NBER WORKING PAPER SERIES

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Working Paper 32008
http://www.nber.org/papers/w32008

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2023

Prepared for the IMF 24th Jacques Polak Annual Research Conference. We thank Harald Hau for an insightful discussion and Mark Aguiar, Andy Atkeson, Gita Gopinath, Pierre-Olivier Gourinchas, Maury Obstfeld, Kenneth Rogoff, Jón Steinsson, Adrien Verdelhan and seminar/ conference participants for helpful comments, and Haonan Zhou for outstanding research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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JEL No. F31,F41,F44

ABSTRACT

We use a general open-economy wedge-accounting framework to characterize the set of shocks that can account for major exchange rate puzzles. Focusing on a near-autarky behavior of the economy, we show analytically that all standard macroeconomic shocks — including productivity, monetary, government spending, and markup shocks — are inconsistent with the broad properties of the macro exchange rate disconnect. News shocks about future macroeconomic fundamentals can generate plausible exchange rate properties. However, they show up prominently in contemporaneous asset prices, which violates the finance exchange rate disconnect. International shocks to trade costs, terms of trade and import demand, while potentially consistent with disconnect, do not robustly generate the empirical Backus-Smith, UIP and terms-of-trade properties. In contrast, the observed exchange rate behavior is consistent with risk-sharing (financial) shocks that arise from shifts in demand of foreign investors for home-currency assets, or vice versa.

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1 Introduction

The *exchange rate disconnect* is among the most challenging and persistent international macro puzzles. While this term narrowly refers to the lack of correlation between exchange rates and other macro variables, the broader puzzle is more pervasive and nests a number of additional empirical patterns, which stand at odds with conventional international macro models. This includes: First, the Meese and Rogoff (1983) puzzle that *nominal* exchange rates follow a volatile near-random-walk process and are not robustly correlated, even contemporaneously, with macroeconomic fundamentals.[1] Second, the PPP puzzle with real exchange rates moving almost one-to-one at most frequencies with nominal exchange rates (Rogoff 1996). Third, the Backus and Smith (1993) puzzle that emphasizes a negative correlation between exchange rates and relative consumption which is at odds with the standard risk-sharing logic. Fourth, the forward premium puzzle about the deviations from the uncovered interest parity (UIP, Fama 1984). Finally, the financial disconnect puzzle that emphasizes the lack of comovement between exchange rates and asset prices (see e.g. Brandt, Cochrane, and Santa-Clara 2006).

In our previous work, we argue that introducing a currency demand shock to an otherwise conventional open economy model solves all these puzzles at once (Itskhoki and Mukhin 2021a). The results are robust to different microfoundations of this shock and to alternative general equilibrium structures ranging from an international RBC model to a New-Keynesian open economy model with sticky prices.[2] However, this leaves open the question whether there are alternative shocks that can explain the empirical patterns. There is no lack of potential candidates in the literature: persistent monetary and productivity shocks with a strong news component about future realizations (Engel and West 2005, Corsetti, Dedola, and Leduc 2008, Chahrour, Cormun, Leo, Guerron-Quintana, and Valchev 2022), relative productivity shocks in tradable and non-tradable sectors (Benigno and Thoenissen 2008), idiosyncratic income shocks across households (Kollmann 2012), discount factor shocks (Stockman and Tesar

[1] Note that we emphasize aggregate macroeconomic variables, such as GDP, aggregate consumption and overall CPI inflation. Macro exchange rate disconnect does not imply a lack of exchange rate correlation with all variables, as exchange rates may well, and even mechanically, correlate with trade prices and quantities in international goods and financial markets. There are also non-trivial conditional correlations with some aggregate macroeconomic and financial variables. See: Burstein and Gopinath (2012), Alessandria and Choi (2021), Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020), Jiang, Krishnamurthy, and Lustig (2021), Lilley, Maggiori, Neiman, and Schreger (2022), Fukui, Nakamura, and Steinsson (2023).

[2] Models of financial shocks include both exogenous UIP shocks (see e.g. Devereux and Engel 2002, Kollmann 2005, Farhi and Werning 2012), which can be viewed to emerge from exogenous asset demand following Kouri (1976, 1983), and a variety of models of endogenous UIP deviations include models with incomplete information, expectational errors and heterogeneous beliefs (Evans and Lyons 2002, Gourinchas and Tornell 2004, Bacchetta and van Wincoop 2006, Burnside, Han, Hirshleifer, and Wang 2011), financial frictions (Adrian, Etula, and Shin 2015, ?), habits, long-run risk and rare disasters (Verdelhan 2010, Colacito and Croce 2013, Farhi and Gabaix 2016), as well as models of segmented financial markets (Jeanne and Rose 2002, Alvarez, Atkeson, and Kehoe 2009, Gabaix and Maggiori 2015, Itskhoki and Mukhin 2021b).

1995, Eaton, Kortum, and Neiman 2015), long-run risk (Colacito and Croce 2011), and shocks that manifest themselves as the labor wedge (Karabarbounis 2014).

In this paper, we address this question, refine the set of potential candidates for financial shocks, and show that they are not only *sufficient* to solve the exchange rate disconnect, but also *necessary*. Our work builds on the seminal contribution of Obstfeld and Rogoff (2001) who show that home bias is crucial to solve many international puzzles (mostly unrelated to the exchange rate disconnect). Leveraging this insight, we consider a near-autarky behavior of the economy, and require that the shock process produces a volatile exchange rate behavior with a vanishing effect on the economy's aggregate quantities and prices as the economy becomes closed to trade. Indeed, in the limit of the closed economy, any exchange rate volatility (real or nominal) should be completely inconsequential for allocations. Not surprisingly, productivity and monetary shocks, as well as the majority of other shocks, violate this intuitive requirement. This explains why standard open economy models fail to generate the exchange rate disconnect. Instead, we show that the one shock that satisfies this requirement, and additionally produces the empirically relevant signs of comovement between exchange rates and macro variables (including consumption and interest rates), is the shock to the international asset demand.

We then bring the disconnect between exchange rates and asset prices in the data and leverage these moments to further sharpen our results. We show that news shocks about future macro fundamentals are unlikely to be main drivers of the exchange rate as these shocks also affect asset prices via future returns and the stochastic discount factor. Both asset prices and exchange rates (under incomplete markets) are forward looking and incorporate information about agents' expectations. Therefore, as long as asset markets are sufficiently rich, it is impossible to find a combination of news shocks that move exchange rates, yet have no effect on any asset price. The same approach allows us to refine the set of asset demand shocks that are the most likely candidates to explain the disconnect. To this end, we define sets of "local currency" assets with returns that do not mechanically depend on the exchange rate. In the autarky limit, the prices of such assets in a local currency are pinned down by domestic investors and any local demand shocks are absorbed by asset prices. In contrast, the only way to equilibrate the market in response to foreign demand shocks for home assets involves movements in the exchange rate. In response to such shocks, an appreciation of the home currency on impact and the ensuing slow expected depreciation both act to discourage foreign investors from increasing their holdings of home assets, bringing the market back to equilibrium.

The rest of the paper is organized as follows. Section 2 describes the modeling framework and the set of shocks. Section 3 defines formally the exchange rate disconnect in the autarky limit. Subsection 3.1 focuses on the macroeconomic variables and proves that financial shocks broadly defined are the most likely candidates to explain empirical moments. Subsection 3.2 then refines the argument and shows that these shocks cannot be interpreted as news about future macro fundamentals and that only demand shocks of foreign investors for home-currency assets, or vice versa, can generate the disconnect. The appendix summarizes the entire equilibrium system and provides detailed derivations and proofs.

2 Modeling Framework

We start with a flexible modelling framework that nests most standard international macro models and builds on Itskhoki and Mukhin (2021b) and Farhi, Gopinath, and Itskhoki (2014). There are two countries — home (Europe) and foreign (US, denoted with a $*$). Each country has its nominal unit of account, in which the local prices are quoted. In particular, the home wage rate is W_t euros and the foreign wage rate is W_t^* dollars. The nominal exchange rate $\mathcal{E}_t$ is the price of dollars in terms of euros. Hence, an increase in $\mathcal{E}_t$ signifies a nominal devaluation of the euro (the home currency). We allow for a variety of shocks to hit the economy. In certain cases, these shocks act as wedges that proxy for unmodelled market imperfections. We then explore which of these shocks can account for the exchange rate disconnect, as we formally define it below in Section 3.

Consumers Households maximize their discounted expected utility over consumption and labor:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t e^{\chi_t} \left(\frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{e^{\kappa_t}}{1+1/\varphi} L_t^{1+1/\varphi} \right), \tag{1}$$

where $\sigma \geq 0$ is the relative risk aversion parameter and $\varphi \in [0, \infty]$ is the Frisch elasticity of labor supply. Shocks χ_t and κ_t are the inter- and intra-temporal utility shifters, respectively. The household flow budget constraint is given by:

$$P_t C_t + \sum_{j \in J_t} e^{\psi_t^j} \mathcal{P}_t^j B_{t+1}^j \leq \sum_{j \in J_{t-1}} (\mathcal{P}_t^j + \mathcal{D}_t^j) B_t^j + W_t L_t + \Pi_t + T_t, \tag{2}$$

where P_t is the consumer price index, W_t is the nominal wage rate, Π_t are profits of home firms and T_t are lump-sum transfers from the government. B_{t+1}^j is the quantity of asset $j \in J_t$ purchased at time t at price $\mathcal{P}_t^j$, subject to a purchase tax (or sales subsidy) ψ_t^j, and paying a state-contingent dividend $\mathcal{D}_{t+1}^j$ at $t+1$. Without loss of generality, we assume that all assets are in zero net supply — households receive profits of local firms, but can issue equity and sell it to foreigners.

Households are active in three markets. First, they supply labor according to the standard static optimality condition:

$$e^{\kappa_t} C_t^\sigma L_t^{1/\varphi} = \frac{W_t}{P_t}, \tag{3}$$

where the preference shock κ_t can be alternatively interpreted as the *labor wedge*. This wedge plays an important role in the closed-economy business cycle literature where it captures departures from neoclassical labor market dynamics due to search frictions or sticky wages (see e.g. Chari, Kehoe, and McGrattan 2007, Shimer 2009).

Second, households allocate their within-period expenditure between home and foreign goods, $P_tC_t = P_{Ht}C_{Ht} + P_{Ft}C_{Ft}$. For simplicity, we assume preferences with a constant elasticity of substitution:[3]

$$C_{Ht} = (1-\gamma)e^{-\gamma\xi_t}\left(\frac{P_{Ht}}{P_t}\right)^{-\theta} C_t \qquad \text{and} \qquad C_{Ft} = \gamma e^{(1-\gamma)\xi_t}\left(\frac{P_{Ft}}{P_t}\right)^{-\theta} C_t, \tag{4}$$

where ξ_t is the relative demand shock for the foreign good (as in Pavlova and Rigobon 2007), $\theta > 0$ is the elasticity of substitution between home and foreign goods, and $1-\gamma$ captures the *home bias*, which can be due to a combination of home bias in preferences, trade costs and non-tradable goods (see Obstfeld and Rogoff 2001).

The ideal price index is given by $P_t = \left[(1-\gamma)e^{-\gamma\xi_t}P_{Ht}^{1-\theta} + \gamma e^{(1-\gamma)\xi_t}P_{Ft}^{1-\theta}\right]^{\frac{1}{1-\theta}}$. We assume that monetary policy chooses the path of the nominal price level P_t. Specifically, we write the consumer price level as $P_t \equiv e^{p_t}$ with $\Delta p_t = \pi_t$, and we interpret π_t as the inflation shock to the nominal value of the local unit of account (numeraire), which captures monetary shocks in our framework.

Lastly, households choose their asset positions according to the dynamic optimality conditions for every available asset $j \in J_t$:

$$\beta\mathbb{E}_t\left\{e^{\Delta\chi_{t+1}-\psi_t^j}\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\frac{P_t}{P_{t+1}}\mathcal{R}_{t+1}^j\right\} = 1, \tag{5}$$

where $\mathcal{R}_{t+1}^j = \frac{\mathcal{P}_{t+1}^j + \mathcal{D}_{t+1}^j}{\mathcal{P}_t^j}$ is the next-period realized return on asset j. Notice that uniform asset taxes (wedges) — $\psi_t^j = \psi_t$ for all $j \in J_t$ — affect the overall consumption-savings decision in a similar way as the Stockman and Tesar (1995) intertemporal preference shock $\Delta\chi_{t+1}$ in (1). In contrast, differential asset wedges ψ_t^j across j act as relative asset demand shifters that affect the portfolio choice for a given level of savings.

[3] The results generalize to any homothetic demand system. Introducing demand shocks ξ_t as in (4) ensures that they only shift demand for home versus foreign goods, but do not affect the first-order approximation to the aggregate price index given by $p_t = (1-\gamma)p_{Ht} + \gamma p_{Ft}$.

Producers Output is produced by a given pool of identical firms with a linear technology

$$Y_t = e^{a_t} L_t. \tag{6}$$

For analytical tractability, we focus on a constant-returns-to-scale production without capital or intermediate inputs, which are subsumed by a productivity wedge a_t (see generalization in Itskhoki and Mukhin 2021a). Therefore, the marginal cost of production is:

$$MC_t = e^{-a_t} W_t. \tag{7}$$

The total production of domestic firms is divided between the home and foreign markets, $Y_t = Y_{Ht} + Y^*_{Ht}$, resulting in profits that are distributed to the domestic households:

$$\Pi_t = (P_{Ht} - MC_t)\, Y_{Ht} + (P^*_{Ht}\mathcal{E}_t - MC_t)\, Y^*_{Ht}. \tag{8}$$

We assume the following price setting rules:

$$P_{Ht} = e^{\mu_t} MC_t, \qquad\qquad P^*_{Ht} = e^{\mu_t + \eta_t} MC_t / \mathcal{E}_t, \tag{9}$$

where μ_t is the markup shock and η_t is the law of one price (LOP) shock. Given these prices, firms satisfy the resulting demand in both markets. Equations (9) are *ad hoc* yet general pricing equations as the markup terms allow them to be consistent with a broad range of price setting models, including both monopolistic and oligopolistic competition models under both CES and non-CES demand. Furthermore, if the time path of (μ_t, η_t) is not restricted, these equations are also consistent with dynamic price setting models, and in particular the sticky price models with either producer, local or dollar currency pricing.[4]

Government uses lump-sum taxes to finance an exogenous stochastic path of government expenditure $G_t \equiv e^{g_t}$, where g_t is the government spending shock. For simplicity, we assume that government expenditure is allocated between home and foreign goods in the same way as final consumption in (4). The government collects taxes on financial positions of domestic

[4] Note that η_t can stand in for a trade cost shock, which plays a central role in the recent quantitative analyses of Eaton, Kortum, and Neiman (2015), Reyes-Heroles (2016), Alessandria and Choi (2021) and Mac Mullen and Woo (2023). A combination of η_t and ξ_t can also stand in for world commodity price shocks, acting as a wealth transfer between countries (i.e., a higher international price for a given level of quantity demanded). Such shocks are an important source of volatility for commodity-exporting and also commodity-importing countries (Chen and Rogoff 2003, Ayres, Hevia, and Nicolini 2020).

households and returns the net income lump-sum to households to run a balanced budget:

$$T_t = \sum_{j \in J_t} (e^{\psi_t^j} - 1) \mathcal{P}_t^j B_{t+1}^j - P_t G_t. \tag{10}$$

In view of Ricardian equivalence, the balanced-budget assumption is without loss of generality. The wedge g_t also subsumes any expenditures on investment that arise in a model with endogenous capital dynamics (see generalization in Itskhoki and Mukhin 2021a).

Rest of the world Foreign households are symmetric, except that their asset choice set is J_t^* which is, in general, different from J_t. Their budget constraint in nominal foreign-currency terms is given by:

$$P_t^* C_t^* + \sum_{j \in J_t^*} e^{\psi_t^{j*}} \mathcal{P}_t^{j*} B_{t+1}^{j*} \leq \sum_{j \in J_{t-1}^*} (\mathcal{P}_t^{j*} + \mathcal{D}_t^{j*}) B_t^{j*} + W_t^* L_t^* + \Pi_t^* + T_t^*,$$

where $\mathcal{P}_t^{j*} = \mathcal{P}_t^j / \mathcal{E}_t$ and $\mathcal{D}_t^{j*} = \mathcal{D}_t^j / \mathcal{E}_t$ are the prices and dividends of asset j converted into the foreign currency using the nominal exchange rate $\mathcal{E}_t$, and B_{t+1}^{j*} is the quantity of asset j purchased by foreigners at t subject to a purchase tax ψ_t^{j*}. The optimal savings and portfolio choice decisions of the foreign households are characterized by the Euler equations for every asset available to them, $j \in J_t^*$:

$$\beta \mathbb{E}_t \left\{ e^{\Delta \chi_{t+1}^* - \psi_t^{j*}} \left(\frac{C_{t+1}^*}{C_t^*} \right)^{-\sigma} \frac{P_t^*}{P_{t+1}^*} \frac{\mathcal{P}_{t+1}^j + \mathcal{D}_{t+1}^j}{\mathcal{P}_t^j} \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \right\} = 1. \tag{11}$$

Foreign households supply labor and demand home and foreign goods according to the optimality conditions parallel to (3) and (4), respectively. In particular, the goods market demand of foreign households is given by:

$$C_{Ht}^* = \gamma e^{(1-\gamma)\xi_t^*} \left(\frac{P_{Ht}^*}{P_t^*} \right)^{-\theta} C_t^* \qquad \text{and} \qquad C_{Ft}^* = (1-\gamma) e^{-\gamma \xi_t^*} \left(\frac{P_{Ft}^*}{P_t^*} \right)^{-\theta} C_t^*, \tag{12}$$

where ξ_t^* is the foreign demand shock for home goods. Like home firms, foreign firms demand labor, charge prices according to the counterparts of (9) with their own markup and LOP shocks μ_t^* and η_t^*, and pay out profits Π_t^* to foreign households, as we detail in Appendix A.1. Finally, the foreign government operates a balanced-budget parallel to (10). In particular, the foreign economy additionally features macroeconomic shocks and wedges similar to those in the home economy, $(\pi_t^*, a_t^*, g_t^*, \chi_t^*, \kappa_t^*)$, as we summarize in Table 1 below, along with the model parameters.

Equilibrium conditions ensure that the asset, product and labor markets clear and the intertemporal budget constraints of the countries are satisfied. The labor market clears when L_t is consistent simultaneously with labor supply in (3) and labor demand in (6), and symmetrically for L_t^* in foreign. The goods market clearing requires $Y_t = Y_{Ht} + Y_{Ht}^*$, where:

$$Y_{Ht} = C_{Ht} + G_{Ht} = (1-\gamma)e^{-\gamma\xi_t}\left(\frac{P_{Ht}}{P_t}\right)^{-\theta}\left[C_t + G_t\right], \tag{13}$$

$$Y_{Ht}^* = C_{Ht}^* + G_{Ht}^* = \gamma e^{(1-\gamma)\xi_t^*}\left(\frac{P_{Ht}^*}{P_t^*}\right)^{-\theta}\left[C_t^* + G_t^*\right], \tag{14}$$

as well as symmetric conditions for $Y_{Ft} + Y_{Ft}^* = Y_t^*$. Because all assets are in zero net supply, market clearing requires that

$$B_{t+1}^j + B_{t+1}^{j*} = 0 \qquad \text{for} \quad j \in J_t \cap J_t^*, \tag{15}$$

and $B_{t+1}^j = B_{t+1}^{j*} = 0$ for all other assets that are not traded internationally.

Lastly, we combine the household budget constraint (2) with profits (8) and the government budget constraint (10) to derive the country budget constraint:

$$\sum_{j\in J_t\cap J_t^*} \mathcal{P}_t^j B_{t+1}^j - \sum_{j\in J_{t-1}\cap J_{t-1}^*} (\mathcal{P}_t^j + \mathcal{D}_t^j) B_t^j = NX_t, \tag{16}$$

where $NX_t = \mathcal{E}_t P_{Ht}^* Y_{Ht}^* - P_{Ft} Y_{Ft}$ is the net exports of the home country (in home currency).

The *real exchange rate* $\mathcal{Q}_t$ is defined conventionally as the relative price of consumption baskets across the two markets and the *terms of trade* are given by the relative price at which the home country exchanges its exports for imports:

$$\mathcal{Q}_t \equiv \frac{P_t^* \mathcal{E}_t}{P_t} \qquad \text{and} \qquad \mathcal{S}_t \equiv \frac{P_{Ft}}{P_{Ht}^* \mathcal{E}_t}. \tag{17}$$

This environment can be generalized to feature heterogeneous households and firms without affecting the international equilibrium conditions.

Shocks and wedges We summarize the full set of shocks and wedges in Table 1, along with the parameters of the model and their standard values, which we use in our numerical illustration. In general, we allow shocks to follow arbitrary joint stochastic processes with unrestricted patterns of covariation. In this sense, our shocks are not primitive innovations, but rather disturbances to the equilibrium conditions of the model, akin to Chari, Kehoe, and Mc-

Table 1: Model parameters and shocks

Shocks / wedges		Parameters	
π_t, π_t^*	inflation (monetary) shock	$\beta = 0.99$	discount factor
a_t, a_t^*	productivity shock	$\sigma = 2$	relative risk aversion (inverse of IES)
g_t, g_t^*	government spending shock	$\varphi = 1$	Frisch elasticity of labor supply
χ_t, χ_t^*	intertemporal preference (deleveraging) shock	$\gamma = 0.15$	foreign share (home bias) parameter
κ_t, κ_t^*	labor wedge (sticky wages)	$\theta = 1.5$	elasticity of substitution
μ_t, μ_t^*	markup shock (sticky prices)	$\rho = 0.97$	persistence of shocks
η_t, η^*	law-of-one-price shock (LCP/DCP, trade costs)		
ξ_t, ξ_t^*	international good demand shock		
ψ_t^j, ψ_t^{j*}	financial (asset demand) shocks		

Note: the left panel summarizes the shocks in the home and foreign economies; the right panel reports the baseline parameter values.

Grattan (2007) *wedges*.[5] We use them differently, however. Instead of accounting for all sources of variation in macro variables, we prove theoretical results characterizing which subsets of wedges can and cannot result in an equilibrium *disconnect* behavior of the exchange rate, as we define in the next section.

We denote the full set of shocks in Table 1 with $\Omega_t = \big(\pi_t, a_t, g_t, \chi_t, \kappa_t, \mu_t, \eta_t, \xi_t, \{\psi_t^j\}_{j \in J_t}\big)$ and use Ω_t^* for the corresponding foreign shocks. Note that the first six types of shocks and wedges, $\Omega_t^M \equiv (\pi_t, a_t, g_t, \chi_t, \kappa_t, \mu_t)$, are conventional in both the closed-economy and open-economy macroeconomic DSGE literature and, thus, can be labelled as macroeconomic shocks. The remaining three types of shocks, $\Omega_t^I \equiv \big(\eta_t, \xi_t, \{\psi_t^j\}_{j \in J_t \cap J_t^*}\big)$ correspond to international shocks in goods and asset markets, respectively. Note that ψ_t^j shocks that are not in $J_t \cap J_t^*$ are immaterial for international allocations.

3 Disconnect in the Limit

This section provides several theoretical results that narrow down the set of shocks that can be consistent with the empirical exchange rate disconnect. Our key methodological contribution, which allows us to make progress answering this question analytically, is the focus on the equilibrium system around the autarky limit. This limit — where the share of foreign goods in consumption converges to zero $\gamma \to 0$ — is interesting for two additional reasons.

[5]For example, Eaton, Kortum, and Neiman (2015) is a recent study, which uses wedge accounting in the international context. Our approach differs in that we do not attempt to fully match macroeconomic time series, but instead focus on a specific theoretical mechanism which accounts for a set of exchange rate disconnect moments within a parsimonious model. This is also what sets our paper apart from the international DSGE literature following Eichenbaum and Evans (1995).

First, full trade autarky $\gamma = 0$ offers a model of *complete* exchange rate disconnect. Although financial markets can still pin down the level of the nominal exchange rate, its value is of no consequence for macroeconomic variables (the Meese-Rogoff puzzle). Since price levels do not respond to this volatility, the real exchange rate comoves perfectly with such nominal exchange rate shocks, and as a result can exhibit arbitrary volatility and persistence (the PPP puzzle).[6]

Second, away from autarky, the response of macro variables to the exchange rate tends to increase with the degree of openness γ. This results in more volatile and less disconnected macroeconomic behavior. Therefore, if the economy does not exhibit exchange rate disconnect properties near autarky (for $\gamma \approx 0$), it is unlikely to feature them away from autarky (for $\gamma \gg 0$). In addition, $\gamma \approx 0$ is not an unreasonable point of approximation for countries with the most pronounced disconnect between macro variables and exchange rates. The ratio of imports to GDP is around 15% for the U.S., Eurozone, and Japan, and even lower if estimated as an average over the period of free-floating exchange rates since 1973. The empirical literature finds that more open economies have less volatile exchange rates and more volatile macroeconomic variables, even after controlling for country size and other characteristics (Hau 2002, Itskhoki and Mukhin 2021a).[7]

We now extend the autarky logic to study circumstances under which a near-closed economy features a near-complete exchange rate disconnect. We then argue that this continuity requirement around autarky offers a sharp selection criterion for a subset of exogenous shocks (wedges) that can be consistent with the empirical properties of the exchange rate.

3.1 Macro disconnect

Our first set of results focuses on the disconnect between exchange rates and macroeconomic variables. For this part of our analysis, and following the wedge accounting tradition, we assume that the baseline asset markets are complete but subject to risk-sharing wedges. For simplicity, we further assume that $\psi_t^j - \psi_t^{j*} = \tilde{\psi}_t$ for all assets $j \in J_t \cap J_t^*$, and combine household Euler equations (5) and (11) to obtain the Backus-Smith international risk-sharing condition with risk-sharing wedges:

$$\frac{\mathcal{Q}_{t+1}}{\mathcal{Q}_t} = e^{\tilde{\psi}_t - \Delta\tilde{\chi}_{t+1}} \left(\frac{C_{t+1}/C_t}{C_{t+1}^*/C_t^*}\right)^{\sigma}, \tag{18}$$

[6] This "complete disconnect" in the limit bridges our approach with a distinct literature that aims to explain the exchange rate with models of indeterminacy, multiplicity and sunspot equilibria (Kareken and Wallace 1981, King and Weber 1992, Li 2014). Nonetheless, our analysis focuses on disconnect properties in an environment with a unique equilibrium when $\gamma > 0$, yet arbitrary small.

[7] Intuitively, with greater openness, it is harder to sustain a very volatile exchange rate as an equilibrium outcome, as its volatility increasingly spills over into macroeconomic variables.

where $\tilde{\chi}_t \equiv \chi_t - \chi_t^*$. Since we did not restrict the stochastic path of $\tilde{\psi}_t$, condition (18) remains fully flexible, and hence our restriction on $\{\psi_t^j, \psi_t^{j*}\}$ are without loss of generality. However, this approach allows us to disentangle the direct effects of shocks from their "news components" that affect the present-period allocation via Euler equations only. Section 3.2 goes back to the more general asset market structure and discusses endogenous deviations from full risk sharing under incomplete markets that arise due to news shocks about future fundamentals.

We proceed by formalizing a macro exchange rate disconnect property in the autarky limit:

Definition 1 (Macro disconnect in the limit) *Denote with* $\mathbf{Z}_t \equiv (W_t, P_t, C_t, L_t, Y_t, R_t)$ *a vector of all domestic macro variables (wage rate, price level, consumption, employment, production, interest rate) and with* $\varepsilon_t \equiv \mathbf{V}'\Omega_t + \mathbf{V}^{*\prime}\Omega_t^*$ *an arbitrary combination of shocks in* (Ω_t, Ω_t^*). *We say that an open economy (with* $\gamma > 0$*) exhibits macro disconnect in the autarky limit if:*

$$\lim_{\gamma\to 0} \frac{\mathrm{d}\mathbf{Z}_t}{\mathrm{d}\varepsilon_t} = 0 \qquad \textit{and} \qquad \lim_{\gamma\to 0} \frac{\mathrm{d}\mathcal{E}_t}{\mathrm{d}\varepsilon_t} \neq 0. \tag{19}$$

A corollary of condition (19) *is that* $\lim_{\gamma\to 0}[\mathrm{d}\log\mathcal{E}_t - \mathrm{d}\log\mathcal{Q}_t]/\mathrm{d}\varepsilon_t = 0$.

In other words, a model, defined by its structure and the set of shocks, exhibits exchange rate disconnect in the autarky limit if the shocks have a vanishingly small effect on the macro variables as $\gamma \to 0$, yet result in a volatile equilibrium exchange rate. This is a stylized way in which we capture the exchange rate disconnect in its narrow Meese-Rogoff sense. In particular, condition (19) emphasizes the feature that the exchange rate is empirically an order of magnitude more volatile than macro variables and with nearly no robust correlation with macro variables. Furthermore, the corollary of the definition emphasizes that the disconnect property also resolves the PPP puzzle, as the real exchange rate comoves one-for-one with the nominal exchange rate when condition (19) holds in the limit. Finally, note that ε_t is an innovation in the informational sense and may correspond to a change today in the shocks/wedges or news about their future path.

Macro shocks Definition 1 allows us to exclude a large number of candidate shocks as drivers of exchange rate disconnect. We prove the following result:[8]

Proposition 1 *The model of Section 2 cannot exhibit macro disconnect in the autarky limit* (19) *if the combined shock* ε_t *in Definition 1 has a weight of zero on the subset of shocks* $\{\eta_t, \eta_t^*, \xi_t, \xi_t^*, \tilde{\psi}_t\}$.

This proposition states that macroeconomic shocks in $\Omega_t^M \equiv \big(\pi_t, a_t, g_t, \chi_t, \kappa_t, \mu_t\big)$ together with their foreign counterparts in Ω_t^{M*}, in any combinations and with arbitrary cross-correlations, cannot reproduce an exchange rate disconnect property even as the economy

[8]The proof of this proposition does not rely on the international risk sharing conditions ((5), (11) or (18)), and therefore this result is robust to the assumption about (in)completeness of the international asset market.

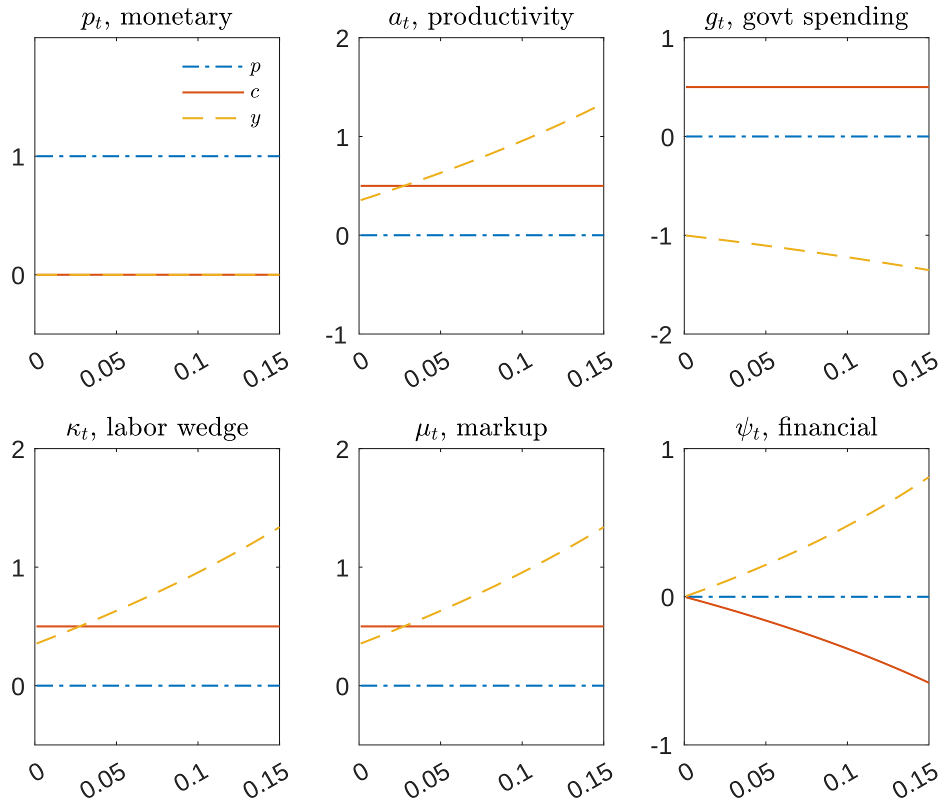

Figure 1: Relative macro and exchange rate volatility as a function of openness γ

Note: The figure plots the relative response $\frac{\mathrm{d}\tilde{z}_t}{\mathrm{d}e_t} \equiv \frac{\partial(z_t - z_t^*)/\partial\varepsilon_t}{\partial e_t/\partial\varepsilon_t}$ for three macro variables $z_t \in \{p_t, c_t, y_t\}$ (price level, consumption and output, all in logs) and shocks $\varepsilon_t \in \Omega_t = \{\pi_t, a_t, g_t, \kappa_t, \mu_t, \psi_t\}$ across models with differing home bias parameter $\gamma \in [0, 0.15]$ and value for other parameters as in Table 1. For financial shock ψ_t, the impulse responses for all three macro variables z_t are negligible relative to e_t in the autarky limit ($\gamma \to 0$), and tend to monotonically depart away from zero with $\gamma > 0$. For the other five shocks, the impulse response for at least one z_t is of the same order of magnitude as that for e_t even for $\gamma \approx 0$.

approaches autarky. We provide a formal proof in Appendix A.2, yet the intuition behind this result is straightforward. Any of the shocks in Ω_t^M will have a direct effect on real allocations, prices, and/or interest rates featured in $\mathbf{Z}_t$ even in a closed economy (when $\gamma = 0$), and thus they cannot result in a volatile exchange rate without having a direct effect on the macro variables of the same order of magnitude.

From the equilibrium system laid out in Section 2, the unit of account shocks π_t result in consumer-price inflation, the markup shocks μ_t result in either wage deflation or reduction in employment and output, the labor wedge shocks κ_t result in changes in either employment or consumption, the productivity shocks a_t result in changes in either employment or output, the government spending shocks g_t result in changes in either consumption or output, and the intertemporal preference shocks χ_t affect the risk-free interest rate. Furthermore, our proof establishes that there is no combination of such shocks that can simultaneously net out in their effects on macro variables, but not on the exchange rate. Therefore, for an economy that only faces such shocks, the disconnect property in the autarky limit (19) is necessarily violated.

Figure 1 illustrates this result by showing the volatility of macro variables relative to the volatility of the exchange rate for different values of openness γ. Consistent with Proposition 1, the relative volatility does not converge to zero for any macro shock in Ω_t^M. Furthermore, the exchange rate "connect" property tends to become more pronounced as γ increases and the economy moves further away from the autarky limit, confirming the usefulness of our focus on the near-autarky behavior.

We view Proposition 1 as an "order-of-magnitude" result. Empirically, floating exchange rates are about an order of magnitude more volatile than macro variables — with a 10–12% versus 1–2% annualized standard deviation in proportional (log) changes, respectively. Thus, Definition 1 requires a qualitatively larger volatility for the exchange rate in the limit to proxy for a big gap in volatility away from the autarky limit (for $\gamma > 0$). Furthermore, in calibrated models, the quantitative properties of macroeconomic shocks in Ω_t^M result in exchange rate volatility that is comparable with macroeconomic volatility, as we establish in greater detail in Itskhoki and Mukhin (2021a) for productivity and monetary shocks.

Proposition 1 can be viewed as pessimistic news for both International RBC and New-Keynesian Open Economy (NKOE) models of the exchange rate that have dominated the literature. It does *not* imply, however, that productivity and monetary shocks are not important sources of macroeconomic volatility. Instead, it suggests that conventional macroeconomic shocks are unlikely to be the dominant drivers of exchange rate volatility if the model is to exhibit exchange rate disconnect, irrespective of whether prices are flexible or sticky. Productivity and monetary shocks can still be key drivers of macroeconomic variables without violating the exchange rate disconnect property so long as some other shocks account for the bulk of the exchange rate volatility.

Provided our modeling of the risk-sharing condition (18), Proposition 1 also rules out news shocks about future macroeconomic fundamentals as the possible source of exchange rate disconnect in Definition 1. In the absence of risk-sharing wedges $\tilde{\psi}_t$, news shocks do not affect exchange rates. It is, of course, the case that news shock may themselves manifest as reduced-form risk-sharing wedges $\tilde{\psi}_t$ under incomplete asset markets, a possibility we return to in Section 3.2.

International shocks We consider next the other three types of shocks in Ω_t^I — namely, the LOP deviation (or trade cost) shock η_t, the international good demand shock ξ_t, and the risk-sharing (financial) shock $\tilde{\psi}_t$ — as possible drivers of the equilibrium exchange rate dynamics. The distinctive feature of these shocks is that they affect the equilibrium system exclusively through the *international* equilibrium conditions. Specifically, $\tilde{\psi}_t$ affects the international risk sharing condition (18), while η_t and ξ_t affect the country budget constraint (16) through their impact on trade balance via export prices (9) and export demand (14), respectively.[9]

The impact of shocks to these international equilibrium conditions on macro variables is vanishingly small as the economy becomes closed to international trade in goods, yet such shocks can have substantial effect on the equilibrium exchange rates and terms of trade even when γ is close to zero. Furthermore, Proposition 1 does not allow us to discriminate between these shocks as they all satisfy the autarky-limit disconnect condition (19). Yet, these shocks differ in the implied comovement between exchange rates and macro variables which we now use as a further selection criterion.

Specifically, we explore the near-autarky comovement between the exchange rates and terms of trade, relative consumption, and the interest rate differential, respectively. Since these shocks are already consistent with the Meese-Rogoff and the PPP puzzles, by virtue of Proposition 1, the additional moments correspond to the three additional exchange rate puzzles — namely, the Backus-Smith puzzle and the Forward Premium (UIP) puzzle, as well as the Terms of Trade puzzle emphasizing weak positive comovement of the terms of trade with the exchange rate (see Engel 1999, Atkeson and Burstein 2008, Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller 2020).

We prove the following result (see Appendix A.2):

Proposition 2 *Near the autarky limit (for $\gamma \to 0$), the international risk-sharing (financial) shock $\tilde{\psi}_t$ is the only shock in $\{\eta_t, \eta_t^*, \xi_t, \xi_t^*, \tilde{\psi}_t\}$ that simultaneously and robustly produces:*

(i) *a positive correlation between the terms of trade and the real exchange rate;*

(ii) *a negative correlation between the relative consumption growth and the real exchange rate depreciation;*

(iii) *deviations from UIP and a negative Fama coefficient.*

The main conclusion is that both LOP deviation (trade cost) shocks η_t and international good demand shocks ξ_t produce a *counterfactual* comovement between exchange rate changes and both the relative consumption growth (the Backus-Smith puzzle) and the interest rate differential (the Forward Premium puzzle). The financial shock $\tilde{\psi}_t$ is instead consistent with both of these empirical patterns.[10] Combined together, Propositions 1 and 2 explain why most

[9]The ξ_t and η_t shocks are additionally featured in the goods market clearing (13)–(14) and in aggregate price indices, but in both cases their effect on these conditions is proportional to trade openness γ, and thus vanishes in the autarky limit.

[10]For example, the last panel of Figure 1 for financial shock ψ_t illustrates the consumption-exchange rate comovement with the relative response of consumption (red line) having a negative sign, that is $c_t - c_t^* = \log(C_t/C_t^*)$ is low when the exchange rate is depreciated ($e_t = \log \mathcal{E}_t$ and, hence, $q_t = \log \mathcal{Q}_t$ are increased), and therefore $\mathrm{corr}(\Delta c_t - \Delta c_t^*, \Delta q_t) < 0$.

shocks cannot reproduce the empirical exchange rate properties, and hence why these properties are labeled as *puzzles* in the literature. These propositions favor the financial shock $\tilde{\psi}_t$ as the likely shock to generate exchange rate disconnect in an equilibrium model. While these propositions are concerned with the autarky limit, the continuity of the model in trade openness γ suggests that the near-disconnect properties of the financial shock should hold for $\gamma > 0$ as well.

We emphasize that just like Proposition 1, Proposition 2 should not be taken to imply that trade cost shocks, international good demand shocks and commodity price shocks are unimportant for macroeconomic and international dynamics. It suggests instead that these shocks on their own cannot account for the empirical exchange rate properties, and a large portion of exchange rate variation must be accounted for by financial shocks. However, in the presence of financial shocks, additional shocks allow the model to capture quantitatively the observed comovement between the other macro variables. In particular, the moments emphasized in Proposition 2 act as a key source of identification for the share of the exchange rate variance that must be attributed to financial, macroeconomic and international shocks, respectively (Itskhoki and Mukhin 2021a, Eichenbaum, Johannsen, and Rebelo 2021).[11]

Propositions 1 and 2 point towards the risk-sharing condition (18) and, more specifically, the risk-sharing wedge $\tilde{\psi}_t$ as the key culprit in explaining the equilibrium properties of the exchange rate. As short-hand, we refer to this risk-sharing wedge as a financial shock, however, this does not characterize its specific nature. It may emerge from news shocks about macro-fundamentals under incomplete markets or correspond to a variety of other sources of macro-financial volatility unrelated to the currency market (see footnote 2). In what follows we make use of additional financial moments to narrow down the set of possible equilibrium sources for this risk-sharing wedge.

3.2 Finance disconnect

The analysis in the previous section put the spotlight on the wedge in the international risk-sharing condition as the essential source of exchange rate disconnect. This section narrows down potential origins of such wedges and answers the following additional questions. First, can news shocks about future macro fundamentals under incomplete asset markets generate risk-sharing wedges and account for the bulk of exchange rate volatility (Engel and West 2005, Chahrour, Cormun, Leo, Guerron-Quintana, and Valchev 2022)? Second, what kind of asset demand shocks have the capacity to explain movements in exchange rates?

To answer these questions, we draw on additional moments from financial markets that

[11] An important additional source of identification that we do not rely on in Proposition 2 is the comovement between the real exchange rate and net exports at various frequencies.

capture the disconnect between exchange rates and asset prices. While less profound than macroeconomic disconnect, financial disconnect manifests as the lack of exchange rate spanning in the asset markets (Hau and Rey 2006, Lustig and Verdelhan 2019, Stavrakeva and Tang 2020, Chernov and Creal 2023, Chernov, Haddad, and Itskhoki 2023). Using the full cross-section of asset returns (terms structure of bond returns and cross-section of equity returns) one can explain between 25% and 40% of contemporaneous exchange rate variation. This implies that most exchange rate variation cannot be spanned by asset returns, which motivates our stylized approach below of capturing the finance exchange rate disconnect.

In this section we no longer rely on the reduced-form risk-sharing condition (18), and instead work with the full structure of asset markets defined by the household asset demand conditions (5) and (11) with shifters $\{\psi_t^j\}$ and $\{\psi_t^{j*}\}$, respectively, and subject to asset market clearing (15). This general structure nests various degrees of international asset market (in)completeness. As a result, various macroeconomic shocks may result in endogenous deviations from the Backus-Smith condition under incomplete asset markets which are isomorphic to a $\tilde{\psi}_t$ shock in (18). For example, with one internationally traded bond, news shocks about future productivity generate immediate jumps in C_t/C_t^* and $\mathcal{Q}_t$ despite no changes in contemporaneous fundamentals, violating the frictionless Backus-Smith condition.

To make progress we define two subsets of assets — $\mathcal{A}_t$ in home currency and $\mathcal{A}_t^*$ in foreign currency — with the property that returns of such assets, $\mathcal{R}_{t+1}^i$ for $i \in \mathcal{A}_t$ and $\mathcal{R}_{t+1}^{j*}$ for $j \in \mathcal{A}_t^*$, are not mechanically correlated with the exchange rate. This includes all local currency bonds and local equities as well as all derivatives on these assets, but excludes currency forwards and international carry trades. Therefore, the union of these sets does not cover every possible asset in the world economy, that is $\mathcal{A}_t \cup \mathcal{A}_t^* \subseteq J_t \cup J_t^*$. Furthermore, set $\mathcal{A}_t^*$ cannot include assets from $\mathcal{A}_t$ converted to foreign currency, and vice versa.[12] In other words, local bonds and equities can only belong to one of the sets, and therefore $\mathcal{A}_t \cap \mathcal{A}_t^* = \emptyset$.

Formally, we define $\mathcal{A}_t$ to be the set of assets i with dividends expressed in home currency $\mathcal{D}_t^i$ that are either arbitrary constants (date-asset specific), arbitrary functions of domestic macro variables $\mathbf{Z}_t = (W_t, P_t, C_t, L_t, Y_t, R_t)$, or arbitrary functions of domestic profits Π_t. This definition allows for a full term structure of home-currency nominal fixed income securities, inflation-adjusted bonds, defaultable debt (with default probability that depends on $\mathbf{Z}_t$ and/or Π_t), claims on domestic output, as well as equities of domestic firms, and all corresponding derivative contracts (options, forwards, swaps).[13] We refer to $\mathcal{A}_t$ informally as the

[12] Indeed, note that for an asset $i \in \mathcal{A}_t$, we have $\mathcal{R}_{t+1}^{i*} = \mathcal{R}_{t+1}^i \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}$, which must mechanically co-move with the exchange rate, and hence asset $i \notin \mathcal{A}_t^*$.

[13] This definition also extends to heterogenous firms (with heterogenous productivity shocks) and the full cross-section of equity returns. In particular, it allows for heterogenous export exposure of various firms with the restriction that every firm has non-zero domestic sales; firms with zero domestic sales must be excluded from $\mathcal{A}_t$.

set of "home-currency assets". We define symmetrically the set of "foreign-currency assets" $j \in \mathcal{A}^*_t$ based on the properties of their foreign-currency dividends $\mathcal{D}^{j*}_t$.

While we refer to sets $\mathcal{A}_t$ and $\mathcal{A}^*_t$ as sets of home- and foreign-currency assets, respectively, our definition does not exclude the possibility that dividends $\mathcal{D}^i_t$ and $\mathcal{D}^{j*}_t$ correlate endogenously with international variables, including exchange rates, when the economy is open, $\gamma > 0$. Indeed, foreign shocks affect domestic macroeconomic variables and exchange rate movements affect profits of exporting firms. Nonetheless, we can again make use of the near-trade-autarky property of our model economy as $\gamma \to 0$, and define the concept of the finance exchange rate disconnect in the limiting economy.

Definition 2 (Finance disconnect in the limit) *Denote with* $\mathbf{F}_t \equiv \big(\{\mathcal{R}^i_t\}_{i\in\mathcal{A}_{t-1}}, \{\mathcal{R}^{j*}_t\}_{j\in\mathcal{A}^*_{t-1}}\big)$ *a vector of asset returns that do not mechanically correlated with the exchange rate, and with* $\varepsilon_t \equiv \mathbf{V}'\Omega_t + \mathbf{V}^{*\prime}\Omega^*_t$ *an arbitrary combination of shocks in* (Ω_t, Ω^*_t)*. We say that an open economy (with* $\gamma > 0$*) exhibits financial disconnect in the autarky limit if:*

$$\lim_{\gamma\to 0} \frac{\mathrm{d}\mathbf{F}_t}{\mathrm{d}\varepsilon_t} = 0 \qquad \textit{and} \qquad \lim_{\gamma\to 0} \frac{\mathrm{d}\mathcal{E}_t}{\mathrm{d}\varepsilon_t} \neq 0. \tag{20}$$

According to this definition, a shock (innovation) results in financial disconnect if it moves the exchange rate without affecting returns on any assets that are not mechanically correlated with the exchange rate. In other words, this shock has a vanishingly small effect on local-currency dividends and asset prices in the trade autarky limit.[14]

We emphasize an important difference between macro and financial disconnect. For macro variables $\mathbf{Z}_t$ the empirical unconditional correlation with the exchange rate are close to zero and the exchange rate is an order of magnitude more volatile. This is not the case for financial returns $\mathbf{F}_t$ which have comparable volatility and may exhibit a degree of unconditional correlation with the exchange rate. Instead, financial disconnect refers to the lack of spanning of the exchange rate $\mathcal{E}_t$ with financial returns $\mathbf{F}_t$. We capture this by postulating that there must exist shocks ε_t that in the limit move the exchange rate without affecting any returns in $\mathbf{F}_t$, and such shocks must account for a large portion of the unconditional exchange rate volatility.

News shocks With Definition 2, we can eliminate a variety of contemporaneous and news shocks about macro fundamentals that cannot account for financial disconnect.

[14] We do not include asset positions in the definition as they are not easily observable in the data. Thus, our definition of financial disconnect does not require that exchange rate movements are uncorrelated with changes in portfolio positions.

Proposition 3 *Provided that the sets $\mathcal{A}_t$ and $\mathcal{A}_t^*$ are sufficiently rich, the model of Section 2 cannot exhibit financial disconnect in the autarky limit (20) if the combined shock ε_t in Definition 2 has a weight of zero on the subset of shocks $\big(\eta_t, \eta_t^*, \xi_t, \xi_t^*, \{\psi_t^j, \psi_t^{j*}\}_{j\in J_t\cap J_t^*}\big)$. In particular, news shocks about future macroeconomic fundamentals are inconsistent with financial disconnect.*

The intuition for this result can be seen from the household Euler equations (5) and (11) rewritten as asset pricing equations:

$$\mathcal{P}_t^i = \mathbb{E}_t \sum\nolimits_{\tau=1}^{\infty} \mathcal{M}_{t,t+\tau}\mathcal{D}_{t+\tau}^i e^{-\Psi_{t,t+\tau}^i}, \tag{21}$$

$$\mathcal{P}_t^{j*} = \mathbb{E}_t \sum\nolimits_{\tau=1}^{\infty} \mathcal{M}_{t,t+\tau}^*\mathcal{D}_{t+\tau}^{j*} e^{-\Psi_{t,t+\tau}^{j*}}, \tag{22}$$

where $\mathcal{M}_{t,t+\tau} \equiv \beta^\tau e^{\chi_{t+\tau}-\chi_t}\left(\frac{C_{t+\tau}}{C_t}\right)^{-\sigma}\frac{P_t}{P_{t+\tau}}$ is home nominal stochastic discount factors (SDF), $\Psi_{t,t+\tau}^i \equiv \sum_{k=0}^{\tau-1}\psi_{t+k}^i$ is the accumulated asset demand shock, and symmetrically for foreign SDF $\mathcal{M}_{t,t+\tau}^*$ and cumulative shock $\Psi_{t,t+\tau}^{j*}$. Because dividends $\mathcal{D}_{t+\tau}^i$, $\mathcal{D}_{t+\tau}^{j*}$ and household SDFs $\mathcal{M}_{t,t+\tau}$, $\mathcal{M}_{t,t+\tau}^*$ depend on present and future macro shocks $\{\Omega_t^M, \Omega_t^{M*}\}$ via the path of consumption, inflation and other macro variables in $\mathbf{Z}_t$, such shocks cannot generate a disconnect between exchange rates and asset prices, and hence returns $\mathcal{R}_t^i$, $\mathcal{R}_t^{j*}$. The technical requirement that sets $\mathcal{A}_t, \mathcal{A}_t^*$ are sufficiently large ensures that one cannot find a linear combination of shocks that moves the exchange rate, but has perfectly offsetting effects on all asset prices. In contrast, international non-macro shocks in Ω_t^I have a vanishingly small effect on both SDFs and dividends in the autarky limit, and therefore have a vanishingly small effect on asset prices and returns. Thus, they are consistent with financial disconnect in Definition 2.

Proposition 3 complements Proposition 1 in ruling out further macro-fundamental shocks as a key source of the exchange rate disconnect. It is a powerful result as it suggests that even very persistent or delayed macro shocks with a dominant news component about future realizations are an unlikely solution to the disconnect puzzle if one brings in asset pricing moments.[15] Intuitively, both asset prices and exchange rates are forward-looking variables that can respond sensitively to news about future fundamentals. If such shocks dominate the bulk of exchange rate volatility, one should be able to find financial asset returns that are sensitive to similar kind of news, and they should exhibit strong comovement with the exchange rate. For example, news about future productivity should be reflected in the stock market returns. Thus, an ultimate test for news-shock and long-run-risk theories of exchange rate volatility must be finding asset prices that exhibit strong comovement with the exchange rate unconditionally or conditionally on an identified shock.

[15] Engel and West (2005) and Corsetti, Dedola, and Leduc (2008) propose persistent shocks and endogenous propagation of shock persistence via capital accumulation, respectively, as possible mechanisms for a near-random walk, volatile and disconnected exchange rate process.

Asset demand shocks Finally, we can use the same approach to go beyond macro shocks and identify the type of financial shocks that can move exchange rates without affecting asset prices.

Proposition 4 *Home household demand shocks for foreign-currency assets, ψ_t^j for $j \in \mathcal{A}_t^*$, as well as foreign household demand for home-currency assets, ψ_t^{i*} for $i \in \mathcal{A}_t$, result in financial disconnect in the autarky limit* (20).

The intuition can again be seen from equations (21)–(22). In the autarky limit, SDF $\mathcal{M}_{t,t+\tau}$ is determined solely by local shocks. By construction, the same applies to dividends $\mathcal{D}_t^i$ of the assets from the set $\mathcal{A}_t$, which we label "home-currency assets". It follows that, in the autarky limit, prices and returns of assets in this set, $\mathcal{P}_t^i$ and $\mathcal{R}_t^i$ for $i \in \mathcal{A}_t$, are determined entirely by domestic macroeconomic and financial conditions. However, the foreign-household Euler equations (11) for such assets $i \in \mathcal{A}_t \cap J_t^*$ with asset demand shocks ψ_t^{i*} must also hold in equilibrium. We rewrite this condition as:

$$\mathbb{E}_t\Big\{\mathcal{M}_{t,t+1}^* e^{-\psi_t^{i*}} \mathcal{R}_{t+1}^i \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}\Big\} = 1.$$

Since in the autarky limit both SDF $\mathcal{M}_{t,t+1}^*$ and return $\mathcal{R}_{t+1}^i$ are determined by, respectively, foreign and home macro-finance fundamentals, and do not depend on ψ_{t+1}^{i*}, this shock must affect the equilibrium exchange rate.[16] A similar argument extends to a symmetric shock ψ_{t+1}^j that captures home-household asset demand for foreign-currency assets.[17]

Notice that all other financial shocks will in general affect both the exchange rate and asset prices and violate financial disconnect in Definition 2. In particular, this applies to asset-specific shocks that are common to both economies, $\psi_t^j = \psi_t^{j*}$, which directly change the asset j price $\mathcal{P}_t^j$, but may also affect the exchange rates indirectly through valuation effects in the budget constraint (*cf.* Camanho, Hau, and Rey 2022). Similarly, country-specific shifts in asset demand, $\psi_t^j = \psi_t$ for all $j \in J_t$, are isomorphic to a discount rate shock χ_t, and are absorbed by changes in domestic asset prices and interest rates. A low correlation between exchange rates and short-term nominal interest rates supports the conclusion that such shocks cannot be the main drivers of exchange rates.

What is special about cross-country asset demand shocks that are emphasized by Proposition 4? In the autarky limit, they have to affect the exchange rate without affecting asset

[16] An increase in foreign demand for home-currency assets ($\psi_t^{i*} < 0$) results in home currency appreciation on impact ($\mathcal{E}_t\downarrow$) followed by an expected depreciation ($\mathcal{E}_{t+1} > \mathcal{E}_t$). The former reduces the purchasing power of foreign wealth in the home asset market and the latter reduces the expected foreign-currency return on home-currency assets — both working to bring the asset market to equilibrium after the shift in foreign demand.

[17] Such cross-country asset demand shocks are also emphasized in the work of Jiang, Krishnamurthy, and Lustig (2021).

prices that are determined by local macro-finance conditions. The autarky limit is an essential tool that allows for such a sharp qualitative separation. Away from the autarky limit such shocks will affect asset prices, asset positions and the exchange rate at once. The limit property emphasizes again the qualitative propensity of these shocks to move the exchange rate in a nearly-disconnected way from financial variables. Away from the autarky limit, asset demand shocks must be complemented with inelastic supply of assets to ensure a sharp response of the exchange rate as the only way to bring the financial market back to equilibrium. Recent macro-finance literature emphasizes the interaction between shifts in asset demand and inelastic asset supply as an important source of volatility in the currency market, as well as other financial markets (see e.g. Gabaix and Koijen 2021, Koijen and Yogo 2019, Galaasen, Jamilov, Juelsrud, and Rey 2020).

4 Conclusion

This paper proposes a near-autarky limit as a convenient diagnostic tool to dissect shocks that drive the exchange rate. We demonstrate analytically that traditional macroeconomic shocks, while important for business cycles, are inconsistent with the broad properties of macro exchange rate disconnect in the data. Similarly, news shocks about future macro fundamentals are reflected in current asset prices, thereby violating the finance exchange rate disconnect. Instead, our findings underscore the critical role of financial shocks, particularly those related to shifts in foreign-investor demand for home-currency assets.

This insight not only challenges prevailing models in international macroeconomics but also opens new avenues for research including measuring these financial shocks in the data and understanding their origins. Endogeneity of such shocks and their transmission to monetary policy and foreign exchange (FX) interventions is particularly important from a normative perspective (Itskhoki and Mukhin 2023). Possible origins of financial exchange rate shocks can be identified from macroeconomic moments when they are combined with quasi-natural experiments such as a switch from a peg to a float at the end of the Bretton Woods period (Itskhoki and Mukhin 2021b). However, more definitive evidence on these shocks must come from emerging micro-data on FX trades and FX exposure of investors and intermediaries which would allow to leverage the empirical approach pioneered by Evans and Lyons (2002).

A Appendix

A.1 Equilibrium system

We summarize here the equilibrium system of the general model from Section 2 by breaking it into blocks:

1. Labor supply (3) and its exact foreign counterpart.
2. Labor demand in (6), the definition of the marginal cost (7), and their exact foreign counterparts.
3. Goods market clearing and demand for home and foreign goods:

$$Y_t = Y_{Ht} + Y_{Ht}^* \qquad \text{and} \qquad Y_t^* = Y_{Ft} + Y_{Ft}^*, \tag{A1}$$

   where the sources of demand for home good are given in (13) and (14), and the counterpart sources of demand for foreign good are given by:

$$Y_{Ft} = \gamma e^{(1-\gamma)\xi_t} h\left(\frac{P_{Ft}}{P_t}\right)[C_t + G_t], \tag{A2}$$

$$Y_{Ft}^* = (1-\gamma)e^{-\gamma\xi_t^*} h\left(\frac{P_{Ft}^*}{P_t^*}\right)[C_t^* + G_t^*]. \tag{A3}$$

4. Supply of goods: given price setting (9) and its foreign counterpart given by:

$$P_{Ft} = e^{\mu_t^* + \eta_t^*} MC_t^* \mathcal{E}_t, \qquad P_{Ft}^* = e^{\mu_t^*} MC_t^*, \tag{A4}$$

   and associated CES price indexes for $P_t = e^{p_t}$ and $P_t^* = e^{p_t^*}$ with inflation shocks $\pi_t = \Delta p_t$ and $\pi_t^* = \Delta p_t^*$, output produced is determined by the demand equation (A1).
5. Asset demand by home and foreign households (5) and (11), and asset market clearing (15).
6. Home-country flow budget constraint (16), with its foreign counterpart redundant by Walras Law.

A.1.1 Symmetric steady state

In a symmetric steady state, $B^j = B^{j*} = 0$ and the following shocks take zero values:

$$\psi^j = \psi^{j*} = \xi = \xi^* = \eta = \eta^* = 0,$$

and we normalize $p = p^* = 0$. We let the remaining shocks take arbitrary symmetric values:

$$a = a^*, \qquad g = g^*, \qquad \kappa = \kappa^* \qquad \text{and} \qquad \mu = \mu^*.$$

We start with the equations for prices. In a symmetric steady state, exchange rates and terms of trade are equal to 1:

$$\mathcal{E} = \mathcal{Q} = \mathcal{S} = 1, \tag{A5}$$

and therefore we can evaluate prices and wages using the equilibrium conditions described above:

$$P = P^* = P_H = P_F^* = P_H^* = P_F = 1 \qquad \text{and} \qquad W = W^* = e^{a-\mu}. \tag{A6}$$

Next we use these expressions together with production function, labor demand and labor supply to obtain two relationships for (C, Y, L):

$$L = e^{-a} Y, \qquad C^{\sigma} L^{1/\varphi} = e^{-\kappa} W = e^{a-\mu-\kappa}. \tag{A7}$$

Substitute prices into the goods market clearing to obtain an additional relationship between C and Y:

$$C + e^{g} = Y. \tag{A8}$$

We further have $Y = Y^*$, and $Y_H = Y_F^* = (1-\gamma)Y$ and $Y_H^* = Y_F = \gamma Y$.

A.1.2 Log-linearized system

We log-linearize the equilibrium system around the symmetric steady state. We split the equilibrium system into three blocks — prices, quantities and dynamic equations.

Exchange rates and prices The price block contains the definitions of the price index and its foreign counterpart:

$$p_t = (1-\gamma) p_{Ht} + \gamma p_{Ft}^*, \tag{A9}$$

$$p_t^* = \gamma p_{Ht}^* + (1-\gamma) p_{Ft}^*, \tag{A10}$$

as well as the price setting equations (9) and (A4), in which we substitute the marginal cost (7) and its foreign counterpart, and log-linearize to obtain:

$$p_{Ht} = \mu_t - a_t + w_t, \tag{A11}$$

$$p_{Ht}^* = \mu_t + \eta_t - a_t + w_t - e_t, \tag{A12}$$

$$p_{Ft}^* = \mu_t^* - a_t^* + w_t^*, \tag{A13}$$

$$p_{Ft} = \mu_t^* + \eta_t^* - a_t^* + w_t^* + e_t. \tag{A14}$$

In addition, we use the logs of the definitions of the real exchange rate and terms of trade (17):

$$q_t = p_t^* + e_t - p_t, \tag{A15}$$

$$s_t = p_{Ft} - p_{Ht}^* - e_t. \tag{A16}$$

Combine (A15)–(A16) to obtain:

$$q_t = (1-\gamma)q_t^P - \gamma s_t, \tag{A17}$$

$$s_t = q_t^P - 2\tilde{\eta}_t, \tag{A18}$$

where $q_t^P = p_{Ft}^* + e_t - p_{Ht}$ is the producer-price-based real exchange rate and we use the tilde notation $\tilde{x}_t \equiv (x_t - x_t^*)/2$ for any pair of variables (x_t, x_t^*). Lastly, we solve for q_t^P and s_t as function of q_t:

$$q_t^P = \frac{1}{1-2\gamma}q_t - \frac{2\gamma}{1-2\gamma}\tilde{\eta}_t, \tag{A19}$$

$$s_t = \frac{1}{1-2\gamma}q_t - \frac{2(1-\gamma)}{1-2\gamma}\tilde{\eta}_t. \tag{A20}$$

Next, we use these solutions together with the expressions for price indexes (A9), to solve for:

$$p_{Ht} - p_t = -\frac{\gamma}{1-\gamma}(p_{Ft} - p_t) = \gamma(p_{Ht} - p_{Ft}) = -\frac{\gamma}{1-2\gamma}q_t + \frac{\gamma^2\eta_t - \gamma(1-\gamma)\eta_t^*}{1-2\gamma}, \tag{A21}$$

$$p_{Ft}^* - p_t^* = -\frac{\gamma}{1-\gamma}(p_{Ht}^* - p_t^*) = \gamma(p_{Ft}^* - p_{Ht}^*) = \frac{\gamma}{1-2\gamma}q_t + \frac{\gamma^2\eta_t^* - \gamma(1-\gamma)\eta_t}{1-2\gamma}. \tag{A22}$$

Combining these expression with (A11) and (A13), we can solve for wages:

$$w_t = -\mu_t + \frac{\gamma^2\eta_t - \gamma(1-\gamma)\eta_t^*}{1-2\gamma} + a_t - \frac{\gamma}{1-2\gamma}q_t, \tag{A23}$$

$$w_t^* = -\mu_t^* + \frac{\gamma^2\eta_t^* - \gamma(1-\gamma)\eta_t}{1-2\gamma} + a_t^* + \frac{\gamma}{1-2\gamma}q_t, \tag{A24}$$

which together allow to solve for the relationship between q_t and nominal exchange rate e_t:

$$\frac{1}{1-2\gamma}q_t = e_t - 2\tilde{w}_t + 2\tilde{a}_t - 2\tilde{\mu}_t + \frac{2\gamma}{1-2\gamma}\tilde{\eta}_t. \tag{A25}$$

Real exchange rate and quantities The supply side is the combination of labor supply (3) and labor demand (6), which we log-linearize as:

$$\kappa_t + \sigma c_t + \tfrac{1}{\varphi}\ell_t = w_t - p_t, \tag{A26}$$

$$\ell_t = y_t - a_t. \tag{A27}$$

Combining the two to solve out ℓ_t, and using (A23) to solve out $(w_t - p_t)$, we obtain:[18]

$$\varphi\sigma c_t + y_t = (1+\varphi)a_t - \varphi\left[\mu_t - \frac{\gamma^2\eta_t - \gamma(1-\gamma)\eta_t^*}{1-2\gamma} + \frac{\gamma}{1-2\gamma}q_t\right] - \varphi\kappa_t. \tag{A28}$$

Symmetrically, the same expression for foreign is:

$$\varphi\sigma c_t^* + y_t^* = (1+\varphi)a_t^* - \varphi\left[\mu_t^* - \frac{\gamma^2\eta_t^* - \gamma(1-\gamma)\eta_t}{1-2\gamma} - \frac{\gamma}{1-2\gamma}q_t\right] - \varphi\kappa_t^*.$$

Adding and subtracting the two we obtain:

$$\varphi\sigma\bar{c}_t + \bar{y}_t = (1+\varphi)\bar{a}_t - \varphi(\bar{\mu}_t + \gamma\bar{\eta}_t) - \varphi\bar{\kappa}_t, \tag{A29}$$

$$\varphi\sigma\tilde{c}_t + \tilde{y}_t = (1+\varphi)\tilde{a}_t - \varphi\left[\tilde{\mu}_t - \frac{\gamma}{1-2\gamma}\tilde{\eta}_t + \frac{\gamma}{1-2\gamma}q_t\right] - \varphi\tilde{\kappa}_t, \tag{A30}$$

where $\bar{x}_t \equiv (x_t + x_t^*)/2$ for any pair of variables (x_t, x_t^*).

The demand side is the goods market clearing (A1) together with (13)–(14), which we log-linearize as:

$$\begin{aligned}
y_t &= (1-\gamma)y_{Ht} + \gamma y_{Ht}^*,\\
y_{Ht} &= -\gamma\xi_t - \theta(p_{Ht} - p_t) + \varsigma c_t + (1-\varsigma)g_t,\\
y_{Ht}^* &= (1-\gamma)\xi_t^* - \theta(p_{Ht}^* - p_t^*) + \varsigma c_t^* + (1-\varsigma)g_t^*,
\end{aligned}$$

where $\varsigma \equiv C/(C+G)$. Combining together, we derive:

$$y_t - \varsigma[c_t - 2\gamma\tilde{c}_t] = \frac{2\gamma(1-\gamma)\theta}{1-2\gamma}q_t + (1-\varsigma)[g_t - 2\gamma\tilde{g}_t] + \frac{\gamma(1-\gamma)\theta}{1-2\gamma}(\eta_t + \eta_t^*) - 2\gamma(1-\gamma)\tilde{\xi}_t, \tag{A31}$$

where we have solved out $(w_t - p_t)$ and $(w_t^* - p_t^*)$ using (A23)–(A24) and solved out $(p_{Ht} - p_t)$

[18] A useful interim step is: $\varphi\sigma c_t + y_t = (\varphi + \phi)(w_t - p_t) + a_t - \varphi\kappa_t$.

and $(p^*_{Ht} - p^*_t)$ using (A21)–(A22). Adding and subtracting the foreign counterpart, we obtain:

$$\bar{y}_t = \varsigma\bar{c}_t + (1-\varsigma)\bar{g}_t + \frac{2\gamma(1-\gamma)\theta}{1-2\gamma}\bar{\eta}_t, \tag{A32}$$

$$\tilde{y}_t = (1-2\gamma)\Big[\varsigma\tilde{c}_t + (1-\varsigma)\tilde{g}_t\Big] - 2\gamma(1-\gamma)\tilde{\xi}_t + \gamma\frac{2(1-\gamma)\theta}{1-2\gamma}q_t. \tag{A33}$$

An immediate implication of (A29) and (A32) is that $(\bar{y}_t, \bar{c}_t)$ depends only on $(\bar{a}_t, \bar{g}_t, \bar{\kappa}_t, \bar{\mu}_t, \bar{\eta}_t)$ and does not depend on the real exchange rate q_t. In particular, if $\bar{a}_t = \bar{g}_t = \bar{\kappa}_t = \bar{\mu}_t = \bar{\eta}_t = 0$, then $\bar{y}_t = \bar{c}_t = 0$. This is the case we focus on throughout the paper, since as we see below the variation in $(\bar{a}_t, \bar{g}_t, \bar{\kappa}_t, \bar{\mu}_t, \bar{\eta}_t)$ does not affect q_t. Combining (A30) and (A33) we can solve for $\tilde{y}_t$ and $\tilde{c}_t$. For example, the expression for $\tilde{c}_t$ is:

$$\begin{aligned}\Big[(1-2\gamma)(\varphi\sigma+\varsigma) + 2\gamma\varphi\sigma\Big]\tilde{c}_t = (1+\varphi)\tilde{a}_t - \varphi\tilde{\mu}_t - \varphi\tilde{\kappa}_t - (1-2\gamma)(1-\varsigma)\tilde{g}_t \\ + \gamma\varphi\tilde{\eta}_t + 2\gamma(1-\gamma)\tilde{\xi}_t - \frac{\gamma}{1-2\gamma}\left[2(1-\gamma)\theta + \varphi\right]q_t.\end{aligned} \tag{A34}$$

Lastly, we provide the linearized expression for net exports:

$$nx_t = \gamma\big(y^*_{Ht} - y_{Ft} - s_t\big),$$

where $nx_t = \frac{1}{P_H Y}NX_t$ is linear deviation of net exports from steady state $NX = 0$ relative to the total value of output. Substituting in the expressions for s_t, y^*_{Ht} and y_{Ft}, we obtain:

$$nx_t = \gamma\frac{2(1-\gamma)\theta - 1}{1-2\gamma}q_t - 2\gamma[\varsigma\tilde{c}_t + (1-\varsigma)\tilde{g}_t] - 2\gamma(1-\gamma)\tilde{\xi}_t - 2\gamma(1-\gamma)\left[\theta + \frac{1}{1-2\gamma}\right]\tilde{\eta}_t.$$

Exchange rate and asset prices It only remains now to log-linearize the asset demand conditions (5) and (11), which pins down the equilibrium asset prices, as well as provides an international risk sharing condition:

$$\mathbb{E}_t\left\{\sigma\Delta c_{t+1} + \Delta p_{t+1} - r^j_{t+1} + \psi^j_t - \Delta\chi_{t+1}\right\} = 0,$$
$$\mathbb{E}_t\left\{\sigma\Delta c^*_{t+1} + \Delta p^*_{t+1} - r^j_{t+1} + \Delta e_{t+1} + \psi^{j*}_t - \Delta\chi^*_{t+1}\right\} = 0,$$

where $r^j_{t+1} \equiv \log\frac{\mathcal{P}^j_{t+1} + \mathcal{D}^j_{t+1}}{\mathcal{P}^j_t}$. Combining the two, we obtain the risk-sharing (Backus-Smith) condition:

$$\mathbb{E}_t\left\{\sigma(\Delta c_{t+1} - \Delta c^*_{t+1}) - \Delta q_{t+1} + \tilde{\psi}^j_t - \Delta\tilde{\chi}_{t+1}\right\} = 0, \tag{A35}$$

where $\tilde{\psi}_t^j \equiv \psi_t^j - \psi_t^{j*}$ and $\tilde{\chi}_t \equiv \chi_t - \chi_t^*$. When the asset markets are complete with $\tilde{\psi}_t^j \equiv \tilde{\psi}_t$ for every j, this condition becomes (18):

$$\Delta q_{t+1} = \sigma(\Delta c_{t+1} - \Delta c_{t+1}^*) + \tilde{\psi}_t - \Delta\tilde{\chi}_{t+1},$$

which is equivalent to:

$$q_t = \sigma(\Delta c_t - \Delta c_t^*) + \zeta_t,$$

where $\Delta\zeta_t \equiv \tilde{\psi}_{t-1} - \Delta\tilde{\chi}_t$ and $\zeta_0 = -\tilde{\chi}_0$.

A.2 Autarky Limit and Proofs for Section 3

Proof of Propositions 1 The strategy of the proof is to evaluate the log deviations of the macro variables $z_t \equiv (w_t, p_t, c_t, \ell_t, y_t)$ from the deterministic steady state (described in Appendix A.1.1) in response to a shock $\varepsilon_t = \mathbf{V}'\Omega_t \neq 0$.[19] In particular, we explore under which circumstances $\lim_{\gamma\to 0} z_t = 0$. It is sufficient to consider the log-linearized equilibrium conditions described in Appendix A.1.2, as providing a counterexample is sufficient for the prove (hence, the focus on the small log deviations is without loss of generality).

To prove the propositions, consider any shock ε_t with the restriction that

$$\eta_t = \eta_t^* = \xi_t = \xi_t^* = \tilde{\psi}_t \equiv 0. \tag{A36}$$

We now go through the list of requirements imposed by the first part of the condition (19):

1. No price response $\lim_{\gamma\to 0} p_t = 0$ implies $p_t = 0$, i.e. the monetary shocks cannot lead to the exchange rate disconnect in the limit. When the same requirements are imposed for foreign, it ensures $\lim_{\gamma\to 0}\{q_t - e_t\} = 0$, as immediartely follows from the the definition of the real exchange rate $q_t = p_t^* + e_t - p_t$ (see also (A25)).

2. No wage level response implies, using (A23) and (A36):

$$\lim_{\gamma\to 0} w_t = p_t - \mu_t + a_t = 0,$$

which in light of $p_t = 0$ requires $\mu_t = a_t$, i.e. the markup shocks must offset the productivity shocks to avoid variation in the price level.

3. From the labor supply and labor demand conditions (A26)–(A27), no consumption, em-

[19] We do not impose any restrictions on the process for shocks in Ω_t, with the exception of the mild requirement that any innovation in Ω_t has some contemporaneous effect on the value of shocks in Ω_t, i.e. we rule out pure news shocks. We discuss examples with specific time series processes for the shocks in the end of this subsection.

ployment and output response require:

$$\lim_{\gamma\to 0}\left\{\sigma c_t + \tfrac{1}{\varphi}\ell_t\right\} = a_t - \mu_t - \kappa_t = 0,$$
$$\lim_{\gamma\to 0}\left\{y_t - \ell_t\right\} = a_t = 0,$$

which then implies $a_t = \kappa_t \equiv 0$ and by consequence $\mu_t \equiv 0$ from the result above. That is, there cannot be productivity, markup or labor wedge shocks, if the wage level, consumption, output and employment are not to respond in the autarky limit.

4. Rearranging the goods market clearing in the home market (A31), we have:

$$\lim_{\gamma\to 0}\left\{y_t - \varsigma c_t\right\} = (1-\varsigma)g_t = 0,$$

which requires $g_t \equiv 0$.

5. The Euler equation for a risk-free bond is $r_{ft} = \mathbb{E}_t\left\{\sigma\Delta c_{t+1} + \Delta p_{t+1} - \Delta\chi_{t+1}\right\}$, and thus requires $\mathbb{E}_t\Delta\chi_{t+1} = 0$. In the presence of additional assets (e.g., Arrow-Debreu securities under complete markets), we can conclude that $\chi_t = 0$ state by state.

To summarize, the first condition in (19) (combined with the absence of η_t, ξ_t and ψ_t shocks) implies:

$$w_t = \chi_t = \kappa_t = a_t = \mu_t = g_t \equiv 0,$$

i.e. no other shock can be consistent with $\lim_{\gamma\to 0} z_t = 0$. This leaves only news shocks about future values of these wedges. However, without risk-sharing wedges ($\tilde{\psi}_t = 0$), the risk-sharing condition (18) implies:

$$e_t = \sigma(c_t - c_t^*) + p_t - p_t^*.$$

Given that $p_t = p_t^* = 0$ and $c_t - c_t^* = y_t - y_t^*$ according to (19), the nominal exchange rate at t does not depend on future realizations of shocks and therefore, for any news shocks $\lim_{\gamma\to 0} e_t = 0$, violating the second condition in (19). A symmetric argument for foreign rules out the foreign counterparts of these shocks. This completes the proof. ■

Proof of Proposition 2 For the proof, we consider the equilibrium system in the autarky limit by only keeping the lowest order terms in γ for each shock or variable.[20] Throughout the proof we impose $w_t = \chi_t = \kappa_t = a_t = \mu_t = g_t \equiv 0$, as well as for their foreign counterparts.

[20]For example, consider equation (A25), which we now rewrite as:

$$q_t - e_t = 2\big(\tilde{a}_t - \tilde{\mu}_t - \tilde{w}_t\big) + 2\gamma\tilde{\eta}_t.$$

Note that the gap between q_t and e_t is zero-order in γ for shocks $(\tilde{a}_t, \tilde{\mu}_t, \tilde{w}_t)$ and first-order in γ for shock $\tilde{\eta}_t$.

First, we consider our three moments of interest when $\tilde{\psi}_t$ is the only shock, that is we set $\eta_t = \xi_t \equiv 0$. For this purpose, it is sufficient to consider the static equilibrium conditions only, as the effect of the $\tilde{\psi}_t$ shock on the macro variables is exclusively indirect through q_t. Specifically:

1. Consider the near-autarky comovement between the terms of trade and the real exchange rate from (A20):
$$\lim_{\gamma\to 0} \frac{\text{cov}(\Delta s_t, \Delta q_t)}{\text{var}(\Delta q_t)} = 1 > 0,$$
since we have $\tilde{\eta}_t = 0$.

2. Consider the near-autarky comovement between the relative consumption and the real exchange rate from (A34), which in the absence of all shocks but ψ_t simplifies to:
$$\Big[(1-2\gamma)(\varphi\sigma+\varsigma)+2\gamma\varphi\sigma\Big]\tilde{c}_t = -\gamma\left[\frac{2(1-\gamma)\theta}{1-2\gamma}+\frac{\varphi}{1-2\gamma}\right]q_t.$$
Hence, we have:
$$\lim_{\gamma\to 0}\frac{1}{\gamma}\frac{\text{cov}\left(\Delta c_t - \Delta c_t^*, \Delta q_t\right)}{\text{var}(\Delta q_t)} = -\frac{2\left(2\theta+\varphi\right)}{\varphi\sigma+\varsigma} < 0,$$
which is negative for all parameter values.

3. Consider the near-autarky comovement between the nominal exchange rate and the nominal interest rate differential (the Fama coefficient), which we write in the limit as:
$$i_t - i_t^* = \mathbb{E}_t\{2\sigma\Delta\tilde{c}_{t+1} + 2\Delta\tilde{p}_{t+1}\} = -\frac{2\gamma\sigma(2\theta+\varphi)}{\varphi\sigma+\varsigma}\mathbb{E}_t\Delta q_{t+1}.$$
where we used expression (A34) for $\tilde{c}_t$ and $p_t = p_t^* = 0$. The latter condition also implies that $e_t = q_t$. Therefore, the Fama regression coefficient in the limit is:[21]
$$\lim_{\gamma\to 0}\gamma\frac{\text{cov}\left(\mathbb{E}_t\Delta e_{t+1}, i_t - i_t^*\right)}{\text{var}\left(i_t - i_t^*\right)} = -\frac{2\gamma\sigma(2\theta+\varphi)}{\varphi\sigma+\varsigma} < 0.$$

This proves the first claim of the proposition that the shock $\tilde{\psi}_t$ robustly and simultaneously produces the correct empirical signs for all three moments in the autarky limit.

It is also easy to check directly from the risk sharing condition (18) that the dispersion of the real and nominal (by corollary of Definition 1) exchange rates is separated from zero in response to these shocks.

[21] We make use of the fact that $\text{cov}\left(\Delta e_{t+1}, i_t - i_t^*\right) = \text{cov}\left(\mathbb{E}_t\Delta e_{t+1}, i_t - i_t^*\right)$ since $i_t - i_t^*$ is in the period t information set.

Second, the uncovered interest rate parity implies that the Fama regression coefficient:

$$\beta_F \equiv \frac{\operatorname{cov}(\Delta e_{t+1}, i_t - i_t^*)}{\operatorname{var}(i_t - i_t^*)} = 1 \qquad \text{whenever} \qquad \tilde{\psi}_t \equiv 0.$$

This follows from the linearized Euler equations (5) and (11) for one-period risk-free nominal bonds with price $\mathcal{P}_t^f$ and $\mathcal{P}_t^{*f}$ and payoffs $\mathcal{D}_{t+1}^f = 1$ and $\mathcal{D}_{t+1}^{*f} = \mathcal{E}_{t+1}$:

$$\begin{aligned} i_t &= \log(\beta/\mathcal{P}_t^f) = \mathbb{E}_t\{\sigma\Delta c_{t+1} + \Delta p_{t+1} + \psi_t^f\}, \\ i_t^* &= \log(\beta/\mathcal{P}_t^{f*}) = \mathbb{E}_t\{\sigma\Delta c_{t+1}^* + \Delta p_{t+1}^* + \psi_t^{f*}\}, \end{aligned}$$

and therefore

$$i_t - i_t^* = \mathbb{E}_t\{\sigma(\Delta c_{t+1} - \Delta c_{t+1}^*) + (\Delta p_{t+1} - \Delta p_{t+1}^*) + \tilde{\psi}_t^f\} = \mathbb{E}_t \Delta e_{t+1},$$

where we used $\tilde{\psi}_t^f = \psi_t^f - \psi_t^{f*} = 0$ and the risk-sharing condition (18) that implies $\sigma(\Delta c_{t+1} - \Delta c_{t+1}^*) + (\Delta p_{t+1} - \Delta p_{t+1}^*) = \Delta e_{t+1}$ given that $\Delta q_{t+1} = \Delta e_{t+1} - (\Delta p_{t+1} - \Delta p_{t+1}^*)$ and when $\tilde{\psi}_t^f = 0$. This implies the Fama coefficient of 1. Therefore, $(\eta_t, \eta_t^*, \xi_t, \xi_t^*)$ shocks that follow any joint process cannot resolve the forward premium puzzle.

Third, focus on the ξ_t and η_t shocks (setting all other shocks including $\tilde{\psi}_t$ to zero) and combine the goods market clearing condition (A34) with the risk sharing condition (18) to get

$$q_t = \frac{2\gamma\varphi\sigma}{\varphi\sigma + \varsigma}\tilde{\eta}_t + \frac{4\gamma\sigma}{\varphi\sigma + \varsigma}\tilde{\xi}_t,$$

where again we only keep lower-order terms in γ. From equation (A20), it follows then

$$s_t = -2\left[1 + \frac{\gamma\varsigma}{\varphi\sigma + \varsigma}\right]\tilde{\eta}_t + \frac{4\gamma\sigma}{\varphi\sigma + \varsigma}\tilde{\xi}_t.$$

Combining the last two equations, we get that $\lim_{\gamma\to 0} \frac{\operatorname{cov}(\Delta s_t, \Delta q_t)}{\operatorname{var}(\Delta q_t)} < 0$ for shocks $\tilde{\eta}_t$, i.e. law-of-one-price shocks generate a counterfactual negative correlation between the terms of trade and the real exchange rate (akin to the property of an LCP model, see Obstfeld and Rogoff 2000). At the same time, the international good demand shocks generate a positive correlation, i.e. $\lim_{\gamma\to 0} \frac{\operatorname{cov}(\Delta s_t, \Delta q_t)}{\operatorname{var}(\Delta q_t)} > 0$ for shocks $\tilde{\xi}_t$. Finally, the risk sharing condition $q_t = \sigma(c_t - c_t^*)$ implies that neither of the two shocks can deliver an empirically relevant negative correlation between the real exchange rate and the relative consumption. ■

Proof of Proposition 3 Shut down shocks to $\{\eta_t, \eta_t^*, \xi_t, \xi_t^*, \psi_t^j, \psi_t^{j*}\}$ and rewrite the asset pricing equations (21):

$$\mathcal{P}_t^j = \mathbb{E}_t \left\{ \sum_{\tau=1}^{\infty} \beta^\tau \left(\frac{C_{t+\tau}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+\tau}} \mathcal{D}_{t+\tau}^j \right\}, \qquad \mathcal{P}_t^{j*} = \mathbb{E}_t \left\{ \sum_{\tau=1}^{\infty} \beta^\tau \left(\frac{C_{t+\tau}^*}{C_t^*} \right)^{-\sigma} \frac{P_t^*}{P_{t+\tau}^*} \mathcal{D}_{t+\tau}^{j*} \right\}.$$

Focusing on assets with payoffs independent of international variables $j \in \mathcal{A}_t \cup \mathcal{A}_t^*$ and trade autarky $\gamma \to 0$, it follows that the present and future monetary shocks $\{p_t\}$ have direct effect on asset prices via the nominal SDF. Similarly, the equilibrium conditions summarized in (A34) imply that the expectations about other macro shocks $\{\kappa_t, a_t, g_t, \mu_t, \chi_t\}$ determine the equilibrium path of $\{C_t\}$ and therefore, also affect asset prices via SDF. A symmetric argument applies to foreign shocks and foreign asset prices. The financial disconnect between exchange rates and asset prices is only possible if one combines these shocks in such a way that they only move $\mathcal{E}_t$, but leave all $\mathcal{P}_t^i$, $\mathcal{P}_t^{j*}$ unchanged. This is generically impossible if the number of assets with imperfectly aligned payoffs is sufficiently large. ■

Proof of Proposition 4 Consider an asset $j \in \mathcal{A}_t$ with payoffs in home currency $\mathcal{D}_t^j$. According to equation (21), the price of this asset in home currency is given by

$$\mathcal{P}_t^j = \mathbb{E}_t \left\{ \sum_{\tau=1}^{\infty} \mathcal{M}_{t,t+\tau} \mathcal{D}_{t+\tau}^j e^{-\Psi_{t,t+\tau}^j} \right\}.$$

In the autarky limit, the nominal SDF $\mathcal{M}_{t,t+\tau}$ is determined solely by local shocks $\{p_t, \kappa_t, a_t, g_t, \mu_t, \chi_t\}$ and does not depend directly or via endogenous variables on financial shocks $\{\psi_t^j, \psi_t^{j*}\}$. It follows that $\mathcal{P}_t^j$ is independent of foreign financial shocks ψ_t^{j*}. At the same time, the Euler equation for foreign households investing in the same asset implies

$$\frac{\mathcal{P}_t^j}{\mathcal{E}_t} = \mathbb{E}_t \left\{ \sum_{\tau=1}^{\infty} \mathcal{M}_{t,t+\tau}^* \frac{\mathcal{D}_{t+\tau}^j}{\mathcal{E}_{t+\tau}} e^{-\Psi_{t,t+\tau}^{j*}} \right\},$$

where SDF $\mathcal{M}_{t,t+\tau}^*$ is also independent of financial shocks. Thus, without changes in $\mathcal{P}_t^j$, $\mathcal{M}_{t,t+\tau}^*$ or $\mathcal{D}_t^j$, the foreign demand shocks ψ_t^{j*} must be absorbed by either current or future movements in the nominal exchange rates $\{\mathcal{E}_t, \mathcal{E}_{t+1}\}$. Therefore, these shocks create a disconnect between asset prices and exchange rates. A symmetric argument applies to assets $i \in \mathcal{A}_t^*$ and shocks ψ_t^i. ■

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