The Economics of International Sanctions*

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Abstract

After a wave of globalization following the end of the Cold War, trade wars and financial sanctions have become frequent tools of international policymaking over 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 international sanctions. We show that Lerner (1936) symmetry provides an important benchmark for this analysis with import and export sanctions equivalent in terms of their effects on allocations and welfare, despite a differential effect on the currency market. We further analyze various circumstances when Lerner symmetry fails. In particular, for a country cut off from international borrowing, transitory export sanctions have a larger welfare effect than equivalent import sanctions, with import sanctions mitigating the borrowing constraints in the economy. Lastly, we study the dynamic impact of financial sanctions and the possible use of financial repression policies to mitigate their effects. We use a quantitative model to show the relevance of these forces in the context of sanctions imposed on Russian since its invasion of Ukraine in February 2022.

*Prepared for the 7th Annual Macroprudential Conference in Stockholm, Sweden. This paper builds and extends our earlier analysis in Itskhoki and Mukhin (2022b, 2023), as well as shows some empirical findings from Babina, Hilgenstock, Itskhoki, Mironov, and Ribakova (2023) and Hilgenstock, Ribakova, Shapoval, Babina, Itskhoki, and Mironov (2023).

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.

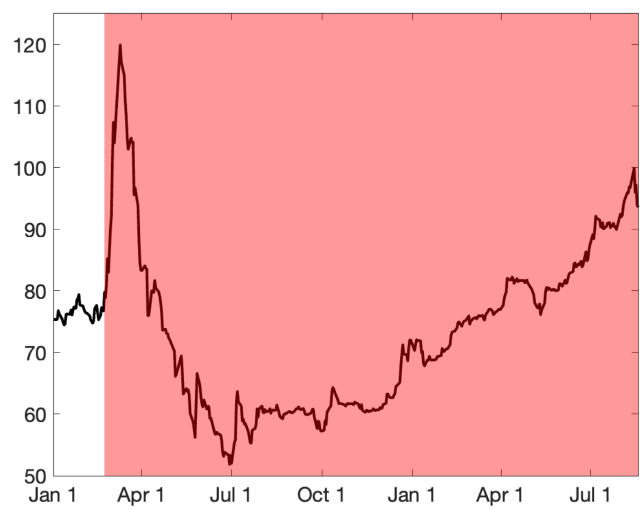

Figure 1: Daily ruble exchange rate (per one USD) since January 1, 2022

This paper is motivated, in particular, by the recent barrage 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, before launching on a shallow but persistent depreciation trend. 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? Did a strong ruble mean that sanctions were not working and had 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 a policy response curb negative effects of sanctions and what trade-offs

[1]See e.g. P. Krugman "Wonking Out: The Curious Case of the Recovering Ruble" (NYT, April 1, 2022), S. Guriev "The

does it face? What are the implications for fiscal revenues and what exchange rate policies can be used to mitigate them? Finally, did the recent acceleration in the pace of ruble depreciation — over a year and half since the invasion and since the majority of the sanctions were imposed — happen because of the accumulate effect of sanctions or despite the lack of decisive sanctions?

Our work aims to address these questions in a unifying framework that incorporates modeling of a variety of international sanctions, both trade-related and financial, with a rich spectrum of potential policy responses. We start our analysis analysis by exploring the long-run consequences of permanent trade sanction and net foreign asset (NFA) freezes. We show that Lerner symmetry between an import tariff and an export tax offers an important benchmark for the analysis of sanctions. Indeed, the same policy goals can be achieved by means of permanent export restrictions (possibly, combined with an NFA seizure) and permanent import restrictions.[2] 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. At the same time, export restrictions and NFA freezes depreciate the country's exchange rate by limiting the supply of currency, while import restrictions appreciate its exchange rate by limiting the demand for currency. Indeed, this is a macroeconomic manifestation of the classic Lerner (1936) symmetry result, which postulates that export and import restrictions yield the same economic outcomes, but are sustained with a differential movement in relative prices.[3] 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 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 cumulative complementary effect.

In the case of Russia, stiff import restrictions and a foreign asset freeze coincided with record-high export revenues (due to a spike in a global energy prices caused by the war), and export restrictions were not imposed in earnest for the first 8 months of the war. The latter largely offset the economic impact of the former force, and both forces worked in the same direction to appreciate the ruble exchange rate.

Our second set of results concerns various circumstances when Lerner symmetry does not hold and import and export restrictions are not equivalent and, in particular, have different complementar-

Incredible Bouncing Ruble" (Project Syndicate, April 12, 2022), and L. Garicano "Sanctions against Russia" (March 8, 2022).

[2]From the point of view of the sanctioned country, a partial export (import) ban is equivalent to a tariff (tax) chosen at an appropriate level, and in our analysis we focus on the effective terms of trade deterioration as the sufficient statistic for the effect of trade sanctions.

[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).

ity properties with financial sanctions and financial constraints on the economy. First, 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. Second, financial and export sanctions tend to work in complementary ways, while import sanctions mitigate borrowing constraints in the economy.

In the case of Russia, steep financial sanctions were combined with import sanctions, while contemporaneously export revenues increased. This meant that foreign currency became abundant, while foreign goods became scarce, appreciating the exchange rate, reducing the foreign-currency debt burden, and eliminating potential forces for a banking and currency crisis. This poor design of the policy mix largely defeated the purpose of swift and decisive economic sanctions in the beginning of the war. A major outstanding counterfactual question is whether, given a feasible Russian policy response, there was at all a possibility of a financial crisis equilibrium, provide that prior to the war Russia had a trade surplus, a fiscal surplus, and a non-dollarized economy.

Our third set of results concerns the dynamic effects of financial sanctions for alternative possible policy responses. 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 provided there is a trade surplus. However, such a financial shock creates a conflict between two competing foreign currency uses — import consumption and savings — resulting in household welfare losses.

The optimal policy response to the financial shock aims to offset it by selling official FX reserves to the private sector. 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 exchange rate depreciation with conventional FX interventions when financial sanctions were imposed. We show quantitatively that this was the main impact of financial sanctions, as their direct flow-value impact on the Russian economy was modest.

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.[4] Again, this alines closely with the actions of the Central

[4]While financial repression is suboptimal in a representative-agent economy, the trade-off is more nuanced when there is a distributional conflict between foreign-currency savers and consumers of imports, as their welfare responds differentially

Bank of Russia that — given FXI unavailable — introduced a host of financial restrictions, including capital controls, limits on withdrawal and fees on buying foreign currency, and obligatory sales of FX by exporters. All of these restrictions were withdrawn as the ruble appreciated following the record-high trade surpluses (and hence currency surpluses) during the first months of the war.

Our analysis builds 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.[5] 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). We set up the model in Section 2.

Section 3 studies the case where Lerner symmetry holds, while Section 4 analyzes the differential impact of import, export and financial sanctions when Lerner symmetry does not apply. Section 5 studies the dynamic effects of financial sanctions and financial repression policy response. Section 6 documents Russian import and export outcomes, and provides a quantitative analysis of the effects of various sanctions and policies on the Russian economy in 2022–23.

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.[6] The 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.

to a currency depreciation. Importantly, the view that the exchange rate is not allocative under financial repression policy is unwarranted, as long as foreign currency is used at least in part for imports and/or savings.

[5]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.

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

2 Modeling Environment

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

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

$$\max \mathbb{E}_0 \sum_{t=0}^{T} \beta^t u(C_{Ht}, C_{Ft}), \tag{1}$$

where T can be either finite or infinite, and 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}^*). In our examples, we use the following CES functional form:

$$u(C_H, C_F) = (1-\gamma)^{1/\theta} C_H^{\frac{\theta-1}{\theta}} + \gamma^{1/\theta} C_F^{\frac{\theta-1}{\theta}}, \tag{3}$$

where $\theta \geq 1$ is the elasticity of substitution between home and imported goods, with $\theta = 1$ corresponding to the log-Cobb-Douglas case, and $\gamma \in [0, 1)$ is the exposure to imported goods.

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. In other words, we can think of $Y_t = \tilde{Y}_t - G_t$ as disposable output for domestic consumption after military expenditure G_t, and $\tilde{Y}_t$ as total measured output.

Finally, F_t^* are 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:

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 2022a).[7]

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.

Another equilibrium conditions for exchange rate determination is the country budget constraint which combines the household and government budget constraints (2) and (4) expressed in foreign currency, together with the non-tradable market clearing condition (5):[8]

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

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

[7] 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.

[8] 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).

held jointly by the households (B_t^*) and the government ($F_t^* - B_t^*$).

Finally, the consumption-savings decision by the households, as well as the foreign bond demand, is shaped by another Euler equation with respect to the foreign currency bond, $\beta R_{Ht}^* \mathbb{E}_t\left\{\frac{P_t^*}{P_{t+1}^*}\frac{u_{F,t+1}}{u_{Ft}}\right\} = 1$, where $u_{Ft} \equiv u_F'(C_{Ht}, C_{Ft})$. Since the country takes foreign prices P_t^* as given, this equation determines the intertemporal path of imports, and hence net exports, given the foreign currency interest rate R_{Ht}^* faced by the households, which may differ from R_t^* under capital controls or financial repression. This condition plays a limited role in our steady-state analysis with permanent sanction shocks in Section 3, but gains prominence in our dynamic analysis in Section 5, where we generalize it to feature an exogenous shock for foreign currency savings.

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.
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.[9]
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 accumulated from trade surpluses is the only source of foreign currency that can be used for foreign-currency savings.

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),

[9] 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.

and the household foreign bond Euler equation, given non-tradable goods market clearing (5), initial net foreign assets F_0^*, and government policies — paths of promised wages W_t, reserve accumulation $(F_{t+1}^* - B_{t+1}^*)$, 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.[10] 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.

Before proceeding with our analysis, we summarizes sources of currency demand and supply in the economy. As usual, exports are flows of currency supply to the economy and imports are flows of currency demand in the economy for the purposes of consumption. Accumulated net exports form net foreign assets which are the stock of currency supply to the economy, equal in equilibrium to the accumulated net savings of the economy — a stock of currency demand. This perspective would be useful throughout our analysis to analyze the exchange rate effects of various sanctions and policies from the perspective of the balance between currency demand and currency in the economy.

3 International Sanctions under Lerner Symmetry

An important benchmark in our analysis is when sanctions are *permanent and uniform* across periods. Both export and import sanctions reduce the real income of the economy — either by limiting the inflow of dollars or increasing the dollar prices of foreign goods — shifting the country's budget constraint inwards, lowering imports, and reducing welfare. The terms of trade of the economy deteriorate permanent and by the same amount under both import and export sanctions, and thus the real effects of both policies are the same, consistent with Lerner (1936) symmetry between an import tariff and an export taxes.[11] At the same time, this equivalence of outcomes must be supported by an exchange rate depreciation ($\mathcal{E}_t/P_t \uparrow$) under export sanctions, which limit the supply of foreign currency, and by an exchange rate appreciation ($\mathcal{E}_t/P_t \downarrow$) under import sanctions which limit the demand for foreign currency. We now provide a detailed discussion of this mechanism and study various departures from equivalence in Section 4.

Sanctions in a stationary equilibrium We study the effects of permanent sanctions as comparative statics in the context of a stationary equilibrium. 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 $\beta R_t^* = 1$. Thus, we drop the time index in the rest of this section. Under these circumstances, a stationary equilibrium satisfies the household foreign-bond Eu-

[10] A no-Ponzi game condition (NPGC) is imposed on both net assets of the government and of the households, amounting to an aggregate NPGC requirement on net foreign assets of the country, F_t^* at $t = T$ or $t \to \infty$.

[11] A uniform tariff on imports reduces imports, but trade balance requires a parallel reduction in exports, which in equilibrium results from the increase in the relative home wage and hence the relative cost of home production. The same effects of reducing exports and imports emerges from an export tax, which however is supported by a reduction in the relative home wage. A differential adjustment in relative prices is attained via an exchange rate movement in our analysis.

ler equation. Thus, permanent sanction shocks result in no equilibrium transition and a jump to a new stationary equilibrium $(C_F, \mathcal{E})$ that satisfy 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. Then, the equilibrium system (6)–(7), given home good market clearing $C_H = Y$, can be written as follows:

$$\mathcal{E}P^*C_F = \frac{\gamma-\delta}{1-\gamma}\left(\frac{\mathcal{E}\bar{P}^*}{P}\right)^{1-\theta} PY, \tag{8}$$

$$P^*C_F = Y^* + (1-\beta)F^*, \tag{9}$$

where $\bar{P}^*$ is the import price index before import sanctions, and the import price index after sanctions is given by $P^* = \left(\frac{\gamma}{\gamma-\delta}\right)^{\frac{1}{\theta-1}} \bar{P}^*$.[12] 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 (9) 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 (8) characterizes the total import expenditure that arises from import demand (6), aggregating over the available import varieties. In particular, the term $\frac{\gamma-\delta}{1-\gamma}\left(\frac{\mathcal{E}\bar{P}^*}{P}\right)^{1-\theta}$ in (8) 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 ($\mathcal{E}\uparrow$). In the Cobb-Douglas limit, $\theta \to 1$, the expenditure share on imports is given simply by the share of import varieties that remain available, $\frac{\gamma-\delta}{1-\gamma}$.

The country budget constraint (9) combined with the expression for P^*, characterizes the welfare-relevant (real) quantity of imports:

$$C_F = \left(\frac{\gamma-\delta}{\gamma}\right)^{\frac{1}{\theta-1}} \frac{Y^* + (1-\beta)F^*}{\bar{P}^*}. \tag{10}$$

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 (8) and (9), we solve for the

[12]Note that combining the expression for P^* with (8) and rearranging results in the CES version of equation (6). See Itskhoki and Mukhin (2022b) for detailed derivations.

equilibrium exchange rate:[13]

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

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 (10) and (11), 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 as:

Result 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 (9). 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.[14] 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.

Second, consider equilibrium from the perspective of expenditure switching and demand for imports. Sanctions on imports shift inward the total import expenditure (8) 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

[13]Interestingly, characterization in (11) applies both for $\theta > 1$ and for the Cobb-Douglas limit $\theta \to 1$, in which case it simplifies to $\mathcal{E} = \frac{\gamma-\delta}{1-\gamma}\frac{PY}{Y^*+(1-\beta)F^*}$.

[14]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.

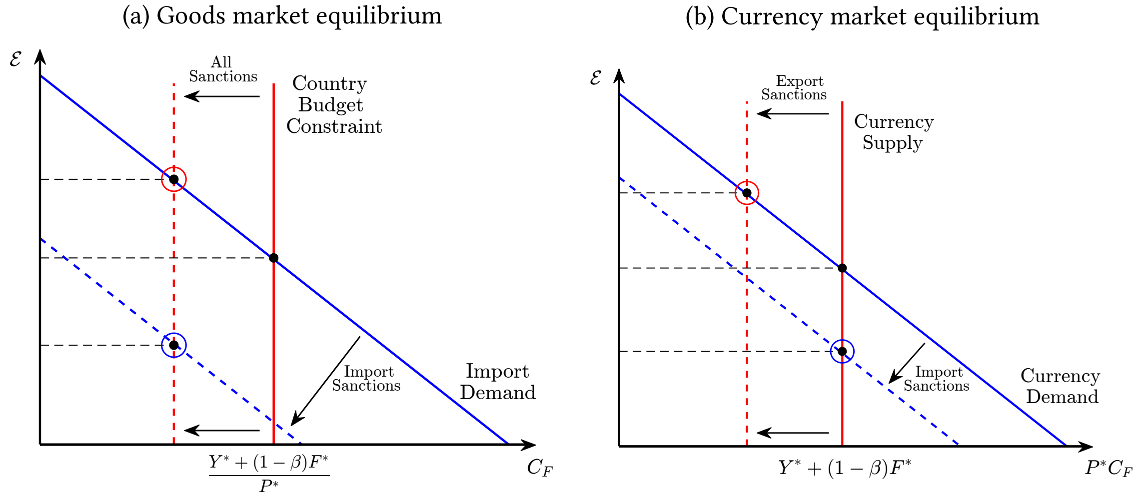

Figure 2: Export and Import Sanctions

Note: The left panel describes the equilibrium in the goods market by plotting (8)–(9) 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 (9) leftward in both panels, while import sanctions do the same only in the left panel. Import sanctions additionally shift inward (8) in both panels. The equilibrium points are characterized by (10)–(11). See discussion in the text.

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.[15] This mechanism is the focus of Lorenzoni and Werning (2022). In fact, 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 (11) 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 (8) 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 (11) 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

[15] 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).

as equations (8)–(9) 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 $\mathcal{E}P^*$, 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:

$$\frac{W}{P} \leq Y + \frac{\mathcal{E}}{P}\big[Y^* + (1-\beta)(F^* - B^*)\big]. \tag{12}$$

Export and foreign asset sanctions reduce the revenue side of the fiscal balance (12) directly, while import sanctions do it indirectly via the equilibrium exchange rate appreciation, $\mathcal{E}/P$, given by (11).[16] Nonetheless, there always exists a level of home price inflation P such that (12) 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.

In Itskhoki and Mukhin (2022b), we further show that Lerner symmetry for allocations under import and export sanctions extends further to government fiscal balance and consumer price inflation (real cost of living). Specifically, provide that import and export sanctions result in the same path of imports C_{Ft}, they have the same impact on the paths of fiscal balance and consumer price inflation. While import sanctions have a direct effect on consumer prices and export sanctions have a direct effect on fiscal revenues (from export taxes on commodities), the equivalence is achieved by means of an exchange rate adjustment. The exchange rate devaluation under export sanctions results in inflationary effects on consumer prices, while the exchange rate appreciation under import sanctions has negative consequences for the fiscal balance where the revenues come in part from exports. This is a manifestation of the fact that Lerner symmetry holds not just in the aggregate, but applies budget set by budget set (see Barbiero, Farhi, Gopinath, and Itskhoki 2019).

Application to Russia The analysis in this section is revealing why a combination of sanctions and shocks that affected the Russian economy since the start of the war in February 2022 resulting in an appreciation of the ruble exchange rate in 2022 and had only mild affects on GDP, welfare and inflation. A combination of financial asset freezes ($F^* \downarrow$) and import sanctions ($\delta \uparrow$) was confounded by a dramatic

[16] In the Cobb-Douglas limit, $\theta \to 1$, this calculation is particularly straightforward, as (12) becomes:

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

Thus, both import sanctions ($\delta \uparrow$), and export sanctions ($Y^* \downarrow$) tighten this government budget constraint, assuming $B^* > 0$, that is a portion of net foreign assets is help by households (the same applies to financial sanctions on official reserves, $F^* \downarrow$ holding B^* constant). This ensures that depreciation of the exchange rate triggered by export and financial sanctions does not more than undo the direct negative effect on the government budget constraint.

increase in commodity terms of trade and, hence, export revenues ($Y^* \uparrow$), in the absence of a coherent sanction policy on Russian exports. As a result, two strong forces for currency appreciation — import sanctions and expansion in export revenues — more than offset the force for depreciation from financial sanctions (that had impact early on, in February-March 2022). Import sanctions resulted in consumer price inflation, welfare losses, and tightened the government budget constraint, but these effects were largely offset by a massive exchange rate appreciation, triggered by an unprecedented expansion in trade surplus in 2022 (see Section 5).

4 International Sanctions without Lerner Symmetry

Lerner symmetry provides an important benchmark with import and export sanctions equivalent in terms of their effects on allocations and welfare. While Lerner symmetry is a very general results, which holds even when Ricardian equivalence fails, an important requirement for Lerner symmetry is that sanctions are uniform. In our macroeconomic application this means that sanctions must be uniform over time, that is permanent. This abstracts from several practical issues, in particular the timing, duration and anticipation of sanctions. We now incorporate these features to study their implications, and emphasize points of departure from Lerner symmetry, including due to interactions between trade and financial restrictions, and the effects of sanctions on the financial sector.

Setup We now consider our baseline economy with two time periods, $T = 2$, and $t = 1, 2$, and generalize the production side of export sector for a possibly finite elasticity of substitution across periods. In the context of the commodity sector, this corresponds to the ability of mining firms to either store or delay (bring forward) the extractions of natural resources from the ground, which we allow to be limited or absent altogether.

Under these circumstances, we rewrite the country budget constraint (7) as follows:

$$\frac{F^*_{t+1}}{R^*_t} - F^*_t = NX^*_t = Q^*_t Y^*_t - P^*_t C_{Ft}, \quad \text{for } t = 1, 2,$$

where we now introduce the international price for country's commodities Q^*_t and an intertemporal production possibilities frontier for commodities, $F(Y^*_1, Y^*_2) = 0$. $F(\cdot)$ is concave and captures intertemporal substitutability which we denote with η. In the limit of zero substitutability, $F(\cdot)$ is Leontieff, and it identifies an exogenous endowment vector (Y^*_1, Y^*_2) that can be sold at prices (Q^*_1, Q^*_2) resulting in export revenues $(Q^*_1 Y^*_1, Q^*_2 Y^*_2)$. In general, the country chooses (Y^*_1, Y^*_2) to maximize the present value of export revenues, $Q^*_1 Y^*_1 + Q^*_2 Y^*_2 / R^*_1$, subject to $F(Y^*_1, Y^*_2) = 0$.

Sanctions and the terms of trade Import sanctions increase the ideal price index for imported goods P^*_t and export sanctions reduce export revenues via a reduction in Q^*_t. We study what kind of sanctions is more damaging to the economy.[17] We define the aggregate terms of trade, $S^*_t \equiv Q^*_t / P^*_t$,

[17] From the point of view of the domestic economy, it does not matter whether these sanctions are implemented using trade tariffs, price floor/ceiling, or quantity restrictions.

which in a static model form a sufficient statistic for the impact of sanctions (Sturm 2022). Our analysis focuses on two paths of shocks $\{P_1^*, P_2^*\}$ and $\{Q_1^*, Q_2^*\}$ with the same resulting path of the terms of trade $\{S_1^*, S_2^*\}$.

Given the path of terms of trade, we can write the intertemporal budget constraint of the country as:

$$C_{F1}^* + \frac{C_{F2}^*}{\tilde{R}^*} \leq S_1^* Y_1^* + \frac{S_2^* Y_2^*}{\tilde{R}^*}, \tag{13}$$

where $\tilde{R}^* = \frac{R_1^*}{P_2^*/P_1^*}$ is the real interest rate in terms of imported consumption goods, i.e. adjusting for the changing price of imports due to import sanctions. We also assumed for simplicity that initial net foreign assets $F_1^* = 0$, which is without loss of generality as we can redefine $Q_1^* Y_1^*$ to incorporate any non-zero F_1^*.

When sanctions are *permanent and uniform* across periods, Lerner symmetry applies, as we discussed in Section 3. Both export and import sanctions reduce the real income of the economy — either by limiting the inflow of dollars or increasing the dollar prices of foreign goods — shifting the country's budget constraint inwards (see Figure 2), lowering imports, and reducing welfare. Because the terms of trade $\{S_t^*\}$ deteriorate by the same amount, and $\tilde{R}^*$ is the same under export and import sanctions (as P_2^*/P_1^* is the same under permanent sanctions), the real effects of import and export sanctions are the same, consistent with Lerner (1936) symmetry. At the same time, this equivalence of outcomes must be supported by an exchange rate depreciation ($\mathcal{E}_t/P_t\uparrow$) under export sanctions which limit the supply of foreign currency and by an exchange rate appreciation ($\mathcal{E}_t/P_t\downarrow$) under import sanctions which limit the demand for foreign currency, as we discussed in the previous section.

Frontloaded sanctions The equivalence between import and export sanctions disappears when restrictions are imposed *non-uniformly* over time.[18] Consider frontloaded temporary sanctions that reduce S_1^* without affecting S_2^*. Using the envelope condition, the first-order welfare effect is given by

$$\Delta\text{Welfare} = \underbrace{\Phi \,\mathrm{d}\log S_1^*}_{\text{wealth effect}} + \underbrace{(\Phi - \Omega)\,\mathrm{d}\log \tilde{R}^*}_{\text{income effect}}, \tag{14}$$

where $\Phi \equiv \frac{Q_1^* Y_1^*}{Q_1^* Y_1^* + Q_2^* Y_2^*/R_1^*}$ and $\Omega \equiv \frac{P_1^* C_1^*}{P_1^* C_1^* + P_2^* C_2^*/R_1^*}$ are respectively the shares of first-period revenues and expenditures in the permanent income of the economy. The first term represents the wealth effect and is the same for the two types of sanctions, while the second term corresponds to the income effect and is non-zero only for import restrictions.[19]

With frontloaded import sanctions, $\mathrm{d}\log \tilde{R}^* > 0$, as import prices increase temporarily in the first period and fall back in the second period, resulting in an increase in the effective interest rate that is absent under export sanctions (see (13)). It follows that borrower countries with a first-period current

[18]For a complementary discussion of departures from Lerner symmetry under sticky prices see Barbiero, Farhi, Gopinath, and Itskhoki (2019) in the context of a border adjustment tax.

[19]A first-order income effect arises in response to a change in the consumption-based real interest rate $\tilde{R}^*$ when the country is either a borrower ($\Phi < \Omega$) or a lender ($\Phi > \Omega$), and this effect is distinct from a second order substitution effect that we explore below (see Obstfeld and Rogoff 1996, Ch. 1.3.2). For this reason, elasticities of substitution θ and η do not appear in the first-order expansion (14).

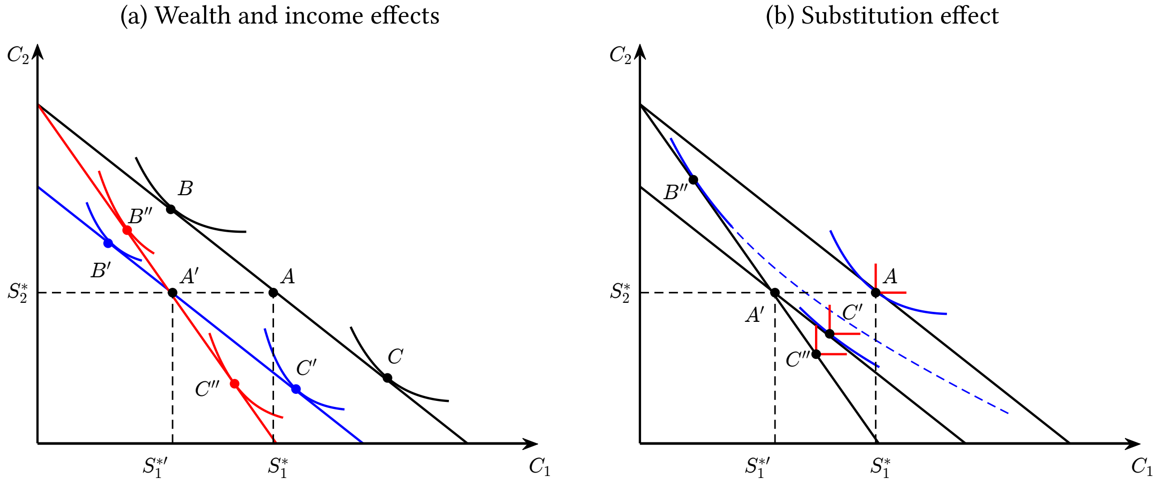

Figure 3: Frontloaded sanctions

Note: Axes in both panels correspond to import consumption at $t = 1, 2$. Panel (a) illustrates the effect of frontloaded temporary export (in blue) and import (in red) sanctions for a saver (points B) and a borrower (points C) country respectively. Panel (b) illustrates the second order consumption substitution effect for $\theta = 0$ (points C'') and for $\theta > 1$ (point B''). Parallel inward shift of the budget constraint line corresponds to export sanctions (reduction in S_1^*), and frontloaded import sanctions add an additional clockwise rotation around $(S_1^{*\prime}, S_2^*)$ corresponding to an increase in $\tilde{R}^*$. Figures normalize $Y_1^* = Y_2^* = 1$.

account deficit $\Phi < \Omega$ suffer more from frontloaded import sanctions, while lender countries that run a first-period current account surplus $\Phi > \Omega$ are more sensitive to export sanctions. This departure from Lerner symmetry is the result of a differential change in the intertemporal price introduced by temporary import sanctions.

Figure 3a illustrates this result. Both export and import sanctions worsen terms of trade S_1^* resulting in an inward shift of the endowment point A to point A'. Both saver and borrower countries experience a negative wealth effect moving from B to B' and from C to C' respectively. However, under import sanctions, there is an additional income effect from an increase in $\tilde{R}^*$ which rotates the budget set and improves welfare for borrowers (shift from B' to B'') and reduces welfare for lenders (shift from C' to C'').

Non-linear effects The welfare analysis above focuses on the first-order effects, which provide an accurate approximation when economic sanctions are small. In practice, imposed restrictions are often sufficiently large to generate substantial intertemporal substitution in production and consumption. To characterize these additional substitution effects from frontloaded temporary sanctions, we take a second-order approximation to the country's welfare around the autarky equilibrium with $\Phi = \Omega$ (*cf.* Baqaee and Farhi 2019):

$$\mathrm{d}\log V = \Omega\,\mathrm{d}\log S_1^* + \frac{1}{2}\Omega(1-\Omega)\Big[(\theta-1)(\mathrm{d}\log P_1^*)^2 + (\eta+1)(\mathrm{d}\log Q_1^*)^2\Big]. \tag{15}$$

Consistent with the analysis above, import and export sanctions are equivalent up to the first order for a country with a zero net foreign asset position — an approximate version of Lerner symmetry with

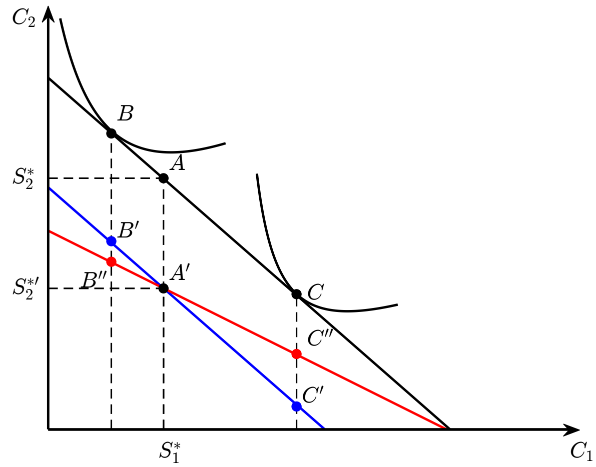

Figure 4: Backloaded sanctions

Note: Axes correspond to import consumption at $t = 1, 2$. The figure illustrates the effects of future unexpected export (in blue) and import (in red) sanctions for a saver (points B) and a borrower (points C) country respectively. Note the downward shift of the budget constraint under future export sanctions and its additional counterclockwise rotation under future import sanctions.

temporary sanctions.

At the same time, the two types of restrictions have different substitution effects captured by the second-order terms. As shown in Figure 3b, a temporary increase in import prices has two effects. On the one hand, by reducing real income in the first period, import sanctions induce the economy to run a current account deficit. As mentioned above, a borrowing country loses more from higher P_1^*, and we now show that this effect is convex. This corresponds to moving from point C' to C'' in the figure. On the other hand, intertemporal substitution allows the country to mitigate the negative effect of temporary sanctions by shifting consumption to the second period. In fact, the country can switch from borrowing to saving, i.e. move from point C'' to B'', if the elasticity is high enough. The net effect depends on the intertemporal elasticity of substitution and is positive when $\theta > 1$, that is when the positive second-order substitution effect ($=\theta$) dominates the negative second-order income effect ($=1$).

Similarly, a fall in export prices in the first period can be partially offset by shifting the production of commodities to the second period. This means that export revenues fall less than export prices which is consistent with a positive coefficient in front of $(\mathrm{d}\log Q_1^*)^2$. The higher the elasticity of substitution in production η, the easier it is to alleviate the effect of export sanctions.[20] To summarize, the ability of the country to substitute consumption and production intertemporally drives a wedge between the welfare effects of *temporary* import and export sanctions, amplifying the departure from Lerner symmetry.

Backloaded sanctions A symmetric argument applies to backloaded sanctions. To the first order, countries with a trade surplus are more sensitive to future increases in import prices than to future

[20]Note that the second-order welfare effect of temporary export sanctions is positive even when $\eta = 0$ due to the ability of the country to intertemporally smooth consumption, that is to shift from the autarky point A' to point C' in Figure 3b. Also note from (15) that both consumption and production substitution effects are stronger when expenditures and revenues are distributed more uniformly across periods, i.e. $\Omega \approx 1/2$.

restrictions on their exports because of the negative effect of P_2^* on their savings. Furthermore, higher elasticities of substitution allow economies to mitigate the effect of sanctions by shifting consumption and production towards the first period with more favorable terms of trade. This analysis assumes that future sanctions are pre-announced in advance.

What happens when shocks to future terms of trade $S_2^* = Q_2^*/P_2^*$ are unanticipated? Both export and import sanctions lower real income in the second period, $S_2^* Y_2^*$, shifting down the endowment point A to A' in Figure 4. Given the unexpected nature of shocks, there is no substitution across periods. Yet, Lerner symmetry still does not hold in this case, with second-period consumption C_{F2}^* being more sensitive to future import sanctions for lenders (point B'' vs B') and to future export restrictions for borrowers (point C' vs C''). This discrepancy arises from the income effect. The purchasing power of accumulated assets B_1^* depends on import prices P_2^*, but not on export revenues $Q_2^* Y_2^*$. The real value of both assets and liabilities goes down in response to import sanctions generating a positive income effect for borrowers and a negative income effect for lenders.

Notice that the same logic extends to the first period if the economy starts with a non-zero net foreign asset position resulting in deviations from Lerner symmetry even under permanent sanctions. The equivalence can be restored if export sanctions are coupled with a net foreign asset tax, which effectively extends the export tax to all previous trade surpluses.

Financial sanctions In practice, trade sanctions are often combined with financial restrictions, in particular, the exclusion of countries from international borrowing markets. Imposing a borrowing constraint $C_{F1}^* \leq S_1^* Y_1^*$ affects the equilibrium allocation when the country runs a current account deficit in the first period. Nonetheless, borrowing constraints do *not* compromise Lerner symmetry between *permanent* import and export sanctions. Furthermore, if the country completely loses access to global financial markets and can neither borrow nor save internationally, the trade is balanced period-by-period and, as a result, the equivalence between import and export sanctions holds even when they are temporary (shift from point A to point A' in Figures 3 and 4).

To the contrary, partial access to international capital markets can amplify the difference between the effects of import and export sanctions when they are temporary. The borrowing constraint ensures that the current account of the economy is weakly positive and, as a result, frontloaded export sanctions and backloaded import sanctions are unambiguously more damaging as borrowing for intertemporal substitution is ruled out in this case. We illustrate the case of frontloaded sanctions under borrowing restrictions in Figure 5. In this case, without financial constraints, the country would borrow under export sanctions and save under import sanctions. However, when borrowing is ruled out, the country must consume the new endowment point A' under export sanctions, amplifying their welfare effects. This is the sense in which financial and export sanctions are complementary.

Importantly, the model also suggests that the sanctioned economy can evade financial sanctions and borrowing constraints by selling claims to future output. Such contracts can take the form of commodity futures or stakes in commodity exporting firms. As long as there are investors — perhaps from non-sanctioning countries — willing to trade such assets, the country's budget constraint is fully restored. In particular, the government can cover additional expenses relative to its export revenues by

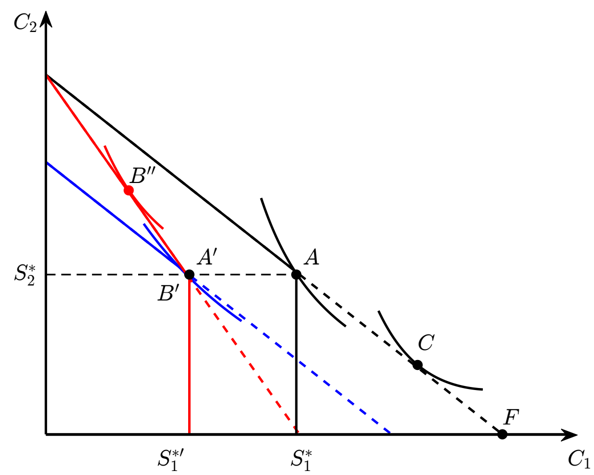

Figure 5: Borrowing limit and the forward sale of endowment

Note: Axes correspond to import consumption at $t = 1, 2$. Borrowing limit is binding under export sanctions in point $A' = B'$ and slack under import sanctions in point B''. Forward sale of endowment relaxes the borrowing limit and makes points C and F feasible.

selling claims worth $P_1^* C_{F1}^* - Q_1^* Y_1^*$ out of the country's future output $Q_2^* Y_2^* / R^*$. This is equivalent to changing the endowment from point A to point C in Figure 5 and allows the country to evade the borrowing constraint and implement optimal consumption smoothing.[21] Import and export sanctions still work in this case as before (Figure 3a). However, when commodities are perfectly storable ($\theta \to \infty$), then such forward financial contracts may help evade export and financial sanctions entirely, while import sanctions remain effective.

Financial frictions Finally, deviations from Lerner symmetry may arise due to financial frictions. To see this, consider again the case of permanent import and export sanctions, which in the baseline model result in the same allocations. However, while terms of trade shocks $S_t^* = Q_t^* / P_t^*$ are the same, the real exchange rate $\mathcal{E}_t / P_t$ must move in opposite directions in response to import and export restrictions (recall Result 1). This differential exchange rate movement may then result in a differential tightening of the international borrowing limit (see e.g. Bianchi 2011) or of the debt overhang constraint in the domestic economy (see e.g. Eggertsson and Krugman 2012). Taking the second route, assume that domestic output depends negatively on the gross real debt in the economy $Y_t = \mathcal{Y}\left(\frac{D_{t-1} + \mathcal{E}_t D_{t-1}^*}{P_t}\right)$, where $\mathcal{Y}'(\cdot) < 0$, and D_t and D_t^* are gross amounts of debt denominated in local and foreign currency respectively. It follows that export sanctions are more damaging to the economy as they depreciate the real exchange rate ($\mathcal{E}_t / P_t \uparrow$) thereby increasing debt burden and lowering output. This effect is stronger for economies with a more dollarized credit market, when D_{t-1}^* is large relative to D_{t-1}.

With foreign-currency borrowing, Lerner symmetry requires that all debt contracts (domestic and international) denominated in foreign currency be adjusted downwards when export sanctions are im-

[21] Alternatively, the country can sell claims to its entire output moving the endowment to point F in Figure 5 and save the proceeds to finance future consumption. However, this strategy is subject to the risk of additional financial sanctions and future asset freezes.

posed (*cf.* Farhi, Gopinath, and Itskhoki 2014). Furthermore, ex-post government interventions that redistribute wealth from savers to borrowers can mitigate the negative effect of export sanctions on local output when it is constrained by debt overhang. This includes partially inflating away or defaulting all gross debt positions, a temporary freeze of debt repayment (e.g. a bank holiday), and direct government bailouts.[22] In contrast, import sanctions reduce foreign currency demand, appreciate the domestic exchange rate and, hence, tend to relax financial constraints in the economy. This is the sense in which export and financial sanctions may trigger a financial crisis episode, while import sanctions tend to mitigate it.

We summarize some of the results of this section in:

Result 2 (i) *Temporary export (import) sanctions are more damaging for a lender (borrower) country.* (ii) *When the elasticity of intertemporal substitution $\theta > 1$, temporary import sanctions can turn a country from a borrower into a lender, mitigating their welfare impact.* (iii) *Financial and export sanctions are complementary. Import sanctions mitigate borrowing constraints in the economy, while export sanctions amplify their effect.*

Application to Russia The results of this section have a clear application to the case of sanctions imposed on Russia in 2022. Even though import restrictions imposed on Russia in 2022 were stiff, they had a very transitory effect, as we discuss in Section 5. Furthermore, Russia was a lender country with large net foreign assets and little international borrowing, in part due to the earlier rounds of sanctions imposed since 2014. As a result, the particular mix of short-lived import sanctions (as Russia quickly figured out ways around formal import restrictions) and stiff financial sanctions on borrowing joint with an official asset freeze turned out particularly ineffective in the short run, if the goal of the sanctions policy were a swift financial crisis. Indeed, import sanctions coupled with nearly doubled export revenues given record-high world energy prices undid any need to borrow to finance the economy, making financial sanctions largely irrelevant. Furthermore, while import sanctions eliminated the need for austerity (as many imported goods became simple unavailable), strengthened ruble made it easier to find alternative sources of imports, as imports became relative cheap and Russia was able to overpay to new suppliers.

More generally, Russia prior to invasion was a country with a trade surplus, a fiscal surplus, significant net foreign assets, and little dollarization of contracts and debts within or outside the economy. Under such circumstances, financial sanctions have limited capacity to inflict damage, unless they are coupled with substantial export restrictions. Furthermore, a financial crisis is an unlikely scenario in such an economy, where there is limited capacity for private or public default even when ruble depreciates considerably.

[22] As a second-best policy, the government can also use FX interventions and capital controls to offset the depreciation of the exchange rates (see Itskhoki and Mukhin 2022a).

5 Equilibrium Dynamics under Financial Sanctions

We now extend our analysis to a fully dynamic environment with stochastic shocks, 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.

Dynamic currency demand We extend the household utility (1) to feature an exogenous demand for foreign-currency bonds (savings):

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(C_{Ht}, C_{Ft}) + v\left(\frac{B^*_{t+1}}{P^*_{t+1}}; \Psi_t \right) \right], \tag{16}$$

where B^*_{t+1}/P^*_{t+1} is the real value of foreign currency savings (in terms of its purchasing power of imports), and the new term in the utility function reflects hedging (precautionary) demand for purchasing foreign tradables with Ψ_t denoting an exogenous shock to the demand for foreign currency balances.[23] For concreteness, we focus on the utility specification in (3) and further adopt:

$$v(b;\Psi) = -\frac{\kappa}{2} \cdot (b - \Psi)^2,$$

for some $\kappa \geq 0$.

Given this parametrization, the household Euler equation with respect to foreign-currency bonds is given by:

$$\beta R^*_{Ht} \mathbb{E}_t \left\{ \frac{P^*_t}{P^*_{t+1}} \Big[\Big(\frac{C_{Ft}}{C_{Ft+1}} \Big)^{1/\theta} + \tilde{\kappa} C_{Ft}^{1/\theta} \Big(\Psi_t - \frac{B^*_{t+1}}{P^*_{t+1}} \Big) \Big] \right\} = 1, \tag{17}$$

where $\tilde{\kappa} \equiv \frac{\theta}{\theta-1} \frac{\kappa}{\beta \gamma^{1/\theta}} \geq 0$. In addition to the conventional consumption smoothing motive for savings (the first term in the square brackets in (17)), household currency demand also features $\big(\Psi_t - B^*_{t+1}/P^*_{t+1}\big)$ which reflects additional precautionary savings motives, or demand for safe assets. An increase in Ψ_t above the real value of household foreign-currency savings B^*_{t+1}/P^*_{t+1} results in an additional demand for currency. Specifically, in this case, households are willing to delay import consumption (i.e., set $C_{Ft}/C_{Ft+1} < 1$) to accumulate foreign-currency savings, despite their, possibly, low expected return R^*_{Ht}. In response, the government can use financial repression to further depress the rate of return R^*_{Ht} on FX savings in order to neutralize the currency demand shock.

Financial sanctions and financial repression In addition to the sanctions shock, the Russian invasion of Ukraine in February 2022 triggered a substantial capital outflow, a sell-off of local currency

[23]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 and overlapping generations, and our modeling is in line with the growing empirical literature on convenience yields (Jiang, Krishnamurthy, and Lustig 2018, Bianchi, Bigio, and Engel 2021).

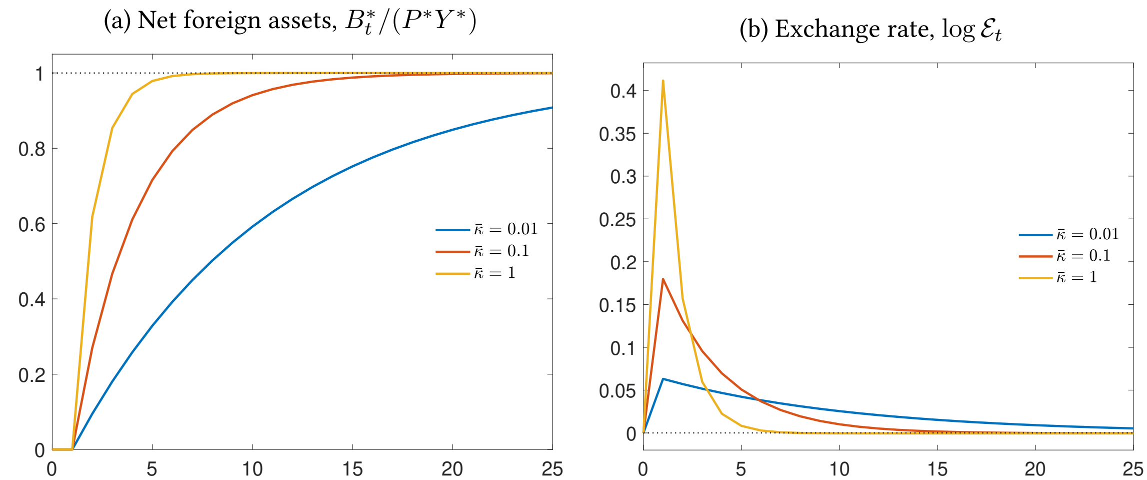

Figure 6: Laissez-faire response to foreign currency demand shock Ψ_t

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 $\bar\kappa \equiv \frac{\theta\kappa/\beta}{\theta-1}(\bar C_F/\gamma)^{1/\theta}$.

assets, and a flight to safety of foreign currency savings by households. We capture this with a Ψ_t shock in the utility (16), and discuss the equilibrium dynamics in response to such shock under various policy responses. The dynamic equilibrium system consists now of three equations, adding the (currency demand) Euler equation (17) to the country budget constraint (7) and import demand (6) studied earlier in Section 3.

We show in Itskhoki and Mukhin (2022b) that there are three scenarios depending on the government policy response to the shock:

1. *Laissez-faire*, or passive government. In this case, the government neither conducts FX interventions, nor utilizes financial repression, and thus $R^*_{Ht} = R^*_t$ and F^*_{t+1} tracks B^*_{t+1} for given initial FX reserves $F^*_t - B^*_t$. Under these circumstances, households delay import ($C_{Ft} \downarrow$) to accumulate foreign-currency savings ($B^*_{t+1} \uparrow$) according to (17). This, in turn, results in an exchange rate depreciation ($\mathcal{E}_t \uparrow$) to satisfy the import demand condition (6). Over time, foreign savings (and hence net foreign assets) are accumulated, and both import demand and exchange rate mean-revert (in fact overshoot, reflecting now larger net foreign assets of the country). The larger is the currency demand shock Ψ_t, the larger is the devaluation on impact and the longer is the transition towards a new steady state. Figure 6 illustrates the transition dynamics in this case. This scenario is associated with welfare losses due to distortions to the intertemporal consumption smoothing. The exchange rate depreciation reflects the increased demand for currency and accommodates the necessary decline in import consumption.

2. *FX interventions*. Alternatively, the increased household demand for foreign currency Ψ_t can be accommodated with 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} can 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 (17) 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 (see Itskhoki and Mukhin 2022a). However, such accommodation may be infeasible if the government lacks FX reserves, has no access to currency swap lines, or is under international sanctions.

3. *Financial repression.* 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 or capital controls 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 (17) 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 (17) 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 the $v(\cdot)$ in the utility (16), and is generally suboptimal relative to the laissez-faire.[24]

Financial autarky The case of financial repression just discussed 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).[25] 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

[24]In Itskhoki and Mukhin (2022b), we show that, while financial repression is welfare reducing in a representative-agent economy, it can increase utilitarian welfare in an economy with consumers and savers by redistributing away from savers and towards poorer hand-to-mouth consumers by smoothing exchange rate devaluation and ensuring more affordable import consumption. Another reason that justifies financial repression is the presence of externalities associated with borrowing constraints that tighten in response to a currency devaluation (see Section 4).

[25]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.

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.

We summarize the discussion in this section in:

Result 3 *Financial sanctions and freezes of official FX reserves limit the ability of the government to use FX interventions to accommodate currency demand and capital outflow shocks. This leaves the government a choice between laissez-faire and financial repressions (including capital controls). Given limited currency supply from exports, laissez-faire accommodates FX savings over import consumption, and results in an exchange rate devaluation, while financial repression is generally welfare reducing in a representative-agent economy.*

Application to Russia Arguably, the main shock following the invasion was a financial panic, a bank run, and a capital flight combined in one. A typical government response would involve FX interventions to stabilize the currency market. However, this was made impossible by the financial sanctions and frozen official FX reserves — arguably, the main achievement of the Western sanctions policy. This narrowed dramatically the choice set for Russian policymakers. Indeed, they had to recur immediately to a whole host of financial repressions, including emergency policy rate hike, a banking holiday, a tax on currency purchases, obligatory sales of export revenues, and capital controls. In the following weeks, record-high trade surpluses brought in a large inflow of currency supply, which allowed the government to gradually relax most measures of financial repression and capital controls.

6 Quantitative Evaluation

We now provide a quantitative evaluation of the Russian economic dynamics in 2022-23 by combining together the financial and trade mechanisms discussed in the previous sections. We solve the model using a first-order perturbation of the country's budget constraint (7), the household Euler equation (17), and import demand (6). 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:

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

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 $\tilde{\kappa}$ defined following (17). 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.[26] 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.

6.1 Sanctions and Russian trade dynamics

Before calibrating the model, we take a look at the data on the dynamics of Russian exports and imports under international sanctions. We rely on the aggregate empirical findings in Babina, Hilgenstock, Itskhoki, Mironov, and Ribakova (2023) and Hilgenstock, Ribakova, Shapoval, Babina, Itskhoki, and Mironov (2023), who use detailed customs data to further study the dynamics of Russian exports and imports by detailed goods categories and by destination/source countries.

Figure 7a plots the dynamics of Russian exports and imports in USD in shares of 2021 GDP in USD (a constant of normalization). There is a steep increase in Russian exports just before and during the invasion associated with a dramatic increase in world commodity prices. Exports increase about 50% relative to the pre-war years, from around \$30Bb/month to over \$45Bb/month at the peak. The extra exports in 2022 alone accumulate to nearly the total stock amount of frozen official reserves of \$300Bb, or nearly 17% of annual GDP.

At the same time, imports collapse — from over \$20Bb/month to around \$12Bb/month — immediately following the invasion and the imposition of import sanctions. This results in a massive trade surplus in the first months since the invasion, reaching 20% of GDP. However, imports recover remarkably fast by the end of 2023 towards nearly the pre-war levels, suggesting that Russia managed to effectively find ways around import sanctions and find alternative suppliers for majority of import categories.

Figure 7b splits Russian exports into major categories and shows that crude oil, oil products and natural gas (together with LNG) jointly account for nearly two thirds or Russian exports, with another 10% accounted for by metals and diamonds. It is the dynamics of these commodity categories that accounts for a steep increase in Russian exports in 2021–22.

While world commodity prices reached their peak in 2022 following the Russian invasion, Western sanctions largely avoided Russian exports. The European oil embargo did not start until December 2022 on crude oil and until February 2023 on oil products. The price cap on Russian seaborne crude exports did not start operating until December 2022. Russia unilaterally limited natural gas supply to Europe in September 2022. In addition, the world commodity prices have come down from their 2022 peak levels.

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

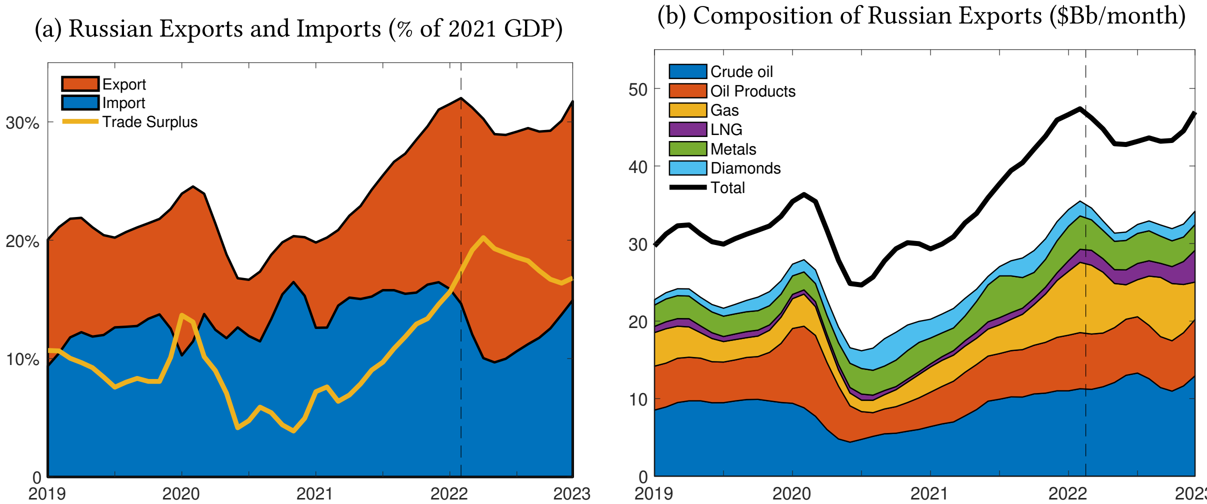

Figure 7: Russian Trade under International Sanctions

Note: Panel (a) plots the dynamics of exports, imports and trade balance as a % of 2021 GDP (in USD). Panel (b) plot the composition of exports in billions USD per month.

These developments have effectively curbed Russian export revenues in 2023.

We now use these facts to calibrate our dynamic model and study the impact of sanctions and policies on the dynamics of Russian economy in 2022–23.

6.2 Economic impact of sanctions

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 6), 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 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, $\psi_0 = 1.5$, cor-

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).

responding to 1.5 months of exports and with a half-life of one year ($\rho = 0.94$).[27] 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 Section 5.

All other shocks arrive with a one month lag to capture the delayed effects of non-financial sanctions. We set the fall in domestic output to be 5% with a half-life of 3 years, reflecting the decline in non-military output. To capture Russian import dynamics, effective import prices (that reflect the effects of sanctions) are calibrated to jump up by 50% on impact and have a short half-life of 4 months reflecting the fast rebound. While Russian exports fall after the European embargo late in 2022, a spike in energy prices in the first months of the invasion magnified Russian export revenues. 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.

Exchange rate and imports Figure 8 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 August 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 and predicted empirical paths of exports and imports. The model also does not factor in any additional capital outflow shocks that happened in the summer of 2023 since Prigozhin's mutiny and create additional forces for exchange rate depreciation.

[27] 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).

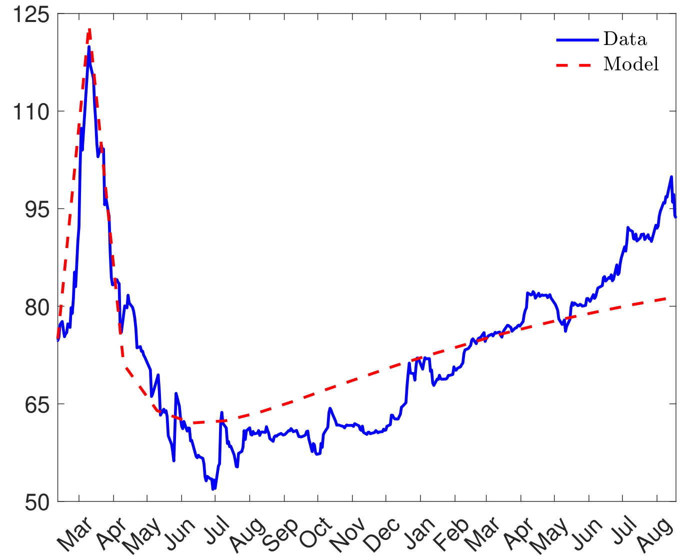

Figure 8: Exchange rate dynamics: model vs data

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-August 2023; as in Figure 1).

The calibrated model allows us to study the contribution of various sanctions shocks to the dynamics of equilibrium variables. Figure 9 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%, 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 further 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.[28]

One month out, the financial shock is combined with trade and recession shocks, and the trade

[28]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.

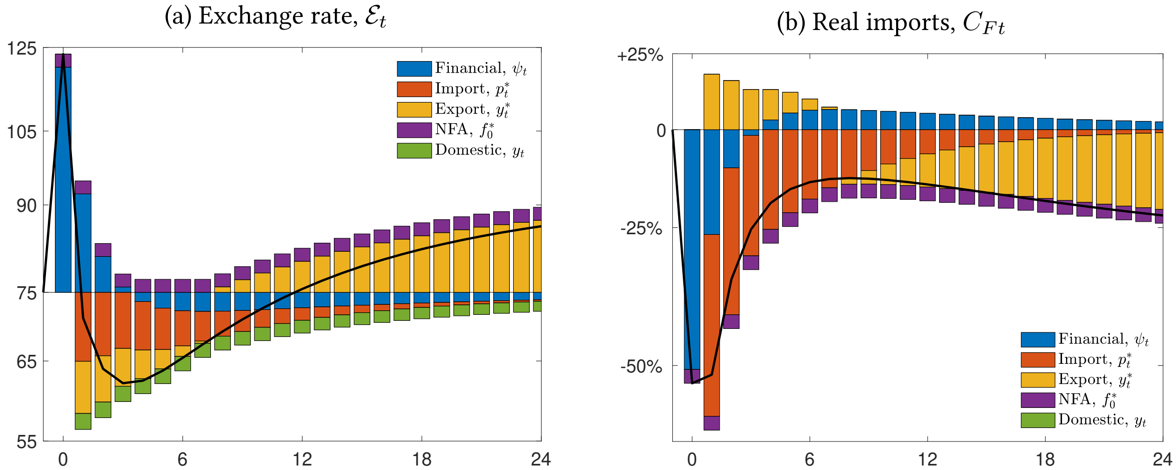

Figure 9: Exchange rate and import dynamics: model-based decomposition

Note: The figure plots with solid black lines the simulated path of the exchange rate (in panel a; extending the path from Figure 8) 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.

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 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 10). 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 Section 3.

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 9 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 9.

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 in Sections 4–5.[29]

Recent devaluation Our model, calibrated to the initial trade and financial shocks, provides an accurate description of the dynamics of the ruble exchange rate in the first 15 months since the invasion. However, the depreciation trend predicted by our model, which lasted for a year since June 2022, has significantly accelerated since May 2023. Our model suggests that the delayed effects of various trade and financial sanctions were already incorporated in the initial depreciation trend, and the recent additional depreciation is not due to sanctions directly, but rather reflect the new developments in the currency market. Namely, given a persistent (albeit smaller) trade surplus in 2023, the ruble depreci-

[29]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.

ation in the summer 2023 likely reflects the accelerated capital outflows in the aftermath of Prigozhin mutiny and a wave of expropriations/nationalizations of private companies. Existing financial sanctions act to limit the space of policy response to such outflows and confront Russian authorities with increasingly difficult policy choices.

7 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.

We further analyze empirically-relevant cases where import and export restrictions are not equivalent. We show that for a country cut off from international borrowing, transitory export sanctions have a larger welfare effect than equivalent import sanctions. Furthermore, financial and export sanctions tend to work in complementary ways, while import sanctions mitigate borrowing constraints in the economy.

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.

We use a quantitative model to show the relevance of these various forces in the context of sanctions imposed on the Russian economy since its invasion of Ukraine in February 2022.

APPENDIX

A Additional Displays

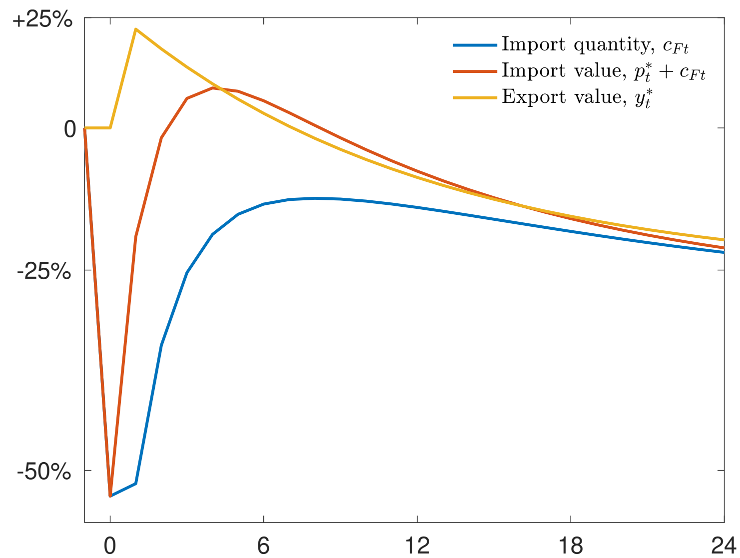

Figure 10: Trade dynamics

Note: The figure plots the simulated path of import quantities c_{Ft} (the same as black line in Figure 9b), 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.

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