Macroeconomic Uncertainty and Firm Leverage

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Abstract

This paper investigates the link between the optimal level of nonfinancial firms' leverage and macroeconomic uncertainty. We develop a structural model of a firm's value maximization problem that predicts that as macroeconomic uncertainty increases the firm will decrease its optimal level of borrowing. We test this proposition using a panel of non–financial US firms drawn from the COMPUSTAT quarterly database covering the period 1991–2001. The estimates confirm that as macroeconomic uncertainty increases, firms decrease their levels of leverage. Furthermore, we demonstrate that our results are robust with respect to the inclusion of the index of leading indicators.

Keywords: leverage, uncertainty, non–financial firms, panel data.

JEL classification: C23, D8, D92, G32.

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1 Introduction

"WASHINGTON, March 12 (Reuters) — Newell Rubbermaid Inc. (NYSE:NWL — News), a household and business products maker, on Wednesday filed with the Securities and Exchange Commission (News – Websites) to periodically sell up to $1 billion in debt securities ... company said the net proceeds of the sale would be used for general corporate purposes. These could include additions to working capital, repayment of existing debt and acquisitions, according to the shelf registration filing. Under such a filing, a company may sell securities from time to time in one or more offerings, with amounts, prices and terms determined at the time of sale."[1] As all these changes in debt affect the leverage level, it is important to understand the driving factors leading to this variation. For this purpose one has to study the indicators that influence the underwriters' advice with respect to the best timing for issuing debt. The motivation for this research is further illustrated by the amount of debt issuance taking place. For example on March 12, 2003 Reuters announced twelve other debt issues, including Moore North America ($400 mln), Citigroup ($1.5 bln), Bank of America ($295 mln), Shaw Group ($253 mln), Comcast ($1.5 bln), Eli Lilly ($500 mln), Hanson Australia Funding ($600 mln), and Unisys Corp ($300 mln).[2]

The most common purposes for borrowing are capital investment and existing debt repayment. However, some corporations change the amount of debt they issue just before the official announcement. For instance, both Citigroup and Comcast originally planned to sell $1.0 billion notes each. Therefore, we intend to shed some light on the issue why firms change their decisions about initial offerings.

The determinants of capital structure have always attracted considerable attention in the literature. In their seminal work, Modigliani & Miller (1958) derived

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[1] Citation: Yahoo! Bond Center: Latest Bond Market News, 12 March 2003, http://biz.yahoo.com/n/z/z0400.html?htime=1047576818

[2] Ibid.

the theoretical result that under the assumption of perfect capital markets, financial and real variables are irrelevant for a firm's capital structure. However, recent empirical research provides contrary evidence. For instance, a vast number of studies show a positive relationship between liquid asset holdings and firms' investment decisions.[3] Other studies show that firm leverage depends on firm–specific characteristics such as cash holdings, total assets, and the investment–to–capital ratio.[4] However, empirical evidence on the interaction of macroeconomic level variables and capital structure indicators is rather scarce. As an exception, Baum, Caglayan, Ozkan & Talavera (2002) find a negative relationship between macroeconomic uncertainty and the cross–sectional dispersion of cash–to–asset ratios for US non–financial firms. Hence, their study supports the view that macroeconomic uncertainty is an important factor in firms' decision–making. By furthering this idea, we intend to contribute to the literature on corporate debt by analyzing the impact of macroeconomic uncertainty on the optimal level of leverage.[5]

We formulate a dynamic stochastic partial equilibrium model of a representative firm's value optimization problem. The model is based upon an empirically testable hypothesis regarding the association between the optimal level of debt and macroeconomic uncertainty. The model predicts that an increase in money growth uncertainty or inflation uncertainty leads to a decrease in leverage. In times of greater macroeconomic uncertainty companies will issue less debt.

For testing this prediction we utilize an unbalanced panel of non–financial firms' data obtained from the quarterly COMPUSTAT database over the 1991–2001 period. After some screening procedures it includes more than 30,000 manufacturing firm–year observations, with about 700 firms per quarter. We also consider a sample split,

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[3] See for example Gilchrist & Himmelberg (1998); Fazzari, Hubbard & Petersen (1988).

[4] See Shuetrim, Lowe & Morling (1993); Auerbach (1985); Weill (2001).

[5] One natural extension would be to examine the effect of idiosyncratic firm–specific uncertainty on leverage. However, such an analysis would be beyond the scope of this paper.

defining categories of durable–goods makers vs. non–durable goods makers. We apply the Arellano & Bond (1991) dynamic panel data approach.

Our main findings can be summarized as follows. We find evidence of a negative association between the optimal level of debt and macroeconomic uncertainty as proxied by either the conditional variance of money growth or the conditional variance of industrial production. Moreover, leverage levels of durable–goods makers are more sensitive to changes in monetary policy than those of non–durable goods makers. The results turn out to be robust to the inclusion of the index of leading indicators.

These results provide useful insights into corporate capital structure decisions. Changes in macroeconomic uncertainty, partially influenced by monetary policy, will not only affect firms' leverage but also their costs of obtaining external finance, and in turn their investment dynamics. Moreover, monetary policy will have an effect on the discount rates of investment projects. Therefore, our results suggest that the transmission mechanism of monetary policy is much more complicated than formulated in standard models which ignore the interaction of real and financial variables' first and second moments.

The remainder of the paper is structured as follows. Section 2 presents a simple value maximization model for a representative firm. Section 3 describes the data and discusses our results. Finally, Section 4 concludes and gives suggestions for further research.

2 The Q Model of Firm Value Optimization

2.1 Model Setup

The theoretical model proposed in this paper is based on the firm value optimization problem and represents a generalization of the standard Q models of investment by Gilchrist & Himmelberg (1998), Love (2003) and Hubbard & Kashyap (1992). The present value of the firm is equated to the expected discounted stream of D_t, dividends paid to shareholders, where β is the discount factor.

$$
\begin{aligned}
& V_t(K_t) = \max_{\{I_{t+s}, B_{t+s+1}\}_{s=0}^{\infty}} D_t + E_t \left[\sum_{s=1}^{\infty} \beta^{t+s-1} D_{t+s} \right], && (1) \\
& K_{t+1} = (1-\delta)K_t + I_t, \\
& D_t = \Pi(K_t, \xi_t) - C(I_t, K_t, \varepsilon_t) - I_t + B_{t+1} - (1+r_t)(1+\eta(B_t, K_t, \nu_t))B_t, \\
& D_t \geq 0, \\
& \lim_{T\to\infty} \left[\prod_{j=t}^{T-1} \beta_j \right] B_T = 0, \forall t && (2)
\end{aligned}
$$

The firm maximizes equation (1) subject to three constraints. The first is the capital stock accounting identity $K_{t+1} = (1-\delta)K_t + I_t$, where K_t is the beginning–of–period capital stock, I_t is investment expenditures, and δ is the rate of capital depreciation. The second constraint defines firm dividends, where $\Pi(K_t, \xi_t)$ denotes the maximized value of current profits taking as given the beginning–of–period capital stock, and ξ_t is a profitability shock. $C(I_t, K_t, \varepsilon_t)$ is the real cost of adjusting I_t units of capital. Note that ε is a shock that occurs between periods $t-1$ and t and it is assumed to be independent of firm–specific variables. We incorporate financial frictions assuming that risk–neutral shareholders require an external premium, $\eta(B_t, K_t, \nu_t)$, which depends on firm–specific characteristics such as debt and capital stock. Similar to Gilchrist & Himmelberg (1998), we also assume $\partial\eta/\partial B_t > 0$: i.e., highly indebted firms must pay an additional premium to compensate debt–holders for additional costs because of monitoring or hazard problems. Moreover, $\partial\eta/\partial K_t < 0$: i.e., large firms enjoy a lower risk premium. The gross interest rate is equal to $(1+r_t)(1+\eta(B_t, K_t, \xi_t))$, where r_t is the risk–free rate of return. Finally, B_t denotes financial liabilities of the firm.

Financial frictions are also introduced through the non–negativity constraint for dividends, $D_t \geq 0$ and the corresponding Lagrange multiplier λ_t. The λ_t can be interpreted as the shadow cost of internally generated funds. Equation (2) is the transversality condition which prevents the firm from borrowing an infinite amount and paying it out as dividends.

Solving the optimization problem we derive the following Euler equation for investment:

$$\begin{aligned} &\frac{\partial C_t}{\partial I_t} + 1 = \\ &E_t\left[\beta\Theta_t\left(\frac{\partial \Pi_{t+1}}{\partial K_{t+1}} + (1-\delta)\left(\frac{\partial C_{t+1}}{\partial I_{t+1}} + 1\right) - (1+r_{t+1})\frac{\partial \eta_{t+1}}{\partial K_{t+1}}B_{t+1}\right)\right] \end{aligned} \tag{3}$$

Note that $\Theta_t = \frac{(1+\lambda_{t+1})}{(1+\lambda_t)}$. Expression $\beta\Theta_t$ may serve as a stochastic time-varying discount factor which is equal to β in the absence of financial constraints ($\lambda_{t+1} = \lambda_t$). Equation (3) relates the optimal level of debt, B_{t+1}, with the marginal profit of capital, $\partial\Pi(K_{t+1}, \xi_{t+1})/\partial K_{t+1}$, the marginal adjustment cost of investment, $\partial C(I_t, K_t)/\partial I_t$, the expected marginal adjustment cost in period $t+1$, $\partial C(I_{t+1}, K_{t+1})/\partial I_{t+1}$, and the relative shadow cost of external financing in periods t and $t+1$.[6]

From the first-order conditions for debt we derive:

$$E_t\left[\beta\Theta_t(1+r_{t+1})\left(1 + \eta_{t+1} + \frac{\partial \eta_{t+1}}{\partial B_{t+1}}B_{t+1}\right)\right] = 1. \tag{4}$$

In the steady state $\beta(1+r_{t+1})\Theta_t = \beta(1+r_{t+1}) = 1$, which implies that $\eta_{t+1} + \frac{\partial\eta_{t+1}}{\partial B_{t+1}}B_{t+1} = 0$. Since we assume $\frac{\partial\eta_{t+1}}{\partial B_{t+1}} > 0$, B_t is guaranteed to be positive only if $\eta_{t+1} < 0$. Gilchrist & Himmelberg (1998) suggest that the risk premium may be negative if η is considered as net of tax advantages or agency benefits.

Our parametrization approach roughly follows Love (2003) and Gilchrist & Himmelberg (1998). The level of financing constraint for a representative firm i, Θ_{it}, is a function of their stock of cash and level of debt:

$$\Theta_{it} = a_{0i} + a_1\frac{Cash_{it}}{K_{it}} + a_2\frac{B_{it}}{K_{it}} \tag{5}$$

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[6] For simplicity, we ignore the derivative of the investment adjustment cost function with respect to the capital stock, $\frac{\partial C_t}{\partial K_t}$. In our data the mean of $\frac{I_t}{K_t}$=0.04, and the squared term will be 0.0016 given that $\frac{\partial C_t}{\partial K_t} = \left(\frac{I_t}{K_t}\right)^2$. Therefore, its effect is negligible.

where $\frac{Cash_{it}}{K_{it}}$ is the cash–to–total assets ratio, $\frac{B_{it}}{K_{it}}$ is the debt level and a_{0i} is a firm–specific indicator of financial constraints. Debt generates interest and principal obligations and increases the probability of financial distress, while the availability of liquid assets decreases the external finance constraint (see also Hubbard, Kashyap & Whited (1995); Almeida, Campello & Weisbach (2004)). Therefore, the ratio $\frac{a_2}{a_1}$ is expected to be negative, and its value may be either greater or lesser than unity depending on whether the source of financial constraints are existing debt or liquidity problems.

We utilize a traditional adjustment cost function given by $C(I_t, K_t) = \frac{\alpha}{2}\left(\frac{I_t}{K_t} - \nu_i\right)^2 K_t$. The parameter ν_i might be interpreted as a firm-specific optimal level of investment. The marginal adjustment cost of investment is given by:

$$\frac{\partial C_t}{\partial I_t} = \alpha\left(\frac{I_t}{K_t} - \nu_i\right) \tag{6}$$

In order to introduce macroeconomic uncertainty into the model, we parameterize expected adjustment cost $E_t C(I_{t+1}, K_{t+1}) = E_t\left\{\frac{\alpha}{2}\left(\frac{I_{t+1}}{K_{t+1}} - \nu_i + b\varepsilon_{t+1}\sqrt{\frac{I_{t+1}}{K_{t+1}}}\right)^2 K_{t+1}\right\} = E_t\left\{\frac{\alpha}{2}\left(\frac{I_{t+1}}{K_{t+1}} - \nu_i\right)^2\right\} K_{t+1} + \frac{\alpha b^2}{2} E_t\left\{\varepsilon^2_{t+1}\right\} I_{t+1}$, where ε_{t+1} is a macroeconomic shock independent of $\frac{I_{t+1}}{K_{t+1}}$ and ν_i. $E_t\left\{\varepsilon^2_{t+1}\right\}$ could be written as $E_t\left\{\varepsilon^2_{t+1}\right\} = \tau_t$. Then the expected marginal adjustment cost is:

$$E_t\left\{\frac{\partial C_{t+1}}{\partial I_{t+1}}\right\} = \alpha\left(E_t\left\{\frac{I_{t+1}}{K_{t+1}}\right\} - \nu_i\right) + \frac{\alpha b^2 \tau_t}{2} \tag{7}$$

The marginal profit of capital is parameterized using a sales–based measure[7]

$$\frac{\partial \Pi}{\partial K} = \theta \frac{S}{K} \tag{8}$$

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[7] The discussion in Gilchrist & Himmelberg (1998) suggests that a sales–based measure of the marginal profit of capital is more desirable comparing to operating income measure.

where S is the firm's sales, K is the capital stock, $\theta = \frac{\alpha_k}{\mu}$, α_k is the capital share in the Cobb–Douglas production function specification and μ is the markup (defined as $1/(1+\kappa^{-1})$, where κ is the firm–level price elasticity of demand).

Finally, we linearize the product of β_t, Θ_t and A_t, where $A_t = \frac{\partial \Pi_{t+1}}{\partial K_{t+1}} + (1-\delta)\left(\frac{\partial C_{t+1}}{\partial I_{t+1}} + 1\right) - (1 + r_{t+1})\frac{\partial \eta_{t+1}}{\partial K_{t+1}} B_{t+1}$. We utilize a first–order Taylor approximation around the means. Ignoring constant terms, the approximation is equal to:

$$\beta_t \Theta_t A_t = \overline{\beta}\gamma\Theta_t + \overline{\beta}A_t + \gamma\beta_t \tag{9}$$

where $\overline{\beta}$ is the average discount factor and γ denotes the unconditional mean of A_t. We assume rational expectations in order to replace expected with realized values plus a firm–specific error term, e_t, assumed to be orthogonal to the information set available at the time when optimal investment and borrowing are chosen. Our final model specification takes the form[8]

$$\begin{aligned} \frac{B_{it}}{TA_{it}} &= \beta_0 + \beta_1 \frac{B_{it-1}}{TA_{it-1}} + \beta_2 \frac{Cash_{it}}{TA_{it}} + \beta_3 \frac{S_{it}}{TA_{it}} \\ &+ \beta_4 \frac{I_{it+1}}{TA_{it+1}} + \beta_5 \frac{I_{it}}{TA_{it}} + \beta_6 \tau_{t-1} + f_i + Ind_i + e_{it} \end{aligned} \tag{10}$$

where the parameters are defined as[9]

$$\begin{aligned} \beta_1 &= \frac{\overline{\beta}\gamma a_2}{d}, \beta_2 = \frac{\overline{\beta}\gamma a_1}{d}, \beta_3 = \frac{\overline{\beta}\theta}{d}, \\ \beta_4 &= \frac{\overline{\beta}(1-\delta)\alpha}{d}, \beta_5 = \frac{-\alpha}{d}, \beta_6 = \frac{\overline{\beta}(1-\delta)\alpha b^2}{2d} \end{aligned}$$

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[8] The level of the capital stock K is proxied by total assets, TA. Moreover, we scaled debt by total assets in order to decrease the effect of heteroscedasticity, and changed time indices for B/TA_{t+1}, which is determined at time t.

[9] We assume that in equilibrium $\overline{\beta}(1 + r_{t+1}) = 1$.

In our notation, $d = \left[\frac{\partial \eta_{t+1}}{\partial K_{t+1}}\right]^{-1} < 0$ and f_i is a firm-specific fixed effect which is a function of a_{0i} and ν_i.[10] Moreover, we control for industry specific effects using industry dummies Ind_i.

Since COMPUSTAT gives end–of–period values for firms, we include lagged proxies for uncertainty in the regressions rather than contemporaneous proxies.[11] Thus, we can say that recently–experienced volatility will affect firms' behavior. The main hypothesis of our paper can be stated as:

$$H_0 : \beta_6 < 0 \tag{11}$$

That is, macroeconomic uncertainty affects optimal level of leverage and this effect is negative. In other words, when firms anticipate "bad times" then they carry a lower level of debt. Our model specification also predicts that $\beta_3 < 0$ and $\beta_4 < 0$. The optimal level of firm leverage increases in response to a decrease in liquid assets or sales. Moreover, given the existence of multi–period liabilities, we expect to find persistence in the leverage ratio, $\beta_1 > 0$.

2.2 Identifying Macroeconomic Uncertainty

The macroeconomic uncertainty identification approach resembles that of Baum et al. (2002). Firms' debt decisions depend on anticipation of future profits and investments. The difficulty of evaluating the optimal amount of debt issuing increases with the level of macroeconomic uncertainty.

The literature suggests candidates for macroeconomic uncertainty proxies such as a moving standard deviation (see Ghosal & Loungani (2000)), standard deviation across 12 forecasting terms of output growth and inflation rate in the next 12 month (see Driver & Moreton (1991)). However, as in Driver, Temple & Urga (2002)

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[10] The firm–specific effect is equal to $f_i = \left(1 - \overline{\beta}(1-\delta)\right)\alpha\nu_i + \overline{\beta}\gamma a_{0i}$.

[11] In our analysis we also employ the lagged value of the detrended index of leading indicators as a control variable.

and Byrne & Davis (2002) we use a GARCH model for measuring macroeconomic uncertainty. We argue that this approach is better suited in our case because disagreement among forecasters may not a valid uncertainty measure and it may contain measurement errors.

Two proxies for macroeconomic uncertainty are derived: first, the conditional variance of money growth, which is a measure influenced by monetary policymakers. As an alternative we employ the conditional variance of the detrended log of industrial production to capture the uncertainty emerging from the real economy.[12] We employ arithmetic weighted lags of the conditional variances of money growth (WCV_MON) and industrial production (WCV_IP), respectively.[13] This approach allows us to capture the combined effects of contemporaneous and lagged levels of uncertainty.[14]

We draw our series for measuring macroeconomic uncertainty from the monthly real monetary base (DRI series $FMBASE$) and from industrial production (International Financial Statistics series $64IZF$). For each of these cases we build a GARCH(2,1) model for the series where the mean equation is a first–order autoregression. Details of the estimated model are described in Table 1. We estimate significant ARCH and GARCH coefficients for both time series. The conditional variances derived from these GARCH models are averaged to the quarterly frequency.

3 Empirical Implementation

3.1 Dataset

We work with the COMPUSTAT Industrial Quarterly database of U.S. firms. The initial databases include 173,505 firms' quarterly characteristics over 1991–2001. The

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[12] We regress $\log(IP_t)$ on trend and constant. The generated residuals from this equation are used as the detrended log of industrial production.

[13] The weights are 0.4, 0.3, 0.2, and 0.1 corresponding to $\sigma^2_{t-1}, \sigma^2_{t-2}, \sigma^2_{t-3}$ and σ^2_{t-4} respectively.

[14] We also employed a single lagged value of conditional variance of industrial production and money growth and received quantitatively similar results.

firms are classified by two–digit Standard Industrial Classification (SIC). The main advantage of the dataset is that it contains detailed balance sheet information. However, one potential shortcoming of the data is the significant over–representation of large companies.

We also apply a few sample selection criteria to the original sample. First, we set all negative values for all variables in the sample as missing. Second, we set observations as missing if the values of ratio variables are lower than 1st percentile or higher than 99th percentile. We decided to use the screened data to reduce the potential impact of outliers upon the parameter estimates. After the screening and including only manufacturing sector firms we obtain on average 700 firms' quarterly characteristics.

In order to construct firm-specific variables we utilize COMPUSTAT variables Long-term debt (item $data9$) and Total Assets (item $data6$) for the leverage ratio, Cash and Short–Term Investments (item $data1$), Capital Expenditures ($data90$ item), Sales (item $data12$) for the Cash–to–Asset ratio ($Cash/TA$), the Investment–to–Asset ratio (I/TA) and the Sales–to–Asset ratio (S/TA).

Table 2 presents descriptive statistics for the firm–specific variables. The median long-term debt as a percentage of total assets is 19% compared to the mean of 21%. We subdivide the data of manufacturing–sector firms (two–digit SIC 20–39) into producers of durable goods and producers of non–durable goods on the basis of firms' primary SIC codes. A firm is considered DURABLE if its primary SIC is 24, 25, 32–39.[15] SIC classifications for NON–DURABLE industries are 20–23 or 26–31.[16] As a control variable, we also use the detrended index of leading indicators ($Leading_t$). It is computed from DRI-McGraw Hill Basic Economics series DLEAD.

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[15] These industries include lumber and wood products, furniture, stone, clay, and glass products, primary and fabricated metal products, industrial machinery, electronic equipment, transportation equipment, instruments, and miscellaneous manufacturing industries.

[16] These industries include food, tobacco, textiles, apparel, paper products, printing and publishing, chemicals, petroleum and coal products, rubber and plastics, and leather products makers.

In order to detrend we regress the index on a trend and constant, and retain the generated residuals.

3.2 Empirical results

In this section we present the estimation results on the link between the leverage level of the firm and both firm–specific and macroeconomic variables. Based on the predictions of the dynamic stochastic partial equilibrium model, we hypothesize that non-financial firms decrease their level of debt as uncertainty increases.

The results of estimating Equation (11) are given in Tables 3, 4 and 5 for all manufacturing firms, durable–goods makers and non–durable goods makers respectively. Column (1) of Table 3 represents the Arellano–Bond one–step GMM estimator with the weighted conditional variance of industrial production and the weighted conditional variance of money growth as proxies for macroeconomic uncertainty. Column (2) contains results from the two–step GMM estimator. We include the detrended index of leading indicators ($Leading_{t-1}$) in order to control for the macroeconomic environment. The models are estimated using an orthogonal transformation instrumented by all available moment restrictions starting from $(t-2)$.[17] As instruments we use B/TA_{t-2} to B/TA_{t-7}, $CASH/TA_{t-2}$ to $CASH/TA_{t-7}$, I/TA_{t-2} to I/TA_{t-7}, and S/TA_{t-2} to S/TA_{t-7}.

Columns (3) and (4) include one–step and two–step system GMM results with the same proxies for macroeconomic uncertainty. In addition to instruments for transformed equations (B/K_{t-2} to B/TA_{t-7}, $CASH/TA_{t-2}$ to $CASH/TA_{t-7}$, I/TA_{t-2} to I/TA_{t-7}, S/TA_{t-2} to S/TA_{t-7}) we also use instruments for level equations ($\Delta S/TA_{t-1}$

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[17] The orthogonal transformation uses

$$x*_{it} = \left(x_{it} - \frac{x_{i(t+1)} + ... + x_{iT}}{T-t}\right)\left(\frac{T-t}{T-t+1}\right)^{1/2}$$

where the transformed variable does not depend on its lagged values.

to $\Delta S/TA_{t-2}$, $\Delta CASH/TA_{t-1}$ to $\Delta CASH/TA_{t-2}$, and $\Delta I/TA_{t-1}$ to $\Delta I/TA_{t-2}$). All regressions include a constant and industry dummies. Moreover, two–step results are estimated using a finite sample correction (Windmeijer 2000).

The Sargan test results for one–step DPD estimates are not successful. However, Sargan test has an asymptotic chi–squared distribution only in the case of homoscedastic error terms. In order to correctly interpret the results coming from the Sargan test, it is imported to understand the reason why the null hypothesis of correct specification of the model may be rejected.[18] The validity of instruments is checked using two–step results, and we cannot then reject the validity of overidentifying restrictions.

Our main finding is that there is a negative and significant relationship between leverage and macroeconomic uncertainty. The coefficients for the uncertainty variables takes values from -0.0305 to -0.0458 for industrial production proxy and from -0.0632 to -0.0663 for money growth proxy respectively.

The results also suggest significant positive persistence in the leverage ratio (0.8261–0.9283). The coefficients for the $Cash/TA_t$ and $Sale/TA_t$ ratios are negative and significant and correspond to our model predictions. The coefficients are marginally significant for I/TA_{t+1}. However, the coefficient for I/TA_t is perversely signed, but weakly significant. Finally, overall economic conditions, as captured by the index of leading indicators, positively affects the leverage ratio of US non–financial firms.

We find an interesting contrast in the results for durable goods makers and non–durable goods makers reported in Tables 4 and 5. Durable goods makers exhibit negative significant effects for macroeconomic uncertainty proxied by weighted conditional variance of money growth. The coefficient for durable good makers is larger in absolute magnitude than that estimated for all firms. As these companies have larger inventories of work in progress and have a longer production cycle they are

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[18] Arellano & Bond (1991) mention that the Sargan test on the one–step estimation often leads to rejection of the null hypothesis that the overidentifying restrictions are valid.

more sensitive to volatility in monetary policy, including money growth. At the same time, they are not sensitive to uncertainty derived from industrial production, while non–durable goods makers are more sensitive to this type of uncertainty.

The results for firm–specific variables for durable/non–durable goods makers follow the pattern of the sample of all firms. The puzzle of significance of a negative coefficient for I/TA_t still exists for durable goods makers but disappears when we use data for non–durable goods makers.

In summary, we find strong support for the hypothesis of Equation (11). Firms decrease their borrowing in more uncertain times. The results differ for durable good makers and non–durable manufacturers. When the macroeconomic environment becomes more uncertain, companies become more cautious and borrow less, even when they might expect to face decreased revenues and potential cashflow shortages. Note that these results confirm the results regarding the impact of uncertainty on investment reported in Bloom, Bond & Reenen (2001).

4 Conclusions

This paper investigates the relationship between leverage of manufacturing firms and macroeconomic uncertainty using quarterly COMPUSTAT data. Based on the theoretical predictions developed using the well-established Q model of investment, we anticipate that firms decrease their use of debt when macroeconomic uncertainty increases. In order to empirically test our model we employ dynamic panel data methodology. The results suggest negative and significant effects of macroeconomic uncertainty on leverage for US non–financial firms during 1991–2001.

There are significant differences in the results for durable goods makers and non–durable goods manufacturers. The former exhibit a larger sensitivity to macroeconomic uncertainty reflected by money growth, while the latter reacted more vigorously to changes in industrial production volatility. Our results are shown to be robust to inclusion of the index of leading indicators.

From the policy perspective, we suggest that macroeconomic uncertainty has an effect on nonfinancial firms' capital structure which in turn affects their dynamics of investment. Other studies (see Bernanke & Gertler (1989)) have shown that balance sheet shocks may affect the amplitude of investment cycles in a simple neoclassical model. Moreover, in many countries monetary policy tends to be persistent in the direction of change of the monetary instrument, with rare reversals (perhaps reflecting central banks' interest rate smoothing objectives). Therefore, firms' sensitivity to macroeconomic uncertainty should be taken into account if more activist monetary policies are contemplated.

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Appendix A: Construction of leverage, macroeconomic and firm specific measures

The following variables are used in the quarterly empirical study.

From the COMPUSTAT database:

DATA1: Cash and Short–Term Investments
DATA6: Total Assets
DATA9: Long-Term Debt
DATA12: Sales
DATA90: Capital Expenditures

From International Financial Statistics:

64IZF: Industrial Production monthly

From the DRI–McGraw Hill Basic Economics database:

DLEAD: index of leading indicators
FMBASE: real monetary base

Table 1: GARCH (2,1) proxies for macroeconomic uncertainty.

	$\log(IP)_t$	MON_t
$\log(IP)_{t-1}$	0.9812***	
	[0.0099]	
MON_{t-1}		1.0172***
		[0.0026]
Constant	0.0006	0.0002*
	[0.0006]	[0.0001]
AR(1)	0.8076***	0.0030
	[0.0680]	[0.0278]
MA(1)	-0.5904***	-0.9779***
	[0.0968]	[0.0038]
ARCH(1)	0.2915***	1.0512***
	[0.0542]	[0.0377]
ARCH(2)	-0.2039***	-0.9973***
	[0.0497]	[0.0361]
GARCH(1)	0.8888***	0.9717***
	[0.0305]	[0.9717]
Constant	0.0000**	-0.0000*
	[0.0000]	[0.0000]
Observations	535	677

Note: Models fit to detrended log(Industrial production) and to money growth. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: Descriptive Statistics

All firms	μ	σ^2	$p25$	$p50$	$p75$
$\frac{B_t}{TA_t}$	0.2140	0.0258	0.0872	0.1896	0.3083
$\frac{I_t}{TA_t}$	0.0372	0.0357	0.0131	0.0269	0.0495
$\frac{Cash_t}{TA_t}$	0.0747	0.0097	0.0117	0.0329	0.0969
$\frac{S_t}{TA_t}$	0.3064	0.0211	0.2117	0.2832	0.3721
Durable					
$\frac{B_t}{TA_t}$	0.2047	0.0252	0.0792	0.1771	0.2969
$\frac{I_t}{TA_t}$	0.0360	0.0355	0.0126	0.0258	0.0472
$\frac{Cash_t}{TA_t}$	0.0797	0.0102	0.0136	0.0376	0.1054
$\frac{S_t}{TA_t}$	0.0205	0.0211	0.2177	0.2881	0.3734
Non–Durable					
$\frac{B_t}{TA_t}$	0.2268	0.0264	0.1017	0.2059	0.3215
$\frac{I_t}{TA_t}$	0.0387	0.0359	0.0139	0.0285	0.0524
$\frac{Cash_t}{TA_t}$	0.0676	0.0090	0.0098	0.0275	0.0873
$\frac{S_t}{TA_t}$	0.2995	0.0217	0.2023	0.2763	0.3693

Note: p25, p50 and p75 represent the quartiles of the distribution, while σ^2 and μ represent its variance and mean respectively.

Table 3: Determinants of Leverage: All Firms

	GMM		GMM-System	
Variable	1–Step	2–step	1–step	2–step
B/TA_{t-1}	0.8261***	0.8261***	0.9274***	0.9283***
	[0.0166]	[0.0166]	[0.0054]	[0.0054]
C/TA_t	-0.0744***	-0.0739***	-0.0480***	-0.0478***
	[0.0101]	[0.0101]	[0.0055]	[0.0055]
I/TA_t	-0.0286*	-0.0283*	-0.0186	-0.0189
	[0.0162]	[0.0162]	[0.0148]	[0.0147]
I/TA_{t+1}	-0.0205	-0.0206	0.00766	0.00718
	[0.0138]	[0.0136]	[0.0138]	[0.0138]
S/TA_t	-0.0864***	-0.0865***	-0.0418***	-0.0411***
	[0.0089]	[0.0089]	[0.0039]	[0.0040]
CV_MON_{t-1}	-0.0644***	-0.0632***	-0.0663***	-0.0628***
	[0.0173]	[0.0172]	[0.0159]	[0.0158]
CV_IP_{t-1}	-0.0321**	-0.0305**	-0.0458***	-0.0423***
	[0.0150]	[0.0148]	[0.0145]	[0.0144]
$Leading_{t-1}$	0.0008***	0.0007***	0.0009***	0.0008***
	[0.0002]	[0.0002]	[0.0001]	[0.0001]
Sargan	0.000	0.384	0.000	0.999
df	875	875	1039	1039
LM(1)	-13.48***	-12.08***	-12.88***	-12.43***
LM(2)	0.7018	0.6969	0.7139	0.7110
N. Obs	24106	24106	25042	25042

Note: Every equation includes constant and industry dummy variables. Asymptotic robust standard errors are reported in the brackets. Estimation by GMM using the DPD package for Ox. Sargan is a Sargan–Hansen test of overidentifying restrictions (p–value reported). LM (k) is the test for *k*-th order autocorrelation. Instruments for GMM estimations are B/TA_{t-2} to B/TA_{t-7}, $CASH/TA_{t-2}$ to $CASH/TA_{t-7}$, I/TA_{t-2} to I/TA_{t-7}, and S/TA_{t-2} to S/TA_{t-7}. Instruments for GMM-SYSTEM estimations are B/K_{t-2} to B/TA_{t-7}, $CASH/TA_{t-2}$ to $CASH/TA_{t-7}$, I/TA_{t-2} to I/TA_{t-7}, S/TA_{t-2} to S/TA_{t-7} and $\Delta S/TA_{t-1}$ to $\Delta S/TA_{t-2}$, $\Delta CASH/TA_{t-1}$ to $\Delta CASH/TA_{t-2}$, and $\Delta I/TA_{t-1}$ to $\Delta I/TA_{t-2}$.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Determinants of Leverage: Durable goods–makers Firms

	GMM		GMM-System	
Variable	1–Step	2–step	1–step	2–step
B/TA_{t-1}	0.8174***	0.8182***	0.9199***	0.9214***
	[0.0222]	[0.0219]	[0.0077]	[0.0077]
C/TA_t	-0.0775***	-0.0725***	-0.0460***	-0.0454***
	[0.0141]	[0.0131]	[0.0076]	[0.0077]
I/TA_t	-0.0660***	-0.0555**	-0.0506**	-0.0468**
	[0.0242]	[0.0233]	[0.0222]	[0.0215]
I/TA_{t+1}	-0.0286	-0.0301*	0.00895	0.00703
	[0.0191]	[0.0180]	[0.0196]	[0.0194]
S/TA_t	-0.1047***	-0.1021***	-0.0481***	-0.0474***
	[0.0126]	[0.0123]	[0.0053]	[0.0053]
CV_MON_{t-1}	-0.0812***	-0.0672***	-0.0873***	-0.0828***
	[0.0224]	[0.0219]	[0.0209]	[0.0210]
CV_IP_{t-1}	-0.0232	-0.0166	-0.0410**	-0.0402**
	[0.0206]	[0.0196]	[0.0199]	[0.0198]
$Leading_{t-1}$	0.0008**	0.0006	0.0011***	0.0010***
	[0.0004]	[0.0003]	[0.0002]	[0.0002]
Sargan	0.000	0.282	0.000	0.982
df	443	443	607	607
LM(1)	-9.880***	-8.926***	-9.548***	-9.184***
LM(2)	0.7790	0.7777	0.7816	0.7758
N. Obs	14176	14176	14731	14731

Note: Every equation includes constant and industry dummy variables. Asymptotic robust standard errors are reported in the brackets. Estimation by GMM using the DPD package for Ox. Sargan is a Sargan–Hansen test of overidentifying restrictions (p–value reported). LM (k) is the test for k-th order autocorrelation. Instruments for GMM estimations are B/TA_{t-2} to B/TA_{t-4}, $CASH/TA_{t-2}$ to $CASH/TA_{t-4}$, I/TA_{t-2} to I/TA_{t-4}, and S/TA_{t-2} to S/TA_{t-4}. Instruments for GMM-SYSTEM estimations are B/K_{t-2} to B/TA_{t-4}, $CASH/TA_{t-2}$ to $CASH/TA_{t-4}$, I/TA_{t-2} to I/TA_{t-4}, S/TA_{t-2} to S/TA_{t-4} and $\Delta S/TA_{t-1}$ to $\Delta S/TA_{t-2}$, $\Delta CASH/TA_{t-1}$ to $\Delta CASH/TA_{t-2}$, and $\Delta I/TA_{t-1}$ to $\Delta I/TA_{t-2}$. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Determinants of Leverage: Non durable goods-makers

	GMM		GMM-System	
Variable	1–Step	2–step	1–step	2–step
B/TA_{t-1}	0.8726***	0.8727***	0.9401***	0.9421***
	[0.0208]	[0.0203]	[0.0066]	[0.0065]
C/TA_t	-0.0667***	-0.0619***	-0.0499***	-0.0483***
	[0.0129]	[0.0125]	[0.0076]	[0.0078]
I/TA_t	0.0262	0.0221	0.0247	0.0292*
	[0.0187]	[0.0177]	[0.0175]	[0.0169]
I/TA_{t+1}	0.0061	0.0083	0.0049	0.0038
	[0.0193]	[0.0195]	[0.0184]	[0.0180]
S/TA_t	-0.0624***	-0.0622***	-0.0329***	-0.0322***
	[0.0112]	[0.0115]	[0.0057]	[0.0057]
CV_MON_{t-1}	-0.0380	-0.0377	-0.0363	-0.0405
	[0.0270]	[0.0242]	[0.0242]	[0.0234]
CV_IP_{t-1}	-0.0491**	-0.0489**	-0.0522**	-0.0487**
	[0.0211]	[0.0196]	[0.0207]	[0.0201]
$Leading_{t-1}$	0.0006	0.0008*	0.0005**	0.0006**
	[0.0004]	[0.0004]	[0.0002]	[0.0002]
Sargan	0.000	0.358	0.000	1.000
df	295	295	459	459
LM(1)	-10.52***	-9.912***	-10.37***	-10.13***
LM(2)	0.04574	0.04491	0.0456	0.0469
N. Obs	9930	9930	10311	10311

Note: Every equation includes constant and industry dummy variables. Asymptotic robust standard errors are reported in the brackets. Estimation by GMM using the DPD package for Ox. Sargan is a Sargan–Hansen test of overidentifying restrictions (p–value reported). LM (k) is the test for k-th order autocorrelation. Instruments for GMM estimations are B/TA_{t-2} to B/TA_{t-3}, $CASH/TA_{t-2}$ to $CASH/TA_{t-3}$, I/TA_{t-2} to I/TA_{t-3}, and S/TA_{t-2} to S/TA_{t-3}. Instruments for GMM-SYSTEM estimations are B/K_{t-2} to B/TA_{t-3}, $CASH/TA_{t-2}$ to $CASH/TA_{t-3}$, I/TA_{t-2} to I/TA_{t-3}, S/TA_{t-2} to S/TA_{t-3} and $\Delta S/TA_{t-1}$ to $\Delta S/TA_{t-2}$, $\Delta CASH/TA_{t-1}$ to $\Delta CASH/TA_{t-2}$, and $\Delta I/TA_{t-1}$ to $\Delta I/TA_{t-2}$. * significant at 10%; ** significant at 5%; *** significant at 1%.