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 1993–2003. The estimates confirm that as macroeconomic uncertainty increases, firms decrease their levels of leverage. Furthermore, similar firms react differently to different macroeconomic uncertainty proxies. 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.

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. In this paper we intend to shed some light on the issue why firms change their decisions about initial offerings. A firm might apply for external financing because of firm–specific problems, but it could be a case when it is just a good time to get funds.

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

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

[2] Ibid.

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 levels of capital structure indicators is rather scarce. @e intend to contribute to the literature on corporate structure by analyzing the impact of macroeconomic uncertainty on the optimal level of leverage.

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 macroeconomic 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 1993–2003 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, defining categories of durable–goods makers vs. non–durable goods makers. We apply the Arellano and 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 industrial production, CPI inflation, S&P 500 index and index of leading indicators. Moreover, results differ across different groups of the firms. 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.

[3]See for example Gilchrist and Himmelberg (1998); Fazzari, Hubbard and Petersen (1988).
[4]See Johnson (1997); Biais and Casamatta (1999); Weill (2001).

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 Whited (1992) and Hubbard and 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.

$$V_t(K_t) = \max_{\{I_{t+s}, B_{t+s+1}\}_{s=0}^{\infty}} D_t + E_t \left[\sum_{s=1}^{\infty} \beta^{t+s-1} D_{t+s} \right], \tag{1}$$

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{2}$$

$$D_t = \Pi(K_t) - C(I_t, K_t, \varepsilon_t) - I_t + B_{t+1} - B_t R(\tau_t)\eta(B_t, K_t), \tag{3}$$

$$D_t \geq 0, \tag{4}$$

$$\lim_{T\to\infty} \left[\prod_{j=t}^{T-1} \beta_j \right] B_T = 0, \forall t \tag{5}$$

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 $\Pi(K_t)$ denotes the maximized value of current profits taking as given the beginning–of–period capital stock. $C(I_t, K_t, \varepsilon_t)$ is the real cost of adjusting I_t units of capital, which is affected by idiosyncratic uncertainty measure ε_t.

The price of external financing is equal to base gross interest rate, $R(\tau_{t+1})$, multiplied by an external premium, $\eta(B_{t+1}, K_{t+1})$ which depends on firm–specific characteristics such as debt, capital stock. Note, that the base interest rate is assumed to be a positive monotonic function of macroeconomic uncertainty, τ_{t+1}. Similar to Gilchrist and

Himmelberg (1998), we also assume $\eta_{B,t} > 0$: i.e., highly indebted firms must pay an additional premium to compensate debt–holders for additional costs because of monitoring or hazard problems. Moreover, $\eta_{K,t} < 0$: i.e., large firms enjoy a lower risk premium. Finally, B_t denotes financial liabilities of the firm.

At time t, all present values and B_{t+1} are known with certainty while all future variables are stochastic. In order to isolate the role of debt financing we assume that equity financing is too expensive and firms prefer debt financing only. Furthermore, managers are assumed to have rational expectations.

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 (5) 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:

$$C_{I,t} + 1 = E_t \left[\beta \Theta_t \left(\Pi_{K,t+1} + (1-\delta)\left(C_{I,t+1} + 1\right) - R_{t+1}\eta_{K,t+1}B_{t+1}\right)\right] \tag{6}$$

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 ($\lambda_{t+1} = \lambda_t$).[5]

From the first-order conditions for debt we derive:

$$E_t \left[\beta \Theta_t R_{t+1} \left(\eta_{t+1} + \eta_{B,t+1} B_{t+1}\right)\right] = 1. \tag{7}$$

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

Combining the first order conditions and ignoring covariances terms we receive the optimal level for borrowing

$$B_{t+1} = \frac{E_t\{\Pi_{K,t+1}\Theta_t\} + (1-\delta)E_t\{\Theta_t C_{I,t+1}\} - E_t\{\Theta_t \eta_{t+1}\}E_t\{R(\tau_{t+1})\} - 1/\beta C_{I,t}}{\eta_B E_t\{\Theta_t\}E_t\{R(\tau_{t+1})\} + \eta_K E\{R(\tau_{t+1})\}} \tag{8}$$

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

From equation (8) we obtain

$$\frac{\partial B_{t+1}}{\partial \tau_{t+1}} = \frac{\partial B_{t+1}}{\partial E_t\{R(\tau_{t+1})\}} \frac{\partial E_t\{R(\tau_{t+1})\}}{\partial \tau_{t+1}} < 0 \tag{9}$$

Compared to frictionless economy, the firm facing higher costs of external financing, caused by increase in macroeconomic volatility, decreases its borrowing.

2.2 Econometric Specification

We test the hypothesis that macroeconomic uncertainty affects firms' debt decisions based directly on the Euler equation (6). It relates the optimal level of debt, B_{t+1}, with the marginal profit of capital, $\Pi_{K,t+1}$, the marginal adjustment cost of investment, $C_{I,t}$, the expected marginal adjustment cost, $E_t\{C_{I,t+1}\}$, the relative shadow cost of external financing, Θ_t, and expected base interest rate which is a function of macroeconomic uncertainty, $R(\tau_{t+1})$.

To obtain the Euler equation for estimation it is necessary to parameterize the adjustment cost function, $C_{I,t}$. As in Chirinko (1987) and Hayashi (1982), we utilize an adjustment cost function given by $C(I_t, K_t) = \alpha/2\,(I_t/K_t - \nu_i)^2\,K_t$. The parameter ν_i might be interpreted as a firm-specific optimal level of investment. The marginal adjustment cost of investment of a firm i at time t is given by:

$$C_{I,it} = \alpha\left(\frac{I_{it}}{TA_{it}} - \nu_i\right) \tag{10}$$

where TA_{it} is total assets of firm i at time t.

In order to introduce idiosyncratic uncertainty into the model, we parameterize expected marginal adjustment cost as the realized $(I/K)_{i,t+1}$ plus idiosyncratic uncertainty term and a forecast $E_tC(I_{t+1}, K_{t+1}) = E_t\left\{\frac{\alpha}{2}\left(\frac{I_{t+1}}{K_{t+1}} - \nu_i + b\varepsilon_{t+1}\sqrt{\frac{I_{t+1}}{K_{t+1}}}\right)^2 K_{t+1}\right\} = E_t\left\{\frac{\alpha}{2}\left(\frac{I_{t+1}}{K_{t+1}} - \nu_i\right)^2\right\}K_{t+1} + \frac{\alpha b^2}{2}E_t\left\{\varepsilon_{t+1}^2\right\}I_{t+1}$, where ε_{t+1} is a idiosyncratic shock independent of $\frac{I_{t+1}}{K_{t+1}}$ and ν_i. $E_t\left\{\varepsilon_{t+1}^2\right\}$ could be written as $E_t\left\{\varepsilon_{t+1}^2\right\} = \phi_{t+1}$. Then the expected marginal adjustment cost of a firm i at time t is:

$$E_t\left\{C_{I,it+1}\right\} = \alpha\left(E_t\left\{\frac{I_{it+1}}{TA_{it+1}}\right\} - \nu_i\right) + \frac{\alpha b^2\phi_t}{2} \tag{11}$$

The marginal profit of capital is parameterized using a sales–based measure[6]

$$\Pi_{K,it+1} = \theta \frac{S_{it}}{TA_{it}} \tag{12}$$

where S is the firm's sales, TA is the total assets, $\theta = \frac{\alpha_k}{\mu}$, 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).

In order to implement Euler equation estimation we linearize the product of β_t, Θ_t and A_t, where $A_t = \Pi_{K,t+1} + (1-\delta)(C_{I,t+1}+1) - R(\tau_{t+1})\eta_{K,t+1}B_{t+1}$. We utilize a first–order Taylor approximation around the means. Ignoring constant terms, the approximation is equal to:[7]

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

where $\overline{\beta}$ is the average discount factor and γ denotes the unconditional mean of A_t.

The level of financing constraint for a representative firm i at time t, Θ_{it}, is a function of their stock of cash and level of debt:

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

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 and Whited (1995); Almeida, Campello and Weisbach (2004); Gilchrist and Himmelberg (1998)).

Finally, the basic interest rate $R(\tau t+1)$ is assumed to be a linear function of macroeconomic uncertainty and index of leading indicator, which represents the overall economic health.

$$R(\tau_t) = \xi_1\tau_t + \xi_2 Leading_t \tag{13}$$

The resulting empirical specification is:[8]

$$\frac{B_{it}}{TA_{it}} = \beta_0 + \beta_1 \frac{B_{it-1}}{TA_{it-1}} + \beta_2 \frac{Cash_{it}}{TA_{it}} + \beta_3 \frac{S_{it}}{TA_{it}} + \beta_4 \frac{I_{it+1}}{TA_{it+1}} + \beta_5 \frac{I_{it}}{TA_{it}} \tag{14}$$

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

[7]See also Love (2003)

[8]Debt is scaled 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.

$$+ \quad \beta_6 \tau_{t-1} + \beta_7 \phi_t + \beta_8 Leadinc_{t-1} + f_i + Ind_i + e_{it}$$

Since COMPUSTAT gives end–of–period values for firms, we include lagged proxies for uncertainty and macroeconomic "health" in the regressions rather than contemporaneous proxies. Thus, we can say that recently–experienced volatility will affect firms' behavior. Moreover, we control for industry specific effects using industry dummies Ind_i. The main hypothesis of our paper can be stated as:

$$H_0 : \beta_6 < 0 \tag{15}$$

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, $\beta_1 > 0$.

The main aim of our study is to investigate whether robust results are obtained using different uncertainty measures, not to identify every structural model coefficient.[9]

2.3 Identifying Uncertainty

The macroeconomic uncertainty identification approach resembles that of Baum, Caglayan, Ozkan and Talavera (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 and Loungani (2000)), standard deviation across 12 forecasting terms of output growth and inflation rate in the next 12 month (see Driver and Moreton (1991)). However, as in Driver, Temple and Urga (2005) and Byrne and 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.

[9] It is possible to show that all β's are functions of model parameters, but it is not possible to identify every parameter without making non–justifiable assumptions.

To ensure that our empirical findings are not an artifact of a single choice of proxy, we construct four proxies for macroeconomic uncertainty from the conditional variances of index of leading indicators, the index of industrial production, the rate of consumer price inflation and returns on the S&P 500 stockmarket index. Each of these measures captures different elements of the uncertainty perceived by firms' managers relating to the macroeconomic environment; the mean bivariate correlation among the four measures is 0.51. Qualitatively similar findings across each of these proxies lend strength to tests of our hypothesis.

The first proxy employed is the conditional variance of index of leading indicators (DRI-McGraw Hill Basic Economics series $DLEAD$) as a measure of overall macroeconomic activity. The second proxy is derived from the monthly index of industrial production itself (International Financial Statistics series $66IZF$). This is a narrower measure, focusing on industrial activity and omitting the service–sector activity which has become increasingly important to the US economy. The third proxy, designed to pick up uncertainty related to nominal magnitudes, is derived from the monthly rate of consumer price inflation (International Financial Statistics series $64XZF$). The last proxy, focused on financial market uncertainty, is derived from the monthly returns on Standard and Poor's 500 share index (from CRSP Stockmarket Indices).

The conditional variances of each of these variables is estimated with a generalized ARCH (GARCH) model, where the mean equation is a first–order autoregression, allowing for ARMA errors.[10] The specifics of the GARCH models are provided in Table 1.[11] Each GARCH model's estimated conditional variance series, τ_t, is then employed in a revised version of equation (14).

There are different measures of firm–specific risk employed in the literature. Bo and Lensink (2005) use three measures: stock price volatility, estimated as difference between the highest and the lowest stock price normalized by the lowest price; volatility of sales measured by a seven–year window coefficient of variation of sales; and volatility of number of employees estimated similar to volatility of sales. A slightly different

[10] Alternatively, some researchers suggest using a moving standard deviation of the macroeconomic series while others propose using survey–based measures based on the dispersion of forecasts. The former approach suffers from substantial serial correlation problems in the constructed series while the latter potentially contains sizable measurement errors.

[11] Unsurprisingly, the initial model for stock returns did not contain a statistically significant autoregressive term, so it was reestimated without a lagged dependent variable.

approach is used in Bo (2002). First, he sets up the forecasting AR(1) equation for the underlying uncertainty variable. Second, the unpredictable part of the fluctuations, the estimated residuals, are obtained. Third, the estimated three–year moving average standard deviation is obtained. As underlying variables the author uses sales and interest rates.

In contrast to the mentioned firm uncertainty measures, we employ the standard deviation of close price for the stock of firm during last nine months.[12] This measure is calculated using COMPUSTAT items $data12$, 1st month of quarter close price; $data13$, 2nd month of quarter close price; $data14$, 3rd month of quarter close price; and their first and second lags. We suggest that volatility of stock prices reflect not only sales or costs uncertainty, but also captures other idiosyncratic risks.

3 Empirical Implementation

3.1 Dataset

We work with the COMPUSTAT Industrial Quarterly database of U.S. firms. The initial databases include 201,552 firms' quarterly characteristics over 1993–2000. The 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 800 firms' quarterly characteristics.

Table 2 provides descriptive statistics of the firms and macroeconomic uncertainty proxies. All firm–specific variables are from COMPUSTAT and is measured at the fiscal year–end. The leverage ratio, B/TA is defined as the ratio of Short-term Debt (item $data45$) to Total Assets (item $data6$). The Cash–to–Asset ratio (C/TA), the Investment–

[12]To check the robustness of our results to the change of window of variation we also try standard deviation of close price for the stock during last 6 months and we receive quantitatively similar results.

to–Asset ratio (I/TA) and the Sales–to–Asset ratio (S/TA) are defined as Cash and Short–Term Investments (item $data1$) to total assets ratio, Capital Expenditures ($data90$ item) to total assets ratio, Sales (item $data12$) to total assets ratio, respectively.

In our analysis of subsamples of firms, we focus on the applicability of the general model to a group of firms having similar characteristics instead of formal testing for differences between groups of firms, which would necessitate the imposition of constraints across those groups. Furthermore, our groupings are not mutually exhaustive, but designed to identify firms which are strongly classified as, e.g., large or high–leveraged firms. Thus, a strategy based on category indicators would not be appropriate, since many firms will not fall in the group defined by either extreme.

Table 3 breaks down the data across different groups of firms. First, we subdivide the 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.[13] SIC classifications for non–durable industries are 20–23 or 26–31.[14] The characteristics of durable and non–durable goods producers are similar, but the former have higher liquidity ratio.

We categorize firms into high–liquidity and low–liquidity categories, defining firms as above the 75th percentile and below the 25th percentile of the annual distribution of liquidity ratio, respectively. Low liquidity firms have higher leverage and sales to total assets ratios comparing to high liquidity counterparts.

Finally, we define firms as high–leveraged (large) and low leveraged (small) if their leverage ratio (total assets) is above 75th percentile and below the 25th percentile, respectively. Small firms and low leveraged firms keep twice as much of liquid assets comparing to large firms and high leveraged firms, respectively.

3.2 Empirical results

In this section we present the estimation results on the link between the leverage level of the firm and macroeconomic uncertainty variables. Based on the predictions of the

[13]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.

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

dynamic stochastic partial equilibrium model, we hypothesize that non-financial firms decrease their level of debt as uncertainty increases.

The results of estimating Equation (15) are given in Tables 4, 5 and 6 for all manufacturing firms and subsamples. Columns (1)-(4) of Table 4 represent the Arellano–Bond one–step GMM SYSTEM estimator with the lagged conditional variance of industrial production, inflation, S&P index and index of leading indicators, respectively. [15] The models are estimated using first differences transformation instrumented by all available moment restrictions starting from $(t-2)$.The models are estimated using an orthogonal transformation for cleaning the firm specific effect.[16] As instruments we use B/TA_{t-3} to B/TA_{t-5}, $CASH/TA_{t-2}$ to $CASH/TA_{t-5}$, I/TA_{t-2} to I/TA_{t-5}, and S/TA_{t-2} to S/TA_{t-5} for difference equations and $\Delta S/TA_{t-1}$, $\Delta CASH/TA_{t-1}$, and $\Delta I/TA_{t-1}$ for level equations. 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.[17] 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 -0.2007 for industrial production proxy to -1.5489 for index of leading indicators measure.

The results also suggest significant positive persistence in the leverage ratio (0.5191 – 0.5788). 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

[15] We also estimated the model using one–step GMM, two–step GMM and GMM–SYSTEM estimations. None of our results are affected by any of these experiments, the results of which are available upon request.

[16] To check robustness of our results we also try orthogonal transformations and get similar results. 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.

[17] Arellano and 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.

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 the first two panels of Table 5. Durable goods makers exhibit negative significant effects for macroeconomic uncertainty proxied by conditional variance of inflation and index of leading indicators. 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 more sensitive to volatility in real economy. At the same time, non–durable goods producers are more sensitive to macroeconomic uncertainty originated from financial markets. Table 5 also shows that there is negative and statistically significant relationship between volatility of the index of leading indicators and short term debt to assets ratio for low liquidity firms. The high liquidity firms leverage is found to be sensitive to volatility of S&P 500 index while the high liquidity firms change their short term debt to total assets ratio when volatility of index of leading indicators increases.

In Table 6, we investigate the effects of uncertainty on small, large, low leveraged and high leveraged firms. For the low leveraged firms, the effects of macroeconomic uncertainty from financial markets are substantial, whereas for the high leveraged firms macroeconomic uncertainty from financial markets does not appear to have any significant effect (although the point estimates are uniformly negative). However, there is negative and significant effect of volatility of index of leading indicators on leverage of high leveraged firms. This finding may indicate that high–leveraged firms may not be as flexible to frequent changes in macroeconomy (the S&P index measure has twice higher volatility as the index of leading indicators proxy) as low–leveraged firms due to costs of attracting additional external financing.

The common finding is that uncertainty will reduce the dispersion of cash–to–asset ratios for both small and large firms, although uncertainty has a much more substantial effect on smaller firms. The coefficients for macroeconomic uncertainty are negative and significant at the 5% or 10% level for index of leading indicators proxy large firms

In summary, we find strong support for the hypothesis of Equation (15). Firms decrease their borrowing in more uncertain times. The results differ for different groups of companies having similar characteristics. 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 cash flow shortages. Note that these results confirm the results regarding the impact of uncertainty on investment reported in Bloom, Bond and Reenen (2001).

4 Conclusions

This paper investigates the relationship between leverage of manufacturing firms and macroeconomic uncertainty using quarterly COMPUSTAT data. We have developed an empirical model of optimal leverage ratio based on the Euler equation of the standard neoclassical model of capital accumulation subject to adjustment costs. This model is extended to the case when the firm increases its leverage ratio, it faces higher costs of external financing. Based on the theoretical predictions 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 1993–2003.

There are significant differences in the results for different firms' subsamples. Non–durable goods makers, high–liquidity and low leveraged firms exhibit a larger sensitivity to macroeconomic uncertainty reflected by financial markets, while the durable goods makers, low–liquidity and high leveraged firms are sensitive to changed in index of leading indicators. 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 and 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 the DRI–McGraw Hill Basic Economics database:
DLEAD: index of leading indicators

From IMF International Financial Statistics:
66IZF: Industrial Production monthly
64XZF: Consumer Price Inflation

From CRSP Stock Market Indices:
S&P 500 Monthly Returns

Table 1: GARCH proxies for macroeconomic uncertainty

	Leading	log(*IndProdn*)	*CPI Inflation*	*S&P* 500
Lagged dep.var.	0.899	0.981	0.989	
	(0.14)***	(0.00)***	(0.00)***	
Constant	0.080	0.001	0.000	0.007
	(0.13)	(0.00)	(0.00)	(0.00)***
AR(1)	0.909	0.808	0.285	0.907
	(0.14)***	(0.07)***	(0.04)***	(0.07)***
AR(2)				-0.918
				(0.07)***
MA(1)	-0.608	-0.590		-0.941
	(0.06)***	(0.10)***		(0.08)***
MA(2)				0.907
				(0.07)***
ARCH(1)	0.063	0.292	0.089	0.019
	(0.02)***	(0.05)***	(0.02)***	(0.01)***
ARCH(2)		-0.204		
		(0.05)***		
GARCH(1)	0.901	0.889	0.872	1.805
	(0.01)***	(0.03)***	(0.03)***	(0.01)***
GARCH(2)				-0.839
				(0.04)***
Constant	0.007	0.000	0.000	0.000
	(0.00)	(0.00)**	(0.00)***	(0.00)***
Loglikelihood	1937.89	1860.48	2809.59	897.58
Observations	545	535	641	504

Note: OPG standard errors in parentheses. Models are fit to detrended log(IndProdn), CPI inflation, index of leading indicators and S&P 500 returns. ** significant at 5%; *** significant at 1%

Table 2: Descriptive Statistics

All firms	μ	σ^2	$p25$	$p50$	$p75$
B/TA_t	0.0504	0.0695	0.0034	0.0242	0.0672
I/TA_t	0.0327	0.0325	0.0107	0.0228	0.0434
S/TA_t	0.2902	0.1456	0.1959	0.2686	0.3595
C/TA_t	0.1077	0.1399	0.0157	0.0483	0.1455
ϕ_t	0.0318	0.0324	0.0115	0.0224	0.0400
CV_ip_t	0.0099	0.0030	0.0078	0.0086	0.0115
CV_infl_t	0.0022	0.0008	0.0015	0.0017	0.0029
CV_spret_t	0.0052	0.0019	0.0036	0.0050	0.0063
CV_dlead_t	0.0049	0.0008	0.0042	0.0047	0.0056

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

Table 3: Descriptive Statistics by subsample

	Durable		*Non durable*	
	μ	σ	μ	σ
B/TA_t	0.05	0.07	0.05	0.07
I/TA_t	0.03	0.03	0.03	0.03
S/TA_t	0.29	0.14	0.29	0.15
C/TA_t	0.12	0.14	0.09	0.13
ϕ_t	0.03	0.04	0.03	0.03
	Low liquidity		*High liquidity*	
	μ	σ	μ	σ
B/TA_t	0.06	0.08	0.03	0.06
I/TA_t	0.03	0.03	0.03	0.04
S/TA_t	0.31	0.13	0.25	0.17
C/TA_t	0.02	0.02	0.29	0.17
ϕ_t	0.03	0.02	0.04	0.04
	Small		*Large*	
	μ	σ	μ	σ
B/TA_t	0.06	0.09	0.06	0.07
I/TA_t	0.03	0.03	0.04	0.03
S/TA_t	0.31	0.17	0.26	0.12
C/TA_t	0.15	0.18	0.08	0.10
ϕ_t	0.01	0.02	0.04	0.04
	Low leverage		*High leverage*	
	μ	σ	μ	σ
B/TA_t	0.01	0.02	0.12	0.09
I/TA_t	0.03	0.03	0.03	0.03
S/TA_t	0.28	0.15	0.30	0.15
C/TA_t	0.17	0.18	0.07	0.09
ϕ_t	0.04	0.04	0.03	0.03

Note: σ^2 and μ represent variance and mean, respectively.

Table 4: Determinants of Leverage: All Firms

	Dependent variable: B/TA_t			
	(1)	(2)	(3)	(4)
B/TA_{t-1}	0.5191***	0.5788***	0.5351***	0.5703***
	[0.037]	[0.034]	[0.041]	[0.034]
S/TA_t	-0.0502***	-0.0441***	-0.0714***	-0.0339**
	[0.016]	[0.014]	[0.019]	[0.013]
C/TA_t	-0.0792***	-0.0971***	-0.0727***	-0.0854***
	[0.013]	[0.014]	[0.014]	[0.014]
I/TA_t	-0.0671***	-0.0704***	-0.0763***	-0.0723***
	[0.016]	[0.015]	[0.014]	[0.015]
I/TA_{t+1}	0.0195	0.0337*	0.0199	0.0420**
	[0.017]	[0.017]	[0.015]	[0.017]
$Leading_{t-1}$	0.0002	-0.0000	0.0004*	-0.0000
	[0.000]	[0.000]	[0.000]	[0.000]
ϕ_t	-0.0244**	-0.0159	-0.0183	-0.0227**
	[0.012]	[0.010]	[0.012]	[0.011]
CV_ip_{t-1}	-0.2007**			
	[0.102]			
CV_infl_{t-1}		-1.1402**		
		[0.497]		
CV_spret_{t-1}			-0.6822***	
			[0.262]	
CV_lead_{t-1}				-1.5489***
				[0.354]
Sargan	0.14	0.41	0.22	0.36
AR(1)	-10.630***	-11.820***	-9.621***	-11.780***
AR(2)	-1.227	-0.135	-0.998	-0.227

Note: Every equation includes constant and industry dummy variables. Asymptotic robust standard errors are reported in the brackets. Estimation by GMM SYSTEM 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-SYSTEM estimations are B/K_{t-3} to B/TA_{t-5}, $CASH/TA_{t-2}$ to $CASH/TA_{t-5}$, I/TA_{t-2} to I/TA_{t-5}, S/TA_{t-2} to S/TA_{t-5} and $\Delta S/TA_{t-1}$, $\Delta CASH/TA_{t-1}$, and $\Delta I/TA_{t-1}$.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Determinants of Leverage: Sample splits

	Dependent variable: B/TA_t			
	CV_ip_{t-1}	CV_infl_{t-1}	CV_spret_{t-1}	CV_lead_{t-1}
Non–durable				
ϕ_t	-0.0036	-0.0073	0.0101	-0.0120
	[0.021]	[0.019]	[0.020]	[0.019]
τ_{t-1}	-0.2276	-0.5862	-0.9607**	-1.8523***
	[0.176]	[0.787]	[0.453]	[0.579]
Durable				
ϕ_t	-0.0505***	-0.0321**	-0.0423***	-0.0408***
	[0.017]	[0.014]	[0.016]	[0.014]
τ_{t-1}	-0.1692	-1.4915**	-0.3905	-1.5332***
	[0.121]	[0.642]	[0.317]	[0.470]
Low liquidity				
ϕ_t	-0.0535*	-0.0529**	-0.0404*	-0.0531**
	[0.028]	[0.024]	[0.023]	[0.024]
τ_{t-1}	-0.1457	-0.9414	-0.3524	-1.7932***
	[0.161]	[0.876]	[0.385]	[0.674]
High liquidity				
ϕ_t	-0.0159	-0.0155	-0.0119	-0.0190
	[0.014]	[0.012]	[0.016]	[0.012]
τ_{t-1}	-0.0048	-0.4801	-0.9622**	-0.8832
	[0.166]	[0.744]	[0.488]	[0.651]

Note: Every equation includes constant, B/TA_{t-1}, S/TA_t, I/TA_t, I/TA_{t+1}, $Leading_{t-1}$ and industry dummy variables. Asymptotic robust standard errors are reported in the brackets. Estimation by GMM SYSTEM 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-SYSTEM estimations are B/K_{t-3}, $CASH/TA_{t-2}$, $CASH/TA_{t-3}$, I/TA_{t-2}, I/TA_{t-3}, S/TA_{t-2}, S/TA_{t-3} and $\Delta S/TA_{t-1}$, $\Delta CASH/TA_{t-1}$, and $\Delta I/TA_{t-1}$.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Determinants of Leverage: Sample splits

	Dependent variable: B/TA_t			
	CV_ip_{t-1}	CV_infl_{t-1}	CV_spret_{t-1}	CV_lead_{t-1}
Low leverage				
ϕ_t	-0.0045	-0.0047	-0.0014	-0.0049
	[0.005]	[0.005]	[0.005]	[0.005]
τ_{t-1}	-0.0543	0.2906	-0.4936***	0.0491
	[0.072]	[0.312]	[0.158]	[0.224]
High leverage				
ϕ_t	-0.0796**	-0.0935	-0.0720**	-0.1005***
	[0.037]	[0.036]	[0.037]	[0.036]
τ_{t-1}	-0.0845	-2.2579	-0.1716	-3.5600***
	[0.341]	[1.919]	[0.981]	[1.285]
Small				
ϕ_t	-0.1365**	-0.1263**	-0.0987*	-0.1441**
	[0.061]	[0.057]	[0.059]	[0.059]
τ_{t-1}	0.0072	-0.4102	-0.5109	-1.8950*
	[0.251]	[1.385]	[0.672]	[1.002]
Large				
ϕ_t	0.0043	0.0216	-0.0013	0.0156
	[0.018]	[0.016]	[0.020]	[0.016]
τ_{t-1}	-0.2793	-1.0223	-0.3129	-1.4347**
	[0.179]	[0.759]	[0.492]	[0.569]

Note: Every equation includes constant, B/TA_{t-1}, S/TA_t, I/TA_t, I/TA_{t+1}, $Leading_{t-1}$ and industry dummy variables. Asymptotic robust standard errors are reported in the brackets. Estimation by GMM SYSTEM 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-SYSTEM estimations are B/K_{t-3}, $CASH/TA_{t-2}$, $CASH/TA_{t-3}$, I/TA_{t-2}, I/TA_{t-3}, S/TA_{t-2}, S/TA_{t-3} and $\Delta S/TA_{t-1}$, $\Delta CASH/TA_{t-1}$, and $\Delta I/TA_{t-1}$.* significant at 10%; ** significant at 5%; *** significant at 1%.