Time-Varying Exchange Rate Pass-Through into Terms of Trade

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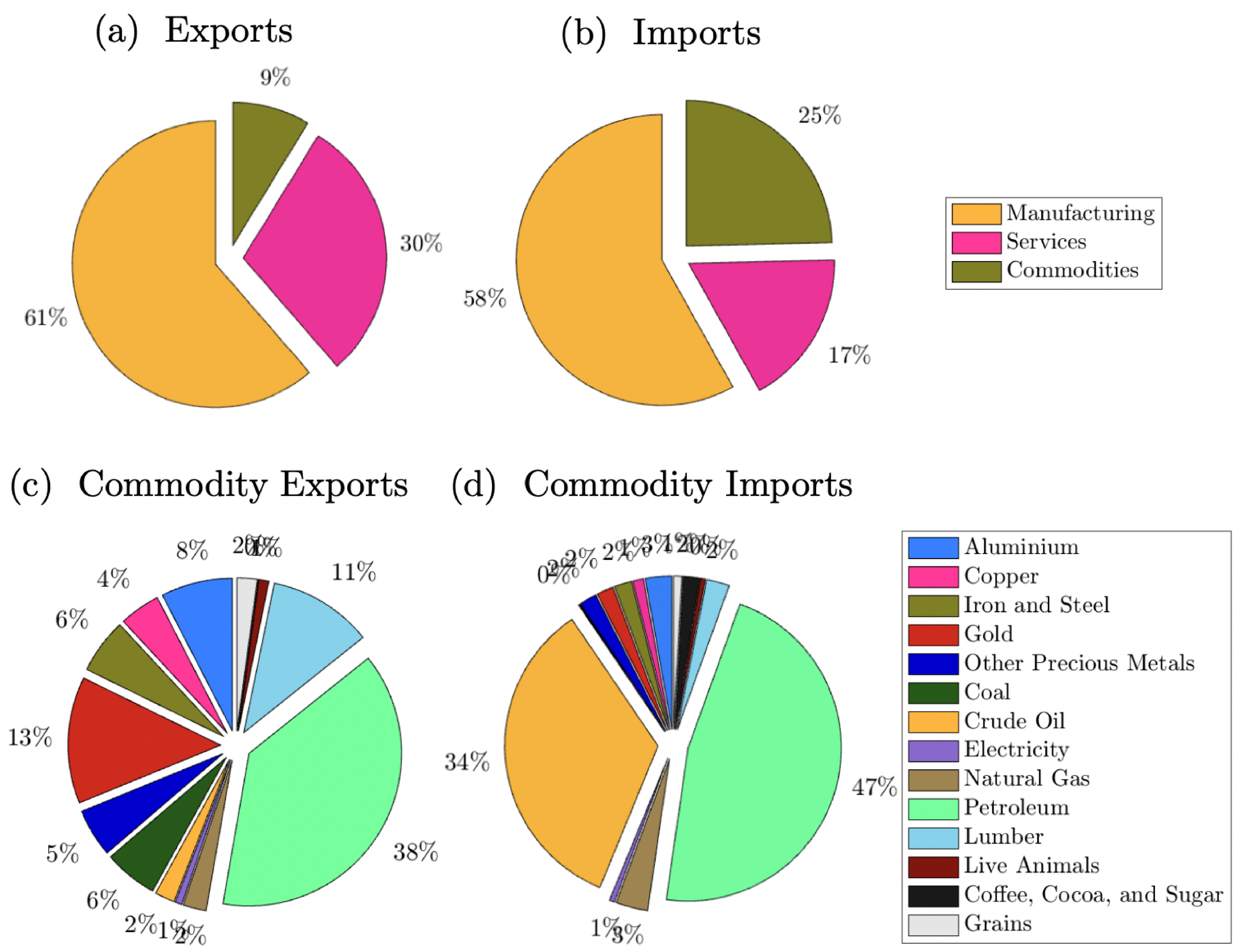
U.S. Dollar: A Dominant Currency

- U.S. pays for 97% of its foreign imports and sells 90% of its exports to the rest of the world using the U.S. dollar (Gopinath and Rigobon (2008))
- This pattern hardly changed throughout 1995-2015 (Gopinath (2015)).
- U.S. dollar also dominates trade invoicing for other countries (Gopinath et al. (2020))
- If U.S. import and export prices are *sticky* in U.S. dollars, then exogenous U.S. dollar depreciations cause the U.S. import (export) prices to increase by 10% (3%).
- U.S. terms of trade, measuring the relative price of imports to exports, would therefore deteriorate by 7%. This magnitude is unusually low.

Is Dollar Invoicing the Same as Dollar Pricing?

- Not all prices are equally sticky.
- Bils and Klenow (2004) show that primary commodity prices adjust far more frequently than non-commodity prices (i.e. manufactured goods and services).
- One quarter and one-tenth of U.S. imports and exports, respectively, are primary commodities (see Figure 1).
- Hypothesis 1: if U.S. terms of trade respond to U.S. dollar depreciations by more than 7%, controlling for confounding factors, then not all prices that are invoiced in U.S. dollars are sticky in U.S. dollars.
- Hypothesis 2: if the amount by which the U.S. terms of trade respond to U.S. dollar depreciations changes over time, controlling for changes in other fundamentals, then price stickiness also changes over time.

Figure 1: U.S. Import and Export Breakdown (1990-2018)



Exchange Rate Pass-Through (ERPT)

- Notation: $\Delta\tau_t = \tau_t - \tau_{t-1}$ and $\Delta e_t = e_t - e_{t-1}$ are the log differences in terms of trade (TOT) and nominal exchange rate (NEER), respectively.
- Definition 1: ERPT measures "how much" and "how fast" Δe_t is transmitted into $\Delta\tau_{t+h}$, where $h = 0, 1, 2, \ldots$ is the time horizon.
- Definition 2: transmission of Δe_t into $\Delta\tau_{t+h}$ is said to be: (i) short-run when $h = 0$; (ii) medium-run when $0 < h < \infty$; and (iii) long-run when $h \to \infty$.
- Standard measurement equation of time-invariant ERPT (e.g. Campa and Goldberg (2005), Burstein and Gopinath (2014)):

$$\Delta\tau_t = \lambda\Delta\tau_{t-1} + \phi\Delta e_t + \mathbf{z}_t\boldsymbol{\zeta} + \varepsilon_t, \tag{1}$$

$-1 \leq \lambda < 1$, $\phi \in [0, 1]$, $\varepsilon_t \sim \text{iid}\mathcal{N}(0, \sigma^2)$, and $\mathbf{z_t}$ is a vector of control variables including the intercept.

- I measure time-varying ERPT using a state-space (SS) model:

$$\mathrm{y}_t = \mathbf{x}_t\boldsymbol{\alpha}_t + \varepsilon_t, \tag{2}$$

$$\boldsymbol{\alpha}_t = \boldsymbol{\eta} + \boldsymbol{\gamma}\boldsymbol{\alpha}_{t-1} + \boldsymbol{\delta}\mathbf{s}_t + \mathbf{u}_{t-1}, \tag{3}$$

where $\mathbf{x}_t = [\Delta\tau_{t-1}, \Delta e_t, \mathbf{z}_t]$ is a $1 \times k$ vector of control variables, $\boldsymbol{\alpha}_t = [\lambda_t, \phi_t, \boldsymbol{\zeta}_t']'$ is a $k \times 1$ vector of unobservable state variables, and $\mathrm{y}_t := \Delta\tau_t$ is a 1×1 measurement variable, $\boldsymbol{\eta} = (\mathbf{I}_k - \boldsymbol{\gamma})\boldsymbol{\alpha}_{0|0}$ is a $k \times 1$ vector of intercepts, $\boldsymbol{\alpha}_{0|0}$ is fixed, $\boldsymbol{\gamma}$ is a diagonal $k \times k$ matrix of autoregressive coefficients, $\boldsymbol{\delta}$ is a $k \times q$ matrix, $\mathbf{s}_t$ is a $q \times 1$ vector of observable factors, such that $k \geq 1$ and $q \geq 1$, $\varepsilon_t \sim \text{iid}\mathcal{N}(0, \sigma^2)$, $\mathbf{u}_t \sim \text{iid}\mathcal{N}(\mathbf{0}_k, \Xi)$, $\mathbb{E}[\mathbf{u}_t\varepsilon_t] = \mathbf{0}_k$, Ξ is a diagonal positive-definite $k \times k$ variance-covariance matrix, and $\mathbf{0}_k$ is a $k \times 1$ vector of zeros.

- Because closed-form solution to σ and Ξ does not exist, $\boldsymbol{\alpha}_t$ is estimated using a sequence of four steps: (i) Kalman (1960) filter; (ii) fixed interval Kalman smoother (de Jong (1989)); (iii) quasi maximum likelihood (Durbin and Koopman (2012)); and (iv) parametric bootstrapping (Rodriguez and Ruiz (2009)).
- If Δe_t and ε_t are uncorrelated, ERPT at any time horizon $h = 0, 1, 2, \ldots$ is given by

$$\mu_{h,t} = \sum_{i=0}^{h} \frac{\partial\Delta\tau_{t+i}}{\partial\Delta e_t} = \phi_t \sum_{i=0}^{h} \lambda_t^i, \tag{4}$$

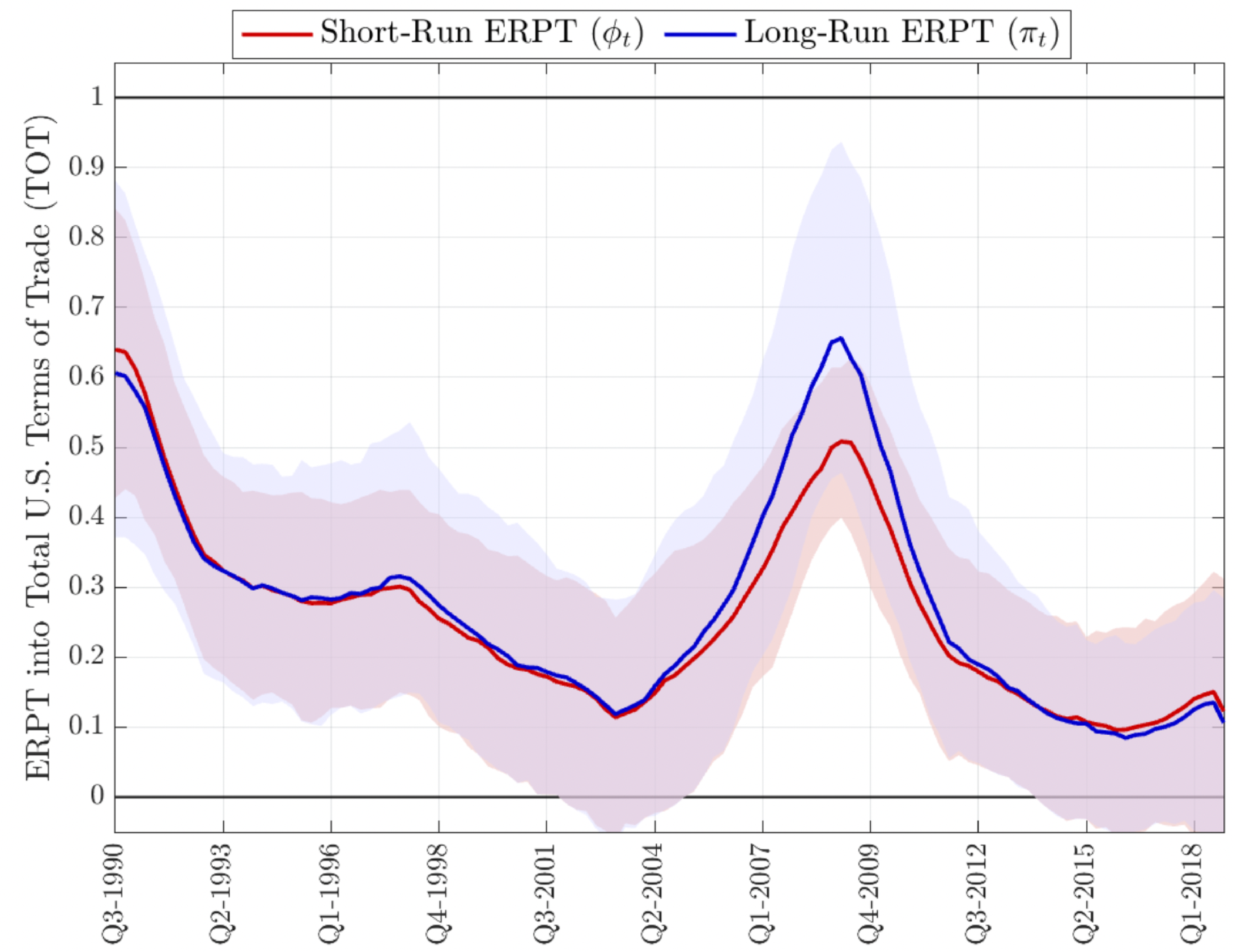
- In the short-run, $\mu_{0,t} := \phi_t$. In the long-run, $\mu_{\infty,t} = \phi_t/(1 - \lambda_t) := \pi_t$.

U.S. Terms of Trade and the U.S. Dollar

- I find a robust time-varying relationship between the U.S. TOT (i.e. incl. commodity and non-commodity prices) and U.S. NEER (see Figure 2).
- By contrast, in the paper, I show that ERPT into TXT (i.e. TOT excl. commodity prices) is virtually constant over time.
- I conclude that ERPT time-variation stems from commodity prices.
- I show that ERPT is counter-cyclical: in 2008-2009 ERPT into TOT peaks at 60-70%, but in 1992-1999 or 2010-2014 it less than 30%.
- Implication: despite being invoiced in U.S. dollars, commodity prices are not always sticky in U.S. dollars, especially not when the U.S. slips into a recession.

- Given the substantial time variation of ERPT into TOT, it can affect the U.S. trade balance adjustments and can be important for FED monetary policy conduct.
- Yet much of the literature is focused on measuring ERPT directly into the U.S. CPI inflation, which tends to be low not only due to U.S. dollar invoicing, but also due to sizeable distribution costs (Burstein, Neves, and Rebelo (2003)).

Figure 2: Time-Varying ERPT into the U.S. Terms of Trade (1990-2018)



References

Bils, Mark and Peter J. Klenow (2004). "Some Evidence on the Importance of Sticky Prices". In: *Journal of Political Economy* 112.5, pp. 947–985.

Burstein, Ariel and Gita Gopinath (2014). "Chapter 7 - International Prices and Exchange Rates". In: *Handbook of International Economics*. Ed. by Elhanan Helpman Gita Gopinath and Kenneth Rogoff. Vol. 4. Handbook of International Economics. Elsevier, pp. 391 –451.

Burstein, Ariel T, João C Neves, and Sergio Rebelo (2003). "Distribution Costs and Real Exchange Rate Dynamics During Exchange-Rate-Based Stabilizations ". In: *Journal of Monetary Economics* 50.6, pp. 1189 –1214. ISSN: 0304-3932.

Campa, José and Linda Goldberg (2005). "Exchange Rate Pass-Through into Import Prices". In: *The Review of Economics and Statistics* 87.4, pp. 679–690.

de Jong, Piet (1989). "Smoothing and Interpolation with the State-Space Model". In: *Journal of the American Statistical Association* 84.408, pp. 1085–1088. ISSN: 01621459.

Durbin, J. and S. J. Koopman (2012). *Time Series Analysis by State Space Methods*. Oxford University Press.

Gopinath, Gita (2015). *The International Price System*. NBER Working Papers 21646. National Bureau of Economic Research, Inc.

Gopinath, Gita and Roberto Rigobon (2008). "Sticky Borders". In: *The Quarterly Journal of Economics* 123.2, pp. 531–575.

Gopinath, Gita et al. (2020). "Dominant Currency Paradigm". In: *American Economic Review* 110.3, pp. 677–719.

Kalman, R. E. (1960). "A New Approach to Linear Filtering and Prediction Problems". In: *Transactions aSME Journal of Basic Engineering* D82, pp. 35–45.

Rodriguez, Alejandro and Esther Ruiz (2009). "Bootstrap Prediction Intervals in State-Space Models". In: *Journal of Time Series Analysis* 30.2, pp. 167–178.