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Firm Debt Structure and Firm Size: A Micro Approach

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Abstract

Micro industrial firm panel data on short-term and long-term borrowing (term debt structure) for annual and quarterly time periods over the years 1995-2008 are used to test an insulation hypothesis and a related volatility hypothesis. The former test uses a regression model relating the ratio of accounts payable in trade to long-term debt to firm size and other variables. The focus is on a micro perspective of the firm's response to the FED's monetary policy. If differs from an earlier macro perspective that focused on the existence of bank lending channels. The latter hypothesis uses the panel heteroscedastic variances recovered from the first testing procedure to test for a quadratic-form risk function (either U-shaped or inverted U-shaped) using sigma squared and the coefficient of variation as risk indexes and firm size as a determinant. The findings suggest that there is some evidence that firms do insulate themselves from the effects of monetary policy and that retained earnings have a significant role in the insulation effect. The evidence also suggests that the risk index, the variances, is related to firm size by a U-shaped quadratic function. As firm size increases, not only does the term-structure ratio fall, but the volatility falls and at a falling rate of change, approaching zero for a sufficiently large firm.

Keywords: Firms, Debt-Structure, Monetary Policy
JEL Classification: C33; E44; E52

Introduction

The primary purpose of this paper is to use micro corporate manufacturing firm data to analyze the term structure of firm debt, regardless of the sources of the lending (banks versus non-banks). Lending sources have already been the focus of a large volume of literature using aggregated macro corporate data to analyze the existence and extent of short-term lending channels and the transmission of monetary policy via the channels. A selective subset of this literature includes Gertler and Gilchrist (1994), Oliner and Rudebusch (1995 and 1996), Bernanke (1993), Bernanke and Blinder (1992), and Kashyap, Stein, and Wilcox (1993 and 1996). The micro data does not record the sources of loans, but it does permit a term-structure analysis where the ratio of short-term loans to long-term debt defines the term structure.

It is argued that the term-structure ratio from a micro-data perspective serves two analytical purposes. It is a valid index of firm risk taking behavior and reliance on short-term borrowing exposes the firm to early repayment risks and the possibility of non-renewal or renewal at less favorable terms. It is important to examine the factors that influence this risk index. If the term ratio is found to be dependent, for example, on the size of the firm, then risk-taking behavior on the part of firm may be independent of monetary policy and the FED's efforts to regulate credit. A second analytical purpose relates to the variances of the risk ratio across panels (firms). It is useful to analyze such variances to gain a micro understanding of the volatility of the risk ratio.

The paper presents tests for two general hypotheses, one dealing with the extent to which the firm is able to insulate itself from monetary policy (an issue also considered in the macro literature, for example, in Kashyap, Stein, and Wilcox, 1993 and 1996; and

Oliner and Rudebusch, 1995, 1996), and another hypothesis dealing with the volatility of the short-term/long-term debt ratio.

The justification for using micro data which as indicated does not report sources of borrowing is based on two considerations. First, bank sources of credit (short and long term) have a rather small role in the overall supply of credit creation, less than four percent of the average industrial corporation's total current liabilities and less than 14 percent for long-term liabilities (see, tables in the QFR, first quarter, 2006, for a typical period and Kashyap, Stein, and Wilcox, 1993 and 1996 for an earlier recognition of the small role). For this reason, focusing only on the term structure of debt (or borrowing) without any explicit source-of-financing considerations seems justified. The second consideration is that micro data is well suited to analyze the risky behavior of firms. Risk behavior is not just a macro issue. Its analysis has a long tradition in the micro economics of industrial structure, behavior, and performance. There is also the theoretical issue of the consistency between macro aggregate firm behavior and micro firm behavior.

In what follows, in the next section the data and the basic econometric models are discussed. In the following section, the empirical results are presented and interpreted. The final section contains a summary and conclusions.

Data and Econometric Models

Two sets of data are used in the regression analysis. The annual data set is from WRDS compustat data base in Standard & Poor's (2008) data file covering the years 1995 to 2007 for active US industrial (manufacturing) corporations located in the US. It is an unbalanced panel data set consisting of 30,789 time series and cross section observations and, after deleting missing values and long-term debt equal to zero values, representing some 4,385 firms. The second data set of unbalanced panel data is from the same source and for the same type of firms and consists of quarterly calendar data points covering the years 1995 to 2008. It has 69,453 valid observations representing some 2,244 firms (panels). For both data sets, the actual sample sizes will vary slightly depending on the regression methods used. The data are all in millions of nominal dollars.

The variable used for the firm's short-run loans is the accounts-payable-in-trade balance sheet item. There are other variables, for example, notes payable, but it has too many missing values. The accounts payable with long-term debt forms the ST/LTD ratio which is the dependent variable in the level regression analysis. The regressors are total revenue or sales as a proxy for firm output given by REVENUE, total assets given by TOTASST as an index of firm size, net income after taxes given by NETINC, and retained earnings given by RETERN. For the volatility analysis, the dependent variable represents the heteroscedastic panel variances or the coefficient of variation (CV) as a mean-weighted form of the square root of the variances. More details will be given later.

Dummy variables are used for the industrial sectors (SIC) and the monetary policy periods. For the industrial sectors, the reference group referred to as the light industry group (based more or less on the type of products produced) is given by DV1 covering SIC 2000 to 2799 (food, tobacco, textiles, apparel, lumber, furniture, paper products, and printing, primarily nondurables). The DV2 is referred to as the medium industry group covering SIC 2800 to 32999 (chemicals, petroleum, rubber, leather, and stone products). The DV3 variable covers the heavy (more or less) industrial sectors of metals, machinery, electrical, electronics, and transportation given by SIC 3300 to 3999. The three-way grouping is somewhat arbitrary but fits roughly the light, medium, and heavy product criteria.

The monetary policy dummy variables divide the time period into three sub-periods and following Bernanke and Blinder (1992) are based on the historical behavior of the Federal Funds Rate (Wikimedia.org, 7/23/2009). The DVT1 is the reference period, a period of tight monetary policy from 1995 to 2001. The DVT2 variable equals one for the years 2002 to 2004, a period of loose monetary policy and DVT3 variable equals one for the years 2005 to 2007, a period of tight monetary policy.

The basic level econometric model is given by

(1) ST/LTD = a + b1(TOTASST) + b2(REVENUE) + b3(NETINC) + b4(RETERN) + b5(Ind DV's 2&3) + b6(Monetary policy DVT's 2 & 3) + e,

where e is the error term. A time trend variable was also used in some of the regressions. The signs of the coefficients for the main regressors are all expected to be positive. Higher values for the regressors imply that the firm is able and willing to take on higher risks as indicated by a higher short-term/long-term debt ratio. Of particular interest is the role of retained earnings in the insulation hypothesis. At the macro level, retained earnings for industrial corporations are a sizable source of finance, totaling some $1,513,403 (million dollars) for 1Q 2006 (QFR, June 2006, Table 1.1).

The coefficient sign for DVT2 (loose policy) is expected to be positive if FED policy is effective and that for DVT3 (tight policy) is expected to be negative. These two coefficients will be used to test the insulation hypothesis given earlier.

The basic volatility model using the heteroscedastic panel (firm) variances for only the quarterly data is given by

(2) $\sigma_i^2 = a + b1(mTOTASST) + b2(mTOTASST)^2 + b3(mTime) + e$,

where σ_i^2 is either the panel variances (i = 1,2,…,2244) or the coefficient of variation given by ($\sqrt{\sigma^2}$/mTOTASST). Since the panel variances are constructed from the variances of the net values (or residuals) of the ST/LTD ratio (y – xB) over the time period for the given panel (not all equal), the units for the regressors in (2) are the panel mean values of the regressors for the corresponding panel time periods. In other words, each panel has its own specific mean values for the regressors, so the units for the y's and the x's correspond. The hypothesis is that (2) is a quadratic equation which could be either U-shaped with a minimum or an inverted U-shape with a maximum or some other result. For some regression runs the mTime variable is omitted.

Econometric Results

Table 1 presents the econometric results for the best of various regression runs using annual and quarterly data. For the annual data, robust estimates using OLS for pooled data and GLS estimates for the panel data analysis are reported. Other estimating methods were used (such as fixed effects and random effects) with similar results.

The OLS (robust) results are for comparison purposes and are similar to the panel XTGLS results. My analysis will focus on the XTGLS results. The revenue (REVENUE) effect on the accounts payable/long-term debt ratio was positive and significant, indicating that as revenue increases the firm's short-run debt (STD) intensity relative to long-term debt (LTD) also increases. The more a firm sells, the more trade debt it is willing to take on relative to its long-term debt.

In the case of total assets (TOTASST), however, the firm size effect is negative and significant. This makes sense for long-term debt is used to finance capital expansion so the STD/LTD ratio will fall with capital (firm size) expansion. It also suggest that larger firms are more risk adverse relatively. This result is also consistent with the macro result of an inverse relationship between firm asset size and short-term to total debt ratio (Gertler and Gilchrist, 1994, Table II).

The net income (NETINC) effect on debt term structure is negative and statistically significant at p=.05. The higher net income is, the lower the short-term debt, indicating that firms prefer to curtail their short-term borrowing behavior when income is high. The interesting variable for testing the two hypotheses is the retained earnings variable (RETERN). Its coefficient is positive and significant, indicating that higher retained earnings allow the firm to take on more risk in the form of more short-term borrowing relative to long-term debt. Short-term debt is apt to be more volatile (this will be examined more later), but the firm with high retained earnings is in a better financial position to tolerate more risk than what may otherwise be prudent. In reference to the macro effects of monetary policy, retained earnings can serve to insulate the firm from such policy effects.

The industrial sector effects are all significant. The light industries are part of the intercept effect. The medium and heavy industry differential effects are positive, indicating some variation in the reliance of firms on short-term borrowing. A test of the equality of the industry effects for DV2 and DV3 (.352 relative to .765) was rejected with a Chi2 p=.0000, indicating that the heavy industrial sectors have a relatively stronger preference for short-term borrowing compared to the medium industrial sectors.

The monetary policy coefficient for DVT2 (loose policy) is positive and significant, indicating that a move to such a policy will result in an increase in the firm's relative short-term borrowing behavior. The DVT3's (tight policy) coefficient is also positive and significant, indicating that a move to a tight monetary policy produces an increase in short-term borrowing. The fact that both policy effects produce the same results is contrary to expectations. Nevertheless, the same results suggest that the firm does not discriminate between policy types. If this is the case, monetary policy does not have the intended results, which is evidence of insulation. As before, a test of the equality of the two coefficients (.052 versus .200) was rejected at p=.0000. So, while the response to monetary policy changes is the same, there is a relatively stronger positive response to a shift to a tight monetary policy compared to a loose policy.

The time trend (TIME) coefficient is negative and significant, indicating that over time there was a downward trend in the short-term borrowing ratio. This trend also suggests an insulation effect.

For quarterly data, robust estimates for random-effects estimation (fixed effects were virtually the same) and XTGLS estimates using panel data analysis are also reported in Table 1. While the RE effects are statistically good, both NETINC and RETERN coefficients are not significant, where they are for the panel analysis results. The focus, therefore, is on the panel model in Table 1. This model will also be the basis of the subsequent volatility analysis.

All the coefficients for the panel analysis are highly significant. The REVENUE coefficient's sign is positive as before. The TOTASST coefficient is negative as before. The previous explanations apply. The NETINC coefficient is negative, indicating that the higher net income (profit) is, the less will be the firm's reliance on short-term borrowing relative to long-term debt.

The RETERN coefficient is positive, indicating as before with the annual data a willingness to take on more short-term debt, when retained earnings increase. From a micro perspective, this willingness to take on more risky short-term debt in the form of accounts payable in trade suggests that the firm may have a preference for borrowing from other firms rather than from banks. With such a preference, the effectiveness of monetary policy on firm borrowing is questionable and speaks of the insulation hypothesis.

The quarterly industrial sector effects are the same as the previous results. The same goes for the monetary policy panel results. As before, since both coefficients are positive, for either loose or tight monetary policy, there is a positive effect on short-term borrowing by the firm. In other words, the firm's borrowing behavior is the same either way, indicating some over-riding factors affecting borrowing, which, in effect, causes the firm to ignore a monetary policy change.

Table 2 presents the econometric results from the analysis of the heteroscedastic panel (firm) variances over quarterly time periods. As indicated earlier, two forms of variances are used, the standard form, namely sigma squared, and the coefficient of variation (CV) form, sigma divided by the mean (collapsed as explained earlier) of TOTASST. In keeping with the earlier discussion, the volatility hypothesis relates to a quadratic form as given earlier by equation (2). The estimating method is OLS with robust standard errors. Several combinations of regressors were run, but only the best are recorded here.

The first two columns (Models 1 and 2) have the results from the standard variances using either two or three of the regressors for comparison. With either use, all the coefficients are statistically significant. The quarterly time trend variable (mTIME) essentially affects the constant coefficient. The three-regressor version gives the best overall fit (F=4.431, 3, 2241). Both versions result in a U-shaped quadratic form with virtually the same shape and minimum point on the mTOTASST axis (172,535 versus 172,170), but with the former at a higher elevation due to the constant term. The two-regressor version (Model 2) makes more sense, since all the predicted variances from (2) are positive and consistent with the actual variances which are mostly to the left of the minimum point of the function (see, Figure 1 and note the Y-scale differences and the first-derivative functions). For analytical purposes, the left side of the function is the relevant side.

The results indicate that as the firm's size increases on the average for a given time period, the volatility (given by the variance) of the firm's risk index decreases. Combined with the previous results from Table 1, not only does the risk index decline with an increase in the size of the firm, but its volatility also declines. These empirical results are consistent with the conventional wisdom on risk and firm size.

The second two columns (Models 3 and 4) in Table 2 contain the best robust OLS results from using the coefficient of variation (CV) on mTOTASST and mTOTASST-squared and from using the log(CV) on the regressors. In both uses, the coefficients are all statistically significant and the signs indicate again a U-shaped quadratic risk function. As firm size increases, the CV ratio decreases as found before with the variance.

The interpretation of the semi-log form (Log(CV)), Model 4, of the quadratic function is now in terms of the rate of change of the CV ratio relative to the average firm size (mTOTASST). The actual log(CV) values and firm size values are to the left of the minimum point of the U-shaped log form (note the shape in Figure 1). Thus, as firm size increases, the predicted log(CV) values become smaller algebraically (larger negatively), indicating a continuous fall in the level of the CV, but at a slower and slower rate of fall of the CV as firm size increases. Hence, the volatility declines with firm size but at a slowing rate of fall. As suspected, this result is consistent with the previous results using the standard variances.

Summing up, as firm size increases, not only does the level of risk (as given by the term structure ratio, ST/LTD) decrease, but its volatility also decreases but at a decreasing (or slowing) rate of change. Theoretically and hypothetically it may be conjectured that for a sufficiently large firm, the rate of decline of risk would reach zero (at the minimum point using the top function in Figure 1 as typical). For a firm size larger than that, the rate of change of CV becomes positive, the volatility is still small but now it is increasing. Ultimately, an extremely large firm would begin to show increasing volatility at an increasing rate of change. The validity of these conjectures remains an empirical question, but one that certainly seems relevant since the post-2008 US economic crisis.

Summary and Conclusions

Micro corporate industrial firm data was used for annual and quarterly time periods to test an insulation hypothesis and a related volatility hypothesis. The insulation hypothesis relates to the firm's response to the FED's monetary policy position. The testing method used panel-data GLS estimation (along with other estimation methods) of a regression of accounts payable in trade relative to long-term debt (the term structure ST/LTD ratio) on revenue, assets, net income, retained earnings, and dummy variables for industrial sectors and monetary policy conditions.

The volatility hypothesis relates to the behavior of the heteroscedastic panel (firm) variances for the quarterly data. The specific hypothesis is that volatility behaves as a quadratic function (U- or inverted U-shaped) of firm size. Volatility was measured by the standard sigma squared of the residuals and by the coefficient of variation (CV). A semi-log form of the quadratic was also used to examine the rate of change of the volatility using the CV ratio. The estimation method used was robust OLS.

The findings based on the annual data suggest that there is some evidence for accepting the insulation hypothesis with respect to monetary policy directly and indirectly with respect to firm size, output, net income, and retained earnings. In particular, the positive effect of retained earnings on the short-term debt ratio suggests that firms prefer to borrow from other firms via their accounts payable in trade rather than from banks (although, of course, some bank borrowing does take place but as indicated at the outset such borrowing has a relatively small role in the borrowing process). These same conclusions were also evident using the quarterly data.

As to the findings relevant to the volatility hypothesis using quarterly data, all the evidence points to a volatility function (using both the variance and the CV form) that is a U-shaped quadratic risk function. As firm size increases, not only does the level of the term structure ratio decrease, but its volatility also decreases and at a decreasing rate of change approaching zero (based on the semi-log form) for a sufficiently large firm.

As with any econometric study, questions arise as to the sample frame, model specifications, and methods of estimation. The firm data used in this study is the best that was available. Using the same data, it is unlikely that another researcher would obtain substantially different or opposite results. This does not mean that the case is closed. There is always room for fine tuning the statistical process. But, that said, it is believed that the existing results are robust and can stand on their own merits. The monetary policy implications from this micro approach are at odds with some but certainly not all macro approaches. Given the apparent dichotomy between small and large firms, the micro findings suggest that a "one-type macro monetary policy" does not fit all firms.

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Table 1. Regression Results for the log of the ratio of accounts payable in trade to long-term debt as the dependent variable

	Annual Data		Quarterly Data	
Coefficients	OLS(Robust)	XTGLS	XTREG (RE,Robust)	XTGLS
Constant	58.16 (4.34)	51.73 (7.53)	45.33 (6.10)	75.89 (68.37)
REVENUE	.000017 (7.47)	.000015 (14.62)	.000051 (13.53)	.000035 (15.15)
TOTASST	-.000022 (-8.38)	-.000017 (-20.02)	-.000015 (-10.48)	-.000015 (-18.63)
NETINC	-.000027 (-1.96)	-3.19e-06 (-.05)*	-6.58e-06 (-.30)*	-.000011 (-2.96)
RETERN	.000021 (6.11)	.000011 (5.55)	2.35e-06 (.91)*	.000016 (8.81)
DV2	.283 (9.06)	.312 (17.53)	.39 (3.69)	.29 (157.00)
DV3	.820 (29.69)	.765 (46.77)	.90 (9.59)	.75 (128.60)
DVT2	.035 (.81)*	.052 (2.46)	.09 (4.65)	.10 (17.76)
DVT3	.226 (3.65)	.200 (6.49)	.27 (8.58)	.24 (30.35)
TIME	-.029 (-4.40)	-.026 (-7.67)	-2.31e-06 (-6.20)	-3.83e-06 (-69.25)
R-square	.038 (F=128.22)			
LL(fit)		-47337.73		-59845.10
Wald		2875.65	451.46	37654.01
n	30,351	29,694	69,379	69,319
Common AR(1)		.661		panel specific

No. Co-variances	4,274	2,304	2,244

Notes: The t or z values less than 2.00 are not significant even at the 10 percent level and are marked with an *. All the rest of the coefficients are highly significant at .0000 or less. The F and Wald are significant at .0000 or less. Heteroscedasticity across groups was handled by the co-variance matrix, using generalized least squares (XTGLS) for unbalanced panel data. FE results were virtually the same as the reported RE.

Table 2. Regression Robust Results for the Heteroscedastic Variances

Dependent Var	Variance Form		CV Form	LogCV Form
	Model 1	Model 2	Model 3	Model 4
Constant	-59.70	.93	.023	-5.209
	(-2.24)	(30.46)	(15.60)	(-115.06)
mTOTASST	-.0000146	-.0000147	-3.24e-06	-.000561
	(-4.26)	(-4.21)	(-14.61)	(-44.91)
mTOTASSTSQ	4.24e-11	4.26e-11	7.63e-11	1.17e-08
	(3.44)	(3.39)	(13.37)	(26.74)
mTIME	3.03e-06	.	.	.
	(2.27)			
R-square	.0059	.0030	.053	.641
F	4.431	3.371	63.203	2001.50
p	.0041	.034	.0000	.0000

Notes: The sample size is 2,244 obs. All the coefficients are statistically significant at p=.025 or less.

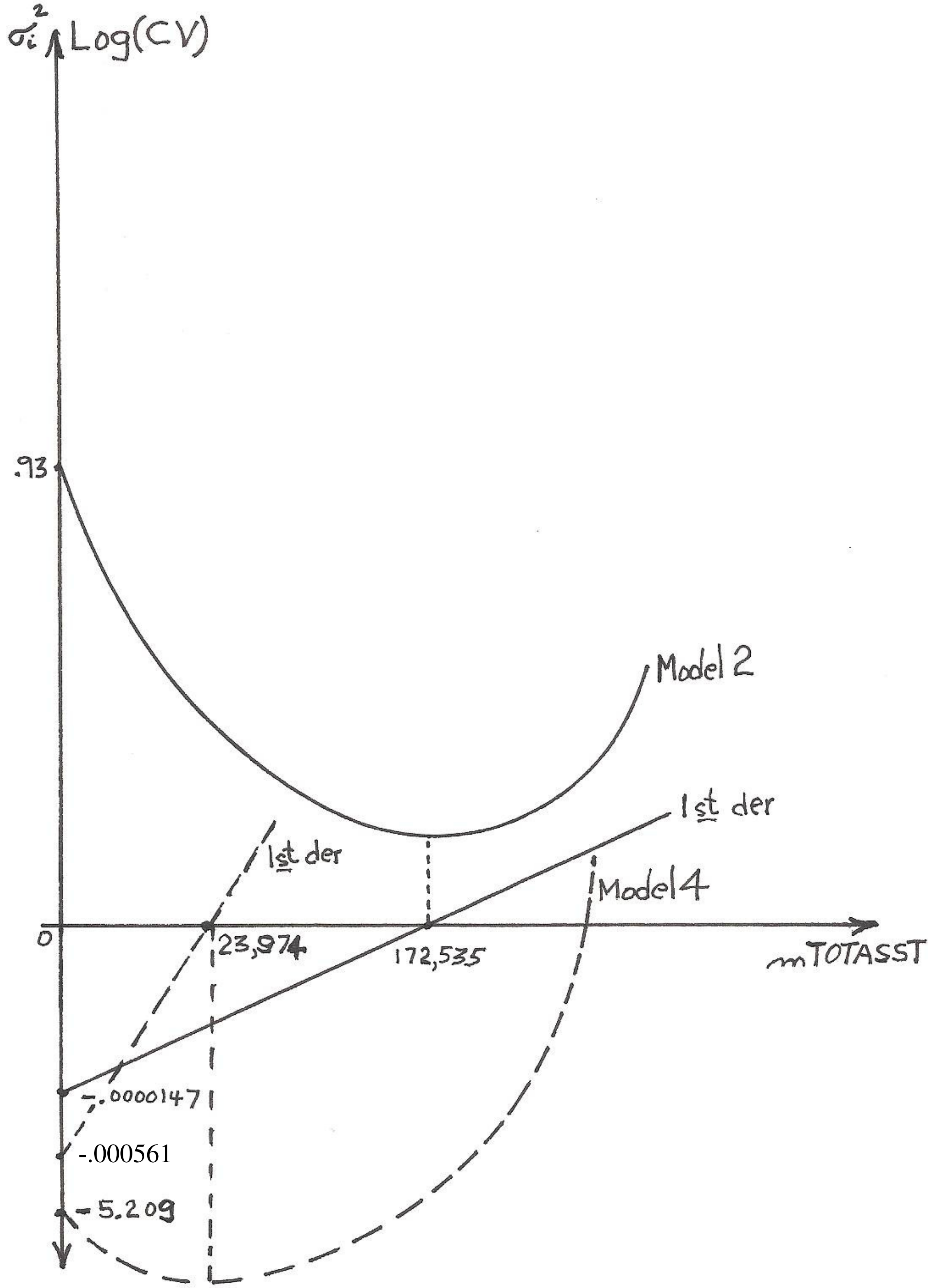

Figure 1: Model 2 and Model 4 Quadratic Forms, Left Y-Scale, Right Y-Scale First-Derivative Functions as Indicated, 1st der.