Sanctions and the Exchange Rate*

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February 18, 2023

Abstract

Trade wars and financial sanctions are again becoming an increasingly common part of the international economic landscape, and the dynamics of the exchange rate are often used in real-time to evaluate the effectiveness of sanctions and policy responses. We show that sanctions limiting a country's exports or freezing its assets depreciate the exchange rate, while sanctions limiting imports appreciate it, even when both types of policies have exactly the same effect on real allocations, including household welfare and government fiscal revenues. Beyond the direct effect from sanctions, increased precautionary savings in foreign currency also depreciate the exchange rate, when they cannot be offset by the sale of official reserves or financial repression of foreign-currency savings. Furthermore, the government may choose to compensate sanctions-induced fiscal deficits with an exchange rate depreciation using either monetary loosening or FX accumulation; the former solution comes at a cost of higher inflation, while the latter policy provides only a temporary relief. The overall effect on the exchange rate depends on the balance of foreign currency demand and supply forces. We show that the dynamics of the ruble exchange rate following Russia's invasion of Ukraine in February 2022 are quantitatively consistent with the combined effects of these forces calibrated to the observed sanctions and government policies.

*We thank Costas Arkolakis, Laura Castillo-Martinez, Arnaud Costinot, Jonathan Eaton, Sebastián Fanelli, Arnaud Mehl, Romain Rancière and Isabel Vansteenkiste for insightful discussions, numerous seminar and conference participants for very helpful suggestions, Maria Besedovskaya and Timur Magzhanov for outstanding research assistance.

1 Introduction

Despite a period of liberalization following the end of the Cold War, tariffs, trade wars and financial sanctions have become frequent tools of international policymaking in the last ten years. This renewal has led to an increased interest in the welfare and allocative consequences, and more generally the overall effectiveness of different forms of international economic and financial warfare, as well as the ability of affected countries to neutralize its effects with various domestic policies. The real effects of trade restrictions and financial sanctions are often difficult to evaluate in real time, and this is why the exchange rate — a variable that responds observably and swiftly to news and reflects the expected near-term and long-term consequences of policies — has received particular attention as a telltale for the economic impact of trade restrictions and sanctions.

This paper is motivated, in particular, by the recent sequence of sanctions imposed by the West on the Russian economy in response to Russia's invasion of Ukraine on February 24, 2022. In the immediate aftermath of the invasion and the imposition of sanctions, the Russian ruble quickly lost half of its value (see Figure 1). However, a few weeks later, the value of the ruble stabilized and then recovered to its pre-war level in April, appreciating another 30% by June, and changing little since then. These dynamics pose a number of challenges for policy analysis. What explains these large swings in the exchange rate despite a monotonically increasing number of sanctions imposed on the Russian economy? Does a strong ruble mean that sanctions are not working and have only minor effects on the Russian economy, as some critics of sanctions have suggested to emphasize their futility? Or, to the contrary, is the ruble exchange rate no longer relevant for economic allocations because of Russian-imposed capital controls and financial repression, as has been suggested by other commentators?[1] Can monetary policy curb negative effects of sanctions and what trade-offs does it face? Finally, what are the implications for fiscal revenues and what exchange rate policies can be used to mitigate them?

This paper offers a unifying framework to address these questions building on the model from Itskhoki and Mukhin (2021a,b) that has been shown to be consistent with the major exchange rate puzzles. In accordance with the decoupling of Russian financial market from the global market, we assume a form of financial market segmentation in which only the government sector (including state banks and exporting companies) can potentially intermediate capital flows across the border.[2] As a result, the main sources of currency supply are exports and foreign exchange (FX) reserves, while the main sources of currency demand are imports and domestic foreign-currency savings. The equilibrium value of the exchange rate is determined by the balance of currency demand and supply in the domestic market, and depends crucially on shocks in both goods and asset markets. This distinguishes our model from recent papers about sanctions and exchange rates that focus primarily on international trade (e.g. Lorenzoni and Werning 2022). The model is tractable enough to attain a closed-form characterization, yet features a rich set of sanctions and policy tools. As a result, we can perform a detailed quantitative analysis of the effects of a spectrum of sanctions on the exchange rate, welfare, budget deficit and

[1] See e.g. P. Krugman "Wonking Out: The Curious Case of the Recovering Ruble" (NYT, April 1, 2022), S. Guriev "The Incredible Bouncing Ruble" (Project Syndicate, April 12, 2022), and L. Garicano "Sanctions against Russia" (March 8, 2022).

[2] This captures both the segmentation of Russian households from the international financial market and the withdrawal of international investors from the Russian market, eliminating ruble-denominated assets from international portfolios.

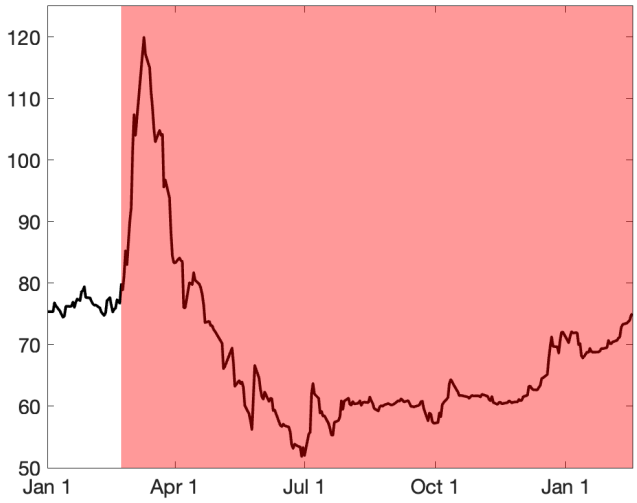

Figure 1: Daily ruble exchange rate (per one USD) since January 1, 2022

consumer price inflation.

Our first main result shows that sanctions limiting imports of a country tend to appreciate the country's exchange rate, while sanctions limiting exports tend to depreciate it, even though both policies have the same effect on real allocations and the resulting welfare. Intuitively, both sanctions reduce the real income of the economy – either by limiting the inflow of dollars or increasing the dollar prices of foreign goods – resulting in lower consumption of foreign foods. We show that this equivalence is a manifestation of Lerner (1936) symmetry, which postulates that export and import restrictions yield the same economic outcomes, but are sustained by a differential movement in relative prices.[3] In our context, since export sanctions reduce the supply of foreign currency, they depreciate the country's exchange rate, and vice versa import sanctions reduce the demand for foreign currency and appreciate the country's exchange rate.

This observation clarifies several recently debated issues. First, it follows immediately that there is no monotonic relationship between the exchange rate and welfare. Therefore, one cannot evaluate the effectiveness of sanctions based solely on the dynamics of the exchange rate. Second, while the equivalence of import and export restrictions implies that the same real effects can be achieved using either of the two instruments, their effectiveness is limited if the sanctioned country can find alternative trade partners. In this case, it might be optimal to employ both types of sanctions as they have a

[3]By Lerner symmetry, export (import) restrictions result in a reduction (increase) in the country's relative nominal wages — a form of a *real* depreciation (appreciation) — in order to achieve intertemporal trade balance. The *terms of trade*, however, move in the same way for both cases: in particular, they deteriorate under foreign-imposed restrictions. Nonetheless, measuring the effective terms of trade is challenging because many trade sanctions take the form of quantity restrictions. For this reason, we follow the same approach as most commentators and focus on the easily observable *nominal* exchange rate. For the recent macroeconomic analysis of Lerner symmetry in other contexts see Farhi, Gopinath, and Itskhoki (2014), Barbiero, Farhi, Gopinath, and Itskhoki (2019), Costinot and Werning (2019) and Lindé and Pescatori (2019). While trade application of Lerner symmetry emphasize *uniform* tariffs across traded goods, *macroeconomic* symmetry emphasizes uniform shifts in aggregate terms of trade over time (see Itskhoki and Mukhin 2023).

cumulative complementary effect.[4] Finally, the equivalence does not hold for transitory sanctions. Under temporary export sanctions, households need to borrow to smooth out temporary export income shocks. In contrast, under temporary import sanctions, households have an incentive to delay imports and save while import prices are temporarily high. Therefore, for a country cut off from international borrowing, transitory export sanctions have a larger welfare effect than equivalent import sanctions.[5]

Perhaps most surprisingly, the equivalence result for export and import sanctions extends to the fiscal balance, even when the government relies exclusively on exports for fiscal revenues. This is achieved by means of a general equilibrium adjustment in the exchange rate. That is, a depreciation partially ameliorates the impact of export sanctions by increasing the purchasing power of export tax revenues in the domestic economy. In contrast, import sanctions result in an exchange rate appreciation, which reduces the purchasing power of export tax revenues. A strong domestic currency (exchange rate) compromises budget balance when fiscal liabilities are, at least in part, denominated in the home currency (goods). Thus, we further study ways in which the government may depreciate the exchange rate to improve its fiscal balance. This can be done either by means of a monetary devaluation at the cost of a higher domestic inflation or using FX accumulation that depreciates the exchange rate without changing domestic prices. However, the latter solution can boost only temporarily the fiscal balance of the government without changing the intertemporal government budget constraint.

Turning to financial sanctions, we show that their effects depend crucially on the policy response. In particular, an increase in the household precautionary demand for foreign currency due to a collapsing supply of alternative vehicles for savings — e.g. local stock market, bank deposits, government bonds — depreciates the exchange rate in the absence of government interventions. Indeed, with financial restrictions on international borrowing, a large jump-depreciation of the exchange rate is required to restore equilibrium, since the currency supply to the domestic economy is inelastic in the short run. On the one hand, such depreciation results in a negative wealth effect, which reduces the foreign-currency savings demand. On the other hand, it accommodates a reduction in the import demand, which releases foreign currency from export revenues for savings purposes. The effect of the financial shock is, thus, transitory and dies out as households accumulate enough foreign currency savings from export revenues.

The optimal policy response to the financial shock aims to offset it by selling FX reserves to the households. This is a welfare enhancing intervention because it accommodates the increased household demand for foreign currency without an exchange rate devaluation and a drop in import consumption (see Itskhoki and Mukhin 2022). FX interventions, however, rely on the availability of official reserves, and this policy may be altogether infeasible under international financial sanctions against the central bank. Indeed, this was the case for the Russian central bank which was constrained from curbing the

[4] We take import price and export revenue aggregators, which combine all bilateral trade flows, as primitives of the model. These can be measured directly in the data and constitute a sufficient statistic for the macroeconomic effect on the exchange rate and welfare. Studying sanctions evasion and the substitution between trade partners is crucial for the optimal *bilateral* sanctions design, but goes beyond the scope of this paper.

[5] In the case of Russia, steep financial sanctions were combined with import sanctions, while contemporaneously export revenues increased due to high energy prices. This meant that foreign currency became abundant, while foreign goods became scarce, appreciating the exchange rate and eliminating potential forces for a banking and currency crisis.

exchange rate depreciation with conventional FX interventions when financial sanctions were imposed.

In the absence of available FX reserves, we show how the government can use financial repression to offset the effects of financial shocks on the exchange rate and import consumption, albeit with a distortion in the domestic financial market. Specifically, the central bank can reduce the household foreign currency demand for savings purposes by lowering the returns on foreign currency deposits through fees on purchasing and withdrawing foreign currency.[6] We show that financial repression is suboptimal in a baseline model with a representative household: in particular, the gains from stabilizing the exchange rate and imports do not fully compensate for the distortion of the safe asset demand. However, the trade-off is more nuanced in an extension with heterogenous agents because financial repression that appreciates the exchange rate shifts welfare from savers towards hand-to-mouth consumers (*cf.* Fanelli and Straub 2021, Auclert, Rognlie, Souchier, and Straub 2021). Importantly, the view that the exchange rate is not allocative is unwarranted in either case. Only in the counterfactual limiting case, with no imports and full financial repression, does the exchange rate become an irrelevant variable, even if it appreciates without bound from the currency proceeds from commodity exports.

Finally, we quantitatively evaluate the ruble exchange rate dynamics since the beginning of the war by combining financial and trade sanctions in a calibrated model. We calibrate the import and savings demand elasticities, and sanctions shocks to the observed dynamics of Russian imports, export revenues, domestic output, precautionary asset demand and official reserves. This allows the model to closely match both the sharp depreciation of the ruble in the first weeks of the war and the ensuing persistent appreciation that lasted through the fall of 2022. The model-based decomposition suggests that the foreign asset freeze had a small *direct* effect on the ruble, and that the initial depreciation was largely caused by a sharp increase in precautionary demand for foreign currency by the households. The central bank was unable to accommodate this increased demand with conventional FX interventions and instead had to resort to financial repression — the *indirect* consequence of financial sanctions. The appreciation of the ruble in the medium term is explained by an unprecedented trade surplus due to the increase in global energy prices, the fact that the West chose to concentrate sanctions on Russian imports and not exports, as well as a smaller effect from domestic recession. As the fall in imports mean-reverts over time and Russian commodity exports decline with the anticipated rounds of sanctions, the model predicts an eventual depreciation of the ruble in the near term. We further use the calibrated model to evaluate the impact of sanctions on the household welfare and the government fiscal balance, as well as alternative policy responses — including FX reserve accumulation — aimed at reducing the fiscal deficit. Specifically, the welfare impact of sanctions predicted by the model is equivalent to a 10.3% permanent decline in the aggregate real consumption, with a larger welfare effect in the first year.

This paper contributes to the growing literature on the economic effects of sanctions. Korhonen (2019) provides a recent survey of the earlier work with particular focus on the Russian economy.[7] The

[6] Indeed, the Russian central bank introduced a temporary fee on buying foreign currency in March-April, which lowered the depreciatory pressure on the exchange rate.

[7] For broader surveys of the earlier work on international sanctions see Eaton and Sykes (1998) and Hufbauer, Schott, and Elliott (2009). A large parallel literature, summarized recently in Fajgelbaum and Khandelwal (2022), studies the economic effects of tariffs and trade wars. Related macroeconomic literature on cyclical trade wars, currency wars and currency manipulations includes Auray, Devereux, and Eyquem (2021), Jeanne (2021) and Hassan, Mertens, and Zhang (2022). See also

analysis of the effects of a Russian energy export ban on the European economy is the focus of Bachmann, Baqaee, Bayer, Kuhn, Löschel, Moll, Peichl, Pittel, and Schularick (2022). Bianchi and Sosa-Padilla (2022), Sturm (2022) and de Souza, Hu, Li, and Mei (2022) study the design of optimal sanctions (see also the early work on the topic, e.g. Eaton and Engers 1992). Eichengreen, Ferrari, Mehl, Vansteenkiste, and Vicquery (2022) provide historical evidence about the effects of trade sanctions which validate the main predictions of our model. Our results on trade sanctions are closely related to the contemporaneous work of Lorenzoni and Werning (2022). We show how to cast the analysis of static trade sanctions within a macroeconomic model of Lerner (1936) symmetry, and then go beyond it to analytically and quantitatively study the implications of dynamic trade and financial sanctions for exchange rates, welfare, inflation and government revenues under alternative policy responses.

2 Modeling Environment

Consider a small open endowment economy with consumption of non-tradables and imported tradables, and exports of commodities. The model features a strong form of financial market segmentation whereby only the government financial sector can potentially intermediate capital flows across the border and satisfy the household demand for foreign currency.[8]

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

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

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 the prices of home and imported goods in the home and foreign currency, respectively, and W_t is the nominal wage bill for the home households. $\mathcal{E}_t$ is the nominal exchange rate, defined as the units of home currency for one unit of foreign currency; an increase in $\mathcal{E}_t$ corresponds to a home currency devaluation. (B_t, B^*_t) are quantities of home and foreign currency deposits at home market interest rates (R_t, R^*_{Ht}). Households are assumed to have the real value of foreign currency deposits in their utility function reflecting hedging (precautionary) demand for purchasing foreign tradables, and Ψ_t captures a shock to the demand for foreign currency balances.[9]

the recent work of Ghironi, Kim, and Ozhan (2022) for the dynamic equilibrium analysis of trade sanctions.

[8] An alternative modeling approach features a frictional international intermediation sector as a source of inelastic foreign currency supply (as in Gabaix and Maggiori 2015, Itskhoki and Mukhin 2021a). Our modeling choice is motivated by both simplicity and realism in the case of Russia under international sanctions.

[9] We use this simple setup with bonds in the utility to generate fundamental foreign currency demand shocks, as opposed to an alternative setup with noise currency traders (as in Jeanne and Rose 2002, Itskhoki and Mukhin 2021a). This makes our model directly amenable to the welfare and normative analysis of such policies as financial repression. The precautionary demand for safe assets also 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). Lastly, we note that all our results still hold if real bond holdings are computed using the consumer price index by replacing B^*_t/P^*_t with $\mathcal{E}_t B^*_t/CPI_t$ in $v(\cdot)$.

In terms of functional forms, we assume that the utility aggregator $u(\cdot)$ is homogeneous in (C_{Ht}, C_{Ft}), increasing and concave in both variables, and satisfies the Marshall-Lerner condition. Note that this allows for arbitrary values of the risk aversion and the intertemporal elasticity of substitution. The utility from the FX bond holdings $v(\cdot)$ is weakly increasing and concave in B^*_{t+1}/P^*_{t+1}, with a saturation point and a positive cross-partial derivative in the two arguments. We normalize the bond demand shock such that $B^*_{t+1}/P^*_{t+1} = \Psi_t$ corresponds to the saturation point for a given value of Ψ_t. This point determines the steady state value of private foreign currency holdings.[10] In our examples and quantitative illustrations, 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 $\kappa \geq 0$ is the bond demand parameter.[11]

Government, production, finance We combine the government, production and financial sectors into one entity. While being a useful abstraction, this approach is representative of the structure of the Russian economy, where the public sector accounts, directly and indirectly, for a major fraction of employment in both tradables and non-tradables (natural resources, transportation, healthcare and education), as well as in financing and banking. The budget constraint of the government sector is:

$$\mathcal{E}_t\left(\frac{F^*_{t+1}}{R^*_t} - F^*_t\right) - \mathcal{E}_t\left(\frac{B^*_{t+1}}{R^*_{Ht}} - B^*_t\right) - \left(\frac{B_{t+1}}{R_t} - B_t\right) = \mathcal{E}_t Y^*_t + P_t Y_t - W_t, \tag{4}$$

where Y_t is the endowment of non-tradable home goods and Y^*_t are commodity export revenues in foreign currency. We denote with $TR_t \equiv \mathcal{E}_t Y^*_t + P_t Y_t$ the aggregate national income in home currency. W_t is the wage commitment to the households fixed in nominal terms in home currency.

While we abstract from price rigidities given the large size of the shock and quick inflation response 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, and the government infrequently resets the wage commitment to satisfy the government budget constraint. One can also generalize (4) to include other government expenditures G_t which do not contribute to the household consumer surplus (military expenditures), with the effects of G_t on the exchange rate isomorphic to the effect of a lower output Y_t.

Finally, F^*_t are the net foreign assets of the country and R^*_t is the world interest rate in foreign currency. The liabilities of the government sector are FX and home currency bonds, B^*_t and B_t, which are held by the households. The set of government policy instruments includes:

[10] Formally, we assume that $u_{Jt}(\cdot) > 0$ and $u_{JJt}(\cdot) < 0$ for $J \in \{H, F\}$, where the index denotes a partial derivative, e.g. $u_{Jt} \equiv \partial u_t/\partial C_{Jt}$ and $u_t \equiv u(C_{Ht}, C_{Ft})$. Futhermore, homogeneity implies that u_{Ht}/u_{Ft} is a decreasing function of C_{Ht}/C_{Ft}. We require that the elasticity of substitution between C_{Ft} and C_{Ht} is greater than one: that is, $-\partial \log(C_{Ft}/C_{Ht})/\partial \log(\mathcal{E}_t P^*_t/P_t) \geq 1$, which holds if and only if $0 < \frac{-u_{FFt}C_{Ft}}{u_{Ft}} + \frac{u_{HFt}C_{Ft}}{u_{Ht}} \leq 1$, and corresponds to the Marshall-Lerner condition in our model. Finally, we assume $v'(\cdot) > 0$ and $v''(\cdot) < 0$ for $B^*_{t+1}/P^*_{t+1} < \Psi_t$ and $v'(\cdot) \leq 0$ for $B^*_{t+1}/P^*_{t+1} \geq \Psi_t$, where we denote $v' \equiv \partial v/\partial(B^*_{t+1}/P^*_{t+1})$.

[11] This utility specification implies that θ is also the intertemporal elasticity of substitution and $\sigma = 1/\theta$ is the relative risk aversion. The case with $\theta = 1$ further corresponds to the Cole and Obstfeld (1991) case wherein $\sigma = \theta = 1$.

1. a standard fiscal choice between borrowing B_t and adjusting expenditure W_t;
2. a conventional monetary policy tool R_t that pins down the path of domestic prices P_t;
3. accumulation (or decumulation) of government holdings of foreign reserves, $F_t^* - B_t^*$;
4. measures of financial repression (capital controls) that depress households' returns on foreign currency savings R_{Ht}^*, which may deviate from the international rate of return R_t^* due to household segmentation from the international asset market (Itskhoki and Mukhin 2022).[12]

Equilibrium conditions The goods market clearing condition in the non-tradable sector is:

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

The home currency nominal interest rate R_t allows the government to control non-tradable inflation P_{t+1}/P_t by choosing the slope of the household Euler equation, $\beta R_t \mathbb{E}_t \left\{ \frac{u_{H,t+1}}{u_{Ht}} \frac{P_t}{P_{t+1}} \right\} = 1$ with $u_{Ht} \equiv u_H(C_{Ht}, C_{Ft})$, which acts as a side equation and does not play a central role in our analysis.

The demand for imports derives from consumer expenditure optimization:

$$\frac{C_{Ft}}{C_{Ht}} = h\left(\frac{\mathcal{E}_t P_t^*}{P_t}\right) \qquad \text{with} \quad h'(\cdot) < 0, \tag{6}$$

where $h(\cdot)$ is defined by its inverse $h^{-1}(C_{Ft}/C_{Ht}) \equiv u_{Ft}/u_{Ht}$ with elasticity $\theta(x) \equiv -\frac{\partial \log h(x)}{\partial x} \geq 1$. Under the CES aggregator in (3), we have $h(\mathcal{E}_t P_t^*/P_t) = \frac{\gamma}{1-\gamma}(\mathcal{E}_t P_t^*/P_t)^{-\theta}$ with $\theta \geq 1$. Condition (6) is our first key equation which determines the equilibrium value of the exchange rate from the point of the relative consumption of imports in the goods market.[13]

The other two key equilibrium conditions for exchange rate determination are the country budget constraint and the household demand for foreign currency. First, combine the household and government budget constraints (2) and (4) expressed in foreign currency, together with the non-tradable market clearing condition (5), to derive the country budget constraint:[14]

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

where NX_t^* denotes the country's net exports expressed in foreign currency terms. Note that NX_t^* is also the inflow of new foreign currency (outflow if negative), while F_t^* is the stock of foreign currency held jointly by the households (B_t^*) and the government ($F_t^* - B_t^*$).

[12] In fact, financial repression may result in expected returns $R_{Ht}^* < 1$ given a possible forced conversion into home currency or inability to withdraw FX deposits from the banking system, or due to an explicit tax on foreign currency purchases.

[13] 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).

[14] 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 because it only results in a transfer between households and the government sector, as captured by (4).

Finally, the household demand for foreign currency B^*_{t+1} must satisfy the following Euler equation:

$$\beta R^*_{Ht}\mathbb{E}_t\left\{\frac{P^*_t}{P^*_{t+1}}\left[\frac{u_{F,t+1}}{u_{Ft}}+\frac{v'_{t+1}}{\beta u_{Ft}}\right]\right\}=1, \tag{8}$$

where $v'_{t+1}\equiv v'(B^*_{t+1}/P^*_{t+1};\Psi_t)$. Under the parametric assumptions in (3), this condition simplifies to $\beta R^*_{Ht}\mathbb{E}_t\left\{P^*_t/P^*_{t+1}\cdot\left[(C_{Ft}/C_{F,t+1})^{1/\theta}+\tilde{\kappa}C_{Ft}^{1/\theta}(\Psi_t-B^*_{t+1}/P^*_{t+1})\right]\right\}=1$ with $\tilde{\kappa}\equiv\frac{\theta}{\theta-1}\frac{\kappa}{\beta\gamma^{1/\theta}}\geq 0$. While the country budget constraint (7) features the world interest rate R^*_t, household currency demand depends on their expected return of holding foreign currency R^*_{Ht}, which may be depressed relative to R^*_t in the presence of capital and financial controls. In addition to the conventional consumption smoothing motive for savings, household currency demand (8) is also shaped by the $\Psi_t>0$ shock which reflects additional precautionary savings motives as well as demand for safe assets. In particular, an increase in Ψ_t above the real value of household FX savings B^*_{t+1}/P^*_{t+1} results in a positive v'_{t+1} term, and thus compels the households to increase their holdings of foreign currency bonds despite their, possibly, low expected return R^*_{Ht}.

Sanctions In our analysis, we consider a variety of individual sanctions as well as their combined effects. In particular, we allow for the following sanction shocks:

1. Export sanctions reduce foreign-currency export revenues Y^*_t. From the point of view of the domestic economy, it does not matter whether this is done by means of a tax (reduction in export price) or a quantity restriction.
2. Import sanctions ration C_{Ft} without changing the price of available products or increase P^*_t, e.g. by means of a tax on imports. In fact, the two cases are equivalent when we model C_{Ft} as a continuum of imperfectly substitutable import varieties, some of which are taxed or made unavailable altogether, in both cases raising the ideal import price index (see Appendix B).
3. The exit of foreign multinationals from the economy and the withdrawal of foreign intermediate inputs are captured with an exogenous reduction in non-tradable output Y_t.
4. Foreign asset freezes reduce F^*_t, whether in private or public hands.[15]
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 say a country is in financial autarky when that country cannot borrow internationally or invest in assets abroad, but can still 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 the domestic foreign currency market must satisfy $B^*_{t+1}\leq F^*_{t+1}$. Thus, foreign cash accu-

[15] Sanctions could also have balance sheet effects on the private financial sector, provided it holds foreign currency debt (via valuation effects; see e.g. Gourinchas and Rey 2014). We omit this mechanism from our analysis because Russian companies had little gross foreign debt by 2022 as a result of existing financial sanctions that were imposed since 2014.

mulated from trade surpluses is the only source of foreign currency that can be used for foreign-currency savings.

6. Financial sanctions are also associated with an increase in the household precautionary demand for foreign currency Ψ_t due to a collapsing supply of alternative vehicles of savings, and in particular safe assets.[16]

Equilibrium Taking endowments (Y_t, Y_t^*), import price P_t^*, and the world interest rate R_t^* as given, 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 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, and the level of financial repression $R_{Ht}^* \leq R_t^*$ of foreign currency deposits. Note from the equilibrium system that $\mathcal{E}_t/P_t$ (a measure of the real exchange rate) is determined independently of monetary policy (inflation), and changes in home good 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 $v'(\cdot) > 0$, Ricardian equivalence does not apply for savings in foreign currency because households cannot costlessly adjust B_{t+1}^* to offset the government asset position. Hence, the choice of government reserves $(F_{t+1}^* - B_{t+1}^*)$ affects the equilibrium allocation.

3 Sanctions in a Stationary Equilibrium

We start by studying the properties of a stationary equilibrium to develop simple intuition for the effects of sanctions, which as we show in Section 4.1 are robust in a dynamic environment. We defer the analysis of financial shocks and financial repression until Section 4.2, as their effects are inherently dynamic. Stationary equilibrium is characterized by a two-equation log-linear system that admits a tractable closed-form solution for the effects of various sanctions on outcomes of interest, in particular the exchange rate and welfare.

Specifically, we consider permanent sanction shocks in a stationary equilibrium with access to foreign financial markets, $R_{Ht}^* = R_t^*$, assuming $\beta R_t^* = 1$, and in the absence of foreign currency demand shocks, $\Psi_t = 0$. Thus, we drop the time index in the rest of this section. Under these circumstances, a stationary equilibrium with $B^* = 0$ satisfies the Euler equation (8) which ensures financial market equilibrium with a stationary exchange rate $\mathcal{E}$. Thus, permanent sanction shocks result in no equilibrium transition and a jump to a new stationary equilibrium $(C_F, \mathcal{E})$ that satisfies the country budget constraint (7) and import demand (6).

For concreteness, we focus on the case with a CES demand aggregator as in (3), and model imports C_F as an aggregator of a continuum of import varieties of measure γ. Furthermore, we model import sanctions as an import ban on measure $\delta \in (0, \gamma)$ of these varieties, while the remaining varieties are traded without restriction. In Appendix B, we derive that the equilibrium system (6)–(7), given

[16] In the Russian context, the local stock market collapsed, home currency deposits were subject to inflation and bank-run risks, and access to foreign assets was constrained.

home good market clearing $C_H = Y$, can be written as follows:

$$\mathcal{E}P^*C_F = \frac{\gamma-\delta}{1-\gamma}\left(\frac{\mathcal{E}\bar{P}^*}{P}\right)^{1-\theta} PY, \tag{9}$$

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

where $\bar{P}^*$ is the import price index before import sanctions, and the import price index after sanctions is given by $P^* = \left(\frac{\gamma}{\gamma-\delta}\right)^{\frac{1}{\theta-1}} \bar{P}^*$.[17] In particular, $\bar{P}^*$ remains the observed average price of imports after sanctions, while P^* characterizes the welfare-relevant increase in the cost of an import bundle when a range δ of import varieties disappears. Interestingly, this characterization applies both for $\theta > 1$ and in the Cobb-Douglas limit $\theta \to 1$, where the impact of import sanctions results in an infinite welfare cost.

This two-equation system captures the dual role of the exchange rate in switching expenditure between home non-tradables and imported tradables and in balancing the net present value of net exports. Equation (10) is the steady-state version of the country budget constraint (7) where we use $1/R^* = \beta$ and hence $(1-\beta)F^*$ corresponds to the flow return from net foreign assets. Equation (9) characterizes the total import expenditure that arises from import demand (6), aggregating over the available import varieties, as derived in Appendix B. In particular, the term $\frac{\gamma-\delta}{1-\gamma}\left(\frac{\mathcal{E}\bar{P}^*}{P}\right)^{1-\theta}$ in (9) captures the relative expenditure share on imports versus the home goods, with this expenditure share shifting inwards with import sanctions δ, as well as with exchange rate depreciation ($\mathcal{E}\uparrow$) provided that $\theta > 1$.

The country budget constraint (10) combined with the expression for P^*, characterizes the welfare-relevant (real) quantity of imports:

$$C_F = \left(\frac{\gamma-\delta}{\gamma}\right)^{\frac{1}{\theta-1}} \frac{Y^* + (1-\beta)F^*}{\bar{P}^*}. \tag{11}$$

All sanctions — whether on imports ($\delta\uparrow$), exports ($Y^*\downarrow$) or foreign assets ($F^*\downarrow$) — result in a reduction in welfare by means of a reduction in the import quantity C_F. Combining (9) and (10), we solve for the equilibrium exchange rate:[18]

$$\mathcal{E}^\theta = \frac{\gamma-\delta}{1-\gamma}\left(\frac{\bar{P}^*}{P}\right)^{1-\theta} \frac{PY}{Y^* + (1-\beta)F^*}. \tag{12}$$

In fact, this condition characterizes the real exchange rate, $\mathcal{E}/P$, as a function of shocks $\{Y, Y^*, F^*, \delta\}$. Monetary policy then determines the price level P, and thus the resulting nominal exchange rate $\mathcal{E}$.

Comparing (11) and (12), it is immediately apparent that the change in the exchange rate is not a sufficient statistic for the welfare impact of sanctions, as import sanctions and domestic recessions ($Y^*\downarrow$) appreciate the exchange rate ($\mathcal{E}\downarrow$), while export sanctions and foreign asset freezes result in a depreciation ($\mathcal{E}\uparrow$). We summarize these results in a proposition and interpret them below.

[17] Note that combining the expression for P^* with (9) and rearranging results in the CES version of equation (6).

[18] Interestingly, characterization in (12) applies both for $\theta > 1$ and for the Cobb-Douglas limit $\theta \to 1$, in which case it simplifies to $\mathcal{E} = \frac{\gamma-\delta}{1-\gamma}\frac{PY}{Y^*+(1-\beta)F^*}$.

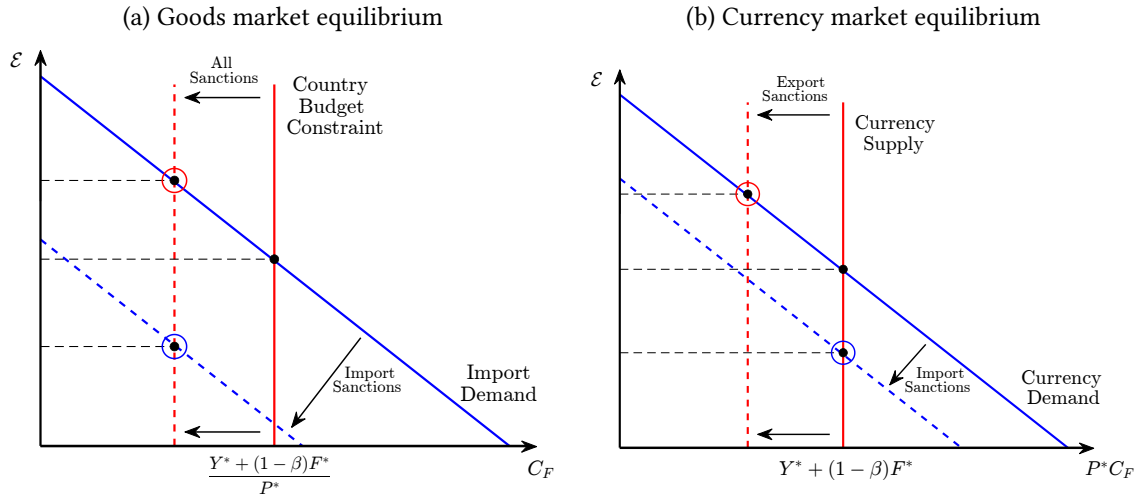

Figure 2: Export and Import Sanctions

Note: The left panel describes the equilibrium in the goods market by plotting (9)–(10) in $(C_F, \mathcal{E})$ space, while the right panel describes the equilibrium in the currency market by plotting the same conditions in the $(P^*C_F, \mathcal{E})$ space. Export sanctions shift (10) leftward in both panels, while import sanctions do the same only in the left panel. Import sanctions additionally shift inward (9) in both panels. The equilibrium points are characterized by (11)–(12). See discussion in the text.

Proposition 1 *In a stationary equilibrium, foreign asset freezes and sanctions on exports depreciate the exchange rate, while import sanctions and domestic recessions result in exchange rate appreciation. All international sanctions result in a reduction in the real value of imports and consumer welfare.*

The import and welfare effects of international sanctions operate via the country budget constraint (10). All types of sanctions make this constraint tighter, whether by reducing revenues $Y^* + (1-\beta)F^*$ or by increasing the real cost of imports P^*. The result is a lower feasible real import consumption C_F. At the same time, the direction of sanctions' impact on the exchange rate depends on whether sanctions reduce country's international income or increase the cost of foreign goods. There are two equivalent ways to see this result, as we illustrate in the two panels of Figure 2.

First, consider equilibrium in the currency market. In a stationary equilibrium without financial shocks, export revenues and flow returns on net foreign assets constitute the supply of foreign currency to the economy, while import expenditure is the only source of demand for foreign currency. Since the currency market must clear, the country's exchange rate depreciates when FX is scare and appreciates when FX is abundant. Export and asset sanctions limit the supply of currency and result in a depreciation. Import sanctions limit the demand for currency and induce an appreciation. The equilibrium in the currency market in this case is a direct reflection of the equilibrium in the goods market. This balance condition can be restated in terms of goods flow, trade balance and the real exchange rate.[19] Our approach of focusing on the currency market is less conventional in real international macro models, but it provides a clear intuition in this case and proves particularly useful later when we consider asset market demand for foreign currency.

[19]Export and asset sanctions reduce a country's income and its overall purchasing power in the international market. Hence the real exchange rate must depreciate to shift expenditure away from imports which become unaffordable according to the country's new budget constraint. Import sanctions do the opposite, as we discuss later in the text.

Second, consider equilibrium from the perspective of expenditure switching and demand for imports. Sanctions on imports shift inward the total import expenditure (9) as a range of import varieties δ becomes unavailable. At the same time, without export sanctions, the purchasing power of the economy remains high. As a result, there must be a home exchange rate appreciation in equilibrium to ensure that aggregate imports still exhaust the country budget constraint. This appreciation reduces the real value of exports (in terms of home goods) and shifts expenditure towards the available import varieties. In other words, as some varieties of imports disappear, the home country needs to shift expenditure towards the varieties of imports that are still available but would not be demanded unless their relative prices fell as a result of exchange rate appreciation.[20] This mechanism is the focus of Lorenzoni and Werning (2022). We show in Section 4.1 below that this result is a macroeconomic version of the fundamental Lerner (1936) symmetry property in international trade.

Domestic production, prices and government budget The equilibrium exchange rate expression (12) has two additional implications for the effect of domestic output Y and prices P. First, a domestic recession ($Y \downarrow$) as a result of the war and sanctions instigates a decrease in the home good consumption, C_H. This has a negative income effect on the demand for imports, shifting the import expenditure schedule (9) inwards for a given level of export revenues and import prices. This again results in abundance of FX in the home market, as import demand shifts in, and leads to the home exchange rate appreciation ($\mathcal{E} \downarrow$), just like the import sanctions discussed above. Therefore, import sanctions trigger an exchange rate appreciation either via their direct effect on imports or indirectly by disrupting the production chains in the domestic economy and causing a domestic recession.

Second, equation (12) only pins down the real exchange rate, $\mathcal{E}/P$, while the domestic price level P and the nominal exchange rate $\mathcal{E}$ shift proportionally with the home monetary stance. This is intuitive as equations (9)–(10) characterize the international equilibrium conditions leaving the choice of domestic monetary policy unconstrained. Thus, Proposition 1 describes the real international forces behind exchange rate appreciations and depreciations. Yet, if the war and sanctions trigger a further domestic inflation shock — beyond the increase in the real cost of imports P^* — this results in an additional proportional exchange rate depreciation. That is, while import sanctions exert a direct force for a real appreciation, their indirect effect on monetary policy may result in an overall nominal depreciation.

Why would sanctions create inflationary pressure? Beyond their effects on the cost of imports $\mathcal{E}P^*$ (see Section 4.1), both export and import sanctions tighten the government budget constraint (4). In steady state (with $R = R^* = 1/\beta$ and, for simplicity, $B = 0$), this budget constraint can be written as:

$$\frac{W}{P} \leq Y + \frac{\mathcal{E}}{P}\left[Y^* + (1-\beta)(F^* - B^*)\right]. \tag{13}$$

Export and foreign asset sanctions reduce the revenue side of the fiscal balance (13) directly, while import sanctions do it indirectly via the equilibrium exchange rate appreciation, $\mathcal{E}/P$, given by (12).

[20] Welfare losses in this case consist of the substitution from desired but sanctioned import varieties towards the less desired import varieties that are not sanctioned. This is reflected in P^* increasing with δ even as the average price of imports $\bar{P}^*$ remains unchanged. In the Cobb-Douglas limit, such welfare losses become unbounded (consider e.g. the case of unavailable drugs and medical equipment; see Ossa 2015).

Nonetheless, there always exists a level of home price inflation P such that (13) holds. That is, the government satisfies its nominal wage commitment W (*cf.* with the fiscal theory of the price level, e.g. Bassetto 2008). This level of inflation — and the corresponding nominal depreciation — is increasing with the intensity of sanctions. We provide a quantitative assessment of the need to monetize the fiscal deficit, and the resulting nominal depreciation, in Section 5.

4 Sanctions: A Dynamic Analysis

We now extend our analysis to a fully dynamic environment with stochastic shocks. This allows us to generalize the results of Proposition 1 outside of a stationary equilibrium and consider a richer set of trade and financial sanctions combined with a policy response that includes financial repression and FX interventions. In particular, we emphasize the role of distinct sources of currency demand in the goods market (for purchasing imports) and in the financial market (for savings) in shaping the equilibrium exchange rate. We also consider a variety of extensions, including one with heterogenous households which sheds light on an economic rationale for financial repression.

4.1 Trade sanctions

We first consider trade sanctions in a dynamic equilibrium and prove a general equivalence result that extends the logic of Proposition 1. Specifically, we assume here that trade sanctions are imposed without excluding the country from the world financial market. 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 shocks $(Y_t, Y^*_t, P^*_t, R^*_t, \Psi_t)$, policy choices $(R_t, P_t, F^*_{t+1} - B^*_{t+1})$ and the initial net foreign assets F^*_0. We model import sanctions as a generic increase in the cost of imports P^*_t, whether due to a tax or a ban on a subset of import varieties (see Appendix B).

Using the equilibrium system, we prove the main general equivalence result:

Proposition 2 *A permanent sanctions shock on imports, $P^*_t \uparrow$ for all $t \geq 0$, is equivalent to a combination of a permanent sanctions shock on exports, $Y^*_t \downarrow$ for all $t \geq 0$, combined with a partial seizure of 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 exports (cum foreign assets) are associated with an exchange rate depreciation, $\mathcal{E}_t \uparrow$, while sanctions on imports are associated with an exchange rate appreciation, $\mathcal{E}_t \downarrow$.*

Proposition 2 generalizes the results of Proposition 1 to a fully dynamic environment with arbitrary pathes of shocks to domestic production Y_t and inflation P_t, precautionary demand for foreign assets Ψ_t, and other exogenous shocks. To prove Proposition 2, note that the budget constraint (7) can be written in real units of aggregate imports C_{Ft} by dividing it through by the import price index P^*_t:

$$\frac{P^*_{t+1}/P^*_t}{R^*_t} \frac{F^*_{t+1}}{P^*_{t+1}} - \frac{F^*_t}{P^*_t} = \frac{Y^*_t}{P^*_t} - C_{Ft} \tag{14}$$

A once-and-for-all increase in all P^*_t at $t = 0$, by $x\%$, does not change the path of real return on foreign bonds, $R^*_t \frac{P^*_t}{P^*_{t+1}}$ for all $t \geq 0$. It is equivalent to a permanent reduction in Y^*_t at $t = 0$, also by $x\%$, com-

bined with a proportional reduction in the initial net foreign assets F_0^*. Then, the same path of imports C_{Ft} and the same evolution of real net foreign assets F_t^*/P_t^* occurs under both sanctions regimes. A reduction in Y_t^*/P_t^* can be interpreted as a negative *terms-of-trade* shock, which summarizes the overall macroeconomic effect of sanctions on the equilibrium allocation. Conditional on the path of aggregate terms of trade Y_t^*/P_t^*, whether sanctions are uniform or not across goods and trade partners is not essential for their macroeconomic impact. However, the exact equivalence applies only when the sanctions shocks are one-time, unanticipated, and permanent; we discuss below the alternative case of transitory sanctions.[21]

The Euler equation (8) is equivalently satisfied under both regimes for the same (sanctioned) path of C_{Ft} and the same real value of foreign currency holding by households B_{t+1}^*/P_{t+1}^*.[22] To establish the consequences for the exchange rate, we study the import demand schedule (6), combined with home non-tradable market clearing (5), which we rewrite as follows:

$$\mathcal{E}_t = \frac{P_t}{P_t^*} \cdot h^{-1}\left(\frac{C_{Ft}}{Y_t}\right), \tag{15}$$

where $h^{-1}(\cdot)$ is a decreasing function. Therefore, the export and foreign asset 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, as we discussed in the previous section.

Next, consider import sanctions. From the budget constraint, export and foreign asset sanctions reduce C_{Ft} by $x\%$. Import sanctions achieve the same effect via an increase in P_t^* by $x\%$. The intuition is that $P_t^* C_{Ft}$ enters the country budget constraint multiplicatively. Thus, a tighter budget constraint from an increase in P_t^* requires a reduction in C_{Ft} by the same proportion (i.e. a unitary elastic effect of the budget constraint). The elasticity of substitution between imports and domestic consumption, as defined in Section 2, is $\theta_t \equiv -\frac{\partial \log(C_{Ft}/C_{Ht})}{\partial \log(\mathcal{E}_t P^*/P_t)} \geq 1$. Therefore, 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 relative import consumption, C_{Ft}/Y_t. Consequently, the nominal exchange rate must appreciate under import sanctions when $\theta_t > 1$, and the extent of the appreciation is given by:[23]

[21] A more general equivalence for dynamic, partially anticipated sanctions shocks requires the use of additional capital controls to offset the tilt in the FX demand in (8) and the budget constraint (14) induced by anticipated changes in import prices P_t^* (see Farhi, Gopinath, and Itskhoki 2014).

[22] The equivalence does not require differential policy for government reserve accumulation, so long as real reserves $(F_t^* - B_t^*)/P_t^*$ follow the same path under both regimes. Under import sanctions, the real value of NFA F_t^*/P_t^* falls because of an increase in P_t^*. Under export sanctions (cum NFA freeze), the real value of NFA falls proportionally due to direct sanctions on F_t^*. As long as the economy is non-Ricardian (i.e., v'_{t+1} is present in (8) and is generally non-zero), the equivalence of equilibrium allocations requires that B_t^*/P_t^* follows the same path under both sanction regimes, and this is ensured by adopting the same path of real government reserves $(F_t^* - B_t^*)/P_t^*$. In particular, the case with no official reserves $F_t^* = B_t^*$ satisfies this requirement.

[23] Note that in our model with exogenous export revenues Y_t^*, $\theta_t \geq 1$ corresponds to the Marshall-Lerner condition which ensures an improvement in the trade balance in response to an exchange rate depreciation. In the CES case, $\theta_t \equiv \theta > 1$, and in the Cobb-Douglas limit $\theta \to 1$. With a tax $\tau > 0$ on all import varieties, $\mathrm{d}\log P_t^* = \log(1+\tau)$, the effect on the exchange rate converges to 0 as $\theta \to 1$. This is because, in the Cobb-Douglas limit, the expenditure share on imports does not depend on the tax or on the exchange rate. However, if instead a measure δ of import varieties is banned, then $\mathrm{d}\log P_t^* = \frac{1}{\theta-1}\log\frac{\gamma}{\gamma-\delta}$, and thus $\mathrm{d}\log \mathcal{E}_t = -\frac{1}{\theta}\log\frac{\gamma}{\gamma-\delta} < 0$ for any $\theta \geq 1$, in line with our results in Section 3. See the derivation in Appendix B.

$$\mathrm{d}\log \mathcal{E}_t = -\frac{\theta_t - 1}{\theta_t} \cdot \mathrm{d}\log P_t^* \leq 0. \tag{16}$$

The exchange rate depreciation under export sanctions is given by $\mathrm{d}\log \mathcal{E}_t = -\frac{1}{\theta_t} \cdot \mathrm{d}\log(Y_t^*) > 0$. Therefore, the same allocation under the two sanctions regimes is sustained with a differential movement in the exchange rate and a gap equal to the extent of sanctions, $x\%$, independent of the value of the elasticity θ_t.

Intuitively, the exchange rate movements under both export or import sanctions ensure that the allocation afforded by the country's budget constraint is also consistent with consumer optimization over expenditure on imports and home goods. The country's budget constraint admits the same allocation in the two cases, however, it is via a reduction of international incomes in the former case and via an increase in the cost of imports in the latter. Therefore, in the former case, the exchange rate must depreciate to discourage import consumption and bring it in line with the new budget constraint. In the latter case, the exchange rate must appreciate to make sure that export revenues are still fully used up on imports despite their increased relative price which curbs import expenditure share (provided $\theta_t > 1$). This is a macroeconomic version of the fundamental Lerner (1936) symmetry logic by which an import tariff is equivalent to an export tax, as they result in the same allocation with depressed international trade flows, yet this is sustained with a differential movement in prices.[24]

From the point of view of the currency market, export sanctions reduce currency supply while import sanctions reduce currency demand in the economy, explaining their opposite effects on the nominal exchange rate, in parallel with the real exchange rate that balances the goods market. In other words, a monetary policy which keeps the price level of the home good P_t constant, ensures that the equilibrium movement in the nominal exchange rate accommodates the required adjustment in the real exchange rate.

The fact that the two types of sanctions have the same welfare implications but the opposite effects on the exchange rate means that, without further information, one cannot infer the effectiveness of sanctions from the dynamics of the nominal exchange rate $\mathcal{E}_t$. Are *relative* prices more informative? Perhaps surprisingly, the equivalence between the two types of sanctions extends to the terms of trade, but not to the real exchange rate. Indeed, from equation (15), it is sufficient to know the relative import price $\mathcal{E}_t P_t^*/P_t$ to evaluate the effect of sanctions on C_{Ft}. However, measuring the ideal price index of imports P_t^* in the data is complicated by quantity restrictions, the extensive margin of sanctions, and substitution responses to sanctions. Measurement thus requires knowledge of the elasticities of substitution and the quality differences between various sanctioned goods and their substitutes. Evaluating the real exchange rate in the data may be somewhat easier, but it is uninformative because of the wedge between consumer prices abroad and import prices P_t^* in the home economy.[25]

[24] According to Lerner symmetry, an import tariff results in a trade surplus on impact, which must be eliminated in equilibrium by means of an increase in the relative wage at home (an appreciation); an export tax does the reverse on impact, and requires a reduction in the home relative wage (a depreciation). Nonetheless, the real wage in terms of the home consumption basket declines in the same way in both cases, while the real exchange rate may move differentially, as we discuss below.

[25] Note that the producer-price real exchange rate, $\mathcal{E}_t/P_t$, tracks the nominal exchange rate $\mathcal{E}_t$ when monetary policy stabilizes domestic prices P_t. In contrast, the consumer-price real exchange rate is determined by $\mathcal{E}_t P_t^*/P_t$, and it depreciates along with the terms of trade for both import and export sanctions. Lerner symmetry, in general, does not require the same

Fiscal revenues and the real cost of living The allocational equivalence of import and export sanctions in Proposition 2 further extends to the government fiscal balance and consumer price inflation:

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

While this result applies more generally, we specialize the discussion here to case with a CES aggregator between imports and home goods with elasticity $\theta > 1$. We can directly evaluate fiscal revenues TR_t in (4) and the price index CPI_t using the equilibrium expression for the exchange rate (15), which yields $\mathcal{E}_t = \frac{P_t}{P_t^*}\left(\frac{\gamma}{1-\gamma} Y_t / C_{Ft}\right)^{1/\theta}$ in the CES case. We then have:

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

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

From Proposition 2, C_{Ft} follows the same reduced path under both sets of sanctions which, in both cases, involves a deterioration in the terms of trade Y_t^*/P_t^* by $x\%$. 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 through 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.

Taking the paths of P_t and Y_t as given, we can evaluate both effects quantitatively (see Appendix C and our quantitative analysis in Section 5):

$$\mathrm{d}\log TR_t = -\chi \cdot \frac{\theta - 1}{\theta} \cdot x\% < 0 \qquad \text{and} \qquad \mathrm{d}\log CPI_t = \mu \cdot \frac{1}{\theta} \cdot x\% > 0. \tag{17}$$

As expected, the effect of export sanctions on fiscal revenues is proportional to the share of taxes on exports in the government budget, denoted with χ, while the effect of import sanctions on costs of living is proportional to the share of imports in GDP, denoted with μ. Remarkably, 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 the real costs of living. Indeed, raising the cost of imports P_t^* by $x\%$ has exactly the same effect on both government revenues and consumer prices as a decrease in country's exports Y_t^* by $x\%$ because of the general equilibrium effect on the exchange rate. Indeed, the equilibrium appreciation of the home currency under import sanctions lowers fiscal revenues from exports, while the depreciation under export sanctions increases consumer prices (*cf.* Barbiero, Farhi, Gopinath, and Itskhoki 2019).

adjustment in the real exchange rate under alternative sanctions regimes, as unexpected jumps in the real exchange rate are not allocative under incomplete asset markets (*cf.* Farhi, Gopinath, and Itskhoki 2014).

Limits of equivalence Proposition 2 emphasizes a baseline equivalence result for import and export sanctions in terms of their allocative effects and despite differential exchange rate movements. Importantly, this is not a knife-edge result in the sense that it offers a reliable benchmark for qualitative and quantitative analysis of sanctions even when the exact conditions of equivalence do not hold, as we show in Proposition 1 above and in Section 5 below. Nonetheless, a few caveats are in order. First, are import and export sanctions substitutes or complements? While the same economic impact can be achieved by means of either export or import sanctions, their combined effect is cumulative and both kinds of sanction matter on the margin provided that international trade is not fully shut down.

Second, the results in this paper do not specify what subsets of goods and trade partners are engaged in sanctions and with what intensity. Instead, we follow the macro approach by taking the overall equilibrium decline in export revenues Y_t^* and the increase in the cost of imports P_t^* as inputs, and the resulting movement in the aggregate terms of trade Y_t^*/P_t^* as a sufficient statistic for the impact of sanctions on the country. We do not address the issue of optimal sanctions design which requires a lot of additional information, in particular on various elasticities of substitution, which would allow us to map primitive sanctions shocks — taxes and quotas for specific goods and by certain trade partners — into their equilibrium effects on the country's overall exports and imports.[26] Similarly, we leave out the question of spillovers of sanctions on third countries.

Finally, there is an important asymmetry in the transmission of export and import sanctions. Specifically, for the sanctioned country, export sanctions make foreign *currency* scarce while import sanctions make foreign *goods* scarce. Proposition 2 suggests that the real outcomes are the same, at least with a conventional modeling of the financial market. However, this leaves out the possibility of sunspot financial and currency crises as well as bank run equilibria. If the economy responds differently to sudden stops (austerity) arising from financial (currency) flows versus goods flows, then equivalence breaks down, as we illustrate in Itskhoki and Mukhin (2023).

One alternative assumption that can be easily considered within our framework, however, is a temporary sanctions shocks. What happens when agents anticipate (wrongly or correctly) that the restrictions will be lifted in the future? The equivalence between export and import sanctions breaks down in this case because the expected dynamics of import prices P_t^* introduce an additional incentive (substitution effect) via the Euler equation (8) to delay import consumption until sanctions are relaxed, as well as tilt the intertemporal slope of the budget constraint (14). In contrast, there are no such effects under export sanctions, and the country attempts to smooth out export sanction shocks with additional international borrowing.

This suggests that financial sanctions (namely, foreign asset freezes and constraints on international borrowing) have considerably more bite when combined with export sanctions than when com-

[26] Some simple claims can be made nonetheless. For example, while restrictions on net foreign assets and on exports are equivalent in their effect on the economy under sanctions, there is a material difference between sanctions on Y^* and F^* from the point of view of foreign countries. Sanctions on foreign assets are the "cheapest" to impose, as they require no immediate sacrifice on the part of the sanctioning countries. Indeed, these sanctions were the first be imposed in practice. Similarly, for sanctioning countries, it matters whether Y^* is reduced by means of a price cap or a quantity limit. More generally, sanctions on exports and imports require sacrifices and, thus, a cost-benefit analysis.

bined with import sanctions, which may altogether increase foreign savings of the country.[27] Similarly, frontloading export sanctions results 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. Furthermore, for a country that cannot borrow, the dynamic equilibrium allocation under export sanctions is always feasible under a symmetric path of import sanctions by offsetting the intertemporal substitution effect with a savings tax. However, such offset is suboptimal because intertemporal substitution under import sanctions increases welfare, thereby making temporary import sanctions less costly by comparison.

4.2 Financial sanctions and financial repression

We next consider a demand shock for foreign currency (precautionary) savings, i.e. an increase in Ψ_t in (1), motivated by the increased uncertainty and the collapse of alternative home-currency safe assets. The equilibrium dynamic system is still given by (6)–(8) which can accommodate financial sanctions and constraints on the path of F^*_{t+1} and R^*_t, as we discuss below. We also allow the government to use FX interventions, $F^*_t - B^*_t$, and financial repression, $R^*_{Ht} < R^*_t$, which includes limits as well as taxes on buying and withdrawing foreign currency.

Proposition 3 *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. This is followed by a gradual increase in imports and appreciation of the exchange rate as foreign currency savings accumulate over time ($F^*_{t+j} = B^*_{t+j} \uparrow$), and an eventual overshooting in the long run with a higher level of net foreign assets.*
2. *If the government accommodates foreign currency precautionary savings by selling reserves $(F^*_{t+1} - B^*_{t+1}) \downarrow$ in response to an increase in demand for B^*_{t+1} in order to maintain the same path of net foreign assets F^*_{t+1}, then the paths of imports and the exchange rate $(C_{Ft}, \mathcal{E}_t)$ also remain unchanged.*
3. *Without government FX interventions, there exists a tax on foreign currency purchases by the households, resulting in $R^*_{Ht} < R^*_t$, which leaves the path of $(B^*_{t+1}, F^*_{t+1}, C_{Ft}, \mathcal{E}_t)$ unchanged. This involves a household welfare loss from the unaccommodated precautionary savings shock Ψ_t.*

The proof of these results follows from the examination of the equilibrium system (6)–(8), as we describe in Appendix D. 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 2021a). The equilibrium dynamics arise from the interplay of the Euler equation (8), which determines the expected changes in imports, $C_{F,t+1}/C_{Ft}$, and the country budget constraint (7), which determines the effect of the shock on impact. The exchange rate is then determined from (6) so as to sustain the equilibrium

[27] Indeed, if the substitution effects is strong enough — as in our parametric case (3) when the intertemporal elasticity of substitution $\theta > 1$ — the country responds to import sanctions by delaying import consumption so as to increase foreign asset accumulation. At the same time, import sanctions that result in additional foreign asset accumulation expose the country to the risk of further rounds of financial sanctions and asset freezes. In full financial autarky, when even foreign savings are infeasible and exports need to be exchanged directly for imports state-by-state, import and export sanctions are equivalent again independent of their dynamic time path. See Itskhoki and Mukhin (2023) for a formal analysis.

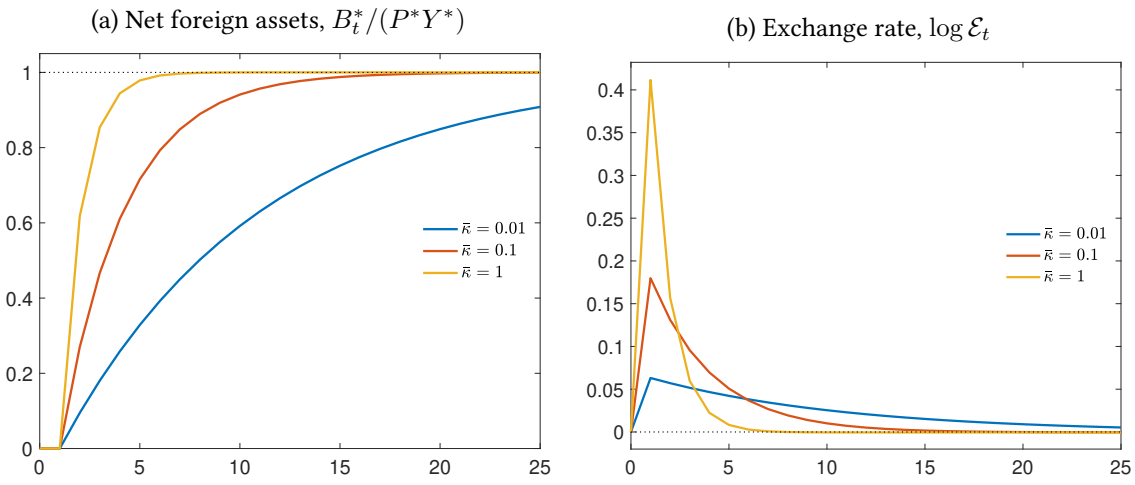

Figure 3: Laissez-faire response to foreign currency demand shock Ψ_t

Note: The figure plots impulse responses — of the household's holdings of foreign currency (as a share of pre-shock exports) in the left panel and of the exchange rate in the right panel — to a permanent increase in foreign currency savings demand Ψ_t equal to the country's monthly imports (the long-run increase in B_t^* in the left panel). One period corresponds to one month, $\beta = 0.96^{1/12}$, $\beta R_t^* = 1$; we use functional forms in (3) with $\theta = 1.5$ and three different values of the currency demand parameter $\bar{\kappa} \equiv \frac{\theta\kappa/\beta}{\theta-1}(\bar{C}_F/\gamma)^{1/\theta}$.

allocation. An increase in Ψ_t leads to $\frac{B_{t+1}^*}{P_{t+1}^*} < \Psi_t$ on impact and results in increased foreign currency demand from households in (8). There are three ways that this excess demand can be accommodated.

First, households can cut down on their import consumption C_{Ft} which allows them to accumulate foreign currency as it becomes available from the resulting trade surplus. In this case, the country accumulates net foreign assets which are held by households, $B_{t+1}^* = F_{t+1}^* \uparrow$. Over time, B_{t+1}^*/P_{t+1}^* increases towards the value of Ψ_t so that foreign currency demand can be satisfied with a stationary C_{Ft} again. Foreign currency accumulation happens at the cost of reduced imports along the transition path. Over time, imports C_{Ft} gradually recover and slightly overshoot in the long run, reflecting the increased net foreign asset position of the country — transitory trade surpluses permit a long-run trade deficit (provided $R_t^* > 1$). Finally, the exchange rate $\mathcal{E}_t$ depreciates on impact with a fall in C_{Ft}, 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). Intuitively, increased foreign currency demand depreciates the value of the home currency on impact, with its value gradually recovering over time as the country builds up the stock of foreign currency assets. Figure 3 provides an illustration: steeper foreign currency savings demand κ implies faster accumulation of foreign currency, which in turn requires a larger initial drop in imports and depreciation of the exchange rate.

Second, increased household demand for foreign currency Ψ_t can be accommodated with the FX interventions by the government that smooth fluctuations in the exchange rate $\mathcal{E}_t$ and imports C_{Ft}. Specifically, the government can supply foreign currency to the market by selling reserves to offset the increased demand by the households. In particular, B_{t+1}^* needs to be increased sufficiently — such that $B_{t+1}^*/P_{t+1}^* = \Psi_t$ at all times — by means of selling official reserves $F_{t+1}^* - B_{t+1}^*$ and without altering the path of the country's net foreign assets F_{t+1}^*. This ensures that both (8) and (7) are satisfied for the original path of C_{Ft} and $\mathcal{E}_t$ despite the increased Ψ_t. From the normative perspective, such policy is

optimal, at least when the origin of Ψ_t is a "liquidity shock" for foreign currency and is not triggered by productivity and other fundamental macroeconomic shocks that require accommodation with trade imbalances (see Itskhoki and Mukhin 2022).

Finally, in the absence of spare official reserves or sufficient export revenues to accommodate the increase in Ψ_t and B^*_{t+1}, the government can resort to financial repressions to curb the exchange rate depreciation and the associated reduction in imports. Direct or indirect taxes on purchasing, holding or withdrawing foreign currency, captured in (8) with $R^*_{Ht} < R^*_t$, can discourage B^*_{t+1} accumulation even when Ψ_t is high. In other words, financial repression ensures that foreign currency is used to buy imports C_{Ft} rather than holding foreign cash B^*_{t+1}. A path of R^*_{Ht} that declines with an increase in Ψ_t can ensure that (8) holds for the original $\{C_{Ft}, B^*_{t+1}\}$ allocation, and thus leads to no exchange rate depreciation. Indeed, the increased currency demand for savings is curbed by a downward shift along the savings demand curve due to depressed returns on foreign currency savings, thereby eliminating the need for an exchange rate depreciation. While smoothing the path of imports and the 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).[28]

Financial autarky The case of financial repression in Proposition 3 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).[29] 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, i.e. these become competing uses for foreign currency export revenues. This emphasizes the dual role of foreign currency in the 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 a country's 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 $\Delta F^*_{t+1} = Y^*_t - P^*_t C_{Ft}$), 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?

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

[29] We assume that the country can still accumulate foreign currency assets from trade surpluses, $F^*_{t+1} > 0$, which may be made impossible by sequential foreign asset freezes. In this case, the only feasible equilibrium may imply full autarky with $F^*_{t+1} = 0$ and $NX^*_t = 0$ in every period.

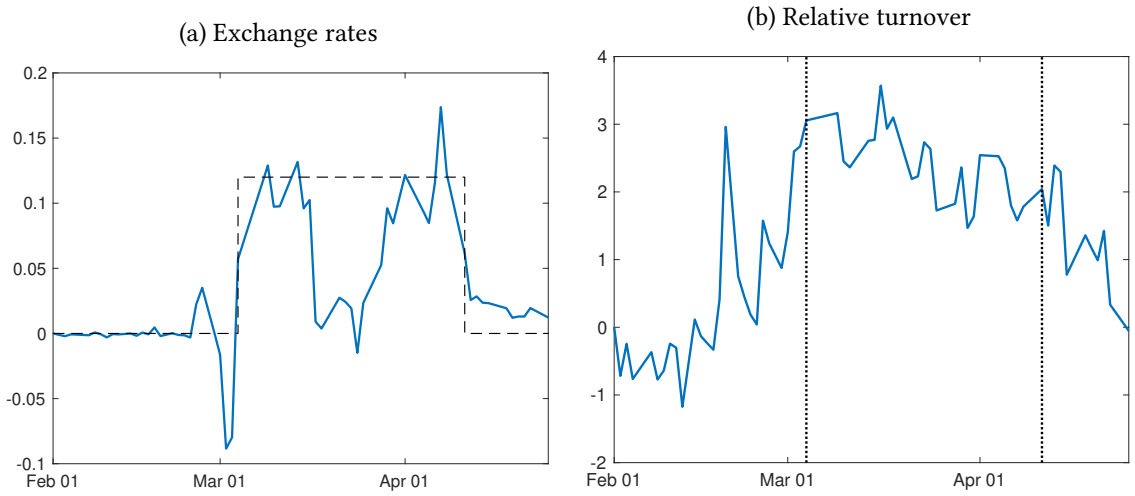

Figure 4: Swiss franc vs U.S. dollar: exchange rate and turnover

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.

To answer this question, we rewrite the government budget constraint (4) in foreign currency terms as:

$$\frac{F^*_{t+1}}{R^*_t} - F^*_t = Y^*_t + \frac{Y_t - W_t/P_t}{\mathcal{E}_t/P_t} + \left(\frac{B^*_{t+1}}{R^*_{Ht}} - B^*_t\right) + \frac{1}{\mathcal{E}_t}\left(\frac{B_{t+1}}{R_t} - B_t\right).$$

It follows that the increased demand for B^*_{t+1} can be satisfied in two ways. One solution is to back foreign currency liabilities with additional foreign assets F^*_{t+1}. In normal times, this allows the government to balance the currency risk in the banking system, however, financial sanctions and the prospect of future foreign asset freezes may render such accommodation infeasible. Alternatively, the government can create artificial foreign currency deposits $B^*_{t+1} = \tilde{B}^*_{t+1}$ not backed by foreign assets (e.g., even when $F^*_{t+1} \equiv 0$), but rather financed with future consolidated revenues, as well as reduced domestic-currency borrowing $B_{t+1} < 0$. However, the resulting currency mismatch means that the value of liabilities B^*_t increases relative to the value of assets $B_t/\mathcal{E}_t$ when the national currency depreciates. The government then faces a trade-off between its commitment to workers W_t and to savers B^*_t with monetary inflation ($P_t \uparrow$) used to redistribute resources from the former to the latter. Such policy is complicated by the fact that higher inflation amplifies demand for foreign currency deposits. Further, large liabilities can undermine the credibility of the government leading to a bank run with large deposit withdrawals ($\tilde{B}^*_{t+1} \ll \tilde{B}^*_t$), 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 autarky.[30] To see this, examine the Euler equation for foreign currency bonds (8) which can be derived

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

for every currency available for purchase in the domestic market. A repressed R^*_{Ht} for a given currency results in a more depreciated exchange rate relative to a foreign currency with a less depressed expected returns which is expected to appreciate over time.

This offers a useful way to test the theory using 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 was presumably as safe and, therefore, offers a close substitute to the dollar. In the left panel of Figure 4, 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 in the convergence of the Moscow exchange rate to the international value. The right panel of Figure 4 additionally shows that the turnover of Swiss francs on the Moscow exchange increased dramatically relative to that of the dollar during the same period.

4.3 Heterogenous agents and redistributive effects

The use of financial repression is generally suboptimal in a representative agent economy. However, it becomes an important policy instrument for redistribution in an economy with heterogeneous agents. Furthermore, in such economies, the exchange rate still plays an important allocative role even under financial autarky and financial repression. We illustrate these points in an extension of our model that features two types of households — constrained hand-to-mouth and unconstrained Ricardian.

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

Under Cobb-Douglas preferences ($\theta = 1$), the aggregate equilibrium quantities in the heterogeneous-agent economy are the same as in a representative-agent economy, and are independent of the income share earned by hand-to-mouth agents α, as we show in Appendix E.[31] 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.

More importantly, this extension shows not only the robustness of the previous results on the aggregate effects of sanctions, but sheds new light on the distributional effects from financial repression

[31] 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.

which affects the equilibrium path of the exchange rate (as in Proposition 3):

Proposition 4 *Assume $\theta = 1$ and hand-to-mouth agents receive a constant fraction α of income in the non-tradable sector. Then the aggregate dynamics of the economy do not depend on α. Given no reserves ($B_t^* = F_t^*$), the use of financial repression $R_{Ht}^* < R_t^*$ to offset the foreign currency demand shock $\Psi_t > 0$ reduces welfare in a representative-agent economy, but increases utilitarian welfare by redistributing from Ricardian to hand-to-mouth agents in a heterogenous-agent 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 economy to be allocated to the purchases of imports. More formally, recall from Proposition 3 that financial repression appreciates the exchange rate ($\mathcal{E}_t \downarrow$). This makes a greater quantity of imports, $C_{Ft}^C = \gamma \frac{\alpha P_t Y_t}{\mathcal{E}_t P_t^*}$, affordable to constrained agents with incomes fixed in home currency terms. Unconstrained Ricardian agents also increase their consumption of imports, but less than proportionally because 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 limits 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.[32]

5 Quantitative Evaluation

We next provide a quantitative evaluation of the ruble exchange rate dynamics in 2022 by combining together the financial and trade mechanisms discussed in the previous section. After examining the quantitative predictions of the model for the path of the exchange rate, we study its implications for other variables of interest, including the decline in real imports which account for the welfare impact of sanctions, as well as the evolution of consumer price inflation and the fiscal deficit. We also evaluate alternative government policies that aim at balancing the resulting fiscal deficit.

We solve the model using a first-order perturbation of the country's budget constraint (7), the household Euler equation (8), and import demand (6) under the functional forms in (3). We use a steady state with $R^* = R_H^* = 1/\beta$, $P^* = 1$ and $F^* = B^* = 0$ as the point of approximation, and write the log-linearized system as follows:

$$\begin{aligned} \mathbb{E}_t \left\{ \Delta c_{F,t+1} + \theta \Delta p_{t+1}^* \right\} &= \theta r_{Ht}^* + \bar{\kappa}(\psi_t - b_{t+1}^*), \\ \beta f_{t+1}^* - f_t^* &= n x_t = y_t^* - p_t^* - c_{Ft}, \\ c_{Ft} &= -\theta(p_t^* + e_t - p_t) + y_t, \end{aligned}$$

where small letters denote log deviations from the steady state, Note that $f_t^* \equiv F_t^*/Y^*$, $b_t^* \equiv B_t^*/Y^*$ and $\psi_t \equiv \Psi_t^*/Y^*$ are normalized by the steady-state value of exports, and $\bar{\kappa} \equiv \tilde{\kappa} \cdot (Y^*)^{(\theta+1)/\theta}$ with

[32] A related mechanism to this effect of FXI on hand-to-mouth import consumption is discussed in Fanelli and Straub (2021).

Table 1: Calibration of shocks

	Financial		Import	Export		Domestic
	NFA, f_0^*	ψ_t & r_{Ht}^*	p_t^*	Temp., y_{1t}^*	Perm., y_{2t}^*	recession, y_t
Initial shock, ε_{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, ρ	1	0.94	0.84	0.92	1	0.98
— half life (months)	∞	12	4	8	∞	36

Note: For each shock, the table shows calibrated values of the initial innovation ε_{t_0}, the period when the shock arrives t_0, as well as 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).

$\tilde{\kappa}$ defined following (8). The vector of sanctions shocks is $\{\psi_t, p_t^*, y_t^*, y_t\}$ and f_0^*, the policy response consists $\{r_{Ht}^*, p_t, f_{t+1}^* - b_{t+1}^*\}$, and the endogenous variables are $\{e_t, c_{Ft}, b_{t+1}^*, f_t^*\}$.

We make the following additional assumptions. First, we focus on an equilibrium with $p_t \equiv 0$ in the baseline calibration because monetary inflation has arguably not yet been a feature of the data and most changes in the price level reflected higher import prices. We then consider alternative paths of monetary policy. Second, while expectations must have played an important role in the response of the economy, it is difficult to calibrate how the 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.[33] Lastly, we abstract from the policy of FX interventions via the use of government reserves (that is, we set $f_t^* - b_t^* \equiv 0$, so that $b_{t+1}^* = f_{t+1}^*$ in the first equation of the dynamic system) because the option for central bank FX interventions was effectively ruled out by financial sanctions. We consider a policy of FX reserve accumulation at the end of this section.

Calibration We calibrate the model parameters and shocks with the aim of matching 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 that there is little empirical guidance regarding the bonds-in-the-utility parameter κ, we set $\bar{\kappa} = 0.5$. A larger κ results in a larger exchange rate jump on impact and a more transitory effect from a financial shock (as illustrated in Figure 3), as well as smaller deviations from trade balance and hence larger variation in import consumption and the exchange rate in response to trade shocks. Similarly, a smaller value of θ results in larger variation in the exchange rate for a given path of trade shocks. Given the conventional values of β and θ, parameter κ is effectively the only degree of freedom in our calibration.

Table 1 shows the calibration of the shocks, which we discipline with the empirical paths of observables, without targeting the equilibrium path of the exchange rate. About half, or \$300B, of Russian

[33] For a discussion of the role of expectations see Erceg, Prestipino, and Raffo (2018) in the context of border taxation.

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 (or, equivalently, 12 months worth of exports). Further, the beginning of the war was associated with a sharp increase in uncertainty, in demand for safe assets, and in capital outflows. We capture these with an increase in foreign currency demand, $\psi_0 = 1.5$, corresponding to 1.5 months of exports and with a half-life of one year ($\rho = 0.94$).[34] Given the isomorphic effect of financial repression r^*_{Ht}, we do not consider it separately and interpret ψ_t as the net effect of financial distress partially offset with government policies. Without additional empirical targets, it is not possible to separately identify the proportions in which the dollar safety demand shock ψ_t waned on its own and the financial repression policy r^*_{Ht} was successful at mitigating it. While this is inconsequential for the positive predictions of the model about exchange rate dynamics, it may have important welfare consequences, as we discussed in Sections 4.2 and 4.3.

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, the trade balances from 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 as European countries switch to alternative sources of energy imports, a spike in energy prices in the first months of the invasion magnified Russian export revenues in the short-run.[35] 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 ($f^*_{t+1} > f^*_t$) and, thus, require no international borrowing which was ruled out by financial sanctions.

5.1 Exchange rate and imports

Figure 5 displays the equilibrium path of the exchange rate in the calibrated model, resulting from the combination of sanctions described in Table 1. The figure also plots the realized path of the ruble exchange rate in the data — from February 2022 to February 2023. The model captures the empirical exchange rate dynamics very closely. Note that the path of the exchange rate is not directly targeted in the calibration, which instead matches the observed empirical paths of exports and imports.

The calibrated model allows us to study the contribution of various sanctions shocks to the dynamics of equilibrium variables. Figure 6 presents the results for the exchange rate (panel a) and import quantities (panel b) with black lines showing the simulated equilibrium path of the variables and the colored bars showing the contribution of each shock. The simulated exchange rate path closely resembles the dynamics of the ruble shown in Figure 1 — the exchange rate depreciates on impact by 50%,

[34] While it is notoriously difficult to obtain data on the demand for foreign currency, our calibration is broadly consistent with the \$20B increase in household foreign-currency cash holdings (reported by the Central Bank of Russia) and the \$100B withdrawal from Russian bond and equity funds by foreigners in February–March 2022 (reported by EPFR/Haver Analytics).

[35] According to the available estimates, Russian monthly exports increased to an average of \$50B for the period of February to June, then began to decline as energy prices came down somewhat and Western countries started to substite away from Russian oil and gas.

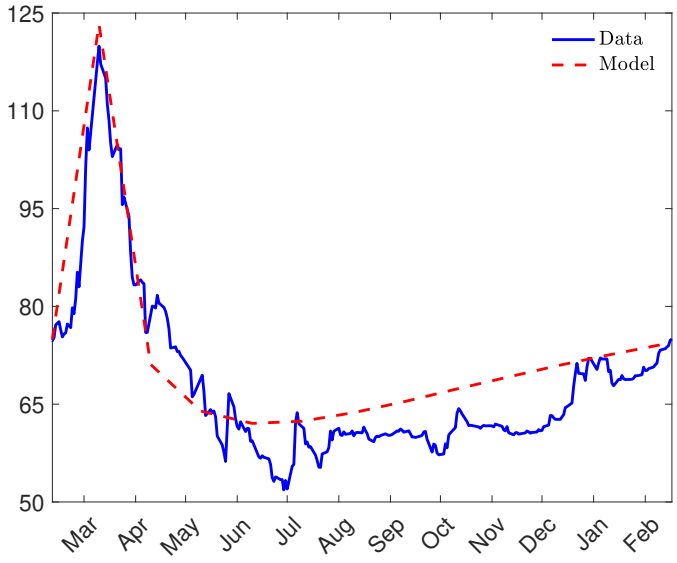

Figure 5: Exchange rate dynamics: model vs data

Note: The figure plots the dynamics of the exchange rate over the first eleven months in the calibrated model (with sanctions shocks described in Table 1) and in the data (mid-February 2022 to mid-February 2023; as in Figure 1).

returns to the initial level about a month after the impact, and then keeps appreciating to a peak of 20% above the pre-war level at the four months horizon. Eight months after the initial shock, the exchange rate remains appreciated, but below its peak, and is predicted to return to the pre-war level at a 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. Despite the large amount of FX reserves frozen by sanctions, the impact of this freeze 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 an 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, the 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 outflows driven by the financial shock ψ_t. We find this shock to be the key driver behind the sharp depreciation of the ruble in the first month. Interestingly, no matter how persistent ψ_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.[36]

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 which result in higher effective import prices, lower import quantities and reduce demand for foreign currency, contributing to a 15% appreciation of the ruble. Second, the increase in energy prices and Russian export revenues in the first months after the invasions increase supply of foreign currency and appreciate the ruble by another 10%. Finally, a domestic recession driven by the exit of multinationals and the reduced

[36] In the model, a ψ_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.

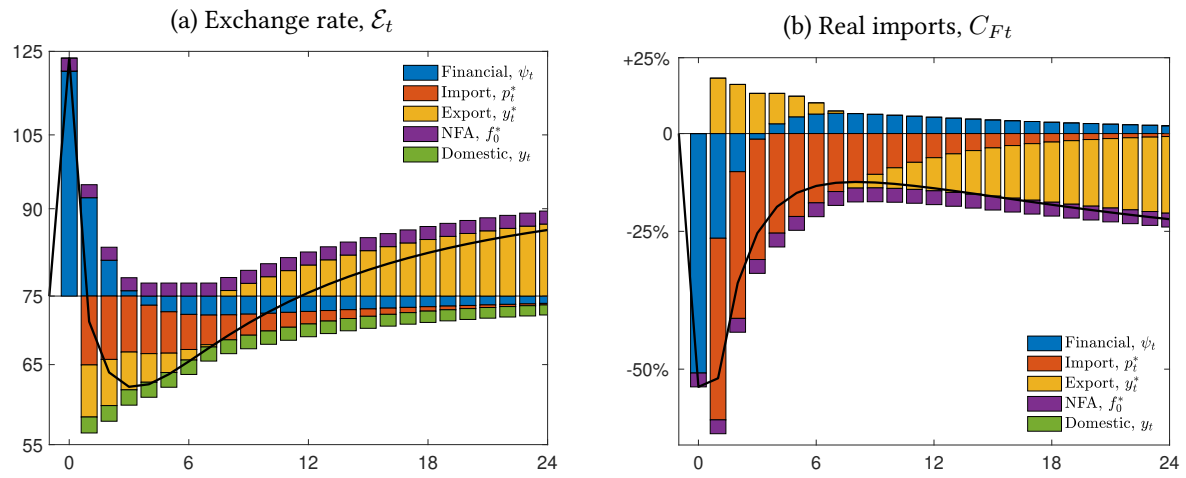

Figure 6: Exchange rate and import dynamics: model-based decomposition

Note: The figure plots with solid black lines the simulated path of the exchange rate (in panel a; extending the path from Figure 5) and import quantities (in panel b) in response to sanctions shocks summarized in Table 1; colored bars represent the contribution of each sanctions shock. One period corresponds to a month and $t = 0$ corresponds to (the end of) February 2022.

supply of foreign intermediates also contributes to the appreciation of the currency. However, this effect is small quantitatively (albeit persistent), resulting in a 3% appreciation. All in all, the combined effect neutralizes the financial depreciation by 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, import prices mean revert and import quantities rebound as parallel imports and new trade linkages are established, resulting in a rebound in foreign-currency demand and an exchange rate depreciation. At the same, the inflow of foreign currency contracts as energy exports decline (e.g., due to restricted demand and price caps/discounts). This persistent reduction in exports and the ensuing force for a depreciation curb the recovery in imports, thus both imports and exports remain below their pre-war levels in the long run (by 25%; see Appendix Figure 9). 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 its 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 independent of the scenario, illustrating predictions of Proposition 2.

The decline in real imports c_{Ft}, along with the domestic recession y_t, is the main channel of welfare losses from sanctions. The right panel of Figure 6 provides a decomposition of the decline in import quantities c_{Ft} into the effects of various sanctions. Import consumption is most affected by the unaccommodated financial shock in the first one-to-two months, then by import sanctions in the medium term during the first year, and ultimately by the long-run decline in export revenues. Increased export revenues in the first months offset some of the welfare losses, while the net foreign asset freeze has a small but permanent negative effect. We further calculate the overall welfare loss from the combined effect of sanctions. Between a large permanent decline in imports and a smaller persistent decline in

domestic output, the overall welfare losses are equivalent to a 10.3% permanent decline in aggregate real consumption. The short run welfare effect of sanctions is steeper and equal to a 13.5% decline in real consumption in the first year, in line with empirical estimates for Russia based upon the drop in turnover for the retail and wholesale sectors.

Two remarks are in order. First, we find that the exchange rate effects of the domestic recession and the asset freeze are both quantitatively small and comparable in value. They 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, and trade restrictions dominating in the medium and long run. In other words, outside the very short run, it is the balance of export and import restrictions that shapes the resulting appreciation or depreciation of the ruble (for $t \geq 3$). Second, we effectively focus on the path of the real exchange rate because we assumed monetary policy stabilized the home-good price level $p_t = 0$. Thus, we set aside a possible inflationary devaluation that may arise from monetization of government debt. This is a plausible scenario in the medium run, in which case we would expect a nominal devaluation over and above the equilibrium path of the exchange rate displayed in Figure 6, 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 steep import sanctions that gradually mean revert help to accommodate the 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 — limited capital flight, permitting to avoid a possible currency and banking crises, as we discussed at the end of Section 4.1.[37]

5.2 Budget deficit and inflation

In this section, we consider the fiscal implications of sanctions. Generalizing the analysis in Section 4, proportional changes in government revenues can be expressed as:

$$\mathrm{d} \log TR_t = \chi(e_t + y_t^*) + (1 - \chi)\,(p_t + y_t), \tag{18}$$

where χ is the steady-state share of government revenues from exports in total government revenues which we set to 50% consistent with the data.[38] 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.

[37] The missing financial crisis in Russia in March 2022, despite unprecedented financial sanctions and a sharp exchange rate devaluation in the first weeks of the war is a topic for future research. The combination of a large trade surplus, a fiscal surplus and no domestic contract dollarization was likely the reason why the Bank of Russia managed to fend off a full scale financial crisis with a steep increase in the ruble policy rate and a battery of financial repressions including a ban on withdrawal of foreign currency deposits. However, the relative contribution of these factors is less clear, Similarly, it is unclear whether the economy was in the region of multiple equilibria and managed to navigate away from the crisis equilibrium and whether an alternative sanctions policy (e.g., focused on curbing export revenues) could have eliminated the existence of the non-crisis equilibrium.

[38] The direct contribution of energy exports to Russian federal budget pre-war 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.

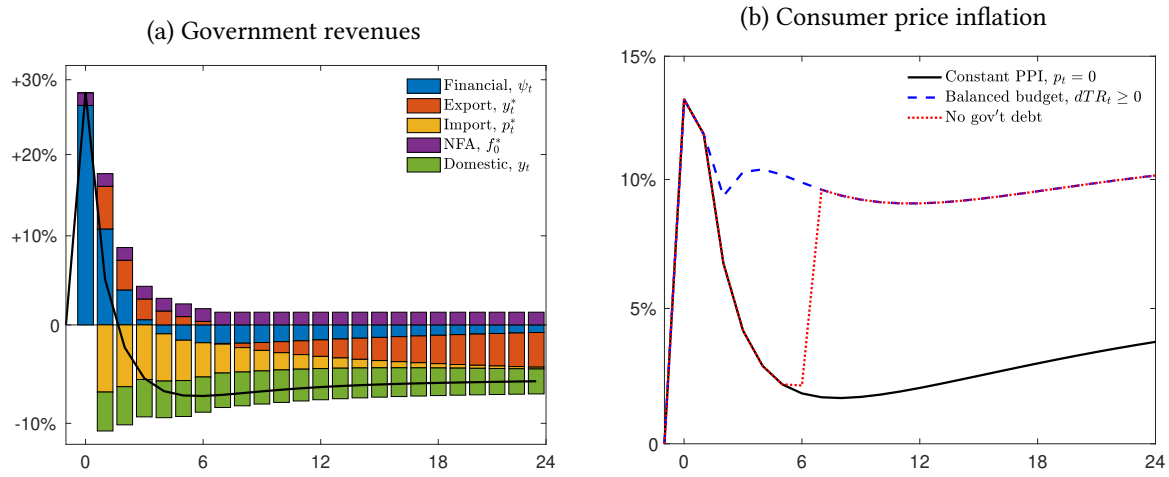

Figure 7: Fiscal and monetary policy

Note: Panel (a) shows a simulated response of government revenues (the black line, in percentage changes relative to the pre-war level) and their components driven by different shocks (colored bars). Panel (b) shows dynamics of CPI (also in percentage changes relative to the pre-war level) under different monetary policy scenarios, as described in the text; the black line corresponds to the increase in the real cost of living.

The left panel of Figure 7 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 exchange rate appreciation (due to both higher exports and lower imports) and also by lower tax revenues because of the recession in the domestic production. 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 the reduction in home production y_t and foreign currency exports y_t^*.[39]

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 to the overall increase in the consumer price level (see (19) below and our discussion in Section 4). Nonetheless, the government can sustain the initial level of expenditures without borrowing by monetizing the fiscal deficit. We also 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:

$$\mathrm{d}\log CPI_t = (1-\gamma)p_t + \gamma(p_t^* + e_t). \tag{19}$$

A monetary policy which targets an increasing path of domestic prices p_t thus resulting in a proportional additional devaluation ($\mathrm{d}e_t = \mathrm{d}p_t$) simultaneously reduces the fiscal pressure on the government revenues, as can bee seen in (18).

The right panel of Figure 7 shows the cumulative change in the consumer price level since the

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

beginning of the war under three alternative scenarios. The black line corresponds to the baseline scenario when the central bank stabilizes domestic producer prices, $p_t = 0$.[40] In this case, consumer prices jump up by 13% in the first two months due to the depreciation of the exchange rate and an increase in import prices. This reflects the increase in the real cost of living, or the welfare costs of sanctions. Once the exchange rate appreciates and the import shock dissipates, the 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 have decreased somewhat since then.

The blue line in the figure corresponds to the case when the central bank aims to ensure a balanced government budget in every period; that is, p_t increases to ensure $\mathrm{d}\log TR_t \geq 0$ for every period t in (18). In the first two months, the government surplus implies that the dynamics of inflation are determined solely by real shocks and coincide with the baseline case. The deficit from the third period on requires a monetary accommodation and does not permit the price level to partially revert as in the baseline scenario. This path of consumer prices closely replicates what we observed in the data.

Finally, the red line in the figure shows the path of consumer prices when the central bank only inflates to offset the cumulative deficit since the beginning of the war. This ensures 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 increase in consumer prices corresponds to an additional depreciation force of 7.5% relative to the path plotted in Figure 6. This introduces a wedge between the nominal and real exchange rates as the latter is still shaped by the trade and financial forces and follows the same path as depicted in Figure 6. Nonetheless, our analysis suggests that fiscal pressures on inflation and the 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.

5.3 Foreign exchange interventions

As an alternative to monetization, the government can accumulate FX reserves with the goal of balancing its fiscal positions by means of a non-monetary exchange rate devaluation. To see this, rewrite the government budget (4) as follows:

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

where, for simplicity, we assume the same foreign-currency interest rate 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

[40] 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).

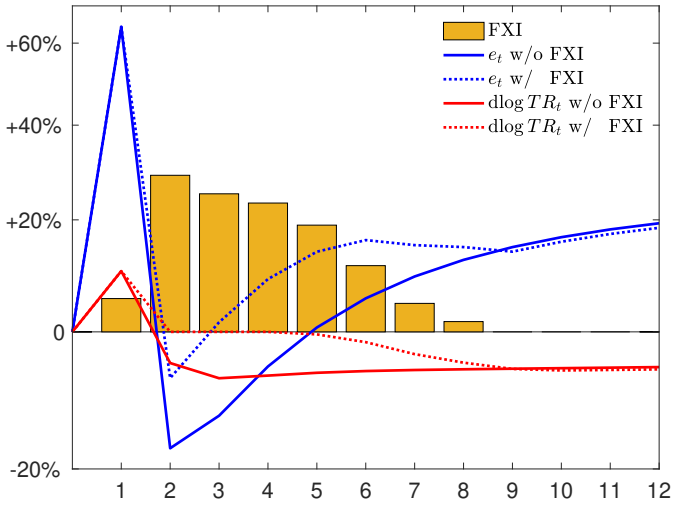

Figure 8: FX interventions

Note: The figure plots the reserve accumulation policy $F^*_{t+1} - B^*_{t+1}$ (yellow bars are reserves accumulated for $t \geq 0$) 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 plot the nominal exchange rate and red lines plot the fiscal surplus; solid line for the baseline case without reserve accumulation and dotted lines for the counterfactual with reserve accumulation.

leaving the net asset position of the government unchanged. Why would such a policy have real effects?

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} which keeps the intertemporal budget constraint unchanged. As a result, this policy does not compromise the ability of the central bank to control 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, Ricardian equivalence does not hold for foreign currency assets in the presence of foreign-currency savings demand by the households. As a result, the change in the composition of government debt — an increase in FX reserves $F^*_t - B^*_t$ and a corresponding increase in home-currency debt B_t — affects the foreign-currency bond holdings of private agents B^*_t. In turn, this influences the equilibrium exchange rate because FX reserve accumulation by the government makes the foreign currency scarce in the domestic market. In sum, sterilized FX interventions, and specifically accumulation of FX reserves, depreciate the exchange rate and boost fiscal revenues in home-currency terms without any monetary inflation.

Figure 8 shows the reserve accumulation policy which ensures a deficit-free budget for one year and then gradually increasing deficits towards their long-run value. During the first year, reserve accumulation depreciates the exchange rate by about 10%. After two years, the exchange rate and fiscal deficit both approximately return to their baseline paths, as in Figures 6 and 7. 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. However, the cost of such a policy is reduced import consumption C_{Ft} associated with the exchange rate depreciation. Furthermore, this policy has limits because the upper bound on reserve accumulation cannot exceed the total accumulated net foreign

asset position of the country F_t^*, as private $B_t^* \geq 0$. Therefore, the fiscal deficit problem cannot be delayed indefinitely.

While sterilized FX interventions can be used to temporarily eliminate fiscal deficit, this policy is associated with its own costs. Two arguments clarify why FX interventions are not a silver bullet. First, FX interventions cannot change real national income which, according to the expressions for nominal GDP and CPI, is equal to:[41]

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

where $y_t^* - p_t^*$ captures the deterioration of the terms of trade and summarizes the effect of sanctions in the tradable sector. Thus, abstracting from the utility of holding assets, managing the exchange rate only generates a redistribution between the government and the household budget constraints. This 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 intervention has additional redistributional effects between savers and consumers, as we discussed in Section 4.3. Second, the proposed way of boosting fiscal revenues requires that the government accumulates foreign reserves. However, this policy can be risky when other countries may impose additional financial sanctions on the government. Instead, current FX revenues should be spent on purchasing additional imports or, at least, sold to private agents that face a lower risk of being sanctioned.

6 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 or even years for these restrictions to take the toll on the economy, many commentators and policymakers attempted to infer the effects of sanctions from the short-term dynamics of the ruble exchange rate. Building on recent models of equilibrium exchange rate determination, this paper clarifies the relationship between sanctions, exchange rates, welfare, and other economic outcomes.

We show theoretically that all forms of international sanctions tend to reduce economic welfare in the same way by means of tightening the country's budget constraint — whether by reducing the sources of income and borrowing or by increasing the costs of imports. However, various sanctions have opposing implications for the equilibrium exchange rate. Import sanctions trigger a trade surplus on impact thereby making foreign currency abundant and requiring an exchange rate appreciation to rebalance the currency and goods markets. Export and foreign asset sanctions have the opposite effect on the exchange rate but, ultimately, also limit the ability of a country to import foreign goods. Therefore, although the exchange rate is allocative and responds to sanctions, it is not a sufficient statistic to judge their welfare impact. Furthermore, we show that the equivalence of various sanctions extends to government fiscal revenues, with import-sanctions induced appreciation resulting in the

[41] 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 (19) provides the expression for $\mathrm{d}\log CPI_t$.

same fiscal deficits as under export restrictions, even when export revenues are the main source of government revenues.

A simple quantitative model allows us to reconcile the seemingly puzzling swings in the exchange rate since the imposition of sanctions. 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 led to a sharp depreciation of the ruble on impact. These factors were exacerbated by the overnight freeze of a significant fraction of government foreign reserves, the exclusion of major banks and corporations from international borrowing markets, and the looming threat of blocking commodity exports. The exchange rate reversed in mid-March and appreciated gradually over the following months surpassing the pre-war level. Tough sanctions on Russia's imports and high export revenues due to unusually high world commodity prices over this period led to a record high current account surplus and an inflow of foreign currency into the economy. In addition, capital controls and financial sanctions prevented capital outflows, while domestic financial repression lowered domestic demand for foreign currency, alleviating the forces driving ruble depreciation. As import sanctions wear out and export revenues shrink over time, the model anticipates a long-run depreciation of the ruble, possibly amplified by the monetization of the enlarged fiscal deficits.

While there is no one-to-one mapping between the exchange rate and welfare, the common view that is equally misleading is that financial sanctions, financial repression and capital controls make the exchange rate irrelevant from the welfare perspective. Instead, the exchange rate remains allocative even under strict borrowing restrictions — in particular, in economies with heterogeneous agents. Financial repression discourages domestic foreign currency savings, appreciates the exchange rate, and leaves more resources to purchase imports — a competing objective of foreign currency use. As a result, such a policy benefits consumers by increasing their purchasing power for buying imported goods at the expense of households that want to hold foreign currency as a safe asset. Furthermore, the exchange rate is also important for fiscal balance and the government can use FX interventions to temporary close budget deficits.

APPENDIX

A Additional Displays

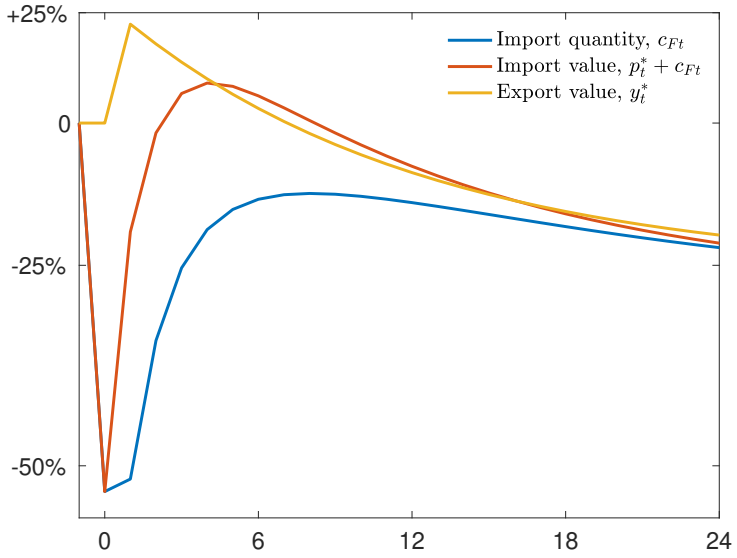

Figure 9: Trade dynamics

Note: The figure plots the simulated path of import quantities c_{Ft} (the same as black line in Figure 6b), import values $p_t^* + c_{Ft}$ and export values y_t^* in response to the calibrated sanctions shocks described in Table 1. While the decline in import quantities is well aligned with the empirical patterns, the model understates the decline in import values for $t \geq 2$, which may be due to under-reporting of the true value of payments for sanctioned imported goods in the data.

B Import Sanctions

In this appendix, we spell out the microfounded model of import sanctions with a continuum of import varieties, and sanctions modeled as either a foreign export tax or a foreign export ban—and we show the equivalence of the two cases. For concreteness, we adopt the functional form in (3), and further assume that the import good is a CES aggregator of import varieties $i \in [0, \gamma]$ with an elasticity of substitution $\theta \geq 1$:

$$C_{Ft} = \left[\frac{1}{\gamma} \int_0^{\gamma} (c_{it}^*)^{\frac{\theta-1}{\theta}} \mathrm{d}i \right]^{\frac{\theta}{\theta-1}},$$

which for $\theta = 1$ becomes a Cobb-Douglas aggregator, $\log C_{Ft} = \frac{1}{\gamma} \int_0^{\gamma} \log c_{it}^* \mathrm{d}i$.

The pre-sanctions prices of import varieties are given by $\{p_{it}^*\}_{i \in [0,\gamma]}$ in foreign currency, and the ideal import price aggregator (index) is given by:

$$P_t^* \equiv \min_{\{c_{it}^*\}} \left\{ \int_0^{\gamma} p_{it}^* c_{it}^* \mathrm{d}i \text{ such that } C_{Ft} \geq 1 \right\} = \left[\gamma^{-\theta} \int_0^{\gamma} (p_{it}^*)^{1-\theta} \mathrm{d}i \right]^{\frac{1}{1-\theta}} \quad \text{for } \theta > 1,$$

and $\log P_t^* = \int_0^\gamma \log p_{it}^* \mathrm{d}i$ for $\theta = 1$. When all $p_{it}^* = p_t^*$ for $i \in [0, \gamma]$, then $P_t^* = \bar{P}_t^* = \gamma p_t^*$ for all $\theta \geq 1$. We assume this is the case, which is a normalization without loss of generality.

We model foreign sanctions as an export tax τ on varieties $i \in [0, \delta]$ for $\delta \in (0, \gamma)$, such that the post-sanctions price of home imports becomes

$$p_{it}^* = p_t^*(1 + \tau \mathbf{1}_{\{i \in [0,\delta]\}}).$$

Alternatively, we model sanctions as an export ban, in which case the consumer optimizes over the remaining available import varieties $i \in (\delta, \gamma]$. Under CES with $\theta > 1$ this constitutes no issue as the aggregator is well defined with $c_{it}^* = 0$ for $i \in [0, \delta]$; under Cobb-Douglas with $\theta = 1$, this results in $C_{Ft} = -\infty$ independently of c_{it}^* for $i \in (\delta, \gamma]$, and we consider this case as the limit of CES with $\theta \to 1$.

Consider the utility maximization problem:

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

$$\text{s.t.} \quad P_t C_{Ht} + \int_0^\gamma \mathcal{E}_t p_{it}^* c_{it}^* \mathrm{d}i = P_t Y_t + \mathcal{E}_t (Y_t^* + \Omega_t^*),$$

where Ω_t^* is an international transfer or return on NFA. When $\theta = 1$, the second term in u_t is $\int_0^\gamma \log c_{it}^* \mathrm{d}i$. Market clearing is $C_{Ht} = Y_t$, which implies trade balance $\int_0^\gamma \mathcal{E}_t p_{it}^* c_{it}^* \mathrm{d}i = \mathcal{E}_t (Y_t^* + \Omega_t^*)$. The optimal import consumption allocation for any $\theta \geq 1$ is given by:

$$c_{it}^* = \frac{\gamma^{1-\theta}}{1-\gamma} \left(\frac{\mathcal{E}_t p_{it}^*}{P_t} \right)^{-\theta} C_{Ht}.$$

Under sanctions, this allocation applies for p_{it}^* inclusive of the export tax τ or for a subset of available varieties $i \in (\delta, \gamma]$ under the export ban, while $c_{it}^* = 0$ for $i \in [0, \delta]$ in this case.

We use the convention that $\tau = \infty$ corresponds to the import ban, and thus, we can write the expenditure on any import variety $i \in [0, \gamma]$ as:

$$\mathcal{E}_t p_{it}^* c_{it}^* = \left[\mathbf{1}_{\{i \in [0,\delta]\}} \mathbf{1}_{\{\tau < \infty\}} (1+\tau)^{1-\theta} + \mathbf{1}_{\{i \in (\delta,\gamma]\}} \right] \frac{\gamma^{1-\theta}}{1-\gamma} \left(\frac{\mathcal{E}_t p_t^*}{P_t} \right)^{1-\theta} P_t C_{Ht},$$

where indicators $\mathbf{1}_{\{i \in [0,\delta]\}} = 1$ for sanctioned varieties and $\mathbf{1}_{\{i \in (\delta,\gamma]\}} = 1$ for non-sanctioned varieties, and zero otherwise. This expression applies for any $\theta \geq 1$, including in the $\theta = 1$ limit. For $\theta > 1$, the limit of $\tau \to \infty$ results in $c_{it}^* \to 0$ for sanctioned varieties, and thus $\mathbf{1}_{\{\tau < \infty\}}$ can be dropped. In the Cobb-Douglas case ($\theta = 1$), import ban ($\tau = \infty$) is not equivalent to an infinite import tax ($\tau \to \infty$), and thus we need to use $\mathbf{1}_{\{\tau < \infty\}} = 0$ for $\tau = \infty$.

Integrating expenditure for all import varieties $i \in [0, \gamma]$, aggregate imports are given by:

$$\mathcal{E}_t P_t^* C_{Ft} = \int_0^\gamma \mathcal{E}_t p_{it}^* c_{it}^* \mathrm{d}i = \left[\delta \mathbf{1}_{\{\tau < \infty\}} (1+\tau)^{1-\theta} + (\gamma - \delta) \right] \frac{\gamma^{1-\theta}}{1-\gamma} \left(\frac{\mathcal{E}_t p_t^*}{P_t} \right)^{1-\theta} P_t C_{Ht}.$$

Using similar notation and the CES import consumption index for $\theta > 1$, we have:

$$C_{Ft} = \left[\frac{1}{\gamma}\int_0^{\gamma}(c_{it}^*)^{\frac{\theta-1}{\theta}}\mathrm{d}i\right]^{\frac{\theta}{\theta-1}} = \frac{\gamma^{1-\theta}}{1-\gamma}\left(\frac{\mathcal{E}_t p_t^*}{P_t}\right)^{-\theta} C_{Ht}\left[\frac{\delta}{\gamma}\mathbf{1}_{\{\tau<\infty\}}(1+\tau)^{1-\theta}+\frac{\gamma-\delta}{\gamma}\right]^{\frac{\theta}{\theta-1}}.$$

Dividing the aggregate import expenditure $P_t^* C_{Ft}$ by the import consumption index C_{Ft} yields:

$$P_t^* = \left[\frac{\delta}{\gamma}\mathbf{1}_{\{\tau<\infty\}}(1+\tau)^{1-\theta}+\frac{\gamma-\delta}{\gamma}\right]^{\frac{1}{1-\theta}}\bar{P}_t^*, \tag{20}$$

$$C_{Ft} = \frac{\gamma}{1-\gamma}\left(\frac{\mathcal{E}_t P_t^*}{P_t}\right)^{-\theta} C_{Ht}, \tag{21}$$

and $\bar{P}_t^* = \gamma p_t^*$ is the pre-sanctions import price index for all $\theta \geq 1$.

Under (finite) import tax, $\tau < \infty$, these equations apply in the Cobb-Douglas limits, $\theta = 1$, with $P_t^* = \bar{P}_t^*(1+\tau)^{\delta/\gamma}$ and $C_{Ft} = \frac{\gamma}{1-\gamma}\frac{P_t C_{Ht}}{\mathcal{E}_t P_t^*}$. Under import ban, $\tau = \infty$, we have

$$P_t^* = \left(\frac{\gamma}{\gamma-\delta}\right)^{\frac{1}{\theta-1}}\bar{P}_t^*, \tag{22}$$

with $P_t^* \to \infty$ and $C_{Ft} \to 0$ as $\theta \to 1$. We treat this limit, with individual c_{it}^* and $p_{it}^* c_{it}^*$ well defined as described above, as the description of the Cobb-Douglas equilibrium under the export ban.[42]

After substituting (22) into (21) and using market clearing $C_{Ht} = Y_t$ and steady-state trade balance $P_t^* C_{Ft} = Y_t^* + \Omega_t^*$ with $\Omega_t^* = (1-\beta)F_t^*$, the equations above correspond to the conditions (9)–(11) in the text, which give rise to the solution for the equilibrium exchange rate (12). In particular, under import sanctions, trade balance implies $\mathrm{d}\log C_{Ft} = -\mathrm{d}\log P_t^*$, while import demand (21) requires $\mathrm{d}\log C_{Ft} = -\theta(\mathrm{d}\log\mathcal{E}_t + \mathrm{d}\log P_t^*)$, which yields the exchange rate solution ((16) in the text):

$$\mathrm{d}\log\mathcal{E}_t = -\frac{\theta-1}{\theta}\mathrm{d}\log P_t^* = \begin{cases} -\dfrac{\theta-1}{\theta}\log\left(\frac{\delta}{\gamma}(1+\tau)^{1-\theta}+\frac{\gamma-\delta}{\gamma}\right)^{\frac{1}{1-\theta}}, & \text{under import tax } \tau<\infty, \\ -\dfrac{1}{\theta}\log\dfrac{\gamma}{\gamma-\delta}, & \text{under import ban } \tau=\infty, \end{cases}$$

which applies for all $\theta \geq 1$. In the case of import tariff ($\tau < \infty$), the Cobb-Douglas limit ($\theta \to 1$) results in $\mathrm{d}\log P_t^* = \frac{\delta}{\gamma}\log(1+\tau)$ and $\mathrm{d}\log\mathcal{E}_t = 0$, that is no effect on the exchange rate (as expenditure share on imports is constant and does not depend on either τ or $\mathcal{E}_t$ in this case; see footnote 23 in Section 4.1). In the CES case ($\theta > 1$), both import tariff ($\tau < \infty$) and import ban ($\tau = \infty$) result in an increase in the import price index ($\mathrm{d}\log P_t^* > 0$) and an appreciation of the exchange rate ($\mathrm{d}\log\mathcal{E}_t < 0$). Note that $\lim_{\tau\to\infty}\left(\frac{\delta}{\gamma}(1+\tau)^{1-\theta}+\frac{\gamma-\delta}{\gamma}\right)^{\frac{1}{1-\theta}} = \left(\frac{\gamma}{\gamma-\delta}\right)^{\frac{1}{\theta-1}}$, and hence import ban is equivalent to import tariff in the limit. Furthermore, for given $\theta > 1$ and $\delta \in (0,\gamma)$, a uniform tariff $1+\tau = \left(\frac{\gamma}{\gamma-\delta}\right)^{\frac{1}{\theta-1}}$ on *all* imports is equivalent to a ban on a share δ/γ of import varieties, with τ increasing to ∞ as θ decreases to 1.

[42] This limit obtains from the infinite limit of the import tax by first taking $\tau \to \infty$ under $\theta > 1$ and then taking $\theta \to 1$. An alternative sequence of limits, $\theta \to 1$ and then $\tau \to \infty$ results in a discontinuity. The reason is that in this case a country "sets on fire" a share δ of its total import expenditure even when these varieties are unavailable altogether, which we believe is unrealistic empirically.

Finally, the import ban case ($\tau = \infty$) under Cobb-Douglas obtains as a limit of $\theta \to 1$ and features $\mathrm{d}\log P_t^* = \infty$ and $\mathrm{d}\log \mathcal{E}_t = -\log\frac{\gamma}{\gamma-\delta} < 0$, rather than $\mathrm{d}\log \mathcal{E}_t = 0$ (which would be the case under alternative sequence of limits, for $\tau \to \infty$ given $\theta = 1$, as we explained above).

C Fiscal Revenues and Price Index

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

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

to be the (steady state) share of taxes on exports in total tax revenues of the government. We take the path of domestic prices and output (P_t, Y_t) as given, and evaluate the marginal effect of export and import sanctions on TR_t and consumer price index CPI_t defined in the text. We have:

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

where

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

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

It only remains to characterize $\mathrm{d}\log(\mathcal{E}_t Y_t^*)$ and $\mathrm{d}\log(P_t^* \mathcal{E}_t)$ under the two sanction regimes. From the country budget constraint (7), both sanction regimes in Proposition 2 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 (15) to obtain:

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

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

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

completing the derivation of (17). ■

D Financial Repression

Proof of Proposition 3 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 and featuring a growing path of import consumption in all future periods, $C_{F,t+1} > C_{Ft}$ for $t \geq 0$, to satisfy (8), as the gap between B_{t+1}^*/P_{t+1}^* and Ψ_t declines with accumulation of B_{t+1}^* until $B_{t+1}^*/P_{t+1}^* = \Psi_t$ in the new steady state.[43] Since B_{t+1}^* increases, the new steady state budget constraint allows for a larger level of imports C_{Ft} in the long run, and the initial drop in imports C_{F0} satisfies the intertemporal budget constraint. The path of the exchange rate $\mathcal{E}_t$ tracks that of imports C_{Ft} with elasticity $-1/\theta$ in order to satisfy (6). Thus, a permanent increase in Ψ_t triggers a jump devaluation and a gradual appreciation thereafter to a more appreciated level in the new steady state with greater net foreign assets.

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. ■

E Heterogeneous Households

Proof of Proposition 4 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

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

[43] For illustration, consider the special parametric case (3) and a permanent shock to Ψ_t at $t = 0$ in an otherwise stationary environment with $\beta R_t^* = 1$, $R_{Ht}^* = R_t^*$, $Y_t^* = Y^* = const$, and $P_t^* = P^* = const$. In this case, we rewrite (8) as:

$$\mathbb{E}_t \left\{ \left(C_{Ft}/C_{F,t+1} \right)^{1/\theta} + \tilde{\kappa} C_{Ft}^{1/\theta} (\Psi_t - B_{t+1}^*/P_{t+1}^*) \right\} = 1,$$

where $\Psi_t - B_{t+1}^*/P_{t+1}^* > 0$ and $C_{Ft}/C_{F,t+1} < 1$ during the transition with these inequalities turning into equalities in the new steady state with larger B_{t+1}^* and C_{Ft} in the long run, which requires a downward jump in C_{F0} on impact to satisfy the intertemporal budget constraint and ensure an increasing path of B_{t+1}^* in (7): $B_{t+1}^* = R^*(B_t^* + Y^* - P^* C_{Ft}) > B_t^*$. This logic generalizes to a fully stochastic environment as the one studied in Itskhoki and Mukhin (2021a).

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:

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

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

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

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

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

$$\max \quad \mathbb{E}\sum_{t=0}^{\infty} \beta^t \left\{ \omega \log C_{Ft}^C + (1-\omega)\left[\log C_{Ft}^R - \frac{\kappa}{2}\left(\frac{B_{t+1}^*}{P_{t+1}^*} - \Psi_t\right)^2\right]\right\}$$

subject to

$$C_{Ft}^C = \gamma\alpha\frac{P_tY_t}{\mathcal{E}_tP_t^*}, \qquad C_{Ft}^R = \gamma\left[\frac{1}{1-\gamma}-\alpha\right]\frac{P_tY_t}{\mathcal{E}_tP_t^*}$$
$$\frac{B_{t+1}^*}{R_t^*} = B_t^* + Y_t^* - P_t^*\left(C_{Ft}^C + C_{Ft}^R\right),$$

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 ω. ■

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