Supplementary Online Appendix for Corporate Financing and Investment: The Firm-Level Credit Multiplier

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This appendix contains the results of tests using the second measure of tangibility, which we do not tabulate in the paper. The proxy we use is an industry-level, time-variant proxy that gauges the ease with which lenders can liquidate a firm's productive capital. In particular, we measure asset redeployability using the ratio of used to total (i.e., used plus new) fixed depreciable capital expenditures in an industry. The proxy captures the idea that the degree of activity in asset resale markets (i.e., demand for second-hand capital) affects financial contractibility. To construct the intended measure, starting from 1981, we hand-collect data for used and new capital acquisitions at the four-digit SIC level from the Bureau of Census' *Annual Survey of the Manufacturers*. Data on plant and equipment acquisitions are compiled by the Bureau every year, but the last survey identifying both used and new capital acquisitions was published in 1996. Besides the shorter time coverage, we note that estimations based on this measure of asset tangibility use smaller sample sizes because not all of COMPUSTAT's SIC codes are present in the Census data. To make the results in this appendix easily comparable to the ones in the paper, we use the corresponding table numbers from the paper in this appendix (i.e., the base regression results are in Table 4-A and the credit multiplier regression results are in Table 5-A). Moreover, we tabulate a few unreported robustness tests using the paper's primary measure of tangibility, which is an annual, firm-level proxy for expected value of assets in liquidation, in Tables 6-A, 7-A, and 8-A. Finally, we establish by means of numerical simulations that coefficient estimates of an interaction term that contains one (or even two) mismeasured variables are also biased towards zero. In other words, a measurement problem in Q would make it *harder* for our tests to find the effect of the credit multiplier via the $Q \times Tangibility$ interaction term.

Table 4-A. Investment Spending, Q, and Asset Tangibility: Base Regressions

This table displays OLS-FE (firm- and year-fixed effects) estimation results of the base investment model (omitting the Q-interactive term from Eq. (31) in the text). The estimations in Panel A use pre-determined firm selection into "financially constrained" and "financially unconstrained" categories. Constraint category assignments use ex-ante criteria based on firm dividend payout, asset size, bond ratings, and commercial paper ratings. In Panel B, switching regression estimations allow for endogenous selection into "financially constrained" and "financially unconstrained" categories via maximum likelihood methods. The"regime selection" regression (unreported) uses payout ratio, asset size, a dummy for bond ratings, a dummy for commercial paper ratings, and *Tangibility* as selection variables to classify firms into constraint categories (see text for details). *Investment* is the ratio of fixed capital expenditures (item #128) over lagged fixed capital stock (item #8). Q is computed as the market value of assets divided by the book value of assets, or (item #6 + (item #24 × item #25) – item #60 – item #74) / (item #6). *Tangibility* is an annual, industry-level measure of asset redeployment; available from 1981 through 1996 (data taken from the Bureau of Census' *Annual Survey of Manufacturers*). All firm data are collected from COMPUSTAT's annual industrial tapes over the 1971–2005 period. All firm data are collected from COMPUSTAT's annual industrial tapes over the 1971–2005 period. The sample firms are from manufacturing industries (SICs 2000–3999). The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. Robust standard errors reported in parentheses.

Panel A: Exogenous Financial Constraint Categorizations (Ex-Ante Classifications)

Dependent Variable	Independent Variables		R^2	Obs.
Investment	Q	*Tangibility*		
1. Payout Policy				
Constrained Firms	0.1958***	0.1459*	0.05	5,795
	(0.0191)	(0.0847)		
Unconstrained Firms	0.0978***	–0.0743*	0.03	3,509
	(0.0145)	(0.0431)		
2. Firm Size				
Constrained Firms	0.1840***	0.2148*	0.04	3,715
	(0.0268)	(0.1127)		
Unconstrained Firms	0.1173***	–0.0677	0.05	3,470
	(0.0152)	(0.0463)		
3. Bond Ratings				
Constrained Firms	0.1670***	0.1604***	0.05	10,744
	(0.0142)	(0.0531)		
Unconstrained Firms	0.1793***	–0.0438	0.05	1,779
	(0.0299)	(0.0696)		
4. Comm. Paper Ratings				
Constrained Firms	0.1685***	0.1505***	0.05	11,874
	(0.0140)	(0.0489)		
Unconstrained Firms	0.1487***	–0.1116	0.08	649
	(0.0434)	(0.0797)		

Panel B: Endogenous Financial Constraint Categorizations (Switching Regressions)

Dependent Variable	Independent Variables		R^2	Obs.
Investment	Q	*Tangibility*		
Constrained Firms	0.2779***	0.1511***	0.11	9,522
	(0.0588)	(0.0573)		
Unconstrained Firm	0.1281***	0.0263	0.05	9,522
	(0.0129)	(0.0334)		

Notes: ***, **, and * indicate statistical significance at the 1-, 5-, and 10-percent (two-tail) test levels, respectively.

Table 5-A. Investment Spending, Q, and Asset Tangibility: The Credit Multiplier Effect Using Ex-Ante Constraint Partitions

This table displays OLS-FE (firm- and year-fixed effects) estimation results of the credit multiplier investment model (Eq. (31) in the text). The estimations in Panel A use pre-determined firm selection into "financially constrained" and "financially unconstrained" categories. Constraint category assignments use ex-ante criteria based on firm dividend payout, asset size, bond ratings, and commercial paper ratings. In Panel B, switching regression estimations allow for endogenous selection into "financially constrained" and "financially unconstrained" categories via maximum likelihood methods. The"regime selection" regression (unreported) uses payout ratio, asset size, a dummy for bond ratings, a dummy for commercial paper ratings, and *Tangibility* as selection variables to classify firms into constraint categories (see text for details). *Investment* is the ratio of fixed capital expenditures (item #128) over lagged fixed capital stock (item #8). Q is computed as the market value of assets divided by the book value of assets, or (item #6 + (item #24 × item #25) – item #60 – item #74) / (item #6). *Tangibility* is an annual, industry-level measure of asset redeployment; available from 1981 through 1996 (data taken from the Bureau of Census' *Annual Survey of Manufacturers*). All firm data are collected from COMPUSTAT's annual industrial tapes over the 1971–2005 period. The sample firms are from manufacturing industries (SICs 2000–3999). The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. Robust standard errors reported in parentheses.

Panel A: Exogenous Financial Constraint Categorizations (Ex-Ante Classifications)

Dependent Variable	Independent Variables			R^2	Obs.
Investment	Q	*Tangibility*	$Q \times$ *Tangibility*		
1. Payout Policy					
Constrained Firms	0.0832***	–0.0819	0.5800***	0.05	5,795
	(0.0210)	(0.2610)	(0.2186)		
Unconstrained Firms	0.0941***	–0.1651	0.1269	0.03	3,509
	(0.0161)	(0.1506)	(0.2034)		
2. Firm Size					
Constrained Firms	0.0488***	–0.4246	0.8431***	0.05	3,715
	(0.0206)	(0.3025)	(0.2386)		
Unconstrained Firms	0.1091***	–0.3011	0.2966	0.05	3,470
	(0.0164)	(0.1997)	(0.2584)		
3. Bond Ratings					
Constrained Firms	0.0480***	–0.3033*	0.4689**	0.05	10,744
	(0.0148)	(0.1686)	(0.2223)		
Unconstrained Firms	0.1764***	–0.0953	0.0624	0.05	1,779
	(0.0323)	(0.1959)	(0.2534)		
4. Comm. Paper Ratings					
Constrained Firms	0.0511***	–0.2807*	0.4218**	0.05	11,874
	(0.0146)	(0.0125)	(0.2068)		
Unconstrained Firms	0.1457***	–0.1823	0.0927	0.08	649
	(0.0441)	(0.4421)	(0.6253)		

Panel B: Endogenous Financial Constraint Categorizations (Switching Regressions)

Dependent Variable	Independent Variables			R^2	Obs.
Investment	Q	*Tangibility*	$Q \times$ *Tangibility*		
Constrained Firms	0.1098***	–0.1310	0.4048***	0.05	9,522
	(0.0134)	(0.1160)	(0.1484)		
Unconstrained Firm	0.2935***	–0.2796	–0.2334	0.11	9,522
	(0.0814)	(0.2891)	(0.7777)		

Notes: ***, **, and * indicate statistical significance at the 1-, 5-, and 10-percent (two-tail) test levels, respectively.

Table 6-A. Investment Spending, Q, and Asset Tangibility: The Credit Multiplier Effect Using GMM Estimations

This table displays GMM-FE (firm- and year-fixed effects) estimation results of the credit multiplier investment model (Eq. (31) in the text). The estimations use pre-determined firm selection into "financially constrained" and "financially unconstrained" categories. Constraint category assignments use ex-ante criteria based on firm dividend payout, asset size, bond ratings, and commercial paper ratings (see text for details). *Investment* is the ratio of fixed capital expenditures (item #128) over lagged fixed capital stock (item #8). Q is computed as the market value of assets divided by the book value of assets, or (item #6 + (item #24 × item #25) – item #60 – item #74) / (item #6). *Tangibility* is an annual, firm-level proxy for expected value of assets in liquidation (the computation follows Berger et al. (1996)). The instruments include lags 1 through 3 of the model's differenced right-hand side variables. All firm data are collected from COMPUSTAT's annual industrial tapes over the 1971–2005 period. The sample firms are from manufacturing industries (SICs 2000–3999). The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. Robust standard errors reported in parentheses. Diagnostic statistics for instrument overidentification restrictions (p-values for Hansen's J-statistics) and instrument relevance (first-stage F-statistics' p-values) are also reported.

Dependent Variable	Independent Variables			P-Value of	P-Value of
Investment	Q	*Tangibility*	$Q \times$ *Tangibility*	Hansen's J-statistic	First-Stage F-Test
1. Payout Policy					
Constrained Firms	–0.4064**	–0.3889	0.9699***	0.58	0.00
	(0.2055)	(0.2816)	(0.3407)		
Unconstrained Firms	0.2091	0.0663	–0.0418	0.83	0.00
	(0.3174)	(0.4557)	(0.5428)		
2. Firm Size					
Constrained Firms	–0.3934**	–0.1949	0.7940***	0.20	0.00
	(0.1847)	(0.2365)	(0.3085)		
Unconstrained Firms	0.2875	0.2067	–0.1501	0.92	0.00
	(0.3858)	(0.6083)	(0.6678)		
3. Bond Ratings					
Constrained Firms	–0.3009**	–0.4071**	0.7964***	0.88	0.00
	(0.1402)	(0.1927)	(0.2379)		
Unconstrained Firms	0.1181	–0.0978	0.2431	0.22	0.00
	(0.3196)	(0.5197)	(0.5881)		
4. Comm. Paper Ratings					
Constrained Firms	–0.3330**	–0.4649**	0.8509***	0.96	0.00
	(0.1439)	(0.1990)	(0.2437)		
Unconstrained Firms	0.3489	0.1171	–0.1239	0.33	0.00
	(0.2962)	(0.4907)	(0.5224)		

Notes: ***, **, and * indicate statistical significance at the 1-, 5-, and 10-percent (two-tail) test levels, respectively.

Table 7-A. Investment Spending, Q, and Asset Tangibility: The Credit Multiplier Effect Replacing Q with the Projection of Q on Industry Prices

This table displays OLS-FE (firm- and year-fixed effects) estimation results of the credit multiplier investment model (Eq. (31) in the text), where conventional Q is replaced by the projection of Q on industry-level PPI (from the Bureau of Labor Statisticcs). This construct is denoted $ProjQ$. The estimations use pre-determined firm selection into "financially constrained" and "financially unconstrained" categories. Constraint category assignments use ex-ante criteria based on firm dividend payout, size, bond ratings, and commercial paper ratings (see text for details). *Investment* is the ratio of fixed capital expenditures (item #128) over lagged fixed capital stock (item #8). *Tangibility* is an annual, firm-level proxy for expected value of assets in liquidation (the computation follows Berger et al. (1996)). All firm data are collected from COMPUSTAT's annual industrial tapes. The sample firms are from manufacturing industries (SICs 2000–3999). While for most industries the PPI series compilations start in the 1970's, for many it starts in the mid-1980's. All of the PPI series end in 2003. The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. Robust standard errors reported in parentheses.

Dependent Variable	Independent Variables			R^2	Obs.
Investment	*ProjQ*	*Tangibility*	*ProjQ* ×*Tangibility*		
1. Payout Policy					
Constrained Firms	0.9459***	0.0505	0.6176***	0.04	19,305
	(0.1409)	(0.1403)	(0.1756)		
Unconstrained Firms	0.3444***	0.0073	0.1187	0.00	14,869
	(0.1083)	(0.0817)	(0.1032)		
2. Firm Size					
Constrained Firms	0.6305***	0.2238	0.4859*	0.04	12,395
	(0.1980)	(0.2139)	(0.2612)		
Unconstrained Firms	0.5318***	0.0676	0.1167	0.02	14,979
	(0.0955)	(0.0695)	(0.0877)		
3. Bond Ratings					
Constrained Firms	0.4962***	0.1112	0.4109***	0.03	37,160
	(0.0910)	(0.0888)	(0.1101)		
Unconstrained Firms	0.4951***	0.0503	0.1307	0.01	9,348
	(0.1449)	(0.1141)	(0.1401)		
4. Comm. Paper Ratings					
Constrained Firms	0.4960***	0.1100	0.3717***	0.03	42,854
	(0.0848)	(0.0793)	(0.0987)		
Unconstrained Firms	0.4792***	0.0277	0.0606	0.02	3,654
	(0.1829)	(0.1223)	(0.1539)		

Notes: ***, **, and * indicate statistical significance at the 1-, 5-, and 10-percent (two-tail) test levels, respectively.

Table 8-A. Investment Spending, Q, and Asset Tangibility: The Credit Multiplier Effect Replacing Investment Levels with Investment Growth Rates

This table displays OLS-FE (firm- and year-fixed effects) estimation results of the credit multiplier investment model (Eq. (31) in the text), where investment level ($Investmet$) is replaced by investment growth rate ($Log(Capex_t/Capex_{t-1})$) as the left-hand side variable. The estimations use pre-determined firm selection into “financially constrained” and “financially unconstrained” categories. Constraint category assignments use ex-ante criteria based on firm dividend payout, size, bond ratings, and commercial paper ratings (see text for details). $Capex$ is item #128. Q is computed as the market value of assets divided by the book value of assets, or (item #6 + (item #24 × item #25) – item #60 – item #74) / (item #6). $Tangibility$ is an annual, firm-level proxy for expected value of assets in liquidation (the computation follows Berger et al. (1996)). All firm data are collected from COMPUSTAT's annual industrial tapes. The sample firms are from manufacturing industries (SICs 2000–3999). The estimations correct the error structure for heteroskedasticity and clustering using the White-Huber estimator. Robust standard errors reported in parentheses.

Dependent Variable	Independent Variables			R^2	Obs.
$Log(Capex_t/Capex_{t-1})$	Q	$Tangibility$	$Q \times Tangibility$		
1. Payout Policy					
Constrained Firms	–0.0410	0.6789***	0.2950***	0.02	22,399
	(0.0724)	(0.1200)	(0.1104)		
Unconstrained Firms	0.1671***	0.5381***	–0.1681*	0.01	17,884
	(0.0611)	(0.1195)	(0.1022)		
2. Firm Size					
Constrained Firms	–0.2405**	0.6275***	0.5127***	0.01	15,170
	(0.0940)	(0.1532)	(0.1438)		
Unconstrained Firms	0.3375***	0.7926***	–0.4154***	0.01	17,913
	(0.0715)	(0.1272)	(0.1210)		
3. Bond Ratings					
Constrained Firms	–0.0342	0.6614***	0.2012**	0.01	45,038
	(0.0518)	(0.0898)	(0.0829)		
Unconstrained Firms	0.3722***	0.8368***	–0.4540**	0.01	11,050
	(0.1261)	(0.2088)	(0.2211)		
4. Comm. Paper Ratings					
Constrained Firms	–0.0065	0.6466***	0.1606**	0.01	51,696
	(0.0498)	(0.0850)	(0.0798)		
Unconstrained Firms	0.3127**	0.6251***	–0.3469	0.01	4,392
	(0.1332)	(0.2084)	(0.2227)		

Notes: ***, **, and * indicate statistical significance at the 1-, 5-, and 10-percent (two-tail) test levels, respectively.

Finally, we examine the effect of mismeasurement on coefficient estimates returned for Q interacted with *Tangibility*. In particular, we study the role of measurement error in one and two independent variables employing Monte Carlo experiments.

In a first set of experiments, we simulate our interactive model considering the case in which only one right-hand side variable is measured with error. That is, we consider:

$$Investment_{i,t} = \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 Tangibility_{i,t-1} + \alpha_3 \left(Q \times Tangibility\right)_{i,t-1} + e_{i,t}, \quad (1)$$

where $e_{i,t}$ is *i.i.d.* and the observable variable Q is mismeasured. In particular,

$$Q_{i,t} = Q^*_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where Q^* is the unobservable, true variable, and the measurement error $\varepsilon_{i,t}$ is *i.i.d.* and independent of $e_{i,t}$. This specification is equivalent to assuming $cov(Q^*_{i,t}, \varepsilon_{i,t}) = 0$ and $cov\left(Q_{i,t}, \varepsilon_{i,t}\right) = var\left(\varepsilon_{i,t}\right)$, which corresponds to the classical errors-in-variables problem.

To study the potential bias in estimates of α_3 (the credit multiplier effect) due to measurement error in Q, we consider three different distributions for innovations $\left(e_i, \varepsilon_i\right)'$: (1) a standard normal distribution, (2) a log-normal distribution, and (3) a chi-square distribution with 3 degrees of freedom. Without loss of generality, we normalize the simulated parameter values of α_i to unity for all $i \in \{0, 1, 2, 3\}$. To allow for various correlation structures, we generate random samples of Q and *Tangibility* from the above distributions, multiply the resulting vectors by the matrix $cov(Q, Tangibility)$, and generate $Q \times Tangibility$. We use four alternative correlation matrices, where the diagonal elements are equal to 1 and off-diagonal elements equal to 0, 0.25, 0.5, and 0.75. We perform simulations for various sample sizes. Since the estimation results are qualitatively similar across different sample sizes, we tabulate the result for $n = 500$ (results for other sample sizes are available upon request). For each simulation the number of repetitions is 10,000.

Table 9-A. Mismeasurement in Q

		Correlation Structure			
Distribution		0	0.25	0.5	0.75
	α_1	0.4996	0.4518	0.3093	0.1097
Normal	α_2	1.0024	1.2580	1.5519	1.8540
	α_3	0.4994	0.5640	0.6699	0.7501
	α_1	0.5043	–0.4706	–1.2694	–2.2365
Log-normal	α_2	0.9950	0.6526	1.6451	3.2811
	α_3	0.5007	0.9230	0.9598	0.9431
	α_1	0.4995	–0.3904	–1.8363	–3.5637
Chi-square	α_2	0.9952	1.5044	2.8623	5.3707
	α_3	0.5003	0.7052	0.8072	0.8192

Table 9-A collects the least squares estimates based on our simulated data. The table shows that the coefficients involving Q are likely biased in the presence of mismeasurement. Crucially, however,

Table 9-A shows that the observed biases work *against* finding evidence for our credit multiplier theory. In particular: (1) as expected, the estimates of α_1 are biased downwardly; (2) notably, estimates of α_3 are also biased downwardly; and (3) the estimates of α_2 could be downwardly or upwardly biased, depending on the assumed correlation structure.

In a second set of experiments, we examine the case in which two explanatory variables are mismeasured. That is, *both* Q and $Tangibility$ suffer from measurement error. To handle this more general case, we incorporate another mismeasurement equation into the simulation framework; that is, the simulated data is now generated by equations (1), (2), and

$$Tangibility_{i,t} = Tangibility^{*}_{i,t} + \epsilon_{i,t}, \tag{3}$$

where $Tangibility^{*}$ is the additional unobservable variable, and the additional measurement error ϵ_i is *i.i.d.* and independent of e_i and ε_i.

Table 10-A summarizes our findings for the second set of Monte Carlo experiments. The estimation results for the case when Q and $Tangibility$ are imprecisely measured are qualitatively similar to the ones for the case when only Q is measured with error. The main difference between the two sets of results is that estimates of α_2 are now, as expected, also downwardly biased.

Table 10-A. Mismeasurement in Q and $Tangibility$

		Correlation Structure			
Distribution		0	0.25	0.5	0.75
	α_1	0.5009	0.6100	0.6921	0.7539
Normal	α_2	0.4997	0.6096	0.6918	0.7525
	α_3	0.2499	0.3058	0.4217	0.5318
	α_1	0.5075	–0.9881	–1.7457	–1.9533
Log-normal	α_2	0.4978	–1.0091	–1.7624	–1.9655
	α_3	0.2498	0.8279	1.0075	1.0499
	α_1	0.5010	–0.2923	–1.5517	–2.2807
Chi-square	α_2	0.4968	–0.2915	–1.5593	–2.2929
	α_3	0.2500	0.5076	0.7473	0.8691

The above simulations have shown that the coefficients of interest for our tests are biased downward when there are measurement errors in one or two of the explanatory variables of our main regression specification (Eq. (31)). More concretely, they indicate that mismeasurement in Q and/or $Tangibility$ also lead to an attenuation bias in the coefficient returned for the interactive term $Q \times Tangibility$. Altogether, these potential biases make it *more difficult* for one to detect a significant role for our credit multiplier theory in the data.