Sanctions and the Exchange Rate *

Oleg Itskhoki
itskhoki@econ.ucla.edu

Dmitry Mukhin
d.mukhin@lse.ac.uk

May 6, 2022

Abstract

We show that the exchange rate may appreciate or depreciate depending on the specific mix of sanctions imposed, even if the underlying equilibrium allocation is the same. Sanctions that limit a country's imports tend to appreciate the country's exchange rate, while sanctions that limit exports and/or freeze net foreign assets tend to depreciate it. Increased precautionary household demand for foreign currency is another force that depreciates the exchange rate, and it can be offset with domestic financial repression of foreign currency savings. The overall effect depends on the balance of currency demand and currency supply forces, where exports and official reserves contribute to currency supply and imports and foreign currency precautionary savings contribute to currency demand. Domestic economic downturn and government fiscal deficits are additional forces that affect the equilibrium exchange rate. The dynamic behavior of the ruble exchange rate following Russia's military invasion of Ukraine in February 2022 and the resulting sanctions is entirely consistent with the combined effects of these mechanisms.

*We thank Sebastián Fanelli for an insightful discussion and seminar participants at UCLA, Stanford, Maryland and BIS-BOE-ECB-IMF spillover conference for very helpful suggestions.

1 Introduction

What is the effect of sanctions on the value of the exchange rate of a country under sanctions? This paper is motivated by the recent events in which the West imposed stiff sanctions on Russia after its military invasion of Ukraine on February 24, 2022. In the immediate aftermath of the invasion and the imposition of sanctions, the Russian ruble quickly lost nearly half of its value. However, a few weeks later, the value of the ruble started to appreciate towards its pre-war level (see Figure 1), posing a puzzle for commentators.

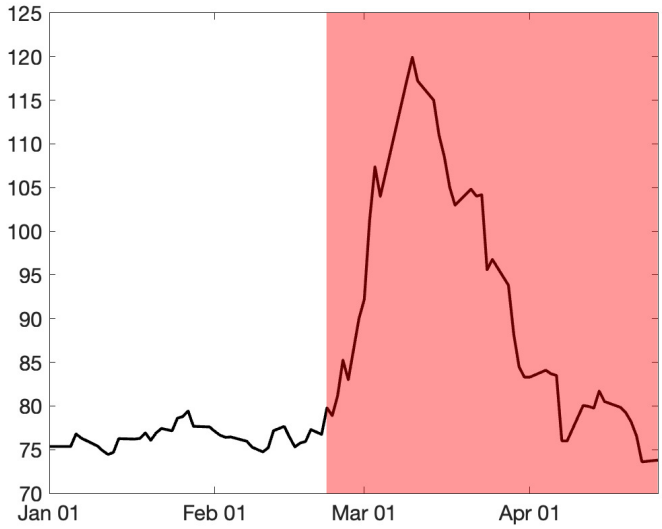


Figure 1: Daily ruble exchange rate (per one USD) in 2022

Building on the equilibrium exchange rate model in Itskhoki and Mukhin (2021, 2022), we show that the exchange rate can move in opposite directions depending on the specific mix of sanctions used, even if the underlying equilibrium allocation and the resulting welfare are the same. In particular, sanctions that limit imports of a country tend to appreciate the country's exchange rate, while sanctions that limit export and/or freeze net foreign assets tend to depreciate it, even if they have the same effect on real allocations.[1] Furthermore, an increase in precautionary household demand for foreign currency in response to the uncertainty associated with the war and sanctions is another force for exchange rate depreciation, which can be offset with domestic financial repression of foreign currency savings.[2]

The overall intuition comes from the balance of currency demand and supply. Exports and government reserves are the main source of currency supply. Imports and foreign currency precautionary savings are the main source of currency demand. Sanctions that reduce the supply of currency tend to depreciate the exchange rate, while sanctions and policy responses that reduce the demand for currency

[1] This equivalence is another manifestation of Lerner (1936) symmetry studied in Barbiero, Farhi, Gopinath, and Itskhoki (2019) in the context of tariffs and border adjustment taxes.

[2] This paper focus on the impact of various forms of sanctions on the exchange rate, leaving aside the issue of optimal sanctions design (see e.g. Bianchi and Sosa-Padilla 2022, Sturm 2022). Korhonen (2019) provides a recent survey of the earlier work on the economic impact of sanctions, in particular in the context of the Russian economy.

tend to appreciate the exchange rate. In the counterfactual limiting case with no imports and full financial repression, there is no use for currency and the exchange rate becomes an irrelevant variable, even if it appreciates without bound from the currency proceeds from commodity exports. When imports and foreign currency savings are not fully constrained, the exchange rate still plays an allocative role. In particular, we show that financial repression that partially limits foreign currency savings, results in exchange rate appreciation, allows the country to increase imports, and in a heterogeneous-agent economy shifts welfare from savers towards hand-to-mouth consumers.

Among additional mechanisms, we point out that sanctions that cause disruption in domestic production (e.g., due to exit of foreign multinationals and withdrawal of intermediate inputs) tend to appreciate the exchange rate by making domestic goods scarce relative to imports. Finally, expected fiscal deficits of the government associated with economic downturn induced by various forms of sanctions create a Sargent and Wallace (1981)-style "unpleasant monetary arithmetics" pressure on monetary policy, and thus may trigger a monetary-driven devaluation. Surprisingly, however, import and export sanctions have the same effect on the fiscal balance of the government, even when fiscal revenues of the government rely heavily on export revenues of the country.

In summary, the dynamic behavior of the Russian ruble exchange rate is entirely consistent with the following timing of events. The initial depreciation was caused by the freeze of net foreign assets and a sharp increase in uncertainty and precautionary demand for foreign currency by households. This effect was moderated by the associated global increase in energy prices, since energy is the main Russian export. Financial repression that followed further stabilized the value of the exchange rate. The fact that the West chose to concentrate sanctions on Russian imports and not cut exports of Russia energy was an additional force towards the appreciation of the ruble. Finally, the combination of sanctions so far has not triggered problems for the fiscal balance of the government, and thus combined with an aggressive increase in the interest rate, has not resulted in monetary inflation and devaluation.

2 Modeling Environment

Consider an endowment small open economy with consumption of non-tradables and imported tradables, and exports of commodities.

Households choose the consumption of the home and import goods C_{Ht} and C_{Ft}:

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(C_{Ht}, C_{Ft}) + v\left(\frac{B^*_{t+1}}{P^*_{t+1}}; \psi_t \right) \right], \tag{1}$$

subject to:

$$P_t C_{Ht} + \mathcal{E}_t P^*_t C_{Ft} + \frac{B_{t+1}}{R_t} + \frac{\mathcal{E}_t B^*_{t+1}}{R^*_{Ht}} \leq B_t + \mathcal{E}_t B^*_t + W_t, \tag{2}$$

where P_t and P^*_t are prices of home and imported goods in home and foreign currency, respectively, and W_t is the nominal wage bill of home households. $\mathcal{E}_t$ is the nominal exchange rate defined as units of home currency for one unit of foreign, and an increase in $\mathcal{E}_t$ corresponds to a home currency

devaluation. (B_t, B_t^*) are quantities of home and foreign currency deposits with home market interest rates (R_t, R_{Ht}^*). Importantly, we allow for asset market segmentation and capital controls that can drive a wedge between the world interest rate R_t^* and domestic rate R_{Ht}^* on foreign currency deposits.[3]

Households are assumed to have the real value of foreign currency deposits in the utility function reflecting hedging (precautionary) demand to purchase foreign tradables.[4] For concreteness, we use the following functional forms:

$$u(C_H, C_F) = (1-\gamma)^{1/\theta} C_H^{\frac{\theta-1}{\theta}} + \gamma^{1/\theta} C_F^{\frac{\theta-1}{\theta}} \quad \text{and} \quad v(b;\psi) = -\frac{\kappa}{2} \cdot (b-\psi)^2. \tag{3}$$

where $\theta \geq 1$ is the elasticity of substitution between home and imported goods, $\gamma \in [0, 1)$ is the exposure to imported goods, and $\psi_t \geq 0$ captures the shock to the demand for foreign currency balances.[5]

Government, production, finance We combine the government, production and financial sectors into one entity that we characterize next. While being a useful abstraction more generally, this also represents the structure of the Russian economy well, where a major fraction of employment in both tradables and non-tradables is directly or indirectly in the public sector (natural resources, transportation, finance, healthcare and education) and the largest financial institutions are government banks.

The budget constraint of the government sector is:

$$\mathcal{E}_t \left(\frac{F_{t+1}^*}{R_t^*} - F_t^* \right) - \mathcal{E}_t \left(\frac{B_{t+1}^*}{R_{Ht}^*} - B_t^* \right) = \underbrace{\mathcal{E}_t Y_t^* + P_t Y_t}_{\equiv TR_t} - W_t, \tag{4}$$

where Y_t is the endowment of non-tradable home goods and Y_t^* are commodity export revenues in foreign currency, TR_t denotes the national income in home currency, and W_t is the wage commitment to the households fixed in nominal terms in home currency.[6] Thus, $TR_t - W_t$ is the primary surplus of the government budget. We assume that the government sets (and occasionally resets) W_t to target the expected permanent income of the country; as a result, this allows us to focus on the consolidated country budget constraint (7) below. Lastly, F_t^* are net foreign assets of the country in foreign currency, $(F_t^* - B_t^*)$ are foreign reserves held by the government sector, and R_t^* is the international interest rate

[3] Note that $R_{Ht}^* < 1$ is possible, even when the nominal interest rate is non-negative, as it reflects measures of *financial repression* such as forced conversion into home currency or inability to withdraw foreign currency deposits from the banking system. The same effect can be achieved with an explicit tax on foreign currency purchases.

[4] While we use the simplest setup with non-Ricardian features, the precautionary demand for safe assets arises in a large class of models with incomplete markets (Aiyagari 1994) and overlapping generations (Diamond 1965, Blanchard 1985, Caballero, Farhi, and Gourinchas 2008). See also the growing empirical literature on convenience yields (Jiang, Krishnamurthy, and Lustig 2018, Bianchi, Bigio, and Engel 2021).

[5] This utility specification implies that θ is also the intertemporal elasticity of substitution and $\sigma = 1/\theta$ is the relative risk aversion. This assumption eliminates spillovers between the dynamic paths of C_{Ft} and C_{Ht}, which in general complicate the analysis, but do not change the main qualitative insights. The case with $\theta = 1$ further corresponds to the Cole and Obstfeld (1991) case with $\sigma = \theta = 1$.

[6] While we abstract from price rigidities given the large size of the shock and high inflation in the economy, the nominal wage commitment is in some ways similar to the downward wage rigidity as it can be relaxed with price inflation. Our framework can be generalized to include other government expenditure G_t in (4) that does not contribute to the household consumer surplus (e.g., on the war); to the extent G_t is taken as exogenous, this has no additional implications for the exchange rate, which is the focus of our analysis.

in foreign currency.[7]

Market clearing condition in the non-tradable sector is:

$$C_{Ht} = Y_t. \tag{5}$$

The market clearing for home currency bonds is $B_t = 0$. The home currency nominal interest rate R_t allows the government to control non-tradable inflation $\pi_{t+1} = \log(P_{t+1}/P_t)$ by choosing the slope of the household Euler equation, $\beta R_t \mathbb{E}_t\left\{\left(C_{Ht}/C_{H,t+1}\right)^{1/\theta} P_t/P_{t+1}\right\} = 1$, which acts as a side equation and does not play a central role in our analysis.

Key equilibrium conditions The demand for imports derives from consumer expenditure optimization:

$$\frac{C_{Ft}}{C_{Ht}} = \frac{\gamma}{1-\gamma}\left(\frac{\mathcal{E}_t P_t^*}{P_t}\right)^{-\theta}. \tag{6}$$

This is the first key equation determining the equilibrium value of the exchange rate from the point of view of relative consumption of imports in the goods market.[8]

The other two key equilibrium conditions for the exchange rate determination are the country budget constraint and the household demand for foreign currency. First, combine the household and government budget constraint (2) and (4) expressed in foreign currency, together with non-tradable market clearing condition (5):[9]

$$\frac{F_{t+1}^*}{R_t^*} - F_t^* = NX_t^* = Y_t^* - P_t^* C_{Ft}, \tag{7}$$

where NX_t^* are foreign currency net exports of the country. Note that NX_t^* is the inflow of new foreign currency (outflow if negative), while F_t^* is the stocks of foreign currency held jointly by the households (B_t^*) and the government ($F_t^* - B_t^*$). Finally, the household demand for foreign currency B_{t+1}^* must satisfy the following Euler equation of the household optimization:

$$\beta R_{Ht}^* \mathbb{E}_t\left\{\frac{P_t^*}{P_{t+1}^*}\left[\left(\frac{C_{Ft}}{C_{F,t+1}}\right)^{1/\theta} + \tilde{\kappa} C_{Ft}^{1/\theta}\left(\psi_t - \frac{B_{t+1}^*}{P_{t+1}^*}\right)\right]\right\} = 1, \tag{8}$$

where $\tilde{\kappa} \equiv \frac{\theta}{\theta-1}\frac{\kappa}{\beta\gamma^{1/\theta}} \geq 0$ is a composite parameter. Here R_{Ht}^* is the household's expected return on holding foreign currency and we interpret $\psi_t > 0$ as the precautionary motive which compels

[7] For simplicity, we assume no government debt in local currency: although the government can frictionlessly borrow from the banks, the total debt of the consolidated government banking sector is limited by the low demand of households for local currency deposits, reflecting inflationary expectations and the risk of a bank run. More generally, the government can respond to changes in its revenues by partially defaulting on its wage commitment W_t or inflating it away with monetary expansion P_t, by exercising financial repression over the households' foreign currency savings with $R_{Ht}^* < R_t^*$, or by additionally forcing the households to hold local currency government debt B_t.

[8] More generally, the combination of import demand and goods market clearing determines the expenditure switching mechanism at the core of the relationship between the real exchange rate and consumption, as discussed in Itskhoki (2021).

[9] Note that the gap between world and home rates R_t^* and R_{Ht}^*, if it exists, does not affect the aggregate country budget constraint, as it only results in a transfer between households and the government sector (as captured by (4)).

households to hold foreign currency despite possibly low expected returns.[10]

Sanctions We consider a variety of individual sanctions and their combinations:

1. Export sanctions limit Y_t^*, and from the point of view of the domestic economy it is not essential whether this is done by means of a tax (reduction in export price) or quantity restrictions.
2. Import sanctions may ration C_{Ft} without changing P_t^* (e.g., a restriction on imports of certain varieties) or may increase P_t^* (e.g., a tax on imports).[11]
3. The exit of foreign multinationals from the home economy and the withdrawal of foreign intermediate inputs are captured with an exogenous reduction in non-tradable endowment Y_t.
4. Foreign asset freezes are sanctions that reduce F_t^*, whether in private or in public hands.[12]
5. Financial sanctions exclude the country from the financial market so that foreign currency is no longer in perfectly elastic supply at the world interest rate R_t^*. In particular, we define financial autarky when the country cannot borrow internationally or hold any assets abroad, and can only accumulate foreign currency from trade surpluses. The country's budget constraint (7) becomes:

$$F_{t+1}^* - F_t^* = NX_t^* \qquad \text{with} \qquad F_{t+1}^* \geq 0,$$

   and domestic foreign currency market must satisfy $B_{t+1}^* \leq F_{t+1}^*$. Thus, foreign cash accumulated from trade surpluses is the only source of foreign currency to be held as a safe asset at home.
6. Financial sanctions are also associated with an increase in the household precautionary demand for foreign currency ψ_t due to a collapsing supply of alternative vehicles of savings, and in particular safe assets. Indeed, the local stock market collapses, the home currency deposits are subject to inflationary and bank-run risks, and the access to foreign assets is limited.

Equilibrium Taking as given endowments (Y_t, Y_t^*), import price P_t^*, and the world interest rate R_t^*, the equilibrium vector $(C_{Ft}, \mathcal{E}_t, B_{t+1}^*)$ satisfies import demand (6), the country budget constraint (7), and the household demand for foreign currency (8), given non-tradable goods market clearing (5), initial net foreign assets F_0^*, and the government policies — reserve accumulation $(F_{t+1}^* - B_{t+1}^*)$, the path of nominal non-tradable prices P_t implemented by monetary policy R_t to satisfy the nominal wage commitment in (4), and the level of financial suppression $R_{Ht}^* \leq R_t^*$ for foreign currency deposits. Note from the equilibrium system that $\mathcal{E}_t/P_t$, which is proportional to the real exchange rate, is determined independently of monetary policy (inflation), and changes in non-tradable inflation shift the path of the nominal exchange rate $\mathcal{E}_t$ one-for-one with P_t. Also note that in the presence of $\kappa > 0$, Ricardian

[10] The presence of $\kappa > 0$ uniquely determines the steady state net foreign asset position B_t^*. Also recall that under our utility specification (3), $\sigma = 1/\theta$ is the relative risk aversion, thus appearing in the stochastic discount factor in (8).

[11] In fact, the two cases are equivalent when we model C_{Ft} as a unit continuum of imperfectly competitive import varieties, some of which are taxed or made unavailable altogether, in both cases raising the ideal import price index (see Appendix A).

[12] An additional impact of sanctions could be due to balance sheet effects on the private financial sector, provided it holds foreign currency debt (via valuation effects; see e.g. ?). We omit this mechanism from the analysis, as Russian companies had little gross foreign debt by 2022, in response to existing financial sanctions that were imposed in 2014.

equivalence does not apply as households cannot costlessly adjust B^*_{t+1} to offset the government asset position, and hence government reserves $(F^*_{t+1} - B^*_{t+1})$ affect the equilibrium allocation.

3 Sanctions and the Exchange Rate

3.1 Stationary equilibrium

We first briefly study the properties of a stationary equilibrium to develop simple intuition for the effects of sanctions, which are robust in a dynamic environment. We consider a stationary equilibrium with access to foreign financial markets, $R^*_{Ht} = R^*_t$, assuming $\beta R^*_t = 1$, no precautionary foreign currency demand $\psi_t = 0$, with an initial net foreign asset position F^* and given exogenous endowments and import prices (Y, Y^*, P^*). We focus, for simplicity, on the Cobb-Douglas case with $\theta = 1$.

Under these circumstances, a stationary equilibrium with $B^* = 0$ satisfies the Euler equation (8), which ensures financial market equilibrium with a stationary exchange rate $\mathcal{E}$ given $\beta R^* = 1$. The remaining equilibrium conditions that determine $(C_F, \mathcal{E})$ are the import demand (6) and the country budget constraint (7). We reproduce these two equilibrium conditions as follows:

$$C_F = \frac{\gamma}{1-\gamma}\frac{PY}{\mathcal{E}\hat{P}^*}, \tag{9}$$

$$P^* C_F = Y^* + (1-\beta)F^*, \tag{10}$$

where $\hat{P}^* \geq P^*$ in the first equation is the domestic shadow price of imports, which is above the actual import price P^* in case import restrictions (rationing) are imposed, as we discuss below. The second equation is the steady state version of the country budget constraint. Note how these two equations capture the dual role of the exchange rate in switching expenditure between home non-tradables and imported tradables (condition (9)) and in balancing the net present value of proceeds from exports and imports (condition (10)).

Mechanically, condition (9) determines the equilibrium quantity of imports C_F, as international prices of imports and revenues from exports are taken as exogenous. Combining (9) and (10), we solve for the equilibrium exchange rate:

$$\mathcal{E} = \frac{\gamma}{1-\gamma}\frac{PY}{Y^* + (1-\beta)F^*} \cdot \frac{P^*}{\hat{P}^*}, \tag{11}$$

where the last term on the right hand side, $P^*/\hat{P}^*$, is one without import rationing and is less than one under import rationing (sanctions). The equilibrium nominal exchange rate in (11) scales up with the domestic price level P, i.e. with cumulative (one-time) equilibrium inflation, which is chosen to ensure the government's fiscal balance (4), given in steady state by:

$$W \leq (1-\beta)(F^* - B^*) + \mathcal{E}Y^* + PY. \tag{12}$$

There always exists high enough P such that (12) holds, that is the government satisfies its nominal

wage commitment.[13]

Immediately from (10)–(12), we can obtain the following long-run comparative statics results, which contrast the pre-sanctions and post-sanctions stationary equilibria.

Proposition 1 *Consider the foreign reserves freeze $F^* \downarrow$ or sanctions on exports $Y^* \downarrow$. This depreciates the exchange rate, $\mathcal{E} \uparrow$, and results in a reduction in imports, $C_F \downarrow$.*

Restrictions on net foreign assets and on exports are equivalent in their effect on the economy under sanctions. This result is intuitive as the exchange rate depreciation comes from the reduction in the international purchasing ability of the country, whether due to reduction in net foreign assets or in the value of exports, which is also the source of supply of foreign currency. A reduction on the income side of the country's budget constraint requires a reduction in imports to restore the balance. Of course, there is a material difference between sanctions on Y^* and F^* from the point of view of foreign countries. If it is achieved via quantity limits on Y^*, the allocation in foreign is strictly worse.[14] Finally, rising world commodity prices, in part as a result of the war, raise Y^* and act to appreciate the exchange rate.

Proposition 2 *Sanctions that limit domestic non-tradable output $Y \downarrow$ (e.g., exit of foreign multinationals) appreciate the exchange rate $\mathcal{E} \downarrow$. This makes the fiscal constraint (12) tighter, increasing the likelihood of inflation and monetary devaluation ($P, \mathcal{E} \uparrow$). In turn, such sanctions have no effect on quantity of imports C_F and foreign currency value of net exports $NX^* = Y^* - P^* C_F$.*

This result is, perhaps, less immediately intuitive. The reason for the initial appreciation is the increased scarcity of the domestic goods Y relative to imported goods C_F, and the exchange rate must appreciate to keep the goods market (9) in equilibrium. This is our first illustration that the direction of the movement in the exchange rate is not a sufficient statistic for the effectiveness of sanctions: if sanctions curb domestic production more than imports, they appreciate the exchange rate.[15]

A second point to emphasize is that there are two distinct types of forces that shape the nominal exchange rate: (a) real international forces such as the flows of goods and the stocks of assets, which

[13] Note that the nominal wage commitment can be relaxed via either price inflation or partial default. Using (11), we can solve out endogenous $\mathcal{E}$ and rewrite (12) as:

$$P \geq \left[1 + \frac{\gamma}{1-\gamma} \frac{P^*}{\hat{P}^*} \frac{1}{1 + (1-\beta) F^*/Y^*}\right]^{-1} \cdot \frac{W - (1-\beta)(F^* - B^*)}{Y}.$$

Intuitively, lower W, higher Y and $F^* - B^*$ make it easier to satisfy this constraint. Lower NFA F^* (with constant $F^* - B^*$) also makes it easier to pay for W by depreciating $\mathcal{E}$ and thus reducing the value of W in foreign currency terms; in contrast, import rationing ($\hat{P}^*/P^* \uparrow$) tightens the fiscal constraint. Finally, lower Y^* has a dual effect (directly and via depreciation), and tightens the fiscal constraint when $F^* > 0$.

[14] For the analysis of the effects of a Russian energy export ban on the European economy see e.g. Bachmann, Baqaee, Bayer, Kuhn, Löschel, Moll, Peichl, Pittel, and Schularick (2022). Sanctions on net foreign assets are cheapest to impose economically, and indeed were implemented up front. Sanctions that impose a tax on energy exports from Russia could in principle substitute for quantity constraints, but their effectiveness crucially depends on the incidence of the tax which is shaped by the balance of energy demand and supply elasticities.

[15] Note that sanctions that limit imports of intermediate inputs that are used in the domestic production of non-tradables are also captured in our model with a decline in Y_t.

affect the real exchange rate $\mathcal{E}/P$; and (b) monetary domestic forces that result in inflation and monetary depreciation, i.e. a proportional increase in both P and $\mathcal{E}$. The same set of sanctions, e.g. those leading to a reduction in Y, may initially appreciate nominal and real exchange rates via their direct effects, but then depreciate the nominal exchange rate by more via their indirect effect on the fiscal balance and, thus, monetary stance.

Proposition 3 *Sanction on imports in the form of rationing of C_F appreciate the exchange rate, $\mathcal{E}\downarrow$.*

We focus here on quantity restrictions on imports under Cobb-Douglas preferences, $\theta = 1$, and show below that the logic is robust whether sanctions are on quantities or in the form of taxes, provided that imports are imperfect substitutes for domestic goods, $\theta > 1$. In Appendix A, we show that if the share of rationed imports is $\delta \in (0, \gamma)$, then $\hat{P}^*/P^* = \frac{\gamma}{\gamma-\delta} > 1$ and is increasing with δ. Rationing effectively shifts the import demand schedule (9) in for any given border price P^*, as desired import varieties are unavailable.[16] Given this, we still combine (9) and (10) to obtain the value of the equilibrium exchange rate in (11), which shows that $\mathcal{E}$ appreciates with $\hat{P}^*/P^*$, and thus with the extent of import sanctions.

What is the intuition for the exchange rate appreciation? Again, it is the equilibrium condition in the currency market. Rationing of imports reduces the total expenditure on imports and hence currency demand of the country. In the absence of reduction in exports and net foreign assets, the supply of currency is unchanged, and thus the currency market is not in equilibrium. The exchange rate must appreciate to bring the currency market in equilibrium when imports are rationed. From the perspective of the goods market, this appreciation results in expenditure reallocation towards varieties of imported goods that are not rationed, but are not demanded unless home currency appreciation brings down their relative prices; this in turn reestablishes intertemporal trade balance, i.e. the country budget constraint.[17] The nature of welfare losses in this case is the forced substitution from desired but sanctioned import varieties towards undesired import varieties that are not rationed, reflected in $\hat{P}^* > P^*$.

While from the perspective of allocations, sanctions on imports have similar implications to sanctions on exports and net foreign assets (as we make precise in Proposition 4 below), they have opposite predictions from the point of view of the nominal exchange rate. Sanctions on import quantities leave the country with a trade surplus on impact, making foreign currency abundant, and thus resulting in an appreciation. Sanctions on exports and NFA have the opposite effect on exchange rate, but ultimately also limit the ability of a country to import foreign goods, which in our discussion so far was the sole use of export revenues and net foreign assets.

3.2 Dynamic analysis

Propositions 1–3 are robust predictions for the impact of sanctions on allocations and the equilibrium exchange rate, whether they are studied in a stationary equilibrium or along a dynamic path with

[16] To capture rationing, we introduce a continuum of Cobb-Douglas import varieties $[0, \gamma]$, and let the first $[0, \delta]$ be sanctioned. While the ideal Cobb-Douglas price index goes to infinite in this case, the equilibrium still exists, and we describe it using an auxiliary variable P^* which represents the shadow price raised to power $\theta - 1$ in the limit as $\theta \to 1$ (see Appendix A). We further discuss the welfare (real cost of living) effects of sanctions in Corollary 1 below.

[17] A similar mechanism for exchange rate appreciation is discussed in Lorenzoni and Werning (2022).

aggregate shocks, as we study next. Our dynamic model allows for the additional analysis of financial autarky with precautionary demand for foreign currency by households and financial repression by the government, thus emphasizing the distinct role foreign currency plays in the goods market (i.e., for purchasing imports) and in the financial market (for savings). We consider two cases in turn.

3.2.1 Trade sanctions

When trade sanctions are imposed without excluding the country from the world financial market, the country still faces a perfectly elastic supply of foreign currency at the world interest rate with $R^*_{Ht} = R^*_t$. The equilibrium system is given by (6)–(8), as described above, which allows us to solve for the equilibrium path of $(C_{Ft}, \mathcal{E}_t, B^*_{t+1})$ given an exogenous path of $(Y_t, Y^*_t, P^*_t, R^*_t)$ and policy choice $(P_t, F^*_{t+1} - B^*_{t+1})$ and initial net foreign assets F^*_t. Using this equilibrium system, we can prove the main general equivalence result (in the spirit of Farhi, Gopinath, and Itskhoki 2014):

Proposition 4 *Permanent sanctions on imports, $P^*_t \uparrow$ for all $t \geq 0$, are equivalent to a combination of permanent sanctions on exports, $Y^*_t \downarrow$ for all $t \geq 0$, and a partial freeze of initial net foreign assets $F^*_0 \downarrow$. Both sets of sanctions result in the same path of reduced import quantities, $C_{Ft} \downarrow$. However, sanctions on imports are associated with an exchange rate appreciation, $\mathcal{E}_t \downarrow$, while sanctions on exports and net foreign assets are associated with an exchange rate depreciation, $\mathcal{E}_t \uparrow$.*

Proposition 4 generalizes results in Propositions 1 and 3 to a fully dynamic environment with arbitrary path of shocks to domestic production Y_t, precautionary demand for foreign assets ψ_t and other exogenous shocks. Note that the exact equivalence applies when a sanctions shock is one-time unexpected and permanent.[18] To prove Proposition 4, note that the budget constraint can be rewritten in physical units of imports C_{Ft} by dividing through by the price of imports P^*_t:

$$\frac{F^*_{t+1}/P^*_t}{R^*_t} - F^*_t/P^*_t = \frac{Y^*_t}{P^*_t} - C_{Ft}$$

Then a one-and-for-all increase in all P^*_t, by $x\%$, is equivalent to a permanent reduction in Y^*_t, also by $x\%$, combined with a proportional reduction in initial net foreign assets F^*_0. Then, the evolution of net foreign assets F^*_{t+1} is satisfied for the same allocation of imports C_{Ft} under both sanctions regimes. The Euler equation (8) is satisfied with the same reduced path of C_{Ft} and the same real value of foreign currency holding by households B^*_{t+1}/P^*_t.[19]

Lastly, to establish the consequences for the exchange rate, we study the import demand sched-

[18] There exists a more general equivalence for dynamic, partially anticipated sanction shocks, but it requires an additional use of capital controls to neutralize the tilt in the foreign currency demand in (8) induced by anticipated changes in import prices P^*_t (see Farhi, Gopinath, and Itskhoki 2014).

[19] Note that the equivalence does not require differential policy of government reserve accumulation, as long as real reserves $(F^*_{t+1} - B^*_{t+1})/P^*_t$ follow the same path under both sanction regimes. Under import sanctions, the real value of reserves falls because of an increase in P^*_t, while under export sanctions and NFA freeze, the value of reserves falls directly due to sanctions. If the government chooses different paths of real government reserves under the two sanction regimes, this will differentially affect allocations if the economy is non-Ricardian ($\kappa > 0$ in (8)), but not if it is Ricardian ($\kappa = 0$).

ule (6), combined with home non-tradable market clearing (5), which we rewrite as follows:

$$\frac{\mathcal{E}_t}{P_t} = \frac{1}{P_t^* C_{Ft}^{1/\theta}} \left(\frac{\gamma}{1-\gamma} Y_t \right)^{1/\theta}. \tag{13}$$

Therefore, export and NFA sanctions that reduce C_{Ft} for a given P_t^* depreciate the exchange rate, $\mathcal{E}_t \uparrow$. This equation also reveals that disruption to domestic non-tradable output Y_t, appreciates the exchange rate instead, as suggested by Proposition 2 above.[20]

Finally, from the analysis of the budget constraint, we know that export and NFA sanctions reduce C_{Ft} by $x\%$, and import sanctions achieve the same effect via an increase in P_t^* by $x\%$. The intuition is that $P_t^* C_{Ft}$ enter the country budget constraint multiplicatively, and thus a tighter budget constraint from an increase in P_t^* requires a reduction in C_{Ft} by the same proportion (i.e. unitary elastic effect of the budget constraint). The elasticity of substitution is, however, $\theta > 1$, and thus import sanctions must be associated with a less than proportional increase in the relative price of imports, $\mathcal{E}_t P_t^*/P_t$, in comparison with the fall in the relative import consumption, C_{Ft}/Y_t. Consequently, the nominal exchange rate must appreciate under import sanctions when $\theta > 1$, and the extent of appreciation is given by:[21]

$$\mathrm{d}\log \mathcal{E}_t = -\frac{\theta - 1}{\theta} \mathrm{d}\log P_t^* < 0.$$

Lastly, equation (13) also implies that the effective relative price of imports, $\mathcal{E}_t P_t^*/P_t$, must increase independently of the type of sanctions, yet in the data an accurate proxy for P_t^* might be hard to obtain when sanctions limit import quantities.

This clarifies the effects of import sanctions via taxation, relative to the case of import rationing discussed in Proposition 3. The overall logic remains the same. Export and NFA sanctions reduce currency supply via the goods market, while import sanctions reduce currency demand in the goods market, explaining their opposite effects on the exchange rate, even when the resulting allocation is the same. From the perspective of goods flows and current account, both types of sanctions tighten the country budget constraint requiring a reduction in imports, and the differential movement in the exchange rate is needed to ensure the new equilibrium import allocation is consistent with import demand.[22]

The allocational equivalence of import and export sanctions in Proposition 4 extends further to the government fiscal balance and consumer price inflation:

Corollary 1 *Import and export-cum-NFA sanctions have identical effects on fiscal revenues of the government sector in local currency, $\mathcal{E}_t Y_t^* + P_t Y_t$, as well as on consumer price inflation (real cost of living).*

[20] Note that Y_t does not affect the exchange rate via any other equilibrium conditions — neither the country budget constraint, which depends on NX_t^*, nor the Euler equation, given our choice of the utility in (3).

[21] The extent of depreciation under export sanctions is given by $\mathrm{d}\log \mathcal{E}_t = -\frac{1}{\theta}\mathrm{d}\log(Y_t^*) > 0$. These expressions allow us to evaluate the quantitative effects of export and import sanctions on exchange rates. With typical calibration of $\theta = 1.5$, they suggests that movements in the exchange rate should be of the same order of magnitude as percentage restrictions on import expenditure and export revenues. Forces that lead to incomplete pass-through can amplify equilibrium movements of the exchange rate. Sanctions on the entire *stock* of foreign reserves, increases in foreign currency savings demand and measures of financial repression discussed below can move the exchange rate more potently, and likely account for the largest swings in the data. For further discussion of these quantitative mechanisms, see Itskhoki and Mukhin (2021).

[22] Recall Lerner (1936) symmetry where a uniform import tariff is equivalent to a uniform export tax, yet they require that relative nominal wages move in opposite directions to sustain the same equilibrium allocation.

Indeed, we can directly evaluate fiscal revenues TR_t in (4) and price index CPI_t using the equilibrium expression for exchange rate (13):

$$TR_t = \mathcal{E}_t Y_t^* + P_t Y_t = P_t Y_t \left[1 + \frac{Y_t^*}{P_t^* Y_t} \left(\frac{\gamma}{1-\gamma} \frac{Y_t}{C_{Ft}}\right)^{1/\theta}\right],$$

$$CPI_t = \left[(1-\gamma) P_t^{1-\theta} + \gamma (P_t^* \mathcal{E}_t)^{1-\theta}\right]^{\frac{1}{1-\theta}} = (1-\gamma)^{\frac{1}{1-\theta}} P_t \left[1 + \left(\frac{\gamma}{1-\gamma}\right)^{\frac{1}{\theta}} \left(\frac{Y_t}{C_{Ft}}\right)^{\frac{1-\theta}{\theta}}\right]^{\frac{1}{1-\theta}}.$$

From Proposition 4, it follows that C_{Ft} follows the same path under both sets of sanctions, and the premise of the proposition is that import sanctions involve an $x\%$ increase in P_t^*, while export sanctions involve an $x\%$ reduction in Y_t^*, so that Y_t^*/P_t^* declines by $x\%$ under both sanction regimes. Moreover, results in Corollary 1 apply even if the government responds to falling revenues or rising costs of living by changing the path of monetary inflation P_t and/or distortionary taxation that affects output Y_t. Indeed, since the direct effect of the two types of sanctions on TR_t and CPI_t is the same, the endogenous response of the government should also be the same in the two cases.[23]

Taking as given the paths of P_t and Y_t, we can evaluate both effects quantitatively (see Appendix B):

$$\mathrm{d}\log TR_t = -\chi \cdot \frac{\theta - 1}{\theta} \cdot x\% < 0 \qquad \text{and} \qquad \mathrm{d}\log CPI_t = \mu \cdot \frac{1}{\theta} \cdot x\% > 0. \tag{14}$$

As can be expected, the effect of export sanctions on fiscal revenues is proportionate to the share of taxes on exports in the government budget, denoted with χ, while the effect of import sanctions on costs of living is proportional to the share of imports in GDP, denoted with μ. Remarkably, however, the equivalence implies that neither the extent of direct taxation of export revenues, nor the extent of consumption exposure to imports result in a differential impact of *export* versus *import* sanctions on fiscal revenues and real costs of living. Indeed, lowering a country's exports Y_t^* by $x\%$ has exactly the same effect on both government revenues and consumer prices as an $x\%$ increase in the cost of imports P_t^*.[24]

Temporary sanctions The equivalence result from Proposition 4 relies on the permanent nature of sanctions. What happens when agents anticipate that the restrictions will be lifted in the future? In the case of temporary import sanctions, there is both an income and a substitution effect. On the one hand, the fall in real income is larger in the short-run generating incentives to borrow. On the other hand, the higher current import prices encourage households to postpone consumption of foreign goods and increase savings. While imports necessarily fall on net, the two forces have opposite effects on saving and the exchange rate. The net effect depends on the relative size of the inter- and intra-temporal elasticities of substitution, and it is the same as under permanent sanctions when the two elasticities are equal, as in (3). In contrast, temporary sanctions on exports lower short-term revenues more than

[23] This is reminiscent of a related revenue equivalence result in Barbiero, Farhi, Gopinath, and Itskhoki (2019).

[24] The increase in CPI_t is the real increase in costs of living (or equivalently, the reduction in welfare) from the decline in the quantity of imports, whether or not it is captured by measured price indexes which often omit price level effects from disappearing varieties.

permanent income, and unambiguously increase borrowing and depreciate the exchange rate. Front-loading of export sanctions can result in a larger drop in imports and exchange rate depreciation if the country is unable to borrow internationally and cannot smooth out the negative shock over time.

3.2.2 Financial sanctions and financial repression

We now consider a demand shock for precautionary savings, namely an increase in ψ_t in (1), driven by the collapse of other safe assets and increasing inflationary expectations. The equilibrium dynamic system is still given by (6)–(8), and we allow the planner to use foreign reserves $F_t^* - B_t^*$ and financial repression $R_{Ht}^* < R_t^*$ that includes limits and taxes on buying and withdrawing foreign currency.

Proposition 5 *Consider an increase in foreign currency precautionary savings demand, $\psi_t \uparrow$.*

1. *If the government is passive, i.e. $F_{t+1}^* = B_{t+1}^*$ and $R_{Ht}^* = R_t^*$, then imports fall, $C_{Ft} \downarrow$, and the exchange rate depreciates, $\mathcal{E}_t \uparrow$, on impact, followed by a gradual mean reversion and overshooting in the long run at a higher level of foreign currency savings, as $F_{t+h}^* = B_{t+h}^* \uparrow$ with time h.*
2. *If the government accommodates foreign currency precautionary savings by selling reserves $F_{t+1}^* - B_{t+1}^*$ in response to an increase in demand for B_{t+1}^* to maintain the same path of net foreign assets F_{t+1}^*, then the path of imports and the exchange rate $(C_{Ft}, \mathcal{E}_t)$ also remains unchanged.*
3. *Without government FX interventions, there exists a tax on foreign currency purchases by the households, $R_{Ht}^* < R_t^*$, which leaves the path of $(B_{t+1}^*, F_{t+1}^*, C_{Ft}, \mathcal{E}_t)$ unchanged. This involves a household welfare loss from the unaccommodated precautionary savings shock ψ_t.*

The proof of these results follows from the examination of the equilibrium system (6)–(8), as we describe in Appendix C. The focus on a one-time permanent shock is for convenience only, and the results generalize to arbitrary dynamic shock processes (see Itskhoki and Mukhin 2021). The effects in Proposition 5 arise from the interplay of the Euler equation (8), which determines the expected changes in imports and the exchange rate, and the country budget constraint (7), which determines the effect of the shock on impact. An increase in ψ_t leads to $\psi_t - \frac{B_{t+1}^*}{P_{t+1}^*} > 0$ on impact, resulting in excess foreign currency demand by the households in (8). There are three ways in which this excess demand can be accommodated.

First, households can cut down on their import consumption C_{Ft}, so that the country accumulates foreign currency from trade surpluses in the form of net foreign assets F_{t+1}^* allocated towards households' foreign currency savings B_{t+1}^*. Over time, B_{t+1}^*/P_{t+1}^* increases towards the value of ψ_t, so that foreign currency demand can be again satisfied with a constant C_{Ft}. Along this path, imports C_{Ft} gradually increase and overshoot the original level in order to satisfy the intertemporal budget constraint (7) — early trade surpluses are compensated by long-run trade deficits. Finally, the exchange rate $\mathcal{E}_t$ depreciates on impact with a fall in C_{Ft}, and then gradually appreciates and overshoots in the long-run, following the path of C_{Ft}, as can be inferred from the import demand condition (6). Figure 2 provides an illustration: the stronger is the precautionary saving motive κ, the faster is the accumulation of foreign currency, which in turn requires a larger initial drop in imports and depreciation of the

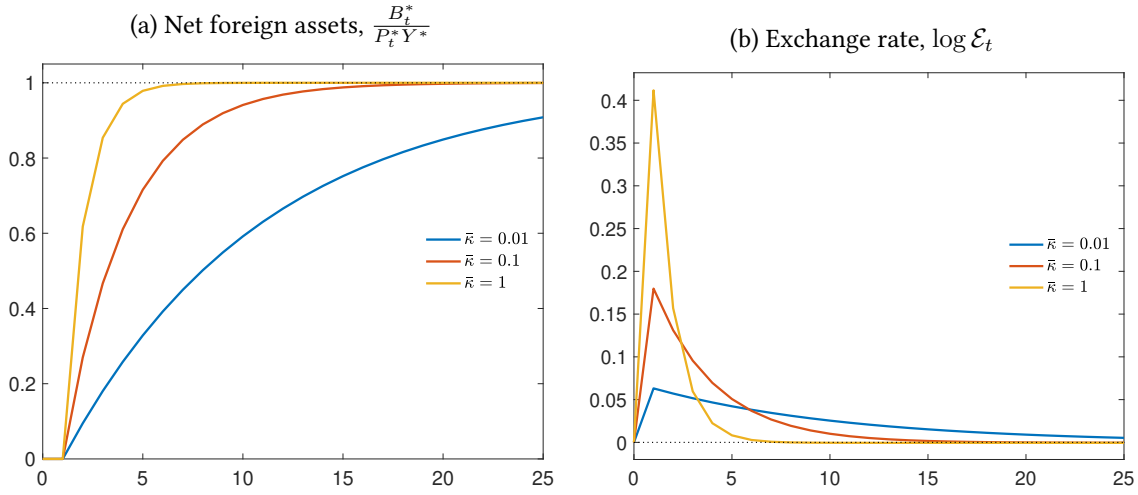


Figure 2: Laissez-faire response to foreign currency demand shock ψ_t

Note: Impulse responses are simulated with $\beta = 0.96^{1/12}$ (one period corresponds to one month), $\beta R_t^* = 1$, $\theta = 1.5$, and three values of asset demand elasticity $\bar{\kappa} \equiv \frac{\theta\kappa}{\gamma} \bar{C}_F^{1+\frac{1}{\theta}}$. The permanent increase in ψ_t equals to the country's monthly imports.

exchange rate.[25]

Second, increased household demand for foreign currency ψ_t can be accommodated with the foreign exchange interventions smoothing fluctuations in exchange rate $\mathcal{E}_t$ and imports C_{Ft}. Specifically, the government can supply foreign currency to the market to offset the increased demand by households to ensure that the path of the country's net foreign assets F_{t+1}^* remains unchanged. That is, an increase in B_{t+1}^*, such that $B_{t+1}^*/P_{t+1}^* = \psi_t$ at all times, is accommodated by a reduction in official reserves $F_{t+1}^* - B_{t+1}^*$. This ensures that both (8) and (7) are satisfied at the original values of C_{Ft} and $\mathcal{E}_t$. From normative perspective, such policy is optimal, at least when the origin of ψ_t is a "liquidity shock" for foreign currency and is not triggered by productivity and other fundamental macroeconomic shocks that need to be accommodated by trade imbalances (see Itskhoki and Mukhin 2022).

Finally, in the absence of spare official reserves or sufficient export revenues to accommodate the increase in ψ_t and B_{t+1}^*, the government can resort to financial repressions to curb the exchange rate depreciation and the associated reduction in imports. Indeed, direct or indirect taxes on purchasing, holding or withdrawing foreign currency, captured in (8) with $R_{Ht}^* < R_t^*$, can discourage B_{t+1}^* accumulation even when ψ_t is high. In other words, such financial repressions ensure that foreign currency is used to buy imports C_{Ft}, and not to hold foreign cash B_{t+1}^*. A path of R_{Ht}^* that declines with an increase in ψ_t can ensure that (8) holds at the original (C_{Ft}, B_{t+1}^*) allocation, and thus leads to no depreciation. In contrast to alternatives, financial repression does not increase government spending and, if anything, relaxes the government budget constraint (4). While smoothing the path of imports and exchange rate, such policy intervention results in household welfare losses from distorted foreign currency savings, as captured by $v(B_{t+1}^*/P_{t+1}^*; \psi_t)$ in the utility (1).[26]

[25] In practice, accumulation of foreign currency assets is largely achieved with rebalancing of households' portfolios away from local currency deposits and other assets; while this margin is not present in our model, it likely generates an even faster transition with a larger depreciation of the exchange rate.

[26] The result that imports are undistorted relies on the assumption that the tax is paid only by agents that purchase foreign currency as a store of value, while importers are exempt from it and can freely exchange currencies to pay for foreign goods.

Financial autarky The case of financial repression in Proposition 5 nests financial autarky as a special case with $R_t^* = 1$ and an additional restriction $F_{t+1}^* \geq 0$, where $\Delta F_{t+1}^* = NX_t^*$ is implied by the country budget constraint (7). An effective interest rate on foreign currency savings R_{Ht}^* in the domestic market must be such that $B_{t+1}^* \leq F_{t+1}^*$, and it is in general different from R_t^*. In other words, the equilibrium under financial autarky requires that foreign currency accumulated from exports is sufficient to cover the expenditure on imports and the domestic demand for foreign currency by households, which become competing uses of foreign currency export revenues. In other words, this emphasizes the dual role of foreign currency in the home economy — it is needed to buy imports, but also as a safe asset that households want to save in. Demand for foreign currency from these two objectives is a force for exchange rate depreciation, when the supply of currency is limited by exports. Thus, sanctions that limit the ability to buy imports and financial repression that makes holding of foreign currency costly are forces that curb exchange rate depreciation. Via financial repression and reserve management (e.g., by taxing foreign currency export revenue of the firms), the government can manage the paths of imports C_{Ft} (and thus of $\Delta F_{t+1}^* = NX_t^* = Y_t^* - P_t^* C_{Ft}$), of household foreign currency savings B_{t+1}^*, and of the exchange rate $\mathcal{E}_t$, in accordance with the equilibrium conditions discussed above.

* * * **Online Appendix** * * *

(next three paragraphs can be moved if space constraint is binding)

Synthetic foreign currency assets If the inflow and reserve of foreign currency is scarce, can the government create artificial safe assets with economic properties that are identical to foreign currency? To answer this question, we rewrite the government budget constraint (4) in foreign currency terms as:

$$\frac{F_{t+1}^*}{R_t^*} - F_t^* = Y_t^* + \frac{Y_t - W_t/P_t}{\mathcal{E}_t/P_t} + \left(\frac{B_{t+1}^*}{R_{Ht}^*} - B_t^*\right).$$

It follows that the increased demand for B_{t+1}^* can be satisfied in two ways. One solution is to draw on government reserves $F_{t+1}^* - B_{t+1}^*$ or to borrow from the rest of the world $F_{t+1}^* < 0$, which may not be feasible because of asset freezes and limited access to international debt markets. Alternatively, the government can create artificial foreign currency deposits $B_{t+1}^* = \tilde{B}_{t+1}^*$ not backed by foreign assets (e.g., when $F_{t+1}^* \equiv 0$), but rather financed with revenues of the consolidated sector. However, once the accumulated liabilities become large, the government faces a trade-off between its commitment to workers W_t and to savers B_t^* with the monetary inflation ($P_t \uparrow$) used to redistribute resources from the former to the latter. Such policy is further complicated by the fact that higher inflation amplifies demand for foreign currency deposits and that larger liabilities can undermine the credibility of the government leading to a bank run with a large deposit withdrawal ($\tilde{B}_{t+1}^* \ll \tilde{B}_t^*$), a mechanism reminiscent of Krugman (1979)'s balance-of-payments crisis.

Multiple foreign currencies With multiple foreign currencies and differential financial repression across currencies, the domestic-market exchange rates of these currencies should feature a wedge relative to their global exchange rate, assuming cross-border arbitrage is not possible under financial

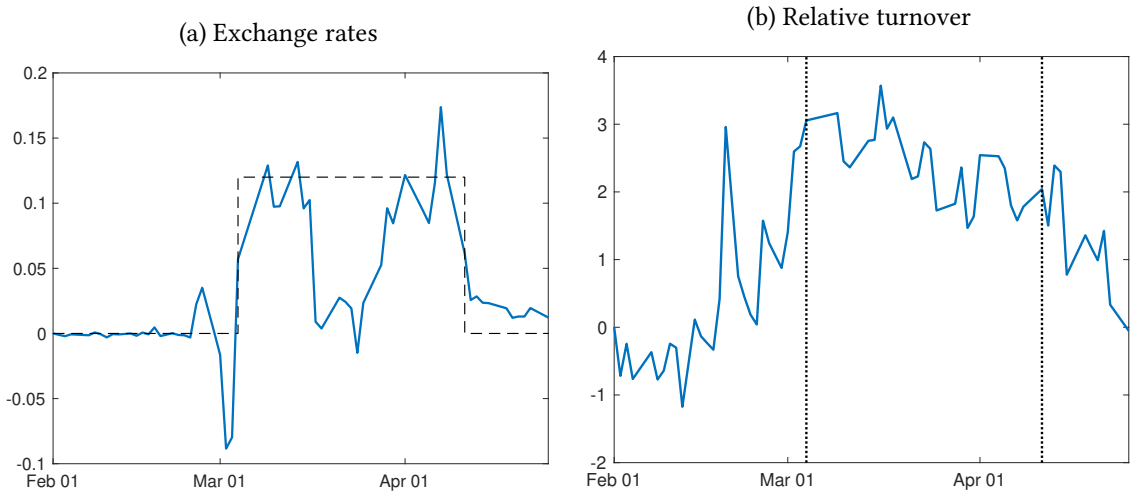


Figure 3: Swiss franc vs U.S. dollar: exchange rate and turnover

Note: panel (a) plots the tax on purchasing dollars as dashed line and the (log) dollar exchange rate against the Swiss franc at the Moscow Exchange relative to its international value. Panel (b) shows the (log) turnover of the Swiss franc relative to the dollar turnover at the Moscow Exchange. The values on February 1st are normalized to zero.

autarky.[27] To see this, examine the Euler equation for foreign currency bonds (8) which can be written for every currency that can be purchased in the domestic market. A repressed R^*_{Ht} for a given currency results in a more depreciated exchange rate relative to foreign currencies with less depressed expected returns, and which is expected to appreciate over time.

This offers a useful way to test the theory against the data from Russia, where the Central Bank introduced non-uniform taxes on transactions with different foreign currencies. Specifically, on March 4, a 12% tax was introduced on purchases of U.S. dollars, euros, and U.K. pounds, but not other currencies. This tax was later eliminated on April 11. For concreteness, we compare the behavior of the U.S. dollar exchange rate with that of Swiss frank, which was not subject to the tax, yet is presumably as safe and therefore offers a close substitute to the dollar. In the left panel of Figure 3, we plot the US dollar exchange rate against the Swiss frank at the Moscow Exchange relative to its international value, which was identically zero before the war, and comoved closely with the tax thereafter. Specifically, the Swiss frank appreciated sharply on the Moscow Exchange (and not internationally) after the 12% tax was imposed on the dollar on March 4, and then depreciated back after the tax was eliminated on April 11, resulting again in the convergence of the Moscow exchange rate to its international value. The right panel of Figure 3 additionally shows that the turnover of Swiss francs on the Moscow exchange increased dramatically relative to that of the dollar during the same period.

Heterogenous agents The use of financial repression is generally suboptimal in a representative agent economy. It becomes, however, an important policy instrument for redistribution in an economy with heterogeneous agents. Furthermore, in such economies, the exchange rate still plays an important allocative role even under financial autarky and financial repression. We illustrate these points now

[27] If cross-border trades were possible, this would result in an arbitrage opportunity by taking a short position in currency under repression and a long position in currency without repression, and taking the reverse position in the offshore market.

in an extension of our model that features two types of households — constrained hand-to-mouth and unconstrained Ricardian.

Consider hand-to-mouth agents who work in the domestic non-tradable sector and receive as wages a fixed share α of non-tradable revenues, $\alpha P_t Y_t$. These agents split their income to consume home and imported goods, maximizing $u(C_{Ht}, C_{Ft})$, but do not hold any savings, and in particular do not have foreign currency deposits. The rest of the income in the economy, $(1-\alpha)P_t Y_t + \mathcal{E}_t Y_t^*$, is received by the unconstrained Ricardian agents, who have access to savings, and in particular can hold foreign currency deposits. These agents are also subject to precautionary savings shock ψ_t, as described in (1).

Under Cobb-Douglas preferences ($\theta = 1$), the aggregate equilibrium quantities in the heterogeneous-agent economy are the same as in a representative-agent economy, and are independent from the income share of hand-to-mouth agents α, as we show in Appendix D.[28] For example, export sanctions that lower Y_t^* have no direct effect on income of constrained households, but lead to a depreciation of the exchange rate, which raises import prices and has an equivalent effect on their welfare. The same logic applies for foreign financial shocks to R_t^* and asset freezes on F_t^*.

However, more importantly, this extension shows not only the robustness of the previous results on aggregate effects of sanctions, but sheds new light on the distributional effects from financial repression that affects the equilibrium path of the exchange rate (as in Proposition 5):

Proposition 6 *Assume $\theta = 1$ and hand-to-mouth agents receive a constant fraction α of income in the non-tradable sector. Then the aggregate dynamics of the economy does not depend on α. Given no reserves ($B_t^* = F_t^*$), the use of financial repression $R_{Ht}^* < R_t^*$ to offset the foreign currency demand shock $\psi_t > 0$ reduces welfare in a representative-agent economy; in contrast, financial repression redistributes welfare from Ricardian to hand-to-mouth agents in a heterogenous-agent economy, and increases utilitarian welfare if hand-to-mouth agents are sufficiently widespread in the economy.*

The intuition behind this result is that financial repression, $R_{Ht}^* < R_t^*$, in a heterogeneous-agent economy limits foreign currency savings by the unconstrained agents and leaves a greater portion of foreign currency supply in the home economy to be allocated to the purchases of imports. More formally, recall from Proposition 5 that financial repression appreciates the exchange rate ($\mathcal{E}_t \downarrow$), which allows constrained agents with incomes fixed in home currency terms to be able to afford a greater quantity of imports, $C_{Ft}^C = \gamma \frac{\alpha P_t Y_t}{\mathcal{E}_t P_t^*}$. Unconstrained Ricardian agents also increase their consumption of imports, but less than proportionally as part of their revenues are from exports, $C_{Ft}^R = \gamma \frac{(1-\alpha)P_t Y_t + \mathcal{E}_t Y_t^*}{\mathcal{E}_t P_t^*}$. The unconstrained agents additionally lose from financial repression which constrains their foreign currency precautionary savings. Therefore, such a policy redistributes welfare away from unconstrained (and presumably richer) agents towards hand-to-mouth (presumably poorer) agents in the economy, providing them with insurance and limiting their welfare losses from sanctions.[29]

[28] This result extends the logic from Werning (2015) and Auclert, Rognlie, Souchier, and Straub (2021) to a rich set of shocks in an open economy.

[29] A related mechanism of the effect of FX interventions on import consumption of hand-to-mouth agents is discussed in Fanelli and Straub (2021).

4 Conclusion: Putting the Pieces Together

A record number of economic sanctions have been imposed on the Russian economy since the invasion of Ukraine in February 2022. Given that it might take months and even years for these restrictions to take a toll on the economy, many commentators and policymakers attempt to infer the effects of sanctions from the short-term dynamics of the ruble exchange rate. Building on recent models of equilibrium exchange rate determination, this paper clarifies the relationship between sanctions, exchange rates, and welfare.

In particular, the model helps to understand the seemingly puzzling swings in the exchange rate over the last months. The overnight freeze of a significant fraction of government foreign reserves, the exclusion of major banks and corporations from international borrowing markets, and a threat of blocking commodity exports led to a sharp depreciation of the ruble on impact. These factors were exacerbated by a sharp increase in the home demand for foreign currency as a store of value driven by the rise in inflationary expectations and a collapse in the supply of alternative vehicles for savings. The exchange rate reversed in mid-March and appreciated gradually over the next month almost to the pre-war level. First, tougher sanctions on Russia's imports than on its exports over this period led to a sizable current account surplus and inflow of foreign currency into the economy. Second, capital controls and financial sanctions prevented capital outflows, while domestic financial repression lowered domestic demand for foreign currency.

These factors were arguably even more important in stabilizing the exchange rate than conventional monetary tools such as the hike in the policy rate to 20% that was aimed at stoping a bank run (the withdrawal of ruble deposits) and at preventing monetary inflation. Due to high export revenues given unusually high world commodity prices, the Russian government enjoys a considerable fiscal surplus, and thus far could avoid monetizing its fiscal obligations with associated devaluation driven by unpleasant monetarist arithmetics. Nonetheless, going forward, the perspective of export sanctions and of fiscal problems driven by domestic recession can result in both devaluation and inflation.

Our analysis also clarifies welfare implications of exchange rates. In contrast to widespread misperception that the effectiveness of sanctions can be inferred from exchange rate depreciation, we show that there is no one-to-one relationship between the exchange rate and welfare. In particular, while import sanctions and sanctions on exports and foreign assets are equivalent in terms of their effects on allocations and welfare, they have opposite implications for the exchange rate, resulting in an appreciation and a depreciation respectively. Furthermore, this equivalence extends to government fiscal revenues, with import sanctions resulting in the same fiscal deficits as export restrictions, even when export revenues are the main source of government revenues.

Equally misleading, however, is the common view that financial repression makes the exchange rate irrelevant from the welfare perspective and there is no rationale for the central bank to target it. Instead, the exchange rate remains allocative even under financial autarky, in particular in economies with heterogeneous agents. Financial repression discourages foreign currency savings, appreciates the exchange rate and leaves more resources to purchase imports. As a result, such a policy benefits consumers by increasing their purchasing power to buy imported goods at the expense of households

that want to hold foreign currency as a safe asset.

APPENDIX

A Import sanctions

Cobb-Douglas case (Proposition 3) When $\theta = 1$, we approach the modeling as follows. Assume there is a $[0, \gamma]$ continuum of imports such that the utility aggregator in (3) can be written as:

$$u_t = (1-\gamma)\log C_{Ht} + \int_0^\gamma \log c^*_{it}\mathrm{d}i,$$

where the price of home good is still P_t and the price of each import variety in foreign currency is $p^*_{it} = P^*_t$ for all $i \in [0, \gamma]$. The demand for each individual variety of imports is then:

$$c^*_{it} = \frac{1}{1-\gamma}\frac{P_t C_{Ht}}{\mathcal{E}_t p^*_{it}}. \tag{15}$$

The total expenditure on imports in foreign currency is then:

$$P^*_t C_{Ft} = \int_0^\gamma p^*_{it} c^*_{it}\mathrm{d}i = \frac{\gamma}{1-\gamma}\frac{P_t C_{Ht}}{\mathcal{E}_t},$$

corresponding to (6) with $\theta = 1$.

We model the import ban as the exclusion of varieties $i \in [0, \delta]$ for $\delta < \gamma$ from imports. The remaining varieties are still consumed according to demand schedules (15) with prices $p^*_{it} = P^*_t$ for $i \in (\delta, \gamma]$. Then total expenditure on imports is:

$$P^*_t C_{Ft} = \int_\delta^\gamma p^*_{it} c^*_{it}\mathrm{d}i = \frac{\gamma-\delta}{1-\gamma}\frac{P_t C_{Ht}}{\mathcal{E}_t} < \frac{\gamma}{1-\gamma}\frac{P_t C_{Ht}}{\mathcal{E}_t}.$$

We can define $\hat{P}^*_t = \frac{\gamma}{\gamma-\delta}P^*_t > P^*_t$ such that:

$$\hat{P}^*_t C_{Ft} = \frac{\gamma}{1-\gamma}\frac{P_t C_{Ht}}{\mathcal{E}_t},$$

as in (9). Note that $\hat{P}^*_t$ is not the ideal price index for imports, as it would be infinite in the absence of varieties under Cobb-Douglas.

From the point of view of trade balance (10), $C_{Ft} = (\gamma-\delta)c^*_{it}$ for all $i \in (\delta, \gamma]$ will have to increase to the original level, as P^*_t, Y^*_t and F^* did nor change under import rationing. This is achieved by means of an appreciation ($\mathcal{E}_t \downarrow$), as described in the text following Proposition 3, with equilibrium $\mathcal{E}_t$ characterized in (11). In other words, this allows a proportionally greater consumption of each import variety still available, $i \in (\delta, \gamma]$, to maintain total expenditure on imports.[30] Note that there

[30] The new allocation, which we denote with $\hat{}$s, is $\hat{c}^*_{it} = 0$ for $i \in [0, \delta]$, $\hat{c}^*_{it} = \frac{\gamma}{\gamma-\delta}c^*_{it}$ for $i \in (\delta, \gamma]$, $\hat{P}^*_t = \frac{\gamma}{\gamma-\delta}P^*_t$, $\hat{\mathcal{E}}_t = \frac{\gamma-\delta}{\gamma}\mathcal{E}_t$, with unchanged average $P^*_t = p^*_{it}$ for $i \in (\delta, \gamma]$ and unchanged $C_{Ft} = \frac{1}{P^*_t}\int_\delta^\gamma p^*_{it}\hat{c}^*_{it}\mathrm{d}i$ defined from expenditure.

is, nonetheless, an unbounded loss of welfare associated with the disappearance of varieties $i \in [0, \delta]$, even as total expenditure on imports ($P_t^* C_{Ft}^*$) and average price of imports (P_t^*) do not change, as P_t^* and C_{Ft} are not utility-based aggregates in this case. This logic can be made smooth when $\theta > 1$, as we show next. ■

CES with $\theta > 1$ In this case, it is more convenient to have a unit continuum $i \in [0, 1]$ of import varieties, and we rewrite the utility aggregator (3) as:

$$u_t = (1-\gamma)^{1/\theta} C_H^{\frac{\theta-1}{\theta}} + \gamma^{1/\theta} \int_0^1 c_{it}^{*\frac{\theta-1}{\theta}} \mathrm{d}i,$$

where $C_{Ft} = \left[\int_0^1 c_{it}^{*\frac{\theta-1}{\theta}} \mathrm{d}i \right]^{\frac{\theta}{\theta-1}}$ is now the utility-based aggregator, with the associated ideal price index given by:

$$P_t^* = \left[\int_0^1 p_{it}^{*1-\theta} \mathrm{d}i \right]^{1/(1-\theta)} = p_{it}^* \qquad \text{(common for all } i \in [0,1]).$$

Consider that a share $\hat{\delta} = \delta/\gamma$ of import varieties $i \in [0, \hat{\delta}]$ is not available, which can be captured with an infinite shadow price $\hat{p}_{it}^* = \infty$ for $i \in [0, \hat{\delta}]$, and thus the new ideal price index is:

$$\hat{P}_t^* = \left[\int_{\hat{\delta}}^1 p_{it}^{*1-\theta} \mathrm{d}i \right]^{1/(1-\theta)} = (1-\hat{\delta})^{\frac{1}{1-\theta}} p_{it}^* = \left(\frac{\gamma}{\gamma - \delta} \right)^{\frac{1}{\theta-1}} P_t^* > P_t^*.$$

Note how this parallels our Cobb-Douglas case above, but with the ideal price index going to infinity with $\delta > 0$ when $\theta \to 1$. Also note that the disappearance of a fraction $\hat{\delta}$ of varieties is welfare-equivalent to a uniform tax τ on all import varieties with $1 + \tau = (1-\hat{\delta})^{\frac{1}{1-\theta}} > 1$, and the effect on import quantity C_{Ft} aggregator and import expenditure $P_t^* C_{Ft}$ is the same under both types of shocks. Therefore, we can now think of import rationing and taxation of imports within the same set of equations. ■

B Fiscal Revenues and Price Index

We consider here the generalized case where total fiscal revenues $TR_t = \tau^* \mathcal{E}_t Y_t^* + \tau P_t Y_t$, where $(\tau^*, \tau) \in [0,1]^2$ are arbitrary tax rates on exports and domestic revenues. We defined

$$\chi = \frac{\tau^* \mathcal{E} Y^*}{\tau^* \mathcal{E} Y^* + \tau P Y}$$

to be the (steady state) share of taxes on exports in total tax revenues of the government. We take the path of domestic prices and output (P_t, Y_t) as given, and evaluate the marginal effect of export and

import sanctions on TR_t and consumer price index CPI_t defined in the text. We have:

$$\begin{aligned}\mathrm{d}\log TR_t &= \chi \cdot \mathrm{d}\log(\mathcal{E}_t Y_t^*),\\ \mathrm{d}\log CPI_t &= \mathrm{d}\log\left[1+\frac{\gamma}{1-\gamma}(P_t^*\mathcal{E}_t/P_t)^{1-\theta}\right]^{\frac{1}{1-\theta}} = \mu\cdot\mathrm{d}\log(P_t^*\mathcal{E}_t),\end{aligned}$$

where

$$\mu = \frac{\gamma}{1-\gamma}\left(\frac{P^*\mathcal{E}}{P}\right)^{1-\theta} = \frac{\mathcal{E}P^*C_F}{PY}$$

is the (steady state) share of imports in domestic production, which is equal to domestic GDP in steady state with balanced trade (which we assume for simplicity). Note that full differentials of TR_t and CPI_t additionally include terms in $\mathrm{d}\log Y_t$ and $\mathrm{d}\log P_t$, which we omit for brevity, as these terms are common to both export and import sanction regimes.

It only remains to characterize $\mathrm{d}\log(\mathcal{E}_t Y_t^*)$ and $\mathrm{d}\log(P_t^*\mathcal{E}_t)$ under the two sanction regimes. From the country budget constraint (7), both sanction regimes in Proposition 4 feature:

$$\mathrm{d}\log C_{Ft} = \mathrm{d}\log\frac{Y_t^*}{P_t^*} = -x$$

for some $x > 0$. We can then use import demand equation (13) to obtain:

$$\mathrm{d}\log\mathcal{E}_t = -\mathrm{d}\log P_t^* - \frac{1}{\theta}\mathrm{d}\log C_{Ft},$$

again omitting terms in $\mathrm{d}\log Y_t$ and $\mathrm{d}\log P_t$. We, therefore, have:

$$\begin{aligned}\mathrm{d}\log(\mathcal{E}_t Y_t^*) &= \mathrm{d}\log\frac{Y_t^*}{P_t^*} - \frac{1}{\theta}\mathrm{d}\log C_{Ft} = -\frac{\theta-1}{\theta}x,\\ \mathrm{d}\log(P_t^*\mathcal{E}_t) &= -\frac{1}{\theta}\mathrm{d}\log C_{Ft} = -\frac{1}{\theta}x,\end{aligned}$$

completing the derivation of (14). ■

C Financial Repression

Proof of Proposition 5 The equilibrium dynamics of $(F_t^*, C_{Ft}, \mathcal{E}_t)$ is governed by the Euler equation (8), the country's budget constraint (7), and import demand (6). When the government is passive, the $\psi_0 > 0$ shock in (8) must be accommodated by the accumulation of $B_{t+1}^* = F_{t+1}^*$ according to the budget constraint (7), as $R_{Ht}^* = R_t^*$ is taken as given. This requires reducing C_{F0} on impact, with an increasing profile of $C_{F,t+1}/C_{Ft}$ in all future periods, as the gap between ψ_t and B_{t+1}^*/P_{t+1}^* in (6) declines with accumulation of B_{t+1}^* towards zero in the new steady state. Since B_{t+1}^* increases, the new steady state budget constraint allows for a larger level of imports C_{Ft} in the long run, and the initial drop in imports C_{F0} satisfies the intertemporal budget constraint. The path of the exchange rate $\mathcal{E}_t$ tracks that of imports C_{Ft} with elasticity $-1/\theta$ in order to satisfy (6). Thus, a permanent increase in ψ_t

triggers a jump devaluation and a gradual appreciation thereafter to a more appreciated level in the new steady state with greater net foreign assets. For a more formal proof in a stochastic linearized environment see Itskhoki and Mukhin (2021).

An alternative policy option is to reduce official reserves $F^*_{t+1} - B^*_{t+1}$ to exactly accommodate the increase in B^*_{t+1} that ensures $B^*_{t+1}/P^*_{t+1} = \psi_t$ in every period. This has no effect on the aggregate net foreign asset position of the country F^*_{t+1}, and thus the original path of imports and exchange rate $(C_{Ft}, \mathcal{E}_t)$ remains consistent with all equilibrium conditions. This policy requires either large enough initial reserves $F^*_t - B^*_t$ or the government's ability to borrow foreign currency from the rest of the world at R^*_t. Finally, the last policy option is to select a path of $R^*_{Ht} < R^*_t$ such that (8) holds for the original path of $(C_{Ft}, \mathcal{E}_t, B^*_{t+1})$ with $\psi_t > 0$, and no other equilibrium condition is affected. ■

D Heterogeneous Households

Proof of Proposition 6 We follow the recent open-economy literature with heterogenous agents (De Ferra, Mitman, and Romei 2020, Guo, Ottonello, and Perez 2020, Auclert, Rognlie, Souchier, and Straub 2021) and consider a simple extension of the baseline model that allows us to disentangle the role of exchange rates in goods and asset markets. In particular, assume two types of agents – the hand-to-mouth (constrained) households and (unconstrained) households with access to asset markets. The former agents work mostly in the non-tradable sector and receive a constant fraction of home output $\alpha P_t Y_t$. These households make no savings or borrowing, enjoy no utility from holding assets, and are subject to the budget constraint

$$P_t C^C_{Ht} + \mathcal{E}_t P^*_t C^C_{Ft} = \alpha P_t Y_t.$$

In contrast, the unconstrained agents can borrow and save and receive the rest of national income:

$$P_t C^R_{Ht} + \mathcal{E}_t P^*_t C^R_{Ft} + \frac{\mathcal{E}_t B^*_{t+1}}{R^*_t} = \mathcal{E}_t B^*_t + (1-\alpha) P_t Y_t + \mathcal{E}_t Y^*_t.$$

The Euler equation (8) still holds, but only for the unconstrained agents.

The Cobb-Douglas preferences $\theta = 1$ imply that constrained households spend a constant fraction of their income on home and foreign goods:

$$C^C_{Ht} = (1-\gamma)\frac{\alpha P_t Y_t}{P_t} = (1-\gamma)\alpha Y_t, \qquad C^C_{Ft} = \gamma\alpha \frac{P_t Y_t}{\mathcal{E}_t P^*_t}.$$

Given the market clearing condition for local goods

$$C^C_{Ht} + C^R_{Ht} = Y_t,$$

consumption of non-tradables by unconstrained agents is equal

$$C^R_{Ht} = \big[1 - (1-\gamma)\alpha\big] Y_t.$$

Combine this expression with the optimality condition for unconstrained households

$$\frac{C_{Ft}^R}{C_{Ht}^R} = \frac{\gamma}{1-\gamma}\frac{P_t}{\mathcal{E}_t P_t^*},$$

to solve for their demand for foreign goods:

$$C_{Ft}^R = \frac{\gamma}{1-\gamma}\big[1-(1-\gamma)\alpha\big]\frac{P_t Y_t}{\mathcal{E}_t P_t^*}.$$

It follows that $C_{Ft} = C_{Ft}^C + C_{Ft}^R = \gamma\frac{P_t Y_t}{\mathcal{E}_t P_t^*}$ and the unconstrained households account for a fixed fraction of total imports

$$C_{Ft}^R = \left[\frac{1}{1-\gamma} - \alpha\right] C_{Ft}.$$

Substitute this expression into the Euler equation (8) for unconstrained households to rewrite it in terms of the aggregate variables. The equilibrium system for $C_{Ft}, \mathcal{E}_t, B_{t+1}^*$ is then isomorphic to the Euler equation, country's budget constraint, and optimal demand (6) in the baseline model and does not depend on α (up to a renormalization of parameter κ).

To prove the second part of the proposition, consider the problem of the planner with the Pareto weight ω on constrained agents, which corresponds to their share in population in the utilitarian case:

$$\begin{aligned}
\max \quad & \mathbb{E}\sum_{t=0}^{\infty}\beta^t\left\{\omega\log C_{Ft}^C + (1-\omega)\left[\log C_{Ft}^R - \frac{\kappa}{2}\left(\frac{B_{t+1}^*}{P_{t+1}^*} - \psi_t\right)^2\right]\right\} \\
\text{s.t.} \quad & C_{Ft}^C = \gamma\alpha\frac{P_t Y_t}{\mathcal{E}_t P_t^*}, \qquad C_{Ft}^R = \gamma\left[\frac{1}{1-\gamma} - \alpha\right]\frac{P_t Y_t}{\mathcal{E}_t P_t^*} \\
& \frac{B_{t+1}^*}{R_t^*} = B_t^* + Y_t^* - P_t^*\big(C_{Ft}^C + C_{Ft}^R\big),
\end{aligned}$$

where we used the fact that consumption of non-tradables is effectively exogenous and the Euler equation (8) is a side equation that pins down the level of financial repression that is necessary to implement the desired allocation. Substitute for C_{Ft}^C and C_{Ft}^R to simplify the planner's objective:

$$\begin{aligned}
\max \quad & \mathbb{E}\sum_{t=0}^{\infty}\beta^t\left\{\log\frac{P_t}{\mathcal{E}_t} - \frac{(1-\omega)\kappa}{2}\left(\frac{B_{t+1}^*}{P_{t+1}^*} - \psi_t\right)^2\right\} \\
\text{s.t.} \quad & \frac{B_{t+1}^*}{R_t^*} = B_t^* + Y_t^* - \frac{\gamma}{1-\gamma}\frac{P_t Y_t}{\mathcal{E}_t}
\end{aligned}$$

In a model with a representative household $\omega = 0$, we get the same optimality condition (8) as in the laissez-faire equilibrium with $R_{Ht}^* = R_t^*$, i.e. it is suboptimal to use financial repression. On the other hand, in a model with two types of agents, the social losses from suboptimal savings $\frac{(1-\omega)\kappa}{2}$ are lower than the private ones. As a result, the optimal intervention requires setting $R_{Ht}^* < R_t^*$, with the financial repression wedge increasing in ω. ■

References

Aiyagari, S. (1994): "Uninsured Idiosyncratic Risk and Aggregate Saving," *The Quarterly Journal of Economics*, 109(3), 659–684.

Auclert, A., M. Rognlie, M. Souchier, and L. Straub (2021): "Exchange rates and monetary policy with heterogeneous agents: Sizing up the real income channel," NBER Working Paper No. 28872.

Bachmann, R., D. Baqaee, C. Bayer, M. Kuhn, A. Löschel, B. Moll, A. Peichl, K. Pittel, and M. Schularick (2022): "What if? The Economic Effects for Germany of a Stop of Energy Imports from Russia," ECONtribute Policy Brief No. 028.

Barbiero, O., E. Farhi, G. Gopinath, and O. Itskhoki (2019): "The Macroeconomics of Border Taxes," in *NBER Macroeconomics Annual 2018*, vol. 33. forthcoming.

Bianchi, J., S. Bigio, and C. Engel (2021): "Scrambling for Dollars: International Liquidity, Banks and Exchange Rates," Discussion paper, National Bureau of Economic Research.

Bianchi, J., and C. Sosa-Padilla (2022): "On Wars, Sanctions and Sovereign Default," working paper.

Blanchard, O. J. (1985): "Debt, deficits, and finite horizons," *Journal of political economy*, 93(2), 223–247.

Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2008): "An Equilibrium Model of "Global Imbalances" and Low Interest Rates," *American Economic Review*, 98(1), 358–393.

Cole, H. L., and M. Obstfeld (1991): "Commodity trade and international risk sharing," *Journal of Monetary Economics*, 28(1), 3–24.

De Ferra, S., K. Mitman, and F. Romei (2020): "Household heterogeneity and the transmission of foreign shocks," *Journal of International Economics*, 124, 103303.

Diamond, P. A. (1965): "National debt in a neoclassical growth model," *The American Economic Review*, 55(5), 1126–1150.

Fanelli, S., and L. Straub (2021): "A Theory of Foreign Exchange Interventions," *The Review of Economic Studies*, 88(6), 2857–2885.

Farhi, E., G. Gopinath, and O. Itskhoki (2014): "Fiscal Devaluations," *Review of Economics Studies*, 81(2), 725–760.

Guo, X., P. Ottonello, and D. J. Perez (2020): "Monetary policy and redistribution in open economies," Discussion paper, National Bureau of Economic Research.

Itskhoki, O. (2021): "The Story of the Real Exchange Rate," *Annual Review of Economics*, 13, 423–455.

Itskhoki, O., and D. Mukhin (2021): "Exchange Rate Disconnect in General Equilibrium," *Journal of Political Economy*, 129(8), 2183–2232.

——— (2022): "Optimal Exchange Rate Policy," https://itskhoki.com/papers/ERpolicy.pdf.

Jiang, Z., A. Krishnamurthy, and H. Lustig (2018): "Foreign safe asset demand for us treasurys and the dollar," in *AEA Papers and Proceedings*, vol. 108, pp. 537–41.

Korhonen, I. (2019): "Economic Sanctions on Russia and Their Effects," *CESifo Forum*, 20(4), 19–22.

Krugman, P. (1979): "A Model of Balance-of-Payments Crises," *Journal of Money, Credit and Banking*, 11(3), 311–325.

Lerner, A. P. (1936): "The Symmetry Between Import and Export Taxes," *Economica*, 3, 306–313.

Lorenzoni, G., and I. Werning (2022): "A Minimalist Model for the Ruble During the Russian Invasion of Ukraine," https://t.co/hddDN7BKhG.

Sargent, T. J., and N. Wallace (1981): "Some unpleasant monetarist arithmetic," *Quarterly Review*, 5(Fall).

Sturm, J. (2022): "A Note on Designing Economic Sanctions," working paper.

Werning, I. (2015): "Incomplete markets and aggregate demand," NBER Working Paper No. 21448.