# Sanctions and the Exchange Rate *

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**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.

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# 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.

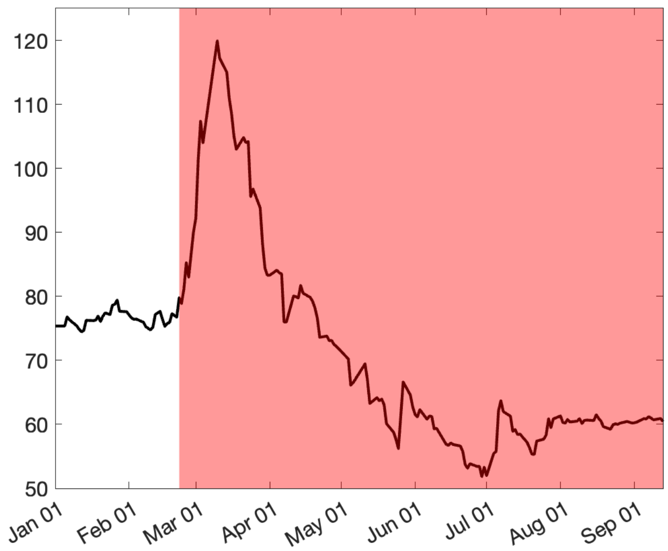


Figure 1: Daily ruble exchange rate (per one USD) in 2022

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

[1] This equivalence is another manifestation of Lerner (1936) symmetry studied in Costinot and Werning (2019) and 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). The results about trade sanctions are closely related to the contemporaneous analysis of Lorenzoni and Werning (2022) despite a different interpretation. 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.

depreciate the exchange rate, while sanctions and policy responses that reduce the demand for currency 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. Surprisingly, 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. We discuss two alternative ways the government can finance the deficit — using monetary inflation and FX interventions to depreciate the exchange rate and boost export revenues in local currency. The latter solution, however, can only temporary boost fiscal revenues, while leaving the intertemporal government budget unchanged.

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,

[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 $\theta$ 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.

$(F_t^* - B_t^*)$ are foreign reserves held by the government sector, and $R_t^*$ is the international interest rate 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, $\beta R_t \mathbb{E}_t\big\{\big(C_{Ht}/C_{H,t+1}\big)^{1/\theta} P_t/P_{t+1}\big\} = 1$, 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

[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)).

on holding foreign currency and we interpret $\Psi_t > 0$ as the precautionary motive which compels 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 $\Psi_t$ 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 $\delta$. 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 $\Psi_t$ 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 (Costinot and Werning 2019).

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 $\chi$, while the effect of import sanctions on costs of living is proportional to the share of imports in GDP, denoted with $\mu$. 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 $\Psi_t$ 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 $\Psi_t$.*

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 $\Psi_t$ 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 $\Psi_t$, 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 $\kappa$, the faster is the accumulation of foreign currency, which in turn requires a larger initial drop in imports and depreciation of the

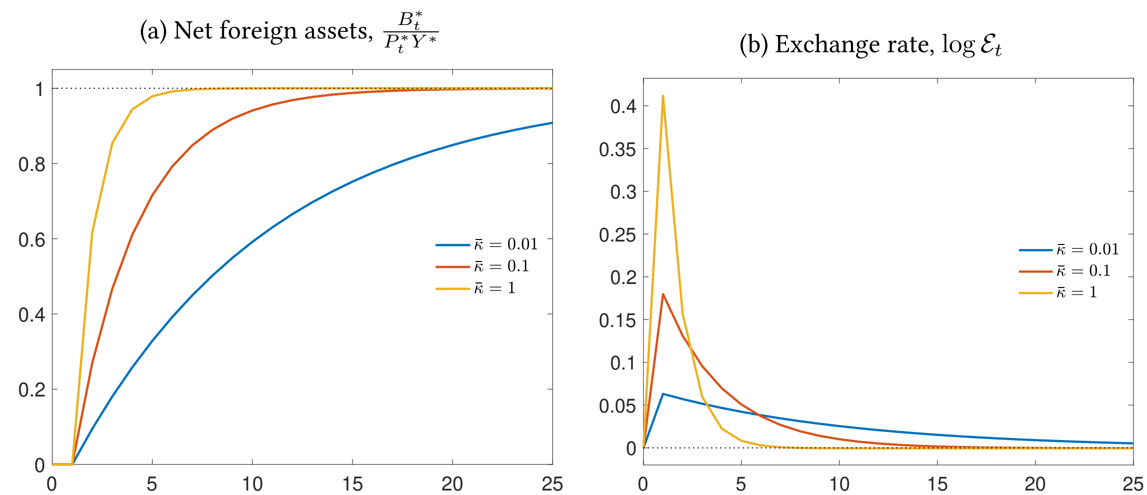


Figure 2: Laissez-faire response to foreign currency demand shock $\Psi_t$

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 $\bar{\kappa} \equiv \frac{\theta^2}{\theta-1}\frac{\kappa C_F^{1+\frac{1}{\theta}}}{\beta\gamma^{1/\theta}}$. The permanent increase in $\Psi_t$ equals to country's monthly imports.

exchange rate.[25]

Second, increased household demand for foreign currency $\Psi_t$ 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 $\Psi_t$ 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 $\Psi_t$ 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 $\Psi_t$ 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 $\Psi_t$ 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

**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.

**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

currency as a store of value, while importers are exempt from it and can freely exchange currencies to pay for foreign goods.

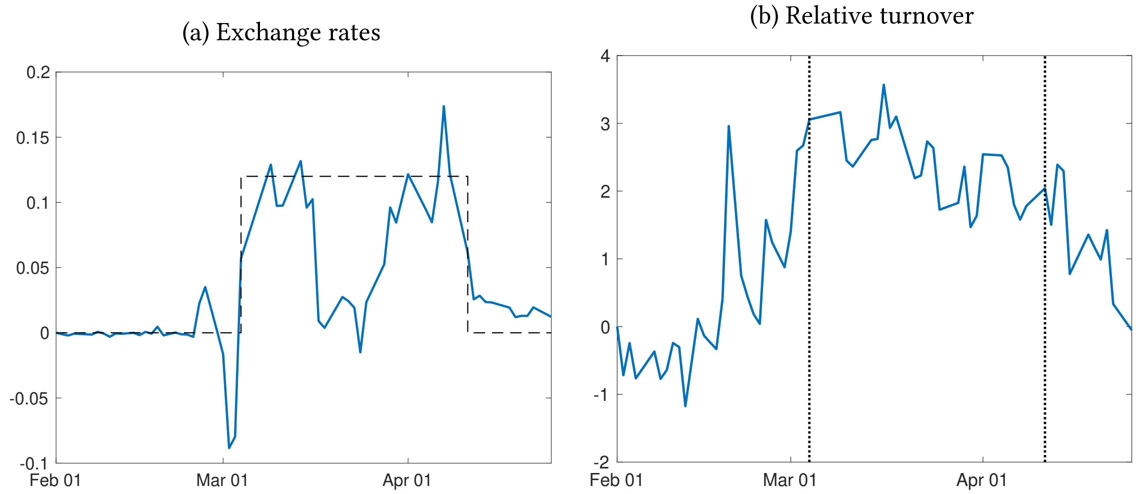


Figure 3: Swiss franc vs U.S. dollar: exchange rate and turnover

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.

### 3.3 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.

[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.

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 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 $\alpha$ 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 $\Psi_t$, 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 $\alpha$, 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 $\alpha$ of income in the non-tradable sector. Then the aggregate dynamics of the economy does not depend on $\alpha$. 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 Quantitative Evaluation

We now provide a quantitative evaluation of the ruble exchange rate dynamics in 2022 putting together financial and trade mechanisms discussed in the previous section. To this end, we solve the model using the first-order perturbation of the country's budget constraint (7), the household Euler equation (8), and import demand (6), which we write as follows:[30]

$$\mathbb{E}_t\left\{\Delta c_{Ft+1}+\theta\Delta p^*_{t+1}\right\}=\theta r^*_{Ht}+\bar{\kappa}(\psi_t-b^*_{t+1}),$$
$$\beta f^*_{t+1}-f^*_t=nx_t=y^*_t-p^*_t-c_{Ft},$$
$$c_{Ft}=-\theta(p^*_t+e_t-p_t)+y_t,$$

where $f^*_t\equiv\frac{F^*_t}{Y^*}$, $b^*_t\equiv\frac{B^*_t}{Y^*}$ and $\psi_t\equiv\frac{\Psi^*_t}{Y^*}$ are normalized by the steady-state value of exports and $\bar{\kappa}\equiv\frac{\theta^2}{\theta-1}\frac{\kappa C_F^{1+\frac{1}{\theta}}}{\beta\gamma^{1/\theta}}$. The vector of war and sanction shocks is $\{\psi_t,p^*_t,y^*_t,y_t\}$ and $f^*_0$, the policy response is $\{r^*_{Ht},p_t\}$, and the endogenous variables are $\{e_t,c_{Ft},b^*_{t+1}\}$.

We make the following further assumption. First, since eight months into the war, monetary inflation has arguably not yet been a feature of the data and most changes in the price level reflected higher import prices, we focus on an equilibrium with $p_t\equiv 0$. With this, nominal exchange rate dynamics $e_t$ corresponds to the movements in the real exchange rate. Second, while expectations must have played an important role in the response of the economy, it is difficult to calibrate how information sets of various agents changed over time, and therefore we focus on a mixture of one-off unanticipated persistent shocks and a corresponding certainty equivalence solution. Lastly, we abstract from the policy of FX interventions via the use of government reserves (that is, $f^*_t-b^*_t\equiv 0$), as the option of the central bank's FX interventions was effectively ruled out by financial sanctions. We consider a policy of FX reserve accumulation in the end of this section.

**Calibration** We calibrate the model parameters and shocks with the aim to match the salient features of the Russian economy since the beginning of the war in February 2022 which we label $t=0$. There are three parameters and multiple shocks to be calibrated. Assuming that one period corresponds to one month, the discount factor takes a standard value of $\beta=0.96^{\frac{1}{12}}$. We use $\theta=1.5$, consistent with conventional values of the macro elasticity of substitution between home and foreign goods (Feenstra, Luck, Obstfeld, and Russ 2014, Chari, Kehoe, and McGrattan 2002). Given little empirical guidance about the bonds-in-the-utility parameter $\kappa$, we use $\bar{\kappa}=0.5$ as a benchmark (see Figure 2 for the sensitivity analysis).

Table 1 shows the calibration of shocks. About half, or \$300B, of Russian foreign assets were frozen in the first week of the war, which corresponds to a permanent decrease in $f^*_0$ by an annual value of the country's exports. We further assume that the beginning of the war was associated with a sharp increase in uncertainty, in demand for safe assets and in capital outflows, which we capture with an increase in the dollar demand, $\psi_0=1.5$, corresponding to 1.5 months of exports and with a half-life

[30] We take a symmetric steady state with $R^*=R^*_H=1/\beta$ and $F^*=B^*=0$ as the point of approximation.

Table 1: Calibration of shocks

| | Financial | | Import | Export | | Domestic |
|---|---|---|---|---|---|---|
| | NFA, $f_0^*$ | $\psi_t$ & $r_{Ht}^*$ | $p_t^*$ | Temp., $y_{1t}^*$ | Perm., $y_{2t}^*$ | recession, $y_t$ |
| Initial shock, $\varepsilon_{t_0}$ | $-12$ | 1.5 | 0.5 | 0.5 | $-0.3$ | $-0.05$ |
| — arrives in period, $t_0$ | 0 | 0 | 1 | 1 | 1 | 1 |
| Persistence, $\rho$ | 1 | 0.94 | 0.84 | 0.92 | 1 | 0.98 |
| — half life (months) | $\infty$ | 12 | 4 | 8 | $\infty$ | 36 |

Note: For each shock, the table shows calibrated values of the initial innovation $\varepsilon_{t_0}$ and the period when the innovation arrives $t_0$, persistence (autocorrelation) and corresponding half lives. All shocks follow an AR(1) process with exports being the sum of two shocks, $y_t^* = y_{1t}^* + y_{2t}^*$. The values of financial shocks are expressed in terms of steady-state monthly exports, while all other shocks are expressed in proportional changes (log point deviations from the initial steady state values).

of one year ($\rho = 0.94$). Given the isomorphic effect of financial repression $r_{Ht}^*$, we do not consider it separately and interpret $\psi_t$ as a net effect of financial distress partially offset with government policies. Without additional direct empirical targets, it is not possible to separately identify whether the dollar safety demand shock $\psi_t$ waned out on its own or the financial repression policy $r_{Ht}^*$ was successful at mitigating it. While this is inconsequential for positive predictions of the model about the exchange rate dynamics, it has important welfare consequences, as we discussed in Section 3.

All other shocks arrive with a one month lag to capture the delayed effects of non-financial sanctions. Following latest estimates, a fall in domestic output is calibrated to 5% and has a half-life of 3 years. Despite Russian trade data having been classified since the beginning of the war, trade balances of other countries suggest that Russian imports went down from a monthly level of \$22B before the war to \$11B in April and rebounced to \$16B in mid-summer. To capture these dynamics, import prices are calibrated to jump up by 50% on impact and have a half-life of 4 months. While Russian exports are expected to fall significantly after European countries switch to alternative sources of energy imports, a spike in energy prices in the first months since the invasion magnified Russian export revenues in the short-run.[31] To capture this, we introduce two export shocks — a temporary increase of 50% with a half-life of 8 months and a permanent decline of 30%. Note that the resulting equilibrium dynamics with short run trade surpluses feature an increasing path of net foreign assets, $b_{t+1}^* > b_t^*$, and thus require no international borrowing that was also ruled out by financial sanctions.

## 4.1 Exchange rate and trade balance

We display the results in Figure 4 which shows the simulated path of the exchange rate (the black line) with the contribution of each shock (colored bars). The series resemble closely the dynamics of the ruble shown in Figure 1: the exchange rate depreciates on impact by 50%, goes back to the initial level about a month after the impact, and then gradually appreciates to the peak of 20% above the pre-war level at the four month horizon. Seven months after the initial shock, the exchange rate remains appreciated, but starts depreciating again and is expected — in the absence of new shocks — to return to the pre-war

[31] According to the available estimates, Russian monthly exports increased to an average of \$50B for the period of February to June, declining somewhat since then.

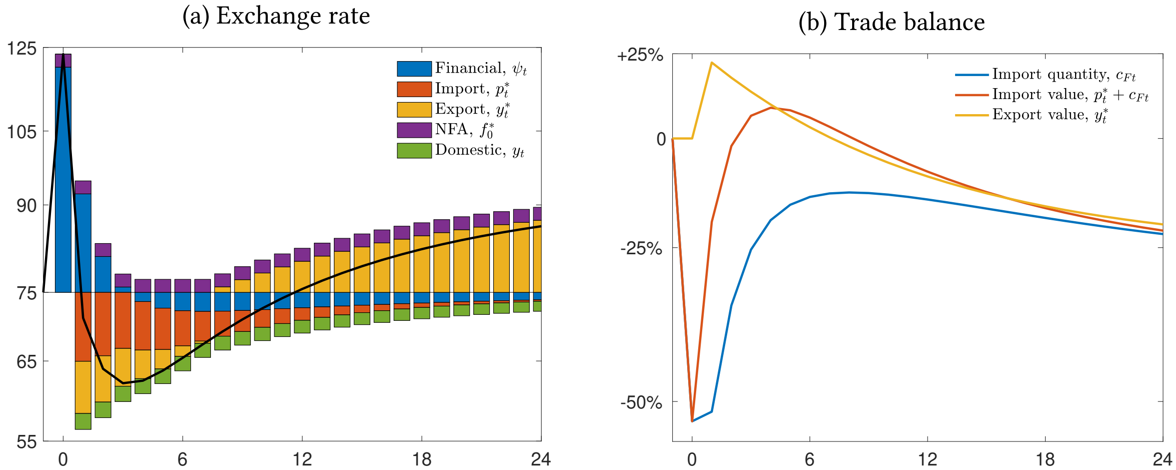


Figure 4: Exchange rate dynamics and trade balance

Note: panel (a) shows a simulated response of the ruble exchange rate (the black line) and its components driven by different shocks (respective colored bars); panel (b) shows simulated dynamics of import quantities $c_{Ft}$, import values $p_t^* + c_{Ft}$ and export values $y_t^*$. One period corresponds to a month and $t = 0$ corresponds to (the end of) February 2022.

level at the horizon of about one year (February 2023), depreciating some more thereafter.

These swings are due to the combination of different shocks driving the exchange rate. Perhaps surprisingly, despite the large amount of FX reserves frozen by sanctions, the impact of this measure on the value of the exchange rate is small, albeit very persistent, and generates a permanent $3\%$ depreciation of the exchange rate. Indeed, a permanent income loss from the asset freeze worth 100% of annual exports corresponds to a permanent reduction of export flows of about 4%, i.e. the annual rate of interest. At the same time, FX freeze eliminates the ability of the central bank to sell off foreign reserves and support the value of the exchange rate in the face of capital outflow driven by the financial shock $\psi_t$. We find this shock to be the key driver behind the sharp depreciation in the first month. Interestingly, no matter how persistent $\psi_t$ is, the effect of this shock on the exchange rate is short-lived and dissipates as private agents accumulate the desired amount of foreign currency from the aggregate trade surplus.[32]

One month out, the financial shock is combined with trade and recession shocks, and the trade shocks begin to dominate the dynamics of the exchange rate. First, trade restrictions that result in high effective import prices, lower import quantities and reduce the demand for foreign currency, contributing to a $15\%$ appreciation of the ruble. Panel (b) of the figure displays the path of simulated import values and quantities, and while the decline in import quantities is well aligned with the empirical patterns described above, the model understates the decline in import values, which may be due to under-reporting of the true value of payments for sanctioned imported goods in the data. Second, the increase in energy prices and Russian export revenues in the first months after the invasions increases the supply of foreign currency and appreciates the ruble by another $10\%$. Finally, domestic recession

[32]In the model, a $\psi_t$ shock is associated with a drop in imports in the initial period, as shown in panel (b) of the figure. The size of the contraction is too large relative to the data, and is likely driven by the absence of price and quantity frictions in imports that delay the response and perhaps prolong the effect of the shock on the exchange rate.

driven by the exit of multinationals and the reduced supply of foreign intermediates also contributes to the appreciation of the currency. This effect is, however, small quantitatively, albeit persistent, resulting in a $3\%$ appreciation. All in all, the combined effect neutralizes the financial depreciation already in the second month ($t = 1$) and turns into an appreciation from the third month onward ($t \geq 2$), consistent with the empirical path of the exchange rate.

Over time, as parallel imports and new trade linkages are established, import prices are expected to go down, while import quantities and the demand for foreign currency rebound, contributing to a medium-term depreciation. At the same, the inflow of foreign currency contracts as energy exports (both prices and quantities) decline. This persistent reduction in exports and the ensuing force for depreciation curb the recovery in imports, and both imports and exports remain below the pre-war level in the long run (by 30%). Combined together, these forces bring the exchange rate back to the pre-war level about 12 months after the start of the war and it continues to gradually depreciate thereafter. As we made the assumption that the negative export shock dominates in the long-run, the ruble eventually depreciates by $20\%$ relative to the pre-war level. If the negative import shock were to dominate in the long run, then the ruble would remain persistently appreciated, despite the fact that both sides of the trade balance are depressed in equilibrium independently of the scenario, illustrating predictions of Proposition 4.

Two remarks are in order. First, we find that quantitatively the exchange rate effects of the domestic recession and of the asset freeze are both quantitatively small and comparable in value, and thus nearly offset each other at all horizons (for $t \geq 1$). Therefore, the net effects on the exchange rate are shaped by the balance of financial shocks and trade restrictions, with the financial shock having a sharper effect in the very short run, while trade restrictions dominating in the medium and long run. In other words, it is the balance of export and import restrictions that shapes the resulting appreciation or depreciation of the ruble at most horizons apart from the very short run (for $t > 2$). Second, we isolated the real exchange rate effects setting aside possible inflationary devaluation that may arise from monetization of the government debt. This is, indeed, a plausible scenario in the medium-to-long run, in which case we expect a nominal devaluation over and above the equilibrium path of the exchange rate displayed in Figure 4, as we discuss below.

Finally, a financial shock unaccommodated with FX interventions triggers a sudden-stop-like episode whereby the country needs to sharply contract its imports. An increase in exports and import sanctions helped to accommodate this sudden capital outflow with a trade-induced capital inflow. In other words, the particular mix of sanctions — that were concentrated on curbing Russian imports without curbing Russian exports — allowed to smooth out the capital flight and avoid the associated likelihood of currency and banking crisis (stepping outside our model).

## 4.2 Budget deficit and inflation

Consider next the fiscal implications of sanctions. Generalizing the analysis in Section 3.2, proportional changes in government revenues can be expressed as:

$$\mathrm{d}\log TR_t = \chi(e_t + y_t^*) + (1-\chi)\,(p_t + y_t), \tag{15}$$

where $\chi$ is the steady-state share of government revenues from exports in total government revenues, which we set to $50\%$ consistent with the data.[33] We also abstract from any increases in government expenditures, which are significant in the data, and focus below exclusively on the deficit driven by falling tax revenues induced by sanctions.

The left panel of Figure 5 shows the dynamics of government revenues (black line) and its decomposition into different shocks. The initial depreciation of the exchange rate boosts home currency revenues by almost $30\%$ and is further amplified by higher exports starting from period one. This positive effect is partially offset in the medium run by the appreciation of the ruble — due to both higher exports and lower imports — and lower tax revenues because of recession in the domestic sector. As a result, the net income is negative starting from the third month onwards ($t \geq 2$). In the long run, the government runs a $6\%$ deficit due to lower domestic output and exports. The losses are relatively small because the long-run exchange rate depreciation partially offsets the loss in home currency revenues due to a reduction in home production $y_t$ and foreign currency exports $y_t^*$.[34]

The calculation above is done under the assumption that monetary policy maintains a constant level of prices for domestically-produced goods, $p_t$, even though there is import price inflation, $p_t^* + e_t$, which contributes the overall increase in the consumer price level (see (16) below and our discussion in Section 3.2). Nonetheless, the government can sustain the initial level of expenditures without borrowing by monetizing the fiscal deficit. We consider alternative monetary policy scenarios that balance the real value of government fiscal commitments. Note that to the first order, the change in the consumer price level is given by:

$$\mathrm{d}\log CPI_t = (1-\gamma)p_t + \gamma(p_t^* + e_t). \tag{16}$$

A monetary policy that targets an increasing path of domestic prices $p_t$ simultaneously reduces the fiscal pressure on the government revenues, as can bee seen in (15), and thus we consider policies with an alternative path of $p_t$.

The right panel of Figure 5 shows the cumulative change in the consumer price level since the beginning of the war under three alternative scenarios. The black line corresponds to the baseline scenario when the central bank stabilizes domestic producer prices, $p_t = 0$.[35] In this case, consumer prices jump up by $13\%$ in the first two months due to the depreciation of the exchange rate and an

[33] Pre-war the direct contribution of energy exports to Russian federal budget was around 40% and it increased to 60% since the beginning of the war. This figure does not include income and corporate profit taxes levied on the energy producing sector.

[34] In this calculation we omit the additional negative effects from the loss of import tariff revenues, which also constitutes a non-negligible (albeit smaller) part of government revenues.

[35] This is a policy that is optimal in a large class of New Keynesian Open-Economy models (Galí and Monacelli 2005, Egorov and Mukhin 2021).

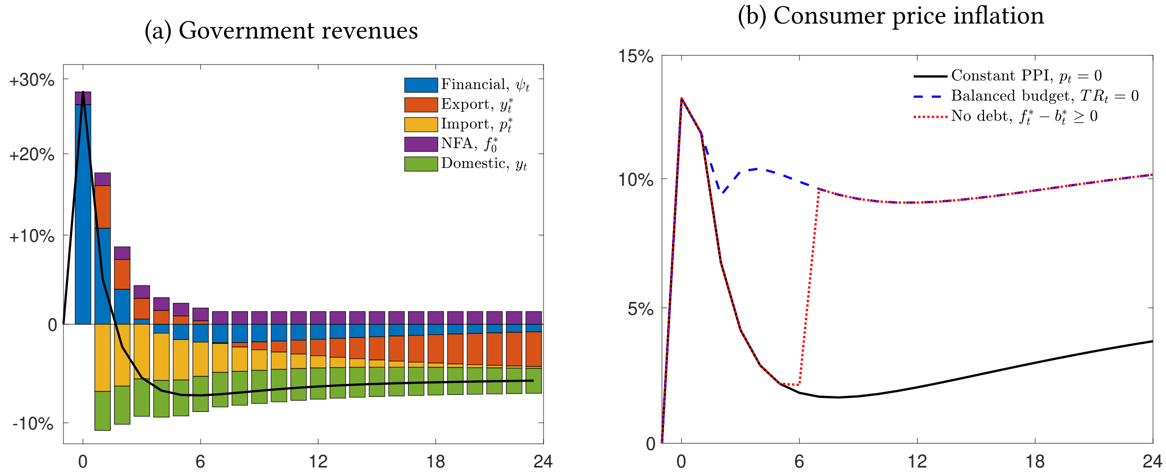


Figure 5: Fiscal and monetary policy

Note: panel (a) shows a simulated response of government revenues (the black line, in percentage changes since relative the pre-war level) and their components driven by different shocks (respective colored bars); panel (b) shows dynamics of CPI (also in percentage changes relative to the pre-war level) under different monetary policies, as described in the text.

increase in import prices. Once the exchange rate appreciates and the import shock dissipate, consumer price level reverts to a cumulative increase of only $4\%$ relative to the initial level. In the data, consumer prices increased by 12% in the first three months and decreased somewhat since then.

The blue line in the figure corresponds to the case when the central bank's policy is to ensure that the government budget is balanced in every period, that is $p_t$ increases to esnure $\mathrm{d}\log TR_t \geq 0$ for every period $t$ in (15). In the first two months, the government surplus implies that the dynamics of inflation is determined solely by real shocks and coincides with the first case. The deficit of the budget from the third period on requires the intervention of monetary policy and does not allow the price level to fall back to the initial level. This path of consumer prices replicates closely what we observed in the data.

Finally, the red line in the figure shows additionally the path of consumer prices when the central bank inflates only to offset the cumulative deficit since the beginning of the war. This ensure that the fiscal authority does not need to borrow, but can save earlier surpluses, and the path of $p_t$ ensures $\sum_{j=0}^{t} \mathrm{d}\log TR_j \geq 0$ for every $t \geq 0$. In this case, the budget surpluses in the first months of the war allow the government to avoid borrowing in the first half of the year without monetizing fiscal deficits. After that, the central bank intervenes to partially inflate away fiscal expenditures. The price level effectively converges to the same level as in the second scenario, but with a six-month lag. In both scenarios, the increase in consumer prices is about $7.5\%$ higher than under domestic producer price targeting.

From the perspective of the equilibrium nominal exchange rate, this corresponds to an additional depreciation force of 7.5% relative to the path plotted in Figure 4. This introduces a wedge between the nominal and the real exchange rate as the latter is still shaped by the trade and financial forces and follows the same path as depicted in Figure 4. Nonetheless, our analysis suggests that fiscal pressures on inflation and nominal exchange rate induced by the existing sanctions, while present, do not dramatically change the path of the nominal exchange rate in the first year.

### 4.3 Foreign exchange interventions

As an alternative to monetary policy, the government can accumulate FX reserves with the goal to balance its fiscal positions by means of a non-monetary exchange rate devaluation. To see this, rewrite the government budget (4) allowing for local-currency debt $B_t$:

$$\mathcal{E}_t\left(\frac{F^*_{t+1}-B^*_{t+1}}{R^*_t}-(F^*_t-B^*_t)\right)-\left(\frac{B_{t+1}}{R_t}-B_t\right)=TR_t-W_t,$$

where for simplicity we assume the same rate on foreign currency at home as abroad, $R^*_{Ht}=R^*_t$. Consider policies that simultaneously increase FX reserves $F^*_t-B^*_t$ and raise the local-currency debt $B_t$ leaving the net asset position of the government unchanged. Why such policy has a real effect?

On the one hand, the Ricardian equivalence holds for local-currency debt. That is, such a change in $B_t$ leaves the permanent income of households and their consumption decisions unchanged, as they expect an offsetting adjustment in future income commitments $W_{t+j}$ that keep the intertemporal budget constraint unchanged. As a result, this policy also does not compromise the ability of the central bank to control the domestic producer price inflation $p_t$ by setting the required path of the nominal rate $R_t$.

On the other hand, as we discussed above, the Ricardian equivalence does not hold for foreign currency assets. As a result, the change in the composition of government debt, with an increase in FX reserves $F^*_t-B^*_t$ and a corresponding increase in home-currency debt $B_t$ directly affecting foreign-currency bond holdings of private agents. Given foreign-currency savings demand, this affects the equilibrium exchange rate. In sum, sterilized FX interventions, namely accumulation of FX reserves, depreciate the ruble and boost fiscal revenues in home-currency terms without any monetary inflation.

Figure 6 shows the reserve accumulation policy which ensures a deficit-free budget for one year and then gradually increases the deficits towards the long-run value. During the first year, reserve accumulation depreciates the exchange rate by about 10%. After two years, the exchange rate and fiscal surplus both return approximately to their baseline paths, as in Figures 4 and 5. Therefore, trade surpluses that result in an inflow of foreign currency allow the central bank to withhold a part of this foreign exchange from the market and delay the fiscal deficit problem in the short run without relying on monetization or reduction of the home-currency expenditures. Such policy, however, has limits as the upper bound on reserve accumulation cannot exceed the total accumulated net foreign asset position of the country (that is, private $B^*_t\geq 0$), and therefore the fiscal deficit problem cannot be delayed indefinitely.

While sterilized FX interventions can be used to temporarily eliminate fiscal deficit, such policy is associated with the costs of its own. Two arguments clarify why FX interventions are not a silver bullet. First, FX interventions cannot change the real national income, which according to the expressions for

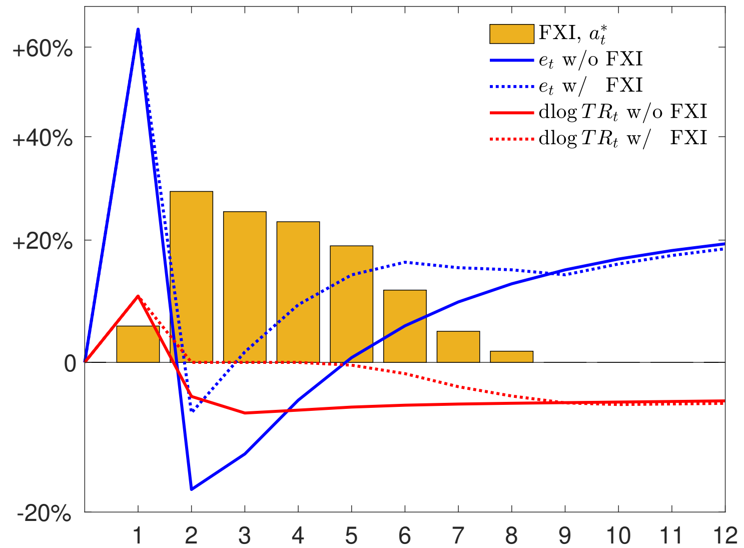


Figure 6: FX interventions

Note: The figure plots the reserve accumulation policy (yellow bars are reserve accumulated starting $t = 0$) that ensures $\mathrm{d}\log TR_t \geq 0$ for one year ($0 \leq t \leq 4$), where one period corresponds to one quarter. Blue lines plots the nominal exchange rate and red lines plot fiscal surplus; solid line for the baseline case without reserve accumulation and dotted lines for the counterfactual with reserve accumulation.

nominal GDP and CPI is equal to:[36]

$$\mathrm{d}\log GDP_t - \mathrm{d}\log CPI_t = (1-\gamma)y_t + \gamma(y_t^* - p_t^*).$$

Thus, abstracting from the utility from holding assets, managing the exchange rate only generates a redistribution between the government and the household budget constraints, which results in the reallocation of expenditure over time — and in this case shifts the real consumption of imports over time — generating a welfare loss. In an economy with heterogeneous households, this has additional redistribution effects between savers and consumers, as we discussed in Section 3.3. Second, the proposed way of boosting fiscal revenues requires that the government accumulates foreign reserves. This policy might, however, be risky when other countries may impose additional financial sanctions on the government. Instead, current FX revenues can be spent on purchasing additional imports or, at least, sold to private agents that face a lower risk of being sanctioned.

# 5 Conclusion

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 equi-

[36]Recall that the nominal GDP in home currency satisfies $\mathrm{d}\log GDP_t = (1-\gamma)(p_t + y_t) + \gamma(e_t + y_t^*)$, while (16) provides the expression for $\mathrm{d}\log CPI_t$.

librium 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:

$$c^*_{it} = \frac{1}{1 - \gamma} \frac{P_t C_{Ht}}{\mathcal{E}_t p^*_{it}}. \tag{17}$$

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 (17) 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.[37] Note that there 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 $P^*_t$

[37] The new allocation, which we denote with ˆs, 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.

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:

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

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 $\tau$ 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 $\mathrm{d}\log(\mathcal{E}_tY_t^*)$ 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:

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

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 $\psi_t$ 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 $\psi_t$ 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

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

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

$$P_t C_{Ht}^R + \mathcal{E}_t P_t^* C_{Ft}^R + \frac{\mathcal{E}_t B_{t+1}^*}{R_t^*} = \mathcal{E}_t B_t^* + (1-\alpha) P_t Y_t + \mathcal{E}_t Y_t^*.$$

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:

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

Given the market clearing condition for local goods

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

consumption of non-tradables by unconstrained agents is equal

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

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:

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

It follows that $C_{Ft} = C_{Ft}^C + C_{Ft}^R = \gamma\frac{P_tY_t}{\mathcal{E}_tP_t^*}$ 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 $\alpha$ (up to a renormalization of parameter $\kappa$).

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

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

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:

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

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 $\omega$. ■

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