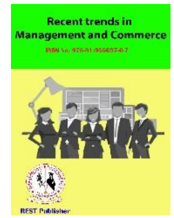
Recent trends in Management and Commerce
Vol: 6(1), March 2025
REST Publisher; ISBN: 978-81-936097-6-7 (Online)
Website: https://restpublisher.com/book-series/rmc/
DOI: https://doi.org/10.46632/rmc/6/1/10



Exchange Rate Regimes, Financial Constraints, and Export Pricing: Evidence from Chinese Firms

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Abstract—This paper investigates the impact of global monetary shocks on Chinese export prices, with a par- ticular focus on the period before and after China's exchange rate regime shift in July 2005. Utilizing firm- level data, I demonstrate that U.S. monetary tightening significantly influences Chinese export prices, primarily through increased borrowing costs and liquidity con- straints. My findings remain robust across different time periods and when controlling for exchange rate fluctuations. I further distinguish between ordinary and processing trade, revealing that processing traders, less dependent on external financing, exhibit smaller price responses. The study also explores the limited spillover effects of European Central Bank monetary shocks on Chinese exports. A partial equilibrium model illustrates how global monetary contractions elevate export prices by exacerbating financial frictions. My results suggest that adopting a more flexible exchange rate regime can mitigate the adverse effects of foreign monetary policy shocks on export pricing.

1. INTRODUCTION

Background and motivation

How export price responds to international shocks is essential in international economics. People usually focus on exchange rate shocks, productivity shocks, and other real demand and cost shocks; less atten- tion is drawn to international monetary policy shocks. Tons of literature have revealed the domestic and spillover effects of monetary policy shocks on the real economy and asset prices, but few people study their implications on the pricing behavior of export firms. It is found that export firms even suffer more from the global financial cycle than domestic firms. In an era of growing global financial and trade in- tegration, the significance of addressing this question becomes even more pronounced, which may deepen my understanding of the international transmission of monetary shocks and the interaction between trade and the financial market. This is the first paper to investigate how international monetary policy shocks affect export prices with de- tailed firm-product level data.

This paper

China is the biggest export country in the world, and using China as an example has general implications. By integrating Chinese custom data with CIE data, my investigation reveals substantial heterogeneity in the re- sponses of firm export prices to international monetary policy shocks, gauged through high-frequency asset price fluctuations. In particular, my analysis delves into the influence of major global central banks, uncovering noteworthy patterns. Notably, a tightening monetary policy shock in the United States substantially elevates China's export prices, whereas European stocks exert a contrasting effect by diminishing export prices. Con- versely, shocks emanating from the United Kingdom and Japan exhibit negligible impacts. The pattern of European shock is consistent with the demand shrink effect. However, as the main driver of the global financial cycle, the US monetary shock also exerts a supple-side effect on China's export prices and dominates the demand-side impact. More specifically, I reveal that tightening US monetary policy worsens the credit conditions of China's exporting firms by raising the borrowing cost and reducing the liquid assets, which drives the rise of export prices.

Literature and contribution

This paper contributes to three strands of literature:

a) Determinants of firm pricing behaviors Exchange rate pass-through papers study how export prices respond to exchange rate shocks, like [1], [2], [3], [4], [5]. Also, some papers investigate the impact of firm characteristics, destinations, and trade liberalization on export prices (e.g. [6], [7], [8], [9], etc.). Compared with these papers, I analyze the impact of interna- tional monetary policy shocks on export prices.

b) Global monetary policy spillover. Many papers investigate the spillover effect of international monetary policy shocks either on the real economy (see [10], [11], [12], [13], [14], [15]) or on asset prices (like [16], [17], [18], [19], [20]). Regarding the impact on trade, some open macroeconomic literature has implications on how monetary shock affects the current account (like [21]). Empirically, [22] investigates how US monetary policy affects global trade volume using country-sector data. However, my paper is the first paper to focus on the impact on export prices.

c) The role of financial friction in international trade. Existing literature reveals how financial friction affects exports, like [23], [7], [24], [22], etc. Compared with these papers, I study, given the existence of financial friction, how monetary policy affects export prices through the change of credit conditions.

2. MAIN RESULTS

Benchmark Regression

$\Delta \ln Pit = \alpha + \beta \cdot brwt + \Gamma \cdot Zit-1 + \xi i + \varepsilon it$ (1) Benchmark: use firm aggregate price, monthly data- Positive and significant, add year FE also hold s

TABLE 1. Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
brw	0.180***	0.143***	0.145***	0.145**	0.139***	0.066***
	(0.011)	(0.010)	(0.010)	(0.041)	(0.011)	(0.011)
L.dlnprice_YoY		0.302***	0.300***	0.300***	0.236***	0.179***
		(0.003)	(0.003)	(0.014)	(0.003)	(0.002)
L12.lnrSI			-0.004***	-0.004	-0.004***	-0.005***
			(0.001)	(0.004)	(0.001)	(0.002)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1108044	946438	923321	923321	839933	803530

Note: Column (1)(2): firm FE; Column (3)(4): firm FE and year FE. All clusters are at the firm level. TBD: Need to add control like firm size, firm productivity, and exchange rate change, etc.

Robustness

a) Using lag values of brw

$$\Delta \ln P_{it} = \alpha + \beta \cdot \sum_{n=1}^{N} brw_{t-n} + \Gamma \cdot \mathbf{Z}_{it-1} + \xi_i + \varepsilon_{it} \quad (2)$$

b) Using firm-product level price, monthly data, no year fixed effect:

$$\Delta \ln P_{hit} = \alpha + \beta \cdot brw_t + \Gamma \cdot \mathbf{Z}_{it-1} + \xi_{hi} + \varepsilon_{hit} \quad (3)$$

Lag effects with different time horizons are all positive and significant, but it is weaker with year FE.

c) Using firm-product-country level price, annual data.
d) Alternative measures of monetary policy shocks: Nakamura and Steinsson shock and Fed fund rate shock
e) Invoicing currency concern. One may argue that the invoicing currency matters in price elasticity. However, due to data limitation, the invoicing currency of each firm is unknown, so the price in RMB increases does not necessarily mean that the price also increases in the true invoicing currency. Actually, although I do not

know the detailed invoic- ing currency for each product, most of these products are denominated in USD or RMB. Before July 2005, because of the fixed exchange rate, invoicing by RMB was equivalent to by USD, so price change in RMB and USD is similar. We will use both nominal prices denominated in RMB and USD.

f) Is the average export price increase driven by some specific countries? That is not the case because nearly all the main countries experienced price in- creases. Test whether certain destinations drive the price change, I use alternative subsamples with only certain countries.

g) Single-product firms. Aggregate firm-product-country level prices into firm-level prices may cancel out some price changes. Also, it would be possible for an exporting firm may switch their export product mix when facing credit constraints. A more thorough analysis calls for further investigation of resource reallocation across core ver- sus non-core product products within a firm, but this would be out of the scope of the current paper. So, I use a subsample with single-product firms.

3. DECOMPOSITION

In this section, I will decompose export prices into markups and marginal costs to find the reasons for price changes.

Markup vs marginal cost

$$\Delta Markup_{it} = \alpha + \beta \cdot brw_t + \Gamma \cdot \mathbf{Z}_{it-1} + \xi_i + \varepsilon_{it} \quad (4)$$

$$\Delta \ln P_{it} = \alpha + \beta \cdot brw_t + \gamma \cdot \Delta Markup_{it} + \Gamma \cdot \mathbf{Z}_{it-1} + \xi_i + \varepsilon_{it} \quad (5)$$

Tight monetary policy shocks lead to lower firm- level markups, so marginal costs are the main driver of export price increases. TBD: Divide firms into high-markup and low- markup groups. Low-markup firms may be hard to adjust their markup and they consist of the majority of Chinese exporters. In a longer period, the variable markup channel maybe more important because the Average markup of Chinese firms increases.

TABLE 2. Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
brw	0.144***	0.118***	0.019*	0.041***	0.159***	0.119***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.014)	(0.014)
L.dlnprice_hit_YoY		0.273***		0.272***		0.322***
		(0.002)		(0.002)		(0.005)
Firm-product FE	Yes	Yes	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	No	No
Product FE	No	No	No	No	Yes	Yes
N	2455577	1824336	2455577	1824336	2494529	1842588

Standard errors in parentheses

*p<0.1, **p<0.05, ***p<0.01

TABLE 3. Regression Results

	(1)	(2)	(3)	(4)
NS_shock	0.150***	0.139***		
	(0.009)	(0.009)		
ffr_shock			0.026***	0.023***
			(0.007)	(0.007)
L.dlnprice_YoY		0.302***		0.303***
		(0.003)		(0.003)
Firm FE	Yes	Yes	Yes	Yes
N	1108044	946438	1108044	946438

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

TABLE 4. Regression Results

Variable	Estimate	Standard Error
S12.Markup		
brw	-0.023***	(0.008)
brw_lag12	-0.057***	(0.010)
dlnprice_YoY		
brw	0.181***	(0.013)
brw_lag12	0.073***	(0.007)
S12.Markup	0.006**	(0.003)
S12.Markup	0.010***	(0.004)
Firm FE	Yes	-
N	836110	-
N	472282	-
N	773718	-
N	451708	-

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Cost decomposition

Cross-validation cost/sales unit of borrowing cost significantly positive, unit labor cost (wage) decrease

4. MECHANISM

Discussion

The literature has confirmed that contractionary U.S. monetary policy shocks will lead to the tightening of foreign financial conditions: interest rate increases, credit shrinking, bank deleveraging, and retrenchments of international credit flows. Although the impacts vary across the receiving country's characteristics, such as trade and financial integration, financial openness, exchange rate regime, financial market development, labor market rigidities, industry structure, and partici- pation in global value chains.

a) “U.S. monetary policy shocks induce comove- ments in the international financial variables that characterize the “Global Financial Cycle.” A single global factor that explains an important share of the variation of risky asset prices around the world decreases significantly after a U.S. monetary tightening. Monetary contractions in the US lead to significant deleveraging of global financial intermediaries, a decline in domestic credit provision globally, strong retrenchments of international credit flows, and tightening of for- eign financial conditions. Countries with floating exchange rate regimes are subject to similar fi- nancial spillovers.” – Miranda-Agrippino, Silvia, and He´lene Rey. ”US monetary policy and the global financial cycle.” The Review of Economic Studies 87.6 (2020): 2754-2776.
b) ” First, several papers investigate the global out- put spillovers from conventional US monetary policy (see, for example, Kim, 2001; Faust and Rogers, 2003; Faust et al., 2003; Mackowiak, 2007; Di Giovanni and Shambaugh, 2008; Blue- dorn and Bowdler, 2011). The results of this liter- ature suggest that US monetary policy has sub- stantial global spillovers across both advanced and emerging market economies and that these arise mainly through spillovers in interest rates.” – Georgiadis, Georgios. ” Determinants of global spillovers from US monetary policy.” Journal of International Money and Finance 67 (2016): 41-61.
c) “The magnitude of spillovers depends on the re- ceiving country’s trade and financial integration, financial openness, exchange rate regime, finan- cial market development, labor market rigidities, industry structure, and participation in global value chains. The role of these country char- acteristics for the spillovers often differs across advanced and non-advanced economies and also involves non-linearities. The results of this paper suggest that policymakers could mitigate their economies’ vulnerability to US monetary policy by fostering trade integration as well as do- mestic financial market development, increasing the flexibility of exchange rates, and reducing frictions in labor markets.”– Georgiadis, Geor- gios. ” Determinants of global spillovers from US monetary policy.” Journal of International Money and Finance 67 (2016): 41-61.
d) [25] has shown that capital flows and stock prices in most countries, regardless of their exchange rate regime against the dollar, display strong comovements with the global cycle.

Actually, although China has capital control, Prasad and Wei (2005) report that there have been huge capital inflows into China since 2003 that cannot be explained by trade surplus or foreign direct investments. Such in- ternational capital is referred as “hot money.” Investors attempt to earn short-term profits by observing interest rate differences or through anticipated currency revalu- ations or expected returns from holding securities (Kim and Singal, 2000). Although China has adopted various measures to restrict volatile international short-term capital flows that are speculative in nature, speculators continue to circumvent Chinese laws and regulations. Martin and Morrison (2008) indicate that more than half of the hot money flown into China takes the form of over-reported or forged FDI. China is not fully isolated from hot money inflows because capital controls are not applied to all capital accounts trans- action categories and several of these categories are loosely managed (Xie, 2004). So, I can treat China as a partially capital-free country, and the channels discussed in [20] still apply to China. What’s more, although China is found to be restric- tive to portfolio flows, it is quite open to FDI inflows. [26] reveal that there exists a trade credit channel through which FDI firms can propagate global liquidity shocks to the host economy despite its tight controls on non-FDI financial flows. To sum up, no matter whether through financial intermediaries, global asset prices, or trade provisions, all the previous literature implies that US tightening may increase Chinese firms’ borrowing costs and de- crease their liquidity. In light of this, I provide two hypotheses:

a) Global borrowing cost channel. Tightening US monetary shock deteriorates the financing environment and increases the borrowing cost of firms forcing them to offset this cost by lifting prices.
b) Global liquidity channel. Tightening US mone- tary shock decreases the liquidity of export firms either through bank and trade credit shrink or through reduction of operational income, which induces firms to raise prices to alleviate liquidity constraints.

Regression

The impact of US shock on borrowing cost and liquidity:

$$\Delta \ln Y_{it} = \alpha + \beta \cdot brw_t + X_{it} + \xi_i + \varepsilon_{it}$$

where Y is the firm's borrowing cost and liquidity. To be consistent with the frequency of dependent variables, here I aggregate US shock in the year level. Consistent with previous literature, the borrowing cost increases. Liquidity ratio decreases (see Columns 3-4). The conclusion of [26] is also verified (see Columns 5-6) that trade provision decreases after a contractionary US shock.

The impact of US shock on export prices through borrowing cost and liquidity: Here, I interact the US shock with borrowing cost and liquidity ratio. It is found that firms with higher borrowing costs and lower cash ratios increase prices more to a tightening US shock, verifying my conjecture.

$$\Delta \ln P_{it} = \alpha + \beta \cdot brw_t * Z + Z + \xi_i + \nu_t + \varepsilon_{it}$$

where Z is the industry-level borrowing cost and liquidity

TABLE 5. Regression Results

Variable	Estimate	Standard Error
D.IEoL		
brw	0.004***	(0.001)
brw	0.003***	(0.000)
D.Cash		
brw	-0.006***	(0.002)
brw	-0.007***	(0.002)
D.Arec		
brw	-0.031***	(0.002)
brw	-0.004**	(0.002)
L.lnrSI	-0.001***	(0.000)
L.lnrSI	-0.001***	(0.000)
L.lnrSI	0.059***	(0.001)
L.Debt	0.045***	(0.001)
L.Debt	-0.005***	(0.002)
L.Debt	-0.053***	(0.002)
Firm FE	Yes	-
N	1080762	-
N	1089541	-

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

TABLE 6. Regression Results

Variable	Estimate
brw	0.143***
	(0.019)
c.brw.c.IEoL_cic2	6.940***
	(2.132)
c.brw.c.IEoS_cic2	21.134***
	(6.365)
c.brw.c.Cash_cic2	-2.025***
	(0.541)
c.brw.c.Arec_cic2	-0.147
	(0.238)
Firm FE	Yes
N	1108044

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Further check: Further check 1: exposure het- erogeneity to US shock across ownership The financial condition of State-owned enterprises (SOE) usually are less likely to be affected by financial distress compared with domestic private enterprises (DPE), see [27], [28], [29], and [30]. So, I expect their borrowing cost and price increase less. Borrowing cost response: SOE vs DPE Note: the dependent variable is d.IEoL. The borrowing cost of SOE even decreases, this is reasonable because under financial distress, bank tends to shift loans to SOE. Price response: SOE vs DPE Note: the dependent variable is dlnprice YoY. Further check 2: exposure heterogeneity to US shock across industries Some industries are more exposed to international financial market, such as the commodities prices, which has very mature global financial market. From this picture, I can see that 25(oil), 26/28(chemistry), 32/33(metal) have much bigger responses compared with other industries . Further check 3: exposure heterogeneity to US shock across regimes: Fixed VS floating “A large body of this literature has shown that in the post-Bretton Woods period interest rates are more closely linked in countries that peg and in countries with open capital markets compared with countries that do not peg or impose capital restrictions. (See e.g., Klein and Shambaugh (2010).)” – Dedola, Luca, Giulia Rivolta, and Livio Stracca. ”If the Fed sneezes, who catches a cold?.” Journal of International Economics 108 (2017): S23-S41. If the global borrowing cost channel and global liquidity channel hold, then under fixed regime Chinese financial conditions are more exposed to US shock, so I expect that the export prices responses should be larger. Note: Column (1)(2): fixed regime; Column (3)(4): floating regime.

5. ALTERNATIVE EXPLANATIONS

Demand side expansion?

The idea presented is that global demand goes up after a shock, causing China’s export prices to rise. However, if I have a tightening shock, it should lead to reduced demand and lower prices, not an increase. So, the argument about the demand side doesn’t make sense. Some people argue that a tightening shock makes Chinese exports more competitive because Chi- nese products become cheaper compared to similar ones from other countries. They compare this to Giffen goods, where prices go up when people’s incomes drop. But this doesn’t seem likely because most prod- uct prices increase after a shock, especially things like oil and metal-related goods, which aren’t considered as Giffen goods.

Import price increase?

This story is that China's export price increases is because the import price increases. To rule out it, I do two tasks:

a) Using the annually firm-product-country level im- port price data, I replace export price change with import price change in the benchmark level regression and find that results are insignificant (Update)
b) Using the annually firm-product-country level export price data, I include brw*import intensity or brw*I(import intensity¿pct75). If this story holds, prices should increase more with higher import inten- sity. But the results are insignificant.

Exchange rate depreciation induced price in- crease?

This story is that export price denominated in RMB increase is just because RMB depreciates against other currencies, so to keep purchasing power of export income unchanged, the firms should increase price. This explanation can be refuted based on two reasons:

a) My results are also significant before 2005m7, when China's exchange rate is almost fixed to US dollar, which means that positive brw shock should appreciate RMB against other currencies
b) Using the annually firm-product-country level export price data, I have controlled the bilateral real exchange rate, and results are robust. (update)

6. MODEL

Baseline model
In this section, I construct a partial-equilibrium model to show how exporting firms' behaviors respond to a global monetary contraction and illustrate the mechanism related to borrowing cost increases and liquidity constrain. 2 my model builds on the heterogeneous-firm trade model of [31] and [23], and I further incorporate the global monetary shocks. The main difference with the existing literature on firm credit constraints and trade is that the constraints not only vary across sectors but also are affected by global monetary shocks. The big picture is that a tightening global monetary shock will increase the borrowing cost and incentivize the firm to uplift its export price. What's more, the contractionary shock worsens the firm's liquidity conditions which will motivate it to

Preferences and demand
The source country and the destination country are denoted by i and j respectively. In this paper, i is China and j denotes the rest of the world. Consumers in country j have access to a set of goods Xj, which is potentially different across countries. It is assumed that a representative consumer in country j has a constant- elasticity-of-substitution (CES) utility function given by

$$U_j = \left(\int_{\omega \in \Omega_j} [\chi_{ij}(\omega)]^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}$$

where χij is country j's quantity consumed of variety ω originated from country i; and σ > 1 is the elasticity of substitution between varieties. Therefore, consumer optimization yields the following demand function for variety ω:

$$\chi_{ij}(\omega) = \frac{p_{ij}(\omega)^{-\sigma}}{P_j^{1-\sigma}} Y_j$$

Where pij(ω) is the price of variety ω, Pj=(∫ω∈Ωj [pij(ω)]1−σdω) 1 is an aggregate price index in country j, and Yj represents the total expenditure of country j. I assume that it is affected by global monetary shocks m (e.g., US monetary shock): Yj = Y¯j + ρj m + ϵY , where Y¯j is a trend component of Y Yj, ρY < 0, ϵY is a random error, and a positive m means tightening shock.

Exporting firm

In each source country i, there is a continuum of firms that ex-ante differ in their productivity level ϕi. I assume that there is only one input (e.g. materials, or labor) for production and the production function is yi = ϕiLi, where ϕi is productivity and Li is input. The firm in country i minimizes its cost to satisfy the demand in the country j, χij(ω) = pij (ω) Yj. This j yields a total cost function C = wi pij (ω) Y , where ij ϕi P 1−σ j wi is the price of input. I allow the input price to fluctuate in response to global monetary shocks: wi = w¯i + ρi m + ϵi , where w¯i is a trend component of wi, i < 0 and ϵi is a random error.4 I further assume a working capital constraint that a fraction δi of the input costs should be borrowed from outside financial institutions (e.g. loans from banks, or issuing bonds) and paid in advance. δi ∈ [0, 1] and is a decreasing function of firm's cash holding and trade credit: δi ≡ 1 − cγ − ti, where ci is the cash to asset ratio, cγ is the fraction of input cost covered by cash, γ is a positive constant and reflects the elasticity of cash fraction with respect to cash ratio, ti is the fraction that is supported by trade credit. 5 ci is assumed to be impacted by monetary policy shock exogenously: ci = c¯i+ρi m+ϵi , where c¯i is a trend component of ci, ρi < 0 and ϵi is a random error.6 Trade credit is also assumed to be affected by global monetary shocks: ti = t¯i +ρim+ϵi, where t¯i is a trend component of ti, ρi < 0 and ϵi . $C_{ij} = \frac{w_i(1-\delta_i+\delta_i R_i)}{\phi_i}\frac{p_{ij}(\omega)^{-\sigma}}{P_j^{1-\sigma}}Y_j$. where R is the gross borrowing interest rate in country i. I explicitly assume R = R¯ + ρi m + ϵi where R¯ is a trend component of Ri, ρi > 0 and ϵi is a random error.8 Also, to allow the non-linear elasticity of cost with respect to interest rate (which can be generated by other financial costs associated with borrowing), I replace Ri with Rα, where I α is a constant and represents the elasticity of cost with respect to the interest rate. Following the convention, I also add an iceberg trade cost such that τij >= 1 units of good must be shipped from country i in order for one unit to arrive in j. For the simplicity of notation, the subscripts for source and destination as well as the index for variety are omitted. Thus, the new cost function is

$$C = \frac{\tau w(1-\delta+\delta R^{\alpha})}{\phi}\frac{p^{-\sigma}}{P^{1-\sigma}}Y$$

We also assume that firms cannot borrow more than a fraction θ of the expected cash flow from exporting and it is smaller when R is higher. The intuition behind this is that higher interest rates imply higher risk and access to credit should be lower. Without loss of generality, I can assume θ = R−ν, where ν is > 0 and reflects the elasticity of financial credit access with respect to the interest rate. The optimization problem of the firm is

$$\max_{p}\ \left(p - \frac{\tau w(1-\delta+\delta R^{\alpha})}{\phi}\right)\frac{p^{-\sigma}}{P^{1-\sigma}}Y$$

$$\text{s.t.}\quad \theta\left[\left(p - t\frac{\tau w}{\phi}\right)\frac{p^{-\sigma}}{P^{1-\sigma}}Y\right] >= (1-c^{\gamma}-t)\frac{\tau w}{\phi}\frac{p^{-\sigma}}{P^{1-\sigma}}Y$$

Case 1: borrowing constraint is binding:

If θ <= θ¯, where θ¯ is a threshold, the borrowing constraint is binding and I can rewrite the borrowing constraint as

$$p = [(1-R^{\nu})t + (1-c^{\gamma})R^{\nu}]\frac{\tau w}{\phi}$$

Case 2: the borrowing constraint is not binding:

Solving the unconstrained optimization problem ob- tains that

$$p = \frac{\sigma}{\sigma-1}\frac{\tau w[c^{\gamma}+t+(1-c^{\gamma}-t)R^{\alpha}]}{\phi}$$

This reduces to p = σ τw if c=0 and R=1, which is similar to [31] σ−1 ϕ

Proposition 1. $\frac{\partial p}{\partial R} > 0,\ \frac{\partial p}{\partial c} < 0,\ \frac{\partial p}{\partial t} < 0$

Proof If the borrowing constraint is binding

$$\frac{\partial p}{\partial R} = \frac{\tau w}{\phi}(1 - c^{\gamma} - t)\nu R^{\nu-1} > 0$$

$$\frac{\partial p}{\partial c} = \frac{\tau w}{\phi} R^{\nu}(-1)\gamma c^{\gamma-1} < 0$$

$$\frac{\partial p}{\partial t} = \frac{\tau w}{\phi}(1 - R^{\nu}) < 0$$

If the borrowing constraint is not binding

$$\frac{\partial p}{\partial R} = \frac{\sigma}{\sigma - 1}\frac{\tau w}{\phi}[\alpha(1 - c^{\gamma} - t)R^{\alpha-1}] > 0$$

$$\frac{\partial p}{\partial c} = \frac{\sigma}{\sigma - 1}\frac{\tau w}{\phi}\gamma(1 - R^{\alpha})c^{\gamma-1} < 0$$

$$\frac{\partial p}{\partial t} = \frac{\sigma}{\sigma - 1}\frac{\tau w}{\phi}(1 - R^{\alpha}) < 0$$

Proposition 2. $\frac{\partial P}{\partial M} > 0$ if supply side dominates. If the borrowing constraint is binding

$$\frac{\partial P}{\partial n} = \frac{\partial P}{\partial R}\frac{\partial R}{\partial M} + \frac{\partial P}{\partial c}\frac{\partial c}{\partial M} + \frac{\partial P}{\partial t}\frac{\partial t}{\partial M} + \frac{\partial P}{\partial W}\frac{\partial W}{\partial M}$$

$$\frac{\tau w}{\phi}(1 - R^{\nu})\rho_t + \frac{\tau}{\phi}[(1 - R^{\nu})t + (1 - c^{\gamma})R^{\nu}]\rho_w$$

If the borrowing constraint is not binding

$$\frac{\partial p}{\partial m} = \frac{\partial p}{\partial R}\frac{\partial R}{\partial m} + \frac{\partial p}{\partial c}\frac{\partial c}{\partial m} + \frac{\partial p}{\partial t}\frac{\partial t}{\partial m} + \frac{\partial p}{\partial w}\frac{\partial w}{\partial m}$$

$$= \frac{\sigma}{\sigma - 1}\frac{\tau w}{\phi}\alpha(1 - c^{\gamma} - t)R^{\alpha-1}\rho_R + \frac{\sigma}{\sigma - 1}\frac{\tau w}{\phi}\gamma(1 - R^{\alpha})c^{\gamma-1}\rho_c + \frac{\sigma}{\sigma - 1}\frac{\tau w}{\phi}(1 - R^{\alpha})\rho_t + \frac{\sigma}{\sigma - 1}\frac{t}{\phi}[c^{\gamma} + t + (1 - c^{\gamma} - t)R^{\alpha}]\rho_w$$

Proposition 3. If α > 1, γ < 1, and ν > 1, ∂p is bigger when R is larger, c and t is smaller. This can be easily derived from Proposition 2.

Extension

Both variable and fixed costs are paid in advance If I incorporate fixed costs into the benchmark model and allow a proportion of δ (≡ 1−cγ −t) of both types of costs to be paid in advance. The firm's problem now Becomes

$$\max_{p} \left(p - \frac{\tau w(1 - \delta + \delta R^{\alpha})}{\phi}\right) \frac{p^{-\sigma}}{P^{1-\sigma}} Y - f$$

$$\text{s.t.} \quad \theta \quad p - t \frac{\tau w}{\varphi} \frac{p^{-\sigma}}{P^{1-\sigma}} Y - tf$$

$$\geq (1 - c^{\gamma} - t) \frac{\tau w}{\phi} \frac{p^{-\sigma}}{P^{1-\sigma}} Y + f$$

where f is the fixed cost, if the constraint not binding, the result is similar to the benchmark model result; if the constraint is binding, I can rewrite it as

$$p^{1-\sigma} = \frac{1 - c^{\gamma} - t}{\theta} + t \frac{\tau w}{\phi} p^{1-\sigma \frac{\sigma}{\sigma-1}}$$

$$+ f \frac{1 - c^{\gamma} - t}{\theta} + t \frac{P^{1-\sigma}}{Y}$$

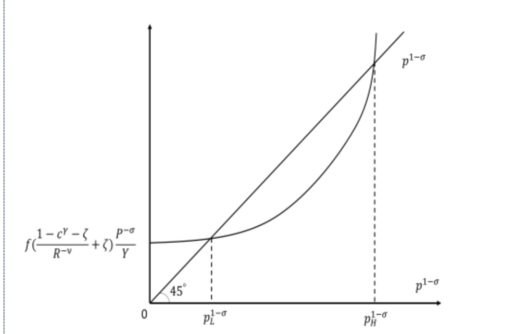
Add the new constraint into the objective function, I get the profit:

$$\frac{1 - c^{\gamma} - t}{R^{-\nu}} - c^{\gamma} \frac{\tau w}{\phi} \frac{Y}{P^{1-\sigma}} p^{-\sigma}$$

$$- (1 - c^{\gamma} - t) R^{\alpha} \frac{\tau w}{\phi} \frac{Y}{P^{1-\sigma}} p^{-\sigma}$$

$$+ f \frac{1 - c^{\gamma} - t}{R^{-\nu}} - 1 + t$$

To solve this constraint equation, I can illustrate it with Figure 1, the left-hand side is represented by the straight line, and the curve denotes the right-hand side. There are two intersections of these two lines, which means there are two solutions to this equation. Owing to the fact that the profit is a decreasing function of p, the firm will choose the lower price, which corresponds to p1−σ. When interest rate R increases, cash ratio c and trade credit t decreases, the curve will move upward, and p1−σ will be smaller, which yields a higher optimal price. So, Proposition 1 still holds. A tightening shock will drive up interest rates, reduce cash holding, and trade credit, so the price goes up. So, Proposition 2 also holds. Also, if $\nu > 1$ and $\gamma > 1$, one percent of change in c and R will cause the curve to move upward with a bigger magnitude, thus one unit of monetary shock will induce a bigger price change. This is exactly what Proposition 3 predicts. To sum up, the inclusion of fixed costs will not alter my main propositions.



Borrowing constraint when both variable and fixed costs are paid in advance

Later, I can relax my assumptions through three τw p−σ lines: (1) endogenize the behavior of banks, or even s.t. θ p – t ϕ P 1−σ Y – tf households; (2) allow mark-up to be variable

7. OTHER ISSUES

About year fixed effect

Our benchmark level regression should not add year fixed effect. There are several reasons: (i) add year effect will absorb the variation of brw. I only have 7-years monthly data, which is a big loss of variation; (ii) control year effect is to alleviate the 1 − cγ − t+ f+ tθP 1−σYconcern of omitted variable, which can affect brw and price simultaneously. However, my brw is very exogenous and can't be affected by other variables;

(iii) add year effect has very few benefits because it can only control the annually varying factors but keep silent on other quarterly and monthly level changes; don't control time fixed effect. Chari (2021, RFS) reg monthly capital flow on mps, without control year fixed effect. Lin (2018, JDE) reg annual trade value on mps, doesn't control decade fixed effect; (v) control year fixed effect, will make the firm-product level regression insignificant, will make firm level regression insignificant in both fixed and floating regime, will make NS shock has a positive effect on dlnprice but negative impact on f.dlnprice. So, to guarantee the consistency of results, I suggest not to control it in my benchmark regression.

About cluster level

Our benchmark now is a cluster on the firm level. Sometimes, this makes some other results also significant, which is difficult to explain

Why do firms increase prices more under tighter constraints?

Our measure of FPC doesn't change over time, so it can't tell us how firms' FPC changes in response to new shock. The data reveals that tighter-constrained firms usually have higher prices, which is consistent with Fan, Lai, and Li (2015). But this doesn't mean that when there is a contractional brw shock, firms with tighter constrains increase prices more because I don't how the FPC changes.

Better to investigate the shocks from all main central banks

To make my research more general, we'd better ex- amine shocks emanating from all major central banks: the US, Europe, Japan, UK. But there is a question that in my firm-level regression, Japan's shock has a positive effect on export prices if I only cluster on the firm level, which is hard to explain. But this result is not robust, if I cluster on both firm and year-month, this effect will be statistically weak. However, the current regression may not be reasonable, because I don't control exchange rate change. Also, I didn't check the impact in the monthly firm-product-country level regression. I remember in the annual firm-product- country regression, this is insignificant. I need to check this again. Also, I need to check how country X shock affects the export prices to country X, especially to verify the demand shrink effect. Additionally, I should put all the shocks in one equation and see what happens. If I can solve this properly, my paper can go to a better place.

Better to explain the difference across country and sectors

Similarly, to make my research more general, we'd better offer explanations on the differences across countries and sectors. Especially, why the prices of US export doesn't respond. In my current model frame- work, price is a function of brw and some other exoge- nous country-sector-specific parameters. The impact of brw is determined by these parameters. As for why the prices of US are insignificant, maybe the demand side and supply side effects are offset because US shock may have a bigger effect on domestic demand and the demand of US-peg countries than other countries. I may still need to regress price change on the interaction term of shock and country/sector-specific characteristics (for country factors: such as gravity controls, financial market development, and financial openness, etc. for sector/product factors: homogeneous or differentiated goods, etc.) to verify which factor drives the differences. If I can solve this properly, my paper can go to a better place.

The impact between 2008-2015

Our primary analysis is grounded in the data from 2000 to 2007. Naturally, questions may arise regarding the impact between 2008 and 2015. In my yearly firm- product-country level regression, this period appears statistically insignificant. I have two plausible explana- tions: Firstly, owing to the zero lower bound, the influ- ence of US monetary policy shocks on global interest rates, particularly short-term rates, has considerably waned. Secondly, noteworthy alterations in China's exchange rate regime, transitioning from a Dollar- targeting approach to a basket-targeting approach, may serve as a mitigating factor in buffering international monetary shocks.

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