Appendices – For Online Publication

This Online Appendix contains supplementary material referenced in the main text of "Inflation Dynamics During the Financial Crisis," by S. Gilchrist, R. Schoenle, J. Sim, and E. Zakrajšek. It consists of two parts: Data Appendix (Appendix A) and Model Appendix (Appendix B).

A Data Appendix

The Data Appendix consists of two subsections. Subsection A.1 compares the pricing patterns in the matched PPI–Compustat sample with those in the full PPI sample; it also describes the construction of our key Compustat variables and compares the various firm characteristics for our sample of firms with those of the entire U.S. nonfinancial corporate sector. Subsection A.2 documents the effects of internal liquidity on other aspects of firms' behavior (i.e., employment, capital investment, R&D expenditures, and inventory accumulation).

A.1 Full PPI vs. Matched PPI–Compustat Samples

Compared with the full PPI sample, the matched PPI–Compustat panel is more heavily concentrated on the manufacturing sector (2-digit NAICS 31–33). More than 90 percent of goods in the matched PPI–Compustat data set are produced by manufacturing firms, compared with about 60 percent in the full PPI data set. Table A-1 compares the key cross-sectional price-change characteristics between the full PPI and matched PPI–Compustat data sets. In the first step, we calculate the *average* price-change characteristic for each good; in the case of good-level inflation, for example, we compute $\pi_{i,j,\cdot} = T_i^{-1} \sum_{t=1}^{T_i} \pi_{i,j,t}$, where T_i denotes the number of months that good i is in the sample. In the second step, we compute the summary statistics of the average good-specific price change characteristics for the two data sets.

An average establishment in the PPI–Compustat panel reports in an average month price information on 5.4 goods, whereas its counterpart in the full PPI panel does so for 4.3 goods. In addition, prices of goods produced by the former are, on average, sampled over a longer time period—51.2 months compared with 42.3 months. Despite these differences, the cross-sectional price change characteristics are very similar across the two samples. The price of an average good in the full PPI panel increases 0.15 percent per month, on average, over its lifetime in the sample, compared with 0.12 percent for an average good in the PPI–Compustat panel. Not surprisingly, the dispersion of average good-level inflation rates in the full PPI sample is noticeably higher than that in the matched PPI–Compustat sample, reflecting the fact that the former sample contains many goods with very volatile prices. In both data sets, the distributions of positive and negative price changes are also very comparable: The median of the average good-specific positive inflation rates is 5.2 percent for the full PPI sample and 4.8 percent for the matched PPI–Compustat sample; the corresponding medians of the average good-specific negative inflation rates are −4.8 percent and −4.4 percent, respectively.

On average, the probability with which prices of an average good are adjusted in the full PPI panel is 16 percent per month, compared with 18 percent per month for the PPI–Compustat panel; that is, an average good changes its price about every 6 months in both data sets. However, as evidenced by the associated standard deviations, the frequency of price changes varies significantly across goods, a pattern also documented by Nakamura and Steinsson (2008). Consistent with a positive average inflation rate in both panels, the average frequency of upward price changes exceeds that of the downward price changes in both cases.

We now describe the construction of firm-specific indicators based on the quarterly Compustat data. In variable definitions, x_n denotes the Compustat data item n.

- **Cash and Short-Term Investments** (x_{36}): cash and all securities readily transferable to cash as listed in the current asset section of the firm's balance sheet.
- **Selling, General, and Administrative Expenses** (x_1): all commercial expenses of operation incurred in the regular course of business.
- **Net Sales** (x_2): gross sales (the amount of actual billings to customers for regular sales completed during the quarter) less cash discounts, trade discounts, returned sales, and allowances for which credit is given to customers.
- **Cost of Goods Sold** (x_{30}): all costs directly allocated by the company to production, such as material, labor, and overhead. Selling, General, and Administrative Expenses are not included in the cost of good sold.
- **Total Assets** (x_{44}): current assets plus net property, plant & equipment, plus other noncurrent assets.

The *liquidity ratio* is defined as the ratio of cash and short-term investments in quarter t to total assets in quarter t ($x_3[t]/x_{44}[t]$), and the *SGAX ratio* is defined as the ratio of selling, general, and administrative expenses in quarter t to sales in quarter t ($x_1[t]/x_2[t]$). To ensure that our results were not influenced by a small number of extreme observations, we deleted from the quarterly Compustat panel data set all firm/quarter observations that failed to satisfy any of the following criteria:

1. $0.00 \leq$ Liquidity Ratio ≤ 1.00;
2. $0.00 \leq$ SGAX Ratio ≤ 10.0;
3. $-2.00 \leq \Delta \log$(Net Sales) ≤ 2.00;
4. $-2.00 \leq \Delta \log$(Cost of Goods Sold) ≤ 2.00.

Table A-2 contains the selected summary statistics for the key variables used in the analysis for both the matched PPI–Compustat sample and for all U.S. nonfinancial firms covered by Compustat. In general, the PPI–Compustat sample contains larger firms—the median firm size, as measured by (quarterly) real sales, is more than \$300 million, compared with only about \$80 million for the entire Compustat sample. Reflecting their larger size, the firms in the PPI–Compustat panel tend to grow more slowly, on average, and also have less volatile sales. The difference in average firm size between the two data sets helps explain the fact that the aggregate dynamics of sales and prices of firms in the PPI–Compustat sample are representative of broader macroeconomic trends (see Figure 1 in the main text).

In terms of financial characteristics, the two sets of firms are fairly similar, especially if one compares the respective medians of the two distributions. Nevertheless, firms in the PPI–Compustat sample tend to have somewhat less liquid balance sheets, on balance, as measured by the liquidity ratio. This difference is consistent with the fact that the PPI–Compustat sample consists of larger firms that, ceteris paribus, have better access to external sources of finance and therefore less need to maintain a precautionary liquidity buffer. An average firm in the PPI–Compustat sample also tends to have a lower SGAX ratio compared with an average nonfinancial firm in Compustat.

As noted in the main text, when sorting firms into low and high liquidity categories in month t, we rely on the trailing average liquidity ratio over the preceding 12 months. When sorting firms into low and high SGAX categories, by contrast, we rely on the average SGAX ratio computed over the 2000–2004 pre-sample period. Table A-3 summarizes the first two moments of the (good-level) price change characteristics—measured from month $t-1$ to month t—for the various categories of firms over the 2005–2012 sample period.

Focusing first on the financial dimension—the top panel—prices of goods produced by firms with relatively ample internal liquidity increase at a slower rate, on average, compared with prices of goods produced by their low liquidity counterparts. In an accounting sense, the average inflation differential of 12 basis points per month reflects the fact that the average price decline at high liquidity firms is about 6.2 percent per month, whereas at low liquidity firms, the average price decline is only 5.5 percent. These differences in the average inflation rates between financially strong and weak firms do not reflect differences in the extensive margin of price adjustment, as the average frequency of price changes—both overall and directional—is very similar between the two types of firms. Finally, as noted in the *Memo* item, low liquidity firms have, on average, a significantly less liquid balance sheets compared with their high liquidity counterparts: in the former category, liquid assets account, on average, for only 3 percent of total assets, compared with 21 percent in the latter category.

As shown in the bottom panel of the table, pricing dynamics also differ across firms with varying intensity of SG&A spending. Prices of goods produced by firms with a high SGAX ratio are estimated to rise at an average rate of only 4 basis points per month, compared with an 18 basis points rate of increase at firms with a low SGAX ratio. This systematic inflation differential primarily reflects larger average price cuts by the high SGAX-ratio firms (6.5 percent), compared with those at the low SGAX-ratio firms (5.5 percent). The intensity of SG&A spending is also correlated with the frequency with which firms adjust their prices. On average, high SGAX-ratio firms exhibit a markedly lower frequency of price adjustment compared with their low SGAX-ratio counterparts (7 percent vs. 14 percent); moreover this difference extends to both positive and negative price changes. As indicated by the *Memo* item, the average SGAX ratio over our sample period differs significantly between the two types of firms, in a manner that is consistent with our ex ante classification.

Panel (a) of Figure A-1 shows the industry-adjusted inflation rates of low and high liquidity firms within the durable and nondurable goods manufacturing sectors, while panel (b) displays the same information for firms with varying intensity of SG&A spending. This analysis is based on a subset of the matched PPI-Compustat data set, though, as noted in Section 2 of the main text, more than 90 percent of goods in the matched PPI–Compustat data set are produced by manufacturing firms, split about evenly between durable and nondurable goods producers.

A.2 Liquidity, Employment, and Investment During the Financial Crisis

In this section, we document that differences in the firms' internal liquidity positions—as measured by the liquidity ratio—had a differential effect not only on their price-setting behavior, but also on their employment and other more traditional forms of investment (i.e., expenditures on fixed capital and research and development (R&D) and inventory accumulation).

To examine formally the role of internal liquidity in employment dynamics, we use the annual Compustat data for the sample of matched PPI-Compustat firms to estimate the following fixed effects panel regression:

$$\Delta \log E_{j,t+1} = \beta \mathrm{LIQ}_{j,t} + \theta \Delta \log \tilde{S}_{j,t+1} + \eta_j + \lambda_{t+j} + \epsilon_{j,t+1}, \tag{A-1}$$

where $\Delta \log E_{j,t+1}$ denotes the log-difference in the number of employees at firm j from year t to year $t+1$, and $\Delta \log \tilde{S}_{j,t+1}$ is the corresponding log-difference in the firm's real sales, as defined in the main text.[1] With regards to capital and R&D expenditures, we estimate:

$$\log \left[\frac{x}{K}\right]_{j,t+1} = \beta \mathrm{LIQ}_{j,t} + \boldsymbol{\theta}'\mathbf{Z}_{j,t+1} + \eta_j + \lambda_{t+1} + \epsilon_{j,t+1}, \tag{A-2}$$

where, if $x = I$, $[I/K]_{j,t+1}$ denotes the ratio of capital expenditures of firm j during year $t+1$ to its capital stock at the end of year t, and if $x = \mathrm{RD}$, $[\mathrm{RD}/K]_{j,t+1}$ denotes the ratio of R&D expenditures during year $t+1$ relative to capital stock at the end of year t.[2] In all specifications, $\mathrm{LIQ}_{j,t}$ denotes the firm's liquidity ratio at the end of year t, a timing convention that is consistent with our benchmark pricing regressions in the main text.

The inclusion of the current growth in real sales $\Delta \log \tilde{S}_{j,t+1}$ in the employment regression (A-1) captures the firm-specific cyclical factors associated with employment fluctuations, while the vector $\mathbf{Z}_{j,t+1}$ in equation (A-2) controls for the firm's investment opportunities. In line with the previous empirical literature (Himmelberg and Petersen, 1994; Gilchrist and Himmelberg, 1998; Gilchrist and Zakrajšek, 2007), we measure investment fundamentals using the log of the operating-income-to-capital ratio in year $t+1$, denoted by $[\Pi/K]_{j,t+1}$.[3] One drawback of this measure is that it is not explicitly forward looking. Accordingly, we also include the log of Tobin's Q—measured as of the end of year t—in the vector of fundamentals $\mathbf{Z}_{j,t+1}$. Because it is based on the firm's equity valuations, Tobin's Q is a forward-looking variable and thus contains information about future investment opportunities that may not captured by the firm's current profit rate.

When analyzing the role of internal liquidity as a determinant of cyclical fluctuations in inventory investment, we can work with quarterly, as opposed to annual, data. In that case, we estimate the following specification:

$$\Delta \log N_{j,t+1} = \beta \mathrm{LIQ}_{j,t} + \theta_1 \log \left[\frac{N}{S}\right]_{j,t} + \theta_2 \Delta \log N_{j,t} + \theta_3 \Delta \log S_{j,t} + \eta_j + \lambda_{t+1} + \epsilon_{j,t+1}, \tag{A-3}$$

where $\Delta \log N_{j,t+1}$ denotes the log-difference of (total) inventories from quarter t to quarter $t+1$, and $\log[N/S]_{j,t}$ is the log of the firm's inventory-to-sales ratio in quarter t. This "error-correction" specification implicitly assumes the the firm's target (log) inventory-to-sales ratio consists of a time-invariant firm-specific component—subsumed into the firm fixed effect η_j—and a time-varying aggregate component, captured by the time fixed effect λ_{t+1} (Calomiris et al., 1995; Carpenter et al., 1998).

We estimate regressions (A-1), (A-2) and (A-3) by OLS, using the "within" transformation to eliminate firm fixed effects.[4] The results of this exercise are tabulated in Table A-4. As shown in columns (1), (3), (5), and (7), differences in the firms' internal liquidity positions are an important determinant—both economically and statistically—of differences in employment growth, capital accumulation, R&D expenditures, and inventory investment across firms over the 2005–2012 period. According to the estimates reported in those columns, a difference in the liquidity ratio of 10 percentage point between two firms in year t—a difference of less than one standard deviation

[1] Similar employment regressions were estimated by Sharpe (1994). Note that because the micro-level producer prices used to construct real sales growth at the firm level start in January 2005, the time-series dimension of the resulting annual panel runs from 2006 to 2012.

[2] We use the log transformation of the dependent variables because $[I/K]_{j,t+1}$ and $[\mathrm{RD}/K]_{j,t+1}$ are positively skewed, which may induce heteroskedasticity in the error term $\epsilon_{j,t+1}$ across firms.

[3] Because operating income may be negative, we use the transformation $\log(c + [\Pi/K]_{j,t+1})$, where c is chosen so that $c + [\Pi/K]_{j,t+1} > 0$, for all j and t.

[4] We applied a set of standard filters to the data in order to eliminate extreme observations.

(see Table A-2)—is associated with a differential growth of employment of about 3.5 percentage points over the subsequent year. Such a difference in the firms' internal liquidity also translates into more than a 25 percentage point differential in the investment rate between financially weak and strong firms and a 22 percentage point differential in R&D expenditures, relative to capital, over the same period. The effects of internal liquidity on inventory accumulation are also sizable in economic terms: a 10 percentage point difference in the liquidity ratio across firms in quarter t implies a difference in the growth of inventory stocks of 2.3 percentage points (at an annual rate) over the subsequent quarter.

These results strongly support our hypothesis that firms holding less liquid assets not only increased prices during the recent financial crisis, but they also slashed employment, cut back capital and R&D spending, and reduced inventory stocks by significantly more than their liquidity unconstrained counterparts. Our empirical results are also consistent with the survey evidence compiled by Campello et al. (2010), who report that in 2008, companies in the U.S., Europe, and Asia that identified themselves as credit constrained planned to lay off significantly more workers and make substantially deeper cuts in their capital and tech spending than companies that categorized themselves as credit unconstrained.

Columns (2), (4), (6), and (8) of the table report the results from specifications in which the coefficient on the liquidity ratio is allowed to differ between the crisis ($\mathbf{1}[\text{CRISIS}_t = 1]$) and non-crisis ($\mathbf{1}[\text{CRISIS}_t = 0]$) periods.[5] According to column (2), the firms' internal liquidity positions had, in economic terms, an appreciably larger effect on employment in 2008 and 2009—the coefficient on the liquidity ratio during the crisis period is 0.418, compared with the non-crisis estimate of 0.346. Moreover, the same sort of asymmetry appears to be also evident in the case of inventory investment (column 8). Thus, employment and inventories become markedly more sensitive to corporate liquidity during the crisis period. As argued by Bils and Kahn (2000), these results provide further evidence that markups of liquidity constrained firms become more countercyclical in periods of widespread turmoil in financial markets.

[5]For specifications that rely on annual data (columns (1)–(4)), the crisis indicator is equal to 1 in 2008 and 2009 (and 0 otherwise), reflecting the fact that the firm-level annual data are reported at fiscal year-ends. For specifications that rely on quarterly data (columns (5) and (6)), the crisis indicator is equal to 1 in 2008 (and 0 otherwise), a definition that is consistent with the pricing regressions reported in Tables 1 and 2 in the main text.

TABLE A-1: Summary Statistics of Good-Level Price Change Characteristics
(*Full PPI Sample vs. Matched PPI–Compustat Sample*)

Variable (percent)	Mean	STD	Min	P50	Max
Inflation					
Full PPI sample	0.15	0.82	−42.80	0.02	55.59
PPI–Compustat sample	0.12	0.57	−7.15	0.08	5.04
Positive price changes					
Full PPI sample	7.52	0.26	0.00	5.21	99.32
PPI–Compustat sample	6.21	6.19	0.00	4.80	89.45
Negative price changes					
Full PPI sample	−7.72	9.73	−99.88	−4.76	−0.00
PPI–Compustat sample	−6.70	8.39	−88.53	−4.38	−0.00
Freq. of price changes					
Full PPI sample	15.52	25.90	0.00	4.88	100.00
PPI–Compustat sample	18.31	27.28	0.00	6.90	100.00
Freq. of positive price changes					
Full PPI sample	9.14	14.45	0.00	3.45	100.00
PPI–Compustat sample	10.44	14.67	0.00	4.76	75.00
Freq. of negative price changes					
Full PPI sample	6.37	13.09	0.00	0.00	100.00
PPI–Compustat sample	7.87	13.68	0.00	1.52	100.00
Avg. number of goods per firm					
Full PPI sample	4.3	2.6	1	4	77
PPI–Compustat sample	5.4	3.3	1	4.9	41
Months in the panel					
Full PPI sample	42.3	25.3	1	41	96
PPI–Compustat sample	51.2	20.2	1	52	95

NOTE: Sample period: monthly data from Jan2005 to Dec2012. Full PPI sample: No. of goods = 202,281; No. of respondents = 46,306; and Obs. = 8,551,681. Matched PPI–Compustat sample: No. of goods = 6,859; No. of respondents = 1,242; and Obs. = 351,192. All price change characteristics correspond to good-level averages computed using trimmed monthly data.

Table A-2: Summary Statistics for Selected Firm Characteristics
(*U.S. Nonfinancial Corporate Sector vs. Matched PPI–Compustat Sample*)

Variable	Mean	STD	Min	P50	Max
Sales ($bil.)[a]					
Compustat sample	0.96	4.44	<.01	0.08	200.25
PPI–Compustat sample	1.69	5.71	<.01	0.33	125.26
Liquidity ratio					
Compustat sample	0.21	0.24	0.00	0.12	1.00
PPI–Compustat sample	0.15	0.16	0.00	0.09	1.00
SGAX ratio					
Compustat sample	0.39	0.59	0.00	0.25	8.00
PPI–Compustat sample	0.26	0.29	0.00	0.21	7.77
Sales growth (pct.)					
Compustat sample	1.51	29.67	−199.87	2.11	199.92
PPI–Compustat sample	1.06	19.36	−196.52	1.83	176.88
COGS growth (pct.)					
Compustat sample	1.32	29.47	−199.80	2.03	199.86
PPI–Compustat sample	0.82	19.72	−187.27	1.70	177.74

Note: Sample period: Jan2005 to Dec2012 at a quarterly frequency. Compustat sample (U.S. nonfinancial sector): No. of firms = 6,138 and Obs. = 152,944. Matched PPI–Compustat sample: No. of firms = 584 and Obs. = 16,052. Liquidity ratio = cash & short-term investments to total assets; SGAX ratio = sales & general administrative expenses (SGAX) relative to sales; and COGS = cost of goods sold. All statistics are based on trimmed data.

[a] Deflated by the U.S. nonfarm business sector GDP price deflator (2009:Q4 = 100).

Table A-3: Summary Statistics of Price Change Characteristics
(*By Selected Firm Characteristics*)

	Low Liquidity Firms		High Liquidity Firms	
Variable (percent)	Mean	STD	Mean	STD
Inflation	0.17	4.09	0.05	4.62
Positive price changes	5.45	6.97	5.46	7.82
Negative price changes	−5.52	7.89	−6.18	10.02
Freq. of price changes	19.90	39.92	19.00	39.23
Freq. of positive price changes	11.56	31.97	10.56	30.73
Freq. of negative price changes	8.34	27.64	8.44	27.80
No. of goods	5,011		3,956	
Observations	189,277		123,220	
Memo: Liquidity ratio	0.03	0.05	0.21	0.17
	Low SGAX Firms		High SGAX Firms	
Variable (percent)	Mean	STD	Mean	STD
Inflation	0.19	4.43	0.03	3.88
Positive price changes	5.42	6.89	5.27	7.91
Negative price changes	−5.42	7.79	−6.25	10.48
Freq. of price changes	23.83	42.60	12.99	33.61
Freq. of positive price changes	13.67	34.35	7.33	26.06
Freq. of negative price changes	10.16	30.21	5.66	23.12
No. of goods	3,891		2,829	
Observations	203,106		141,455	
Memo: SGAX ratio	0.13	0.07	0.37	0.26

Note: Sample period: monthly data from 2005:M1 to 2012:M12; No. of firms = 547.

Table A-4: Liquidity, Employment, and Investment During the Financial Crisis

	Annual Data[a]						Quarterly Data[b]	
	Employment		Capital Expenditures		R&D Expenditures		Inventories	
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{LIQ}_{j,t}$	0.362***	.	1.232***	.	0.860***	.	0.058***	.
	(0.047)		(0.195)		(0.166)		(0.017)	
$\text{LIQ}_{j,t} \times \mathbf{1}[\text{CRISIS}_t = 1]$	.	0.418***	.	1.340***	.	0.851***	.	0.087***
		(0.056)		(0.256)		(0.187)		(0.028)
$\text{LIQ}_{j,t} \times \mathbf{1}[\text{CRISIS}_t = 0]$	.	0.346***	.	1.206***	.	0.862***	.	0.055***
		(0.047)		(0.197)		(0.170)		(0.027)
$\Delta \log \tilde{S}_{j,t+1}$	0.229***	0.230***	.	.	.	.	.	.
	(0.022)	(0.022)						
$\log[\Pi/K]_{j,t+1}$	.	.	0.196***	0.196***	0.089***	0.089***	.	.
			(0.029)	(0.029)	(0.030)	(0.030)		
$\log Q_{j,t}$	.	.	0.290***	0.291***	0.068	0.068	.	.
			(0.059)	(0.060)	(0.060)	(0.060)		
$\log[N/S]_{j,t}$	.	.	.	.	.	.	−0.125***	−0.126***
							(0.008)	(0.008)
$\Delta \log N_{j,t}$	.	.	.	.	.	.	0.050***	0.050***
							(0.012)	(0.012)
$\Delta \log S_{j,t}$	.	.	.	.	.	.	−0.072***	−0.072***
							(0.015)	(0.015)
$\Pr > W$[c]	.	0.075	.	0.504	.	0.927	.	0.168
R^2 (within)	0.226	0.227	0.259	0.259	0.172	0.172	0.150	0.150
No. of firms	543		553		371		571	
Observations	3,218		3,454		2,222		14,516	

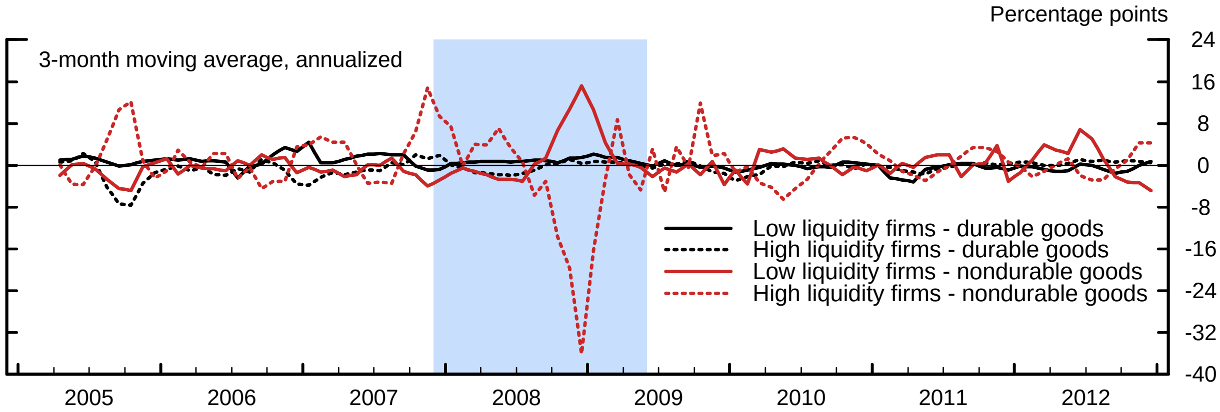
Note: The dependent variable in columns (1) and (2) is $\Delta \log E_{j,t+1}$, the log-difference in the number of employees from year t to year $t+1$; the dependent variable in columns (3) and (4) is $\log[I/K]_{j,t+1}$, the log of the ratio of capital expenditures in year $t+1$ to the stock of capital at the end of year t; the dependent variable in columns (5) and (6) is $\log[\text{RD}/K]_{j,t+1}$, the log of the ratio of R&D expenditures in year $t+1$ to the stock of capital at the end of year t; and the the dependent variable in columns (7) and (8) is $\Delta N_{j,t+1}$, the log-difference of inventories from quarter t to quarter $t+1$. In addition to the specified explanatory variables (see equations A-1–A-3 and the text for details), all specifications include firm and time fixed effects and are estimated by OLS. Robust asymptotic standard errors reported in parentheses are clustered at the firm level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

[a] Sample period: 2006 to 2012 at an annual (fiscal year-end) frequency in columns (1) and (2); and 2005 to 2012 at an annual (fiscal year-end) frequency in columns (3)–(6).

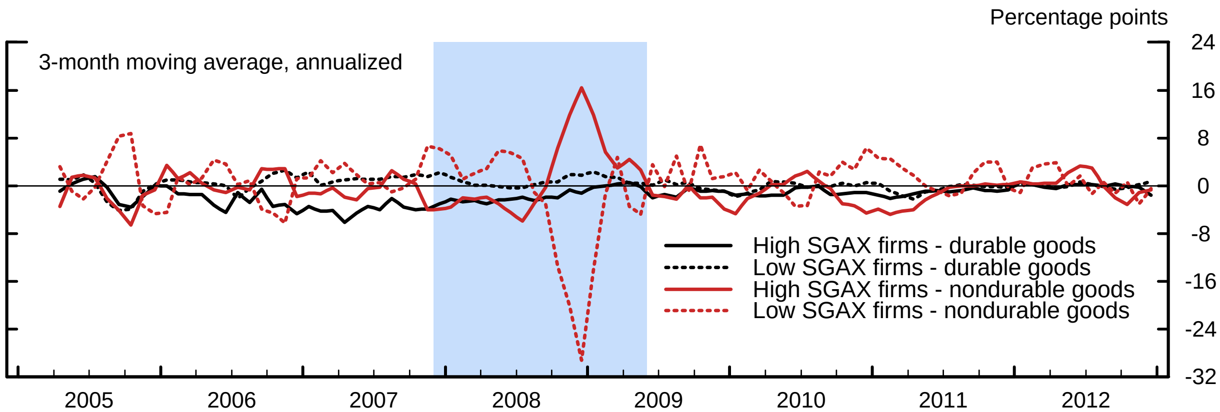
[b] Sample period: 2005:Q1 to 2012:Q4 at a quarterly frequency.

[c] p-value for the Wald test of the null hypothesis that the coefficients on the liquidity ratio ($\text{LIQ}_{j,t}$) are equal between crisis and non-crisis periods.

Figure A-1: Industry-Adjusted Producer Price Inflation
(*By Selected Firm Characteristics and Durability of Output*)



(a) By liquidity ratio and durability of output



(b) By SGAX ratio and durability of output

Note: The solid (dotted) lines in panel (a) depicts the weighted-average industry-adjusted inflation rate for low (high) liquidity firms in durable and nondurable good manufacturing industries. The solid (dotted) lines in panel (b) depicts the weighted-average industry-adjusted inflation rate for high (low) SGAX firms in durable and nondurable good manufacturing industries. All underlying series are seasonally adjusted and annualized. The shaded vertical bar represents the 2007–2009 recession as dated by the NBER.

B Model Appendix

The Model Appendix consists of three subsections. Subsection B.1 describes the model with heterogeneous firms and nominal rigidities, which is introduced in Section 5 of the main text. Subsection B.2 provides details surrounding the derivation of the log-linearized Phillips curve. And Subsection B.3 contains simulations of our benchmark model under alternative calibrations.

B.1 Model with Firm Heterogeneity and Nominal Rigidities

This section describes the key aspects of our full model—that is, the model featuring heterogeneous firms and nominal rigidities. Without loss of generality, we assume that there exist a finite number of firm types indexed by $k = 1, \dots, N$. Firms of different types are characterized by varying degree of operating efficiency, measured by the size of the fixed operating cost. Formally, the production technology of firm i of type k is given by

$$y_{it} = \left(\frac{A_t}{a_{it}} h_{it}\right)^{\alpha} - \phi_k; \quad 0 < \alpha \leq 1, \tag{B-1}$$

where $\phi_k \geq 0$ denotes the fixed operating costs, which can take one of N-values from a set $\mathbf{\Phi} = \{\phi_1, \dots, \phi_N\}$, with $0 \leq \phi_1 < \cdots < \phi_N$. The measure of firms of type k is denoted by Ξ_k, with $\sum_{k=1}^{N} \Xi_k = 1$. We assume that each type of firm faces the same distribution of the idiosyncratic cost shock a_{it}—that is, $\log a_{it} \overset{iid}{\sim} N(-0.5\sigma^2, \sigma^2)$, for all i and k.

The presence of quadratic adjustment costs incurred when firms change nominal prices modifies the flow-of-funds constraint as

$$0 = p_{it}c_{it} - w_t h_{it} - \frac{\gamma_p}{2}\left(\pi_t \frac{p_{it}}{p_{i,t-1}} - \bar{\pi}\right)^2 c_t - d_{it} + \varphi_t \min\{0, d_{it}\}. \tag{B-2}$$

The firm's problem of maximizing the expected present discounted value of dividends then gives rise to the following Lagrangian:

$$\begin{aligned}\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} m_{0,t} \Bigg\{ & d_{it} + \kappa_{it}\left[\left(\frac{A_t}{a_{it}} h_{it}\right)^{\alpha} - \phi_k - c_{it}\right] \\ & + \xi_{it}\left[p_{it}c_{it} - w_t h_{it} - \frac{\gamma_p}{2}\left(\pi_t \frac{p_{it}}{p_{i,t-1}} - \bar{\pi}\right)^2 c_t - d_{it} + \varphi_t \min\{0, d_{it}\}\right] \\ & + \nu_{it}\left[\left(\frac{p_{it}}{\tilde{p}_t}\right)^{-\eta} s_{it-1}^{\theta(1-\eta)} x_t - c_{it}\right] + \lambda_{it}\left[\rho s_{i,t-1} + (1-\rho)c_{it} - s_{it}\right] \Bigg\},\end{aligned} \tag{B-3}$$

and the associated first-order conditions for type-k firms:

$$d_{it}: \quad \xi_{it} = \begin{cases} 1 & \text{if } d_{it} \geq 0 \\ 1/(1-\varphi_t) & \text{if } d_{it} < 0; \end{cases} \tag{B-4}$$

$$h_{it}: \quad \kappa_{it} = \xi_{it} a_{it} \left(\frac{w_t}{\alpha A_t} \right) (c_{it} + \phi_k)^{\frac{1-\alpha}{\alpha}}; \tag{B-5}$$

$$c_{it}: \quad \mathbb{E}_t^a\big[\nu_{it}\big] = \mathbb{E}_t^a\big[\xi_{it}\big] p_{it} - \mathbb{E}_t^a\big[\kappa_{it}\big] + (1-\rho)\mathbb{E}_t^a\big[\lambda_{it}\big]; \tag{B-6}$$

$$s_{it}: \quad \mathbb{E}_t^a\big[\lambda_{it}\big] = \rho \mathbb{E}_t^a\big[m_{t,t+1}\lambda_{i,t+1}\big] + \theta(1-\eta)\mathbb{E}_t \left[m_{t,t+1}\mathbb{E}_{t+1}^a\big[\nu_{i,t+1}\big] \left(\frac{c_{i,t+1}}{s_{it}} \right) \right]; \tag{B-7}$$

$$\begin{aligned} p_{it}: \quad 0 = {} & \mathbb{E}_t^a\big[\xi_{it}\big] c_{it} - \eta \frac{\mathbb{E}_t^a\big[\nu_{it}\big]}{p_{it}} c_{it} - \gamma_p \frac{\pi_t}{p_{i,t-1}} \left(\pi_t \frac{p_{it}}{p_{i,t-1}} - \bar{\pi} \right) c_t \\ & + \gamma_p \mathbb{E}_t \left[m_{t,t+1}\mathbb{E}_{t+1}^a\big[\xi_{i,t+1}\big] \pi_{t+1} \frac{p_{i,t+1}}{p_{it}^2} \left(\pi_{t+1} \frac{p_{i,t+1}}{p_{it}} - \bar{\pi} \right) c_{t+1} \right]. \end{aligned} \tag{B-8}$$

The presence of heterogeneous operating costs and nominal rigidities implies that the type-specific external financing trigger is given by

$$a_t^E(\phi_k) = \frac{c_{it}}{(c_{it} + \phi_k)^{\frac{1}{\alpha}}} \frac{A_t}{w_t} \left[p_{it} - \frac{\gamma_p}{2} \left(\pi_t \frac{p_{it}}{p_{i,t-1}} - \bar{\pi} \right)^2 \frac{c_t}{c_{it}} \right], \tag{B-9}$$

which allows us to express the first-order condition governing the behavior of dividends (equation B-4) as

$$\xi_{it} = \begin{cases} 1 & \text{if } a_{it} \leq a_t^E(\phi_k) \\ 1/(1-\varphi_t) & \text{if } a_{it} > a_t^E(\phi_k). \end{cases} \tag{B-10}$$

Using equation (B-10), one can show that the expected shadow value of internal funds for firms of type k is equal to

$$\mathbb{E}_t^a\big[\xi_{it}|\phi_k\big] = \Phi(z_t^E(\phi_k)) + \frac{1}{1-\varphi_t}\big[1 - \Phi(z_t^E(\phi_k))\big] = 1 + \frac{\varphi_t}{1-\varphi_t}\big[1 - \Phi(z_t^E(\phi_k))\big] \geq 1,$$

where $z_t^E(\phi_k)$ denotes the standardized value of $a_t^E(\phi_k)$. Note that $da_t^E(\phi_k)/d\phi_k < 0$, which implies that $d\mathbb{E}_t^a\big[\xi_{it}|\phi_k\big]/d\phi_k > 0$. In other words, firms with lower operating efficiency are more likely to experience a liquidity shortfall and hence face a higher expected premium on external funds.

B.1.1 Aggregation

In the presence of firm heterogeneity, the nature of the symmetric equilibrium is modified. Specifically, all firms with the same ϕ_k choose the same price level P_{kt}:

$$P_{it}^{1-\eta} = \sum_{k=1}^{N} \mathbf{1}(\phi_i = \phi_k) \times P_{kt}^{1-\eta}. \tag{B-11}$$

Aggregate inflation dynamics are then given by a weighted average of the N types of firms. Because $\pi_t \equiv P_t/P_{t-1} = 1/P_{t-1}\left(\int_0^1 P_{it}^{1-\eta} di\right)^{1/(1-\eta)}$, we can use equation (B-11) to express the aggregate inflation rate as

$$\begin{aligned}
\pi_t &= \frac{1}{P_{t-1}}\left[\int_0^1 \sum_{k=1}^{N} \mathbf{1}(\phi_i = \phi_k) \times P_{kt}^{1-\eta} di\right]^{\frac{1}{1-\eta}} \\
&= \frac{1}{P_{t-1}}\left[\sum_{k=1}^{N} P_{kt}^{1-\eta} \int_0^1 \mathbf{1}(\phi_i = \phi_k) di\right]^{\frac{1}{1-\eta}} \\
&= \left[\sum_{k=1}^{N} \Xi_k \left(\frac{P_{kt}}{P_{t-1}}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}} \\
&= \left[\sum_{k=1}^{N} \Xi_k \left(\frac{P_{kt}}{P_{k,t-1}}\right)^{1-\eta} \left(\frac{P_{k,t-1}}{P_{t-1}}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}.
\end{aligned}$$

Hence, the aggregate inflation rate is determined as a weighted-average of inflation rates of heterogeneous groups:

$$\pi_t = \left[\sum_{k=1}^{N} \Xi_k p_{k,t-1}^{1-\eta} \pi_{kt}^{1-\eta}\right]^{\frac{1}{1-\eta}}, \tag{B-12}$$

where $\pi_{kt} \equiv P_{kt}/P_{k,t-1}$ is a type-specific inflation rate and $p_{kt} \equiv P_{kt}/P_t$ is a type-specific relative price. Note that the relative price p_{kt} can no longer be equalized to one in the symmetric equilibrium. The notion of a symmetric equilibrium is restricted to "within types," that is, within categories, and in equilibrium, there exists a non-degenerate distribution of relative prices.

The following Phillips curve describes the inflation dynamics of the k-type firms:

$$\begin{aligned}
0 = p_{kt}\frac{c_{kt}}{c_t} - \eta\frac{\mathbb{E}_t^a\left[\nu_{kit}|\phi_k\right]}{\mathbb{E}_t^a\left[\xi_{kit}|\phi_k\right]}\frac{c_{kt}}{c_t} - \gamma_p \pi_{kt}\pi_t\left(\pi_{kt}\pi_t - \bar{\pi}\right) \\
+ \gamma_p \mathbb{E}_t\left[m_{t,t+1}\frac{\mathbb{E}_{t+1}^a\left[\xi_{ki,t+1}|\phi_k\right]}{\mathbb{E}_t^a\left[\xi_{kit}|\phi_k\right]}\pi_{k,t+1}\pi_{t+1}\left(\pi_{k,t+1}\pi_{t+1} - \bar{\pi}\right)\frac{c_{t+1}}{c_t}\right].
\end{aligned} \tag{B-13}$$

The same notion of the modified symmetric equilibrium can be applied to equilibrium output:

$$c_{it}^j = \sum_{k=1}^{N} \mathbf{1}(\phi_i = \phi_k) \times c_{kt}^j.$$

Because the household sector is still characterized by a symmetric equilibrium, we can drop the "j" superscript. The individual demand for products produced by firms with efficiency rank k is then given by

$$c_{kt} = \left(\frac{p_{kt}}{\tilde{p}_t}\right)^{-\eta} s_{k,t-1}^{\theta(1-\eta)} x_t, \tag{B-14}$$

where

$$\tilde{p}_t = \left[\sum_{k=1}^{N} \Xi_k p_{kt}^{1-\eta} s_{k,t-1}^{\theta(1-\eta)}\right]^{\frac{1}{1-\eta}}; \tag{B-15}$$

and

$$x_t = \left[\sum_{k=1}^{N} \Xi_k \left(\frac{c_{kt}}{s_{k,t-1}^{\theta}}\right)^{1-\frac{1}{\eta}}\right]^{\frac{1}{1-\frac{1}{\eta}}}. \tag{B-16}$$

Aggregate demand should then satisfy

$$c_t = \left[\sum_{k=1}^{N} \Xi_k \big[\exp(0.5\alpha(1+\alpha)\sigma^2) h_{kt}^{\alpha} - \phi_k \big]^{1-\frac{1}{\eta}} \right]^{\frac{1}{1-\frac{1}{\eta}}}, \tag{B-17}$$

while the type-specific conditional labor demand satisfies

$$h_{kt} = \left[\frac{c_{kt} + \phi_k}{\exp(0.5\alpha(1+\alpha)\sigma^2)} \right]^{\frac{1}{\alpha}}, \tag{B-18}$$

with $h_t = \sum_{k=1}^{N} h_{kt}$. (The term $\exp(0.5\alpha(1+\alpha)\sigma^2)$ is the expected value of $1/a_{it}$, which is strictly greater than one due to Jensen's inequality.)

B.1.2 Equilibrium Relative Prices in the Steady State

In the steady state, the Phillips curve (equation B-13) implies

$$p_k = \eta \frac{\mathbb{E}^a\big[\nu_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]}. \tag{B-19}$$

From the first-order conditions for the habit stock (equation B-7), we have

$$\frac{\mathbb{E}^a\big[\lambda_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]} = \frac{\theta(1-\eta)\beta}{1-\rho\beta} \frac{\mathbb{E}^a\left[\nu_i | \phi_k\right]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]}. \tag{B-20}$$

Combining equations (B-19) and (B-20) yields

$$\frac{\mathbb{E}^a\big[\lambda_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]} = p_k \frac{\theta(1-\eta)\beta}{\eta(1-\rho\beta)}. \tag{B-21}$$

In the steady state, the first-order conditions for labor input (equation B-5) and production scale (equation B-6) together imply

$$\frac{\mathbb{E}^a\big[\nu_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]} = -\frac{\mathbb{E}^a\big[\xi_i a_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]} \frac{w}{\alpha A} (c_k + \phi_k)^{\frac{1-\alpha}{\alpha}} + p_k + (1-\rho) \frac{\mathbb{E}^a\big[\lambda_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]}. \tag{B-22}$$

Substituting equations (B-19) and (B-21) into equation (B-22) yields

$$p_k = \frac{\eta(1-\rho\beta)}{(\eta-1)[(1-\rho\beta) - \theta\beta(1-\rho)]} \frac{\mathbb{E}^a\big[\xi_i a_i | \phi_k\big]}{\mathbb{E}^a\big[\xi_i | \phi_k\big]} \frac{w}{\alpha A} (c_k + \phi_k)^{\frac{1-\alpha}{\alpha}}. \tag{B-23}$$

The type-specific external financing triggers in the steady state are given by

$$a_k^E = \frac{p_k c_k}{(c_k + \phi_k)^{\frac{1}{\alpha}}} \frac{A}{w}, \tag{B-24}$$

while the consumption aggregators imply

$$\frac{c_k}{c_l} = \left(\frac{p_k}{p_l} \right)^{-\eta} \frac{s_k^{\theta(1-\eta)}}{s_l^{\theta(1-\eta)}}; \quad k \neq l, \tag{B-25}$$

and

$$x = \left[\sum_{k=1}^{N} \Xi_k \left(c_k^{1-\theta} \right)^{1-\frac{1}{\eta}} \right]^{\frac{1}{1-\frac{1}{\eta}}}. \tag{B-26}$$

General equilibrium consistency conditions require

$$1 = \left[\sum_{k=1}^{N} \Xi_k p_k^{1-\eta} \right]^{\frac{1}{1-\eta}}, \tag{B-27}$$

which is the steady-state version of equation (B-12), with $\pi = \pi_k = 1$.

The household j's preferences over the habit-adjusted consumption bundle x_t^j and labor h_t^j are given by the following (CRRA) utility function:

$$U(x_t^j, h_t^j) = \frac{x_t^{1-\theta_x}}{1-\theta_x} - \frac{\zeta}{1+\theta_h} h_t^{1+\theta_h}.$$

The resulting market-clearing conditions associated with the labor and goods markets imply

$$\frac{w}{\tilde{p}} x^{-\theta_x} = \zeta h^{\theta_h}, \tag{B-28}$$

and

$$c = \left[\sum_{k=1}^{N} \Xi_k \big[\exp(0.5\alpha(1+\alpha)\sigma^2) h_k^{\alpha} - \phi_k \big]^{1-\frac{1}{\eta}} \right]^{\frac{1}{1-\frac{1}{\eta}}}, \tag{B-29}$$

respectively, where the type-specific conditional labor demand satisfies

$$h_k = \left[\frac{c_k + \phi_k}{\exp(0.5\alpha(1+\alpha)\sigma^2)} \right]^{\frac{1}{\alpha}}, \tag{B-30}$$

with

$$h = \sum_{k=1}^{N} h_k. \tag{B-31}$$

In the steady state, the deep-habit adjusted price index is given by

$$\tilde{p} = \left[\sum_{k=1}^{N} \Xi_k p_k^{1-\eta} c_k^{\theta(1-\eta)} \right]^{\frac{1}{1-\eta}}, \tag{B-32}$$

which is the steady-state version of equation (B-15). The system of equations (B-23)–(B-32) can then be solved numerically for $4N+5$ variables: p_k, c_k, a_k^E, and h_k, $k = 1, \dots, N$; and x, w, $\tilde{p}$, h, and c.

B.2 The Log-Linearized Phillips Curve

To derive the log-linearized Phillips curve (equation 26 in the main text), we use the first-order condition with respect to p_{it} (equation B-8), impose the symmetric equilibrium conditions (that is, $p_{it} = 1$ and $c_{it} = c_t$), and log-linearize the resulting expression to obtain

$$\hat{\pi}_t = -\frac{1}{\gamma_p}(\hat{\nu}_t - \hat{\xi}_t) + \beta \mathbb{E}_t \big[\hat{\pi}_{t+1} \big], \tag{B-33}$$

where $\hat{x}_t$ denotes the log-deviation of a generic variable x_t from its deterministic steady-state value of $\bar{x}$. In equation (B-33), the term $\hat{\nu}_t - \hat{\xi}_t$ is the log-deviation of the ratio $\mathbb{E}_t^a[\nu_{it}]/\mathbb{E}_t^a[\xi_{it}]$, which measures the value of internal funds relative to that of marginal sales:

$$\frac{\mathbb{E}_t^a[\nu_{it}]}{\mathbb{E}_t^a[\xi_{it}]} = 1 - \frac{\mathbb{E}_t^a[\kappa_{it}]}{\mathbb{E}_t^a[\xi_{it}]} + (1-\rho)\frac{\mathbb{E}_t^a[\lambda_{it}]}{\mathbb{E}_t^a[\xi_{it}]}. \tag{B-34}$$

Using the first-order condition with respect to h_{it} (equation B-5), one can show that the first two terms on the right-hand side of equation (B-34) are equivalent to $(\tilde{\mu}_t - 1)/\tilde{\mu}_t$, where $\tilde{\mu}_t \equiv \mu_t \mathbb{E}_t^a[\xi_{it}]/\mathbb{E}_t^a[\xi_{it} a_{it}]$ is the financially adjusted markup. By iterating the first-order condition with respect to the habit stock s_{it} forward, the closed-form solution for the last term in equation (B-34) is given by

$$\frac{\mathbb{E}_t^a[\lambda_{it}]}{\mathbb{E}_t^a[\xi_{it}]} = \theta(1-\eta)\mathbb{E}_t\left[\sum_{s=t}^{\infty}\tilde{\beta}_{t,s+1}\frac{\mathbb{E}_s^a[\xi_{i,s+1}]}{\mathbb{E}_t^a[\xi_{it}]}\left(\frac{\tilde{\mu}_{s+1}-1}{\tilde{\mu}_{s+1}}\right)\right], \tag{B-35}$$

where

$$\tilde{\beta}_{t,s+1} \equiv m_{s,s+1}g_{s+1} \times \prod_{j=1}^{s-t}\left[\rho + \theta(1-\eta)(1-\rho)g_{t+j}\right]m_{t+j-1,t+j}$$

denotes the growth-adjusted discount factor and $g_t \equiv c_t/s_{t-1} = (s_t/s_{t-1} - \rho)/(1-\rho)$.

To obtain the term $\hat{\nu}_t - \hat{\xi}_t$ in equation (B-33), we substitute equation (B-35) into equation (B-34) and log-linearize the right-hand side of the resulting expression. The log-linearized Phillips curve can then be expressed as

$$\begin{aligned}\hat{\pi}_t \quad = \quad & -\frac{\omega(\eta-1)}{\gamma}\left[\hat{\mu}_t + \mathbb{E}_t\sum_{s=t}^{\infty}\chi\tilde{\delta}^{s-t+1}\hat{\mu}_{s+1}\right] + \beta\mathbb{E}_t[\hat{\pi}_{t+1}] \\ & + \frac{1}{\gamma}\left[\eta - \omega(\eta-1)\right]\mathbb{E}_t\sum_{s=t}^{\infty}\chi\tilde{\delta}^{s-t+1}\left[(\hat{\xi}_t - \hat{\xi}_{s+1}) - \hat{\beta}_{t,s+1}\right],\end{aligned}$$

where $\omega = 1 - \beta\theta(1-\rho)/(1-\rho\beta)$ and $\tilde{\delta} = \beta[\rho + \theta(1-\eta)(1-\rho)]$.

B.3 Alternative Calibrations

This section conducts a sensitivity analysis of the model's main results with respect to alternative calibrations. First, we consider the sensitivity of the results reported in the main text to alternative values of the following key parameters: (1) the elasticity of labor supply (θ_h); (2) the elasticity of substitution between differentiated goods (η); and (3) the strength of deep habits (θ). As noted in the main text, our benchmark values for these parameters are $\theta_h = 5$, $\eta = 2$, and $\theta = -0.80$. As an alternative, we consider three different calibrations: (1) lower labor supply elasticity: $\theta_h = 2$; (2) higher elasticity of substitution between differentiated goods: $\eta = 4$, and (3) less powerful deep-habit mechanism: $\theta = -0.40$. In each of the three alternatives, the remaining model parameters are fixed at their benchmark values.

Figure B-1 shows the dynamics of output and inflation under these alternative calibrations in response to a financial shock, a disturbance that temporarily boosts the cost of external finance. For comparison purposes, the solid lines depict the corresponding responses from the baseline model (see Figure 7 in the main text). Imposing a significantly less elastic labor supply and a considerably greater degree of substitution across goods leads to responses that are qualitatively and quantitatively very similar to those implied by our baseline calibration. In contrast, halving the strength of the deep-habit mechanism does attenuate the response of both output and inflation to financial shocks. The latter finding should not be at all surprising given that the main propagation mechanism emphasized in our paper involves the interaction of customer markets and financial market frictions. Nevertheless, this calibration fully preserves the main conclusion of our model—namely, that a temporary deterioration in the firms' internal liquidity positions reduces the financial capacity of the economy and directly shifts the Phillips curve upward.

To see how γ_p, the parameter governing the degree of price stickiness in our model, maps to a Calvo-style price setting, consider a standard New Keynesian Phillips curve (Woodford, 2003), which relates current inflation π_t to expected future inflation and a measure of aggregate marginal costs mc_t, according to

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t + u_t,$$

where $0 < \beta < 1$ is the discount factor, the parameter λ is a function of the structural parameters, and u_t is a random disturbance interpreted as a shock to firms' markups. Specifically, in this setup, $\lambda = (1-\gamma_c)(1-\beta\gamma_c)/\gamma_c$, where $0 < 1-\gamma_c < 1$ is the fraction of firms that are allowed to optimally reset prices in each period.

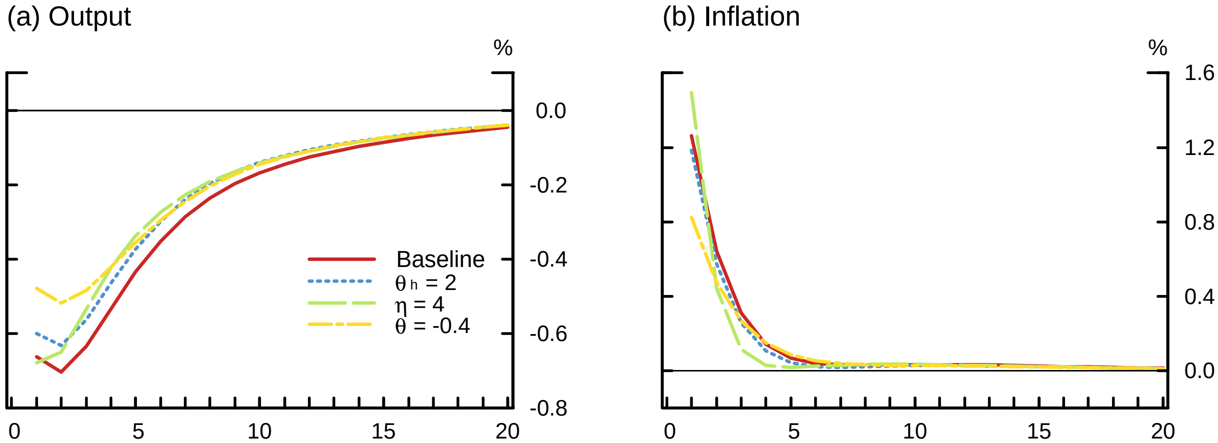
The above Phillips curve can also be derived under the assumption of quadratic adjustment costs for nominal prices (Rotemberg, 1982), in which case $\lambda = (\eta - 1)/\gamma_p$, where η is the elasticity of substitution within the Dixit-Stiglitz aggregator and γ_p is the parameter in the quadratic adjustment cost function. Our baseline calibration of $\eta = 2$ and $\gamma_p = 10$ thus implies that $\lambda = 0.1$. With β close to 1, solving $(1-\gamma_c)^2/\gamma_c = 0.1$ implies that $\gamma_c = 0.73$ or $\gamma_c = 1.37$. By assumption $0 < 1-\gamma_c < 1$, so our calibration of $\gamma_p = 10$ implies that $1-\gamma_c = 0.27$, or that about 27 percent of firms reset their prices in each quarter.

To show how differences in the degree of price stickiness affect the model dynamics in cases where the economy is perturbed by a financial shock, Figure B-2 shows the responses of output and inflation under two alternative values of γ_p. Again, for comparison purposes, the solid lines depict the corresponding responses from the baseline model with $\gamma_p = 10$ (see Figure 7 in the main text). According to these simulations, doubling the degree of nominal price rigidities ($\gamma_p = 20$) dampens the response of both output and inflation to financial shocks; conversely, halving the degree of price stickiness ($\gamma_p = 5$) implies a more pronounced reaction of both macroeconomic aggregates to such disturbances.

The economics underlying these differences are clear. Because of frictions in financial markets, firms would like to increase prices in response to the adverse financial shock in order to preserve internal liquidity. When prices are more rigid, however, firms find it more costly to raise prices. As a result, the markup increases by less, and the response of output is significantly attenuated, relative to a model with more flexible prices. These dynamics stand in stark contrast to those implied by the typical New Keynesian models, in which an increased degree of nominal price stickiness leads to a more volatile output.[6] It is worth noting that these results apply only to changes in the degree of price stickiness—an increase in nominal wage rigidities makes the firms' cost structure less flexible and hence amplifies the financial mechanism in our model.

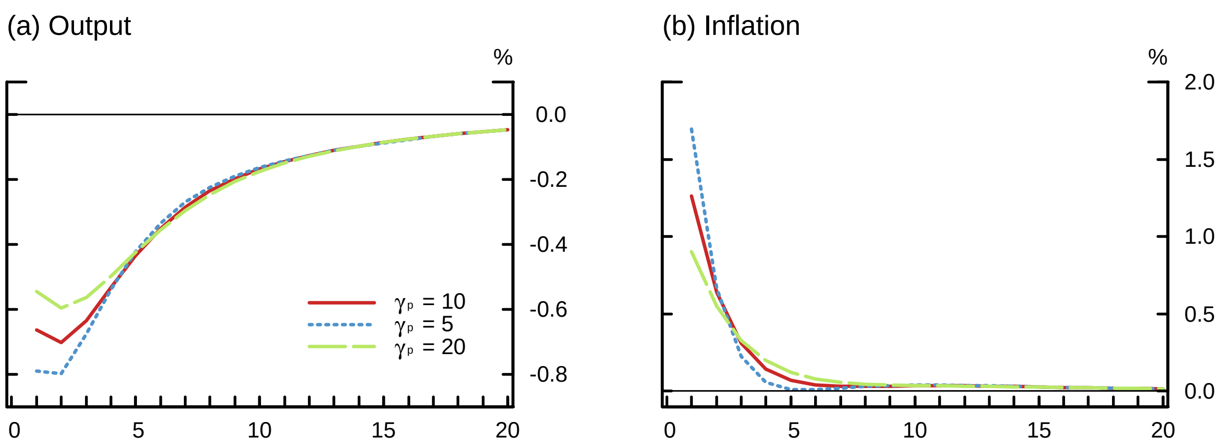
[6]Increased price flexibility, however, can be stabilizing in cases where monetary policy does not respond strongly to inflation, a special case of which is the zero lower bound (Bhattarai et al., 2014).

Figure B-1: The Impact of a Financial Shock
(*Alternative Calibrations*)



Note: Panel (a) of the figure depicts the model-implied responses of output to a temporary increase in the time-varying equity dilution cost parameter φ_t, while panel (b) depicts the corresponding responses of inflation. All responses are based on models featuring nominal rigidities and financial frictions, with the level of financial frictions calibrated to a non-crisis situation ($\bar{\varphi} = 0.3$); see the main text for details.

Figure B-2: The Impact of a Financial Shock
(*The Role of Nominal Rigidities*)



Note: Panel (a) of the figure depicts the model-implied responses of output to a temporary increase in the time-varying equity dilution cost parameter φ_t, while panel (b) depicts the corresponding responses of inflation. All responses are based on models featuring financial frictions, with the level of financial frictions calibrated to a non-crisis situation ($\bar{\varphi} = 0.3$); see the main text for details.

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