Online Data and Calibration Appendix for "Corporate Finance and Monetary Policy"

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In these appendices, we describe the data used in the introduction and calibrated examples in Section 6, and discuss alternative strategies for the calibration.

B1. Data Appendix

Interest Rates

Data on nominal interest rates are obtained from the Federal Reserve Board's H.15 Selected Interest Rates.[1] All series are annual averages and not seasonally adjusted.

3-Month Treasury Bill secondary market rate: the rate on the U.S. government's debt obligations in treasury bills of 3 month maturity issued once a month. The daily rates are annualized using a 360-day year.

Fed Funds rate: the rate at which a depository institution lends funds maintained at the Federal Reserve to another depository institution overnight. The Fed funds rate is generally only applicable to the most creditworthy institutions when they borrow and lend overnight funds to each other.

Bank prime loan rate: the rate posted by a majority of the top-insured U.S. chartered commercial banks. It is used as a base rate for many types of loans, including loans to small businesses and credit card loans.

We obtain real rates from the nominal rates above by subtracting a measure of anticipated inflation following the methodology developed in Hamilton et al. (2015) (we also describe alternative procedures below). For instance, to obtain the real 3-month T-bill rate, we construct

$$\rho_t = i_t - \mathbb{E}_t \pi_{t+1},$$

[1] The statistical release is publicly available at https://www.federalreserve.gov/releases/h15/.

where i_t is the nominal 3-month T-bill rate and $\mathbb{E}_t \pi_{t+1}$ is expected inflation. Similarly, we obtain the real lending rate using

$$r_t = r_t^{prime} - \mathbb{E}_t \pi_{t+1},$$

where r_t^{prime} is the nominal prime bank loan rate. To get expected inflation, we estimate an autoregression using past inflation computed with the GDP deflator following Hamilton et. al (2015).

Finally, we also computed the real lending rate as a spread between the nominal prime loan rate and the nominal policy rate, i.e.

$$r_t = r_t^{prime} - i_t.$$

We tried several specifications depending on the interest rate used for i_t, including the 3-month T-bill rate, Fed funds rate, 10 year government bond rate, and commercial paper rate. Throughout the sample period, all resulted in a positive pass through rate except for the series using the commercial paper rate, which tended to produce a negative pass through rate after 1990.

Firms' Cash Holdings

Data on firms' cash holdings is obtained from Graham and Leary (2016) which uses cash and accounting information from Compustat. We focus on the year 1972 to 2007. Financial firms and regulated firms (utilities, railroads, telecommunications) are excluded from the sample since they may hold cash to meet capital requirements or for regulatory reasons. See Graham and Leary (2016) for additional details on the sample selection.

We use the cash-sales ratio to proxy for firms' money demand (following e.g., Mulligan 1997, Bover and Watson 2005, Graham and Leary 2016, and Adão and Silva 2016). The ratio states how much of total sales firms maintain in cash. For instance, a cash-sales ratio of 0.05 means firms maintain 5% of their yearly sales in cash. The aggregate cash to sales ratio is constructed using total cash (item 1 in Compustat) for all sample firms divided by total sales (item 12) for all sample firms.

The Compustat definition of cash is “any immediately negotiable medium of exchange. It includes money and any instrument normally accepted by banks for deposit and immediate credit to a customer’s account” (Standard and Poor’s, 1993). This includes currency, certificates of deposit (CDs) included in cash by the company, checks, demand certificates of deposit, demand deposits, letters of credit, money orders, bank drafts, and banker’s acceptances. Not included in this definition are certificates of deposit included as short-term investments on the firm’s balance sheet, CDs reported as a separate item in current assets, commercial paper, government securities, legally restricted cash, cash in escrow, cash segregated under federal regulations, marketable securities, short-term investments, time CDs, and time deposits. Cash in Compustat is therefore a closer proxy for M1 than M2.[2]

[2] M1 is currency plus traveler checks and checkable deposits. Some items such as bank drafts, banker’s acceptances, and letters are credit are included in M1 but not included in the Compustat definition of cash. As referenced in footnote 2 in the main text, Adão and Silva (2016) find the ratio between firm cash holdings to M1 increased from 30% to 85% from 1980 to 2010.

B2. Alternative Calibrations

Here we describe alternative calibrations to the one described in the main text.

Table 1: Calibration Alternative 1 (Annual Data, 1958-2007)

Value	Target
$i = 0.054$	3-month T-bill rate (nominal)
$\rho = 0.02$	3 month T-bill rate (real)
$\lambda = 1$	maturity of loans
$\gamma = 0.81$	semi-elasticity of money demand
$\alpha = 0.8$	loan application acceptance rate
$\theta = 0.62$	prime lending rate (real)

Calibration Alternative 1. Instead of fixing γ and choosing λ to match the semi-elasticity money demand, here we we choose the frequency of investment opportunities to match the maturity of loans, $\lambda = 1$, and calibrate γ to match a semi-elasticity of money demand of -7, following Lucas (2000)'s estimate. This is also consistent with Mulligan (1997)'s estimate of money demand for U.S. firms from 1961 to 1992. This gives $\gamma = 0.81$.

We interpret α as the probability a loan application is accepted. The Survey of Small Business Finances reports the fraction of firms with their most recent loan application accepted is 0.78 to 0.9. Here we set $\alpha = 0.8$. The rest of the model is calibrated assuming the pledgeability constraint does not bind for the average value of i in our sample.

The lending rate in our model can be interpreted as a premium over the risk-free rate (since loans are repaid within a period).[3] We obtain θ by targeting the yield difference between the prime lending rate and the 3 month T-bill rate. This difference averages to 2.4% in our sample, which gives $\theta = 0.62$.

Calibration Alternative 2 In this calibration, we calibrate γ and α by targeting the entire U.S. aggregate money demand curve from 1980 to 2007.[4] We use data on M1J (sweep

[3] We have two appendices to justify this premium. In Appendix A6, we consider an extension with one-period lagged production that justifies this interpretation. See also Appendix A7 for our model with long-lived investment projects.

[4] We also calibrated the model with the sample period from the previous calibrations, 1958 to 2007 which implies a flatter money demand correspondence. The resulting α was very high, i.e. very close to one

Table 2: Calibration Alternative 2 (Annual Data, 1980-2007)

Value	Target
$i = 0.058$	annual 3-month T-bill rate (nominal)
$\rho = 0.032$	3 month T-bill rate (real)
$\lambda = 1$	maturity of loans
$\gamma = 0.31$	money demand
$\alpha = 0.97$	money demand
$\theta = 0.29$	prime lending rate minus 3 month T-bill rate

adjusted M1) scaled by GDP from Lucas and Nicolini (2015) as our measure of money demand and the 3-month T-bill rate as i. The average T-bill rate for 1980 to 2007 is $i = 5.8\%$ and the corresponding average real T-bill rate is $\rho = 3.2\%$. Money demand in the model is k^m/Y where $Y = \lambda[\alpha f(k^c) + (1-\alpha)f(k^m)]$ is aggregate output. We then obtain γ and α jointly by minimizing the sum of squared residuals between the money demand in the model. As a result, we obtain $\gamma = 0.31$ and $\alpha = 0.97$. To get θ, we target the yield difference between the prime lending rate and the 3 month T-bill rate. For this sample period, the lending rate premium is $r - \rho = 5.5 - 3.2 = 2.3\%$. This gives $\theta = 0.29$.

Table 3: Calibration Alternative 3 (Quarterly Data, 1958-2007)

Value	Target
$i = 0.014$	3-month T-bill rate (nominal)
$\rho = 0.005$	3 month T-bill rate (real)
$\lambda = 0.15$	elasticity of money demand
$\alpha = 0.85$	loan application approval rate
$\theta = 0.05$	pass through rate

Calibration Alternative 3 Instead of using the semi-elasticity of money demand as a target, we also considering using the elasticity. To calibrate λ, we target the interest elasticity

($\alpha = 0.99$, $\gamma = 0.31$, $\theta = 0.23$) in order to match the level of money demand in the data for low interest rates. The calibration wants to shut down internal finance, which is clearly counterfactual. For lower values of α, the model tends to give a higher money demand than in the data. We therefore reduced our sample period to the post-1980's in order to better illustrate our calibration strategy.

of money demand:

$$\frac{\partial k^m/k^m}{\partial i/i} = \frac{i}{(\gamma-1)\{\lambda[1-\alpha(1-\theta)]+i\}}.$$

Based on Bover and Watson (2005)'s estimate of money demand for U.S. firms from 1978 to 1992, we target an interest elasticity of -0.3.[5] This gives $\lambda = 0.15$.

We think of α in the model as the product of two components: the probability of finding a suitable lender and the probability a loan application is accepted. We set the first component to one. To get the second component, we use the Survey of Small Business Finances that reports the fraction of firms with their most recent loan application accepted is 0.78 to 0.9. We pick a target within this range and hence obtain $\alpha = 0.85$.

To obtain banks' bargaining power θ, we target the empirical pass-through rate from i to r. We take the nominal lending rate as the prime lending rate and compute the real rate following the methodology of Hamilton et al. (2015). We regress the real lending rate on the 3 month Treasury Bill rate and obtain a slope of $\partial r/\partial i \approx 0.53$. In the model, the pass-through rate for low i is $\partial r/\partial i \approx \theta/\{2\lambda[1-\alpha(1-\theta)]\}$.[6] This gives $\theta = 0.03$.

Calibration Alternative 4. Instead of targeting the loan rejection rate to get α, we also considered targeting the sensitively of aggregate output to a one percentage point increase in the nominal interest rate. Aggregate output in the model is $\lambda[\alpha f(k^c)+(1-\alpha)f(k^m)]$. Hence we target α to match the percentage change in aggregate output following a one percentage point increase in i starting from $i = 5\%$. Dedola and Lippi (2005) find an output sensitivity of around -0.5 in the U.S. across industries. Given $\gamma = 0.7$, we reach this target with $\alpha = 0.76$, there is a one-fourth chance an entrepreneur who applies for a loan gets rejected.[7]

To calibrate λ, we match the elasticity of money demand, which, for low interest rates,

[5] Mulligan (1997) obtains a higher estimate of -0.46 for U.S. firms; similarly Lucas (2000) finds -0.5 for the U.S. aggregate money demand curve. Craig and Rocheteau (2008) and Aruoba et. al (2011) find close to -0.3 in New Monetarist models. If we target a lower elasticity, aggregate output is less sensitive to changes in i; e.g., targeting an elasticity of -0.3 implies implies output sensitivity is -0.8 compared with an output sensitivity of -1.9 with an elasticity of -0.5.

[6] Instead of targeting the pass-through rate, we could alternatively calibrate to match the average level of r for the average i in the data. While the implied pass-through rate is a bit lower (0.4), this procedure produces similar results.

[7] The choice of γ matters for the sensitivity of aggregate output to a change in i, which is one of our targets. A higher value of γ (e.g., we tried $\gamma = 0.8$) would imply a too large sensitivity.

Table 4: Calibration Alternative 4

Value	Target
$\beta = 0.98$	3-month T-bill rate (real)
$i = 0.05$	3-month T-bill rate (nominal)
$\lambda = 0.5$	elasticity of money demand
$\alpha = 0.76$	output sensitivity
$\chi_b = 0.15$	ratio tangible assets to total assets
$\theta = 0.27$	pass through rate

is

$$\frac{\partial k^m / k^m}{\partial i / i} = \frac{i}{(\gamma - 1)\left\{\lambda\left[1 - \alpha(1-\theta)\right] + i\right\}}.$$

We choose a target of -0.3, in the lower range of the estimates in the literature, which gives $\lambda = 0.5$. This implies half of entrepreneurs receive an opportunity to invest within a year.

We choose the value of the pledgeability coefficient in the range of plausible estimates for firms' asset tangibility, $\chi_b = 0.15$.[8] This relatively low pledgeability guarantees that liquidity constraints bind for an intermediate value of i in our sample, $i \approx 7\%$.

To obtain banks' bargaining power θ, we target the empirical interest rate pass through rate. We take the nominal lending rate to be the prime lending rate and we compute the real rate as the prime loan rate minus expected inflation following the methodology of Hamilton et al. (2015). In the model, the pass-through rate for low i is $\partial r / \partial i \approx \theta / \left\{2\lambda\left[1 - \alpha(1-\theta)\right]\right\}$. We regress the real lending rate on the 3 month Treasury Bill rate and obtain $\partial r / \partial i \approx 0.6$.[9] This gives $\theta = 0.27$.

[8] Sufi (2009) reports that on average 34% of a firm's asset are tangible. In a different sample of firms, Acharya et al. (2013) finds the ratio of tangible assets to total assets is 0.35. Almeida and Campello (2007) provide different measures of tangibility as proxies for pledgability and find values ranging between 0.06 and 0.6 across firms.

[9] We also tried different measures of the real lending rate, data frequencies, and filtering; all produced slope estimates ranging from 0.4 to 0.76. If we target a higher pass through rate, i.e. 0.75, we get a higher bargaining power, i.e $\theta = 0.32$.