assets	$PPENT_t$
3	recessions months / year	NBER
4	Purchasing Manager's Index	Institute for Supply Management

[a] Shows Compustat data unless another source is specified. CAPX: "Capital Expenditures" (annual item number 128); DP: "Depreciation and Amortization" (14); PPENT: "Property, Plant and Equipment - Total (Net)" (8); CSHO: "Common Shares Outstanding" (25); PRCC: "Price Close - Annual" (24); DLC: "Debt in Current Liabilities - Total" (34); DLTT: "Long-Term Debt - Total" (9); XINT: "Interest and Related Expense - Total" (15); PI: "Pretax Income" (122); SALE: "Sales/Turnover (Net)" (12). BEA deflators from Table 1.1.9. are used in the formulas for I, q and sg.

Table 2: Matrix of Correlation Coefficients

	I_t	I_{t-1}	CF_t	CC_t	Q_t	q_t	sg_t	u_t
I_t	1							
I_{t-1}	0.535	1						
CF_t	0.217	0.083	1					
CC_t	-0.25	-0.181	-0.197	1				
Q_t	-0.086	-0.099	-0.199	0.156	1			
q_t	0.191	0.115	0.067	-0.064	-0.073	1		
sg_t	0.249	0.172	0.088	-0.053	0.124	0.045	1	
u_t	0.051	-0.011	0.024	-0.014	0.028	0.014	0.103	1

Shows pairwise correlations for all observations included in equation 1, table 4.

Table 3: Medians of Regression Variables by Firm Groups[a]

Subsample	I_{t-1}	CF_t	CC_t	Q_t	q_t	sg_t	u_t
Whole	0.042	0.299	0.049	3.113	2.021	0.111	1.001
Good Rating	0.041	0.35	0.04	2.94	4.78	0.072	1.006
Bad Rating	0.008	0.197	0.097	2.851	0.051	0.083	1.002
No Rating	0.021	0.289	0.044	3.923	1.059	0.089	1.003
Large	0.053	0.272	0.044	2.107	2.77	0.112	1.001
Small	-0.046	0.144	0.081	7.564	-2.815	0.086	1
No Recession	0.038	0.298	0.048	3.277	2.167	0.113	1.005
Recession	0.05	0.286	0.053	2.686	0.636	0.098	0.959
High PMI	0.051	0.34	0.047	2.915	2.371	0.153	1.012
Low PMI	0.049	0.281	0.055	2.88	2.154	0.086	0.987

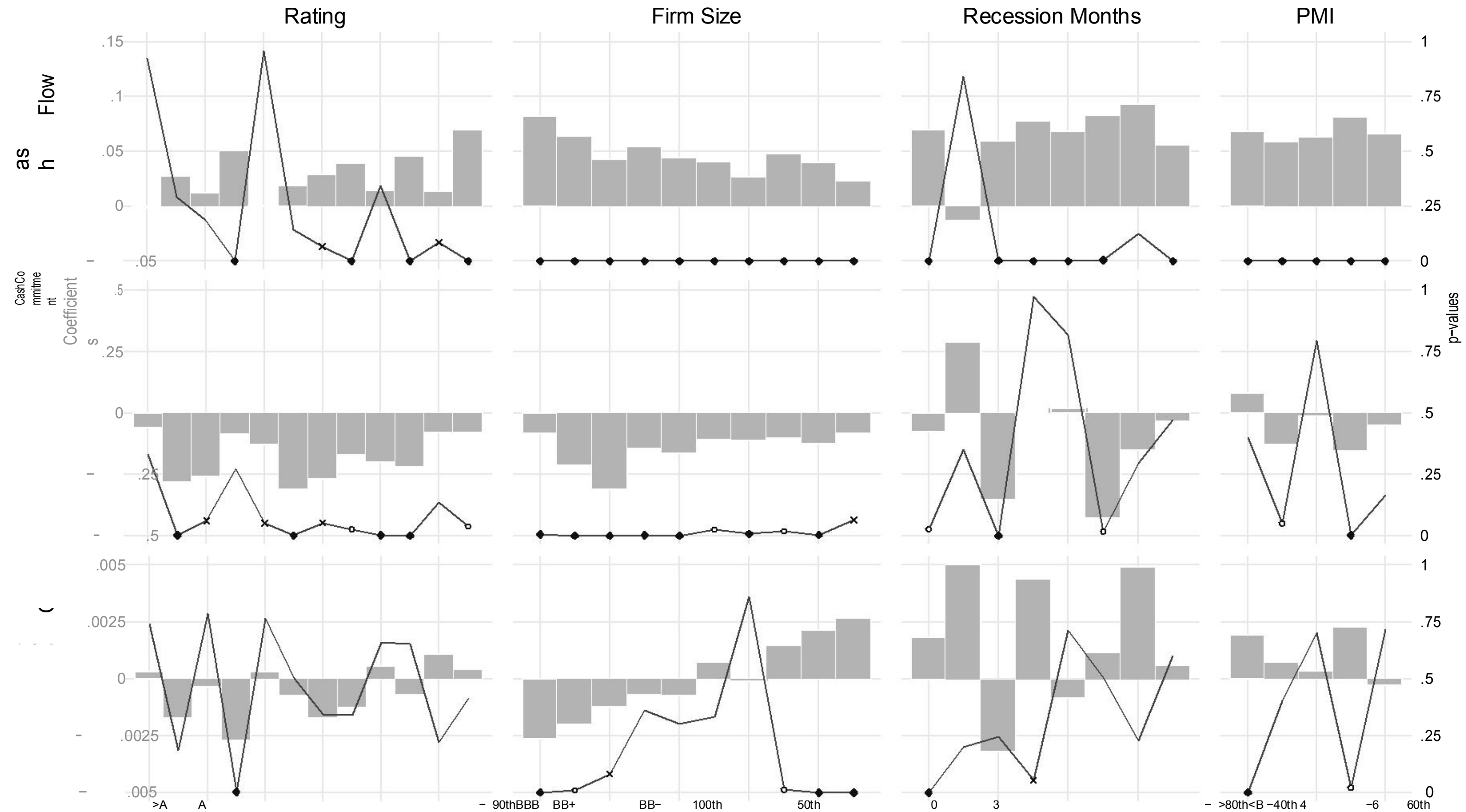
[a] See table 1 for descriptions of regression and categorial variables. Classification and subsamples are identical to the ones used and described in table 4.

Table 4: Regression Results by Firm Groups

	Whole	Rating			Firm Size		Recession Months		PMI	
	Sample	≥ A-	BB+	None	Large	Small	0	7-12	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I_{t-1}	.347	.548	.502	.369	.505	.263	.346	.402	.356	.401
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CF_t	.068	.012	.034	.07	.071	.053	.07	.064	.068	.075
	(0.00)	(0.43)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CC_t	-.094	-.155	-.144	-.083	-.211	-.098	-.077	-.124	-.012	-.09
	(0.00)	(0.08)	(0.01)	(0.04)	(0.00)	(0.01)	(0.03)	(0.01)	(0.83)	(0.01)
Q_t	1.6e-03	-7.8e-04	7.9e-04	4.1e-04	-1.8e-03	3.1e-03	1.9e-03	1.8e-03	1.4e-03	-1.4e-04
	(0.00)	(0.32)	(0.32)	(0.41)	(0.01)	(0.00)	(0.00)	(0.02)	(0.01)	(0.87)
q_t	9.5e-04	3.0e-04	7.4e-04	7.8e-04	4.2e-04	7.7e-04	8.9e-04	3.6e-04	5.5e-04	4.4e-04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.10)	(0.00)	(0.02)
sg_t	.203	.081	.108	.244	.134	.125	.182	.127	.145	.176
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
u_t	.013	.18	.056	-.109	.093	.125	.012	.018	.122	.038
	(0.56)	(0.00)	(0.30)	(0.00)	(0.00)	(0.10)	(0.63)	(0.76)	(0.00)	(0.28)
N	79,356	5,136	5,382	31,867	33,512	11,112	60,778	7,370	21,583	23,620

P-values are in parentheses. Output for the constant is not printed. N is the number of observations. Rating refers to S&P's long-term credit rating. A firm-year is classified as "large" ("small") if it is above (below) the 70th (30th) percentile of the distribution of total assets in that year. NBER classifications for recession months are used. An ISM PMI manufacturing composite index > 55 is defined as "high" and < 50 as "low". I_{t-1} is the lagged dependent variable, investment/capital; CF_t is cash flow/capital; CC_t is cash committed for interest expenditures/capital; Q_t is average Q; q_t marginal q; sg_t sales growth; u_t is actual industry capacity utilization over its lagged 5-year moving average.

Figure 1: Regression Coefficients and p-Values by Detailed Firm Groups



Coefficients are represented by gray bars (left axis), p-values by black lines (right axis). Each row represents a variable and each column a data subsample. “Rating” groups firms using S&P’s long-term credit rating; “Recession Months” is the number of NBER recession months per year; “Size” and “PMI” use percentiles of the distribution of total assets per year and the PMI Composite Index respectively. Moving to the right within a column of figures implies a higher likelihood of financial constraints. Some ratings and recession month numbers had to be merged due to too few observations. The last rating group has no rating. “x” indicates significance at 10%; hollow circles at 5%; diamonds at 1%.

Table 5: Descriptive Statistics

Variables	Mean	Median	Standard Deviation Overall	Between	Within
I_t	0.046	0.042	0.172	0.169	0.137
CF_t	0.205	0.299	1.261	1.769	0.777
CC_t	0.091	0.049	0.133	0.151	0.08
Q_t	6.352	3.113	10.308	13.232	5.959
q_t	-0.342	2.021	59.543	41.356	54.271
sg_t	0.152	0.112	0.283	0.256	0.247
u_t	0.997	1.001	0.046	0.027	0.043

Shows summary statistics for all observations included in equation 1, table 4.