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The Russia Economic Sanctions Impact World Economy

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Abstract

This paper examines the effects of the economic Russian Republic's sanctions on global trade, macroeconomic dynamics, and welfare losses by using a calibrated novel model of three groups sets of the global economy. These groups are Russia, the second imposing the sanctions (EU, UK and the United States) and the third group (Turkey, India and China Republic). We assume that each nation of the group has two spheres subject sanctioned, these are the gas and final necessary commodity product of consumer. We consider three different sanctions types: Financial, trade on Gas and trade sanctions on finished products or goods. We demonstrate that currency rate changes reflect the type of sanction and the direction of the consequent sectoral reallocations within countries, rather than indicating the effectiveness of sanctions. Our welfare study shows that if the third nation group does not ratify the sanctions, the sanctioned country's welfare losses are greatly reduced, and the sanctioning country's welfare losses are increased, but the third country gains from not being associated with the sanctioning group nations. These results demonstrate the need for international sanction coordination but also its difficulties.

Keywords: International coordination; Currency volatility; Economic growth; Reallocation; ; Welfare; Sanctions.

JEL-Classification: E65; F31; F42; F51

* To our heroic NHS staff, always go over and beyond their call of duty. You are quick in action and cooperative. Please keep up the spirit. I like to express my gratitude, in particular, to King's College Hospital Hepatology Department for the tremendous effort in treating me for this insidious disease after so many years of agony, pain and suffering. My special greetings and sincere respect to Dr Abid Sadel, Dr Wayel Jassem and Dr Ali Amir.

1. Introduction

Due to Russia's extensive invasion of Ukraine in February 2022 and the many Western nations imposing harsh sanctions on Russia (we take a broad view of the West and include traditional allies such as, for example, Japan), the debate over the efficacy of economic sanctions as a tool to induce policy change in target countries has reheated. Arguments in favour of sanctions (for example, those discussed in Blackwill and Harris 2016) have been met with two major objections: first, Russia is a large enough economy, particularly for its role in energy markets, that sanctions can backfire through their impact on the economy Global. Second, sanctions targeting trade and financial relations between Russia and the West do not prevent Russia from replacing these relations with stronger ties with other countries. This brings us back to Friedman's (1980) Cold War claim that sanctions will eventually lead to losses for countries imposing them due to substitution in world trade.

Using a calibrated three-country model that allows us to account for both Russia's sizeable economy and its capacity to do commerce with nations outside the Western bloc, we evaluate the impact of sanctions in this paper's interconnected global economy. In order to do this, we calibrate our model's sanctioning country (Home) to a combination of the European Union, the United Kingdom, and the United States; the sanctioned country (Foreign); to Russia; and the third country (RoW, for the Rest of the World; to a combination of China, India, and Turkey). In accordance with the evidence, we chose parameter values so that the GDP of our model Russia, evaluated in purchasing power parity (PPP) terms, amounts to about 10% of the combined GDP of the EU, UK and US. The structure of the model also allows us to capture Russia's comparative advantage and the source's role in mineral fuel production. In this context, we show that sanctions can lower the income and welfare of the target economy even when global influences and the behaviour of third countries are considered.

The model we employ in our analysis has much in common with Ghironi and Melitz (2005), abbreviated as GM, who use Melitz (2003) as the microeconomic foundation for a two-country global trade and macroeconomics model. In order to grow GM, we are adding a primary energy production segment that combines labour and raw materials (for convenience, natural gas) to create energy. We assume that foreigners in this industry have a comparative advantage over natural gas in the form of greater wealth. In the downstream industry, monopolistic competition, heterogeneous firms, and usable gas combine to create differentiated consumer goods. In this area, the house has a comparative advantage because it can produce existing goods more productively while also developing new ones. High entry barriers, fixed trade expenses, and ice costs are challenges for producers in this industry when selling abroad. Fixed trade costs make it profitable for producers whose productivity exceeds

an internally set threshold to export, as is well known. Since we also believe that there are flaws in the global financial system, changes in current accounts will affect cross-border consumption allowances. In a dynamic general equilibrium, this situation offers a rigorous setting for evaluating the effects of sanctions on global trade and the macroeconomic system.

As forced exits with significant margins, we design trade and financial sanctions against foreigners. By barring businesses with productivity levels above a specific threshold from the export market, trade sanctions are imposed on downstream producers. Thus, we notice that the goods from the West to Russia that are subject to sanctions are those whose production calls for cutting-edge technology. Numerous financial sanctions were imposed on Russia by Western nations. These include issues with international messaging systems like SWIFT and the freezing of central bank reserves. The scope of this paper does not allow for a thorough analysis of financial sanctions, which would necessitate modelling a more complex financial sector. Foreign gas exports have been subject to trade sanctions in the form of trade embargoes (this is the case for gas imports from Russia into the UK and the US). Although the EU is moving in this direction, it has not yet stopped importing gas from Russia. For more information, refer to Section 3's Figure 2.

All of the sanctions we take into consideration result in a drop in foreign GDP and consumption, we find. Even though they are contracting less than foreign economies, the national and global economies are both in decline. Export restrictions on the biggest household businesses have a striking impact on foreign GDP and consumption. This kind of sanction encourages foreign producers of consumer goods to increase their output, even if their production is less effective. Foreigners redistribute resources toward industries where they lack a comparative advantage, and this ineffective redistribution amplifies the effects of sanctions. The cost of manufacturing consumer goods for export rises, pushing up domestic prices and increasing the foreign exchange rate. As a result of reallocating resources to the gas sector, where they are at a comparative disadvantage, and increasing the cost of producing household consumption goods, a ban on gas trade, on the other hand, causes the home exchange rate to increase. These findings demonstrate that the trend of resource reallocation within countries as a result of sanctions and the trend of exchange rate movements are related. Additionally, our findings demonstrate that changes in the exchange rate do not accurately reflect how effective sanctions are at causing an economic downturn and welfare loss (this supports the finding by Eichengreen et al. Exchange rates are a poor indicator of the effectiveness of sanctions, according to Itschuki and Mukhin (2023 and 2022, respectively). We investigate a scenario in which the home country imposes all three types of sanctions on foreigners, but the RoW does not impose sanctions in order to replicate Russia's post-February

2022 trade flows. Our calibrated model demonstrates that, regardless of what third countries do, sanctions are effective in causing the target economy to contract and its households to experience welfare losses. Furthermore, if Rowe imposes sanctions as well, their effect on the outside world is amplified. In addition, household GDP and welfare losses will be reduced if RoW participates in the effort. However, if RoW does not support Home's efforts, RoW's GDP is higher and welfare losses are lower. These findings emphasize the significance of international coordination of sanctions as well as their impossibility.

Two literary strands are what our paper primarily adds to. A flurry of papers on the effects of sanctions, including those by Albrizio et al., have been published since the start of the Russo-Ukrainian War. (Bachman et al., 2022). (2022); Bianchi and Sousa Padilla (2022); De Souza and others (2022). (2022); Eichengreen and colleagues. (2022); Itshoki and Mukhin (2022); Lorenzoni and Werning (2022) (work prior to the extensive Russian invasion of Ukraine includes Korhonen (2019); van Bergeijk (2021), and references therein. Our main contribution is the creation of a dynamic general equilibrium analysis that takes into account the effects of applying sanctions to a large economy and their wide-ranging marginal effects. Our paper also contributes to the literature on global trade and macroeconomics that has emerged post-GM. A partial list includes Corsetti, Martin, and Pisenti (2007), Ouray and Ekim (2011), Rodriguez-Lopez (2011), Catchatur (2014), Slips (2016), Cacciatori and Geroni (2021), Corsetti, Martin, and Pisente (2013), Dekle, Jeong, and Kiyotaki (2015), Hamano & Zanetti (2017), Bergin and Cor. By analyzing the effects of sanctions using an asymmetric framework made up of three countries and two sectors, we add to this body of literature. The remaining portions of the essay are structured as follows: Section 2 introduces the model. The calibration is discussed in Section 3. The consequences of sanctions are examined in Section 4. Well-being scores are displayed in Section 5. The sixth and final section comes to an end.

2. The Model

We take into account a three-zone global economy, where areas are labelled as being either at home (H), abroad (F), or elsewhere in the world (RoW, R). The fundamental model's structure resembles that of Geroni, Kim and Ozan (2022), which supports the microeconomics of the production sector that is beneficial for consumers using monopolistic competition and the framework for heterogeneous producers developed by Geroni and Melitz (2005). The disparity between areas in terms of volume and production structure is a significant departure from GM. We index the population by χ_i where $i \in (H, F, R)$. The home countries and world countries are populated by a unit mass of atomic families that $\chi_H = \chi_R = 1$). However, the

size of the foreign state is smaller, that is, $\chi_F \in (0,1)$. There is a representative family in each country before sanctions are applied. The representative family consists of two types of workers. They provide labour to consumer goods producers and gas producers, accordingly. Home and RoW are gas importers, while foreigners are gas exporters.

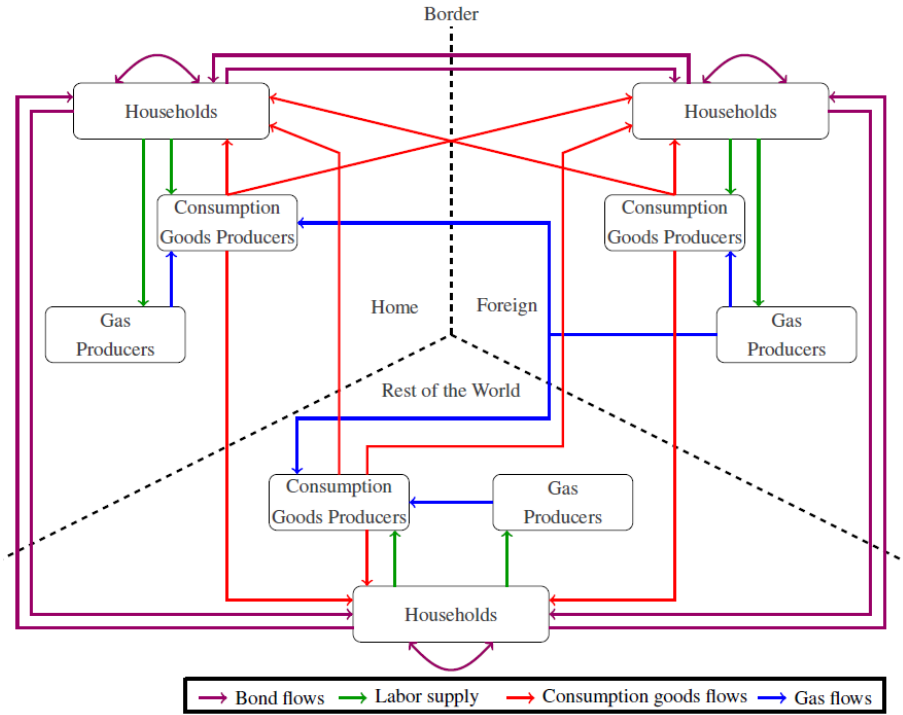


Figure 1: The Model Structure

2.1 The Household Preference

In each of the three countries $i \in (H, F, R)$ the family obtains utility from consuming a basket of commodities C_t^i while unable to provide labour L_t^i to the industries that make consumer goods and gas. We assume a single Frisch elasticity, namely. We employ static elasticity of substitution specifications in accordance with Horvath (2000), where the value $\varrho > 0$ adds some labour mobility between sectors. The following is the anticipated temporary utility function as the family grows:

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left\{ \ln C_{i,t} - \frac{\kappa}{2} \left((L_t^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,t}^i)^{\frac{1+\varrho}{\varrho}} \right)^{\frac{2\varrho}{1+\varrho}} \right\} \right], \beta \in (0,1) \text{ and } \kappa > 0 \quad (1)$$

The consumption basket in country i is defined over a continuum of goods Ω

$$C_{i,t} = \left[\int_{\omega \in \Omega} \{C_{i,t}(\omega)\}^{\frac{\theta-1}{\theta}} d\omega \right]^{\theta/(\theta-1)}, \quad \text{where } \theta > 1$$

Is the symmetric elasticity of substitution across goods. At any time t , only a subset of goods $\Omega_{i,t} \subset \Omega$ is available in the country i . Demand for individual goods in the country i is

$$C_{i,t}(\omega) = \left(\frac{p_{i,t}(\omega)}{P_{i,t}} \right)^{-\theta} C_{i,t}$$

Where $P_{i,t}(\omega)$ is the country i currency i price of a good $\omega \in \Omega_{i,t}$ and

$$P_{i,t} = \left[\int_{\omega \in \Omega} \{p_{i,t}(\omega)\}^{1-\theta} d\omega \right]^{1/(1-\theta)}$$

Letting $p_{i,t}(\omega)$ be the price of good ω relative to the price of the basket in country i , demand for good ω is

$$c_{i,t}(\omega) = \{\rho_{i,t}(\omega)\}^{-\theta} C_{i,t}$$

2.2 The Household Preference

Each nation has a certain amount of natural gas resources G_N^i . We assume that Foreign has a larger endowment, i.e. G_N^F, G_N^H, G_N^R . A perfectly competitive, upstream sector in each country produces usable gas by combining labour and natural gas.

$$G_N^i = G_N^i(\chi_i L_{G,t}^i) \quad (2)$$

This gas can be used domestically $G_{i,t}^i$ or exported $G_{j,t}^i$ for $i \neq j$. Hence, in equilibrium, it will be

$$G_N^i \chi_i L_{G,t}^i = \sum_{j=H,F,R} G_{j,t}^i$$

First-order constraints on the gas-producing yield ideal labour demand as

$$\omega_{G,t}^i = \rho_{G,t}^i G_N^i,$$

where $\rho_{G,t}^i$ is the actual price of useable gas in the nation i and $\omega_{G,t}^i$ is the real wage (per unit) provided to employees in this sector (wages and prices are both expressed in units of the country's consumption basket).

Gas is exported from abroad but not imported into Home or RoW. Produced gas is completely interchangeable, thus the decision of the gas market price guarantees. Gas is exported from abroad but not imported into Home or (RoW). Produced gas is completely interchangeable, thus the decision of the gas market price guarantees

$$\rho_{G,t}^H = \tau_{G,t} Q_{F,t}^H \rho_{G,t}^F \text{ and } \rho_{G,t}^R = \tau_{G,t} Q_{F,t}^R \rho_{G,t}^F$$

where $\tau_{G,t}$ is iceberg gas import costs and $Q_{j,t}^i$ is the consumption-based real exchange rate (units of country i consumption per unit of country j).

2.3 Good Production Consumption

maker of consumer products. By mixing gas and labour, monopolistic competing businesses create differentiated consumer goods. When producing consumer items, gas from home, abroad, and across the globe can be used interchangeably. The output $y_t^i(\omega)$ is produced by company (ω) in nation $i \in (H, R)$ using the following production function:

$$y_t^i(\omega) = z Z_t^i \left[\alpha \left\{ g_{i,t}^i(\omega) + \frac{g_{i,t}^F(\omega)}{\tau_{G,t}} \right\}^\rho + (1 - \alpha) \left(I_{i,t}^i(\omega) \right)^\rho \right]^{\frac{1}{\rho}} \quad (3)$$

The elasticity of substitution between factors, ϵ , is thus given by $\epsilon \equiv 1/(1 - \rho)$. The firm-specific productivity, or $z \in (z_{min}, \infty)$, is established at entry. A sector's overall productivity level is denoted by the symbol $Z_t^i > 0$, labour is denoted by the symbol $I_{i,t}^i(\omega)$, and the relative share of gas in the production function is denoted by the symbol α where $0 \leq \alpha < 1$. We use

$$g_{i,t}(\omega) = g_{i,t}^i(\omega) + g_{i,t}^F(\omega)/\tau_{G,t}$$

to calculate the company's overall gas demand. Gas produced domestically and gas that is imported and subject to an iceberg cost satisfy different portions of the demand. The import of gas from other nations is not done by Foreign. Due to the perfect substitutability assumption, the gas prices are equalized in firm optimization. in the country $i = H$ and R

$$\rho_{G,t}^i = \tau_{G,t} Q_{F,t}^i \rho_{G,t}^F$$

Foreign Firms only use the domestic Gas

$$G_{F,t}^H(\omega) = G_{F,t}^R(\omega) = 0 \text{ and } G_{F,t}(\omega) = G_{F,t}^H(\omega)$$

We replace the identifier (ω) with the heterogeneous productivity (z) . The expressions for labour and gas demand by firm w_t^i are, used z to denote the real wage paid to consumption-sector workers (in units of consumption).

$$I_{i,t}^P(z) = \left(\frac{1-\alpha}{w_t^i}\right)^\epsilon \frac{y_t^i(z)}{\alpha^\epsilon (\rho_{G,t}^i)^{1-\epsilon} + (1-\alpha)^\epsilon (w_t^i)^{1-\epsilon}} \quad (5)$$

$$g_{i,t}(z) = \left(\frac{1-\alpha}{\rho_{G,t}^i}\right)^\epsilon \frac{y_t^i(z)}{\alpha^\epsilon (\rho_{G,t}^i)^{1-\epsilon} + (1-\alpha)^\epsilon (w_t^i)^{1-\epsilon}} \quad (6)$$

It is simple to state the company's marginal cost as

$$mc_t^i(z) = \frac{1}{z z_t^i} \left[\alpha^\epsilon (\rho_{G,t}^i)^{1-\epsilon} + (1-\alpha)^\epsilon (w_t^i)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}} \quad (7)$$

Given Dixit-Stiglitz preferences and iceberg trade costs, the firm based in country i actually charges to sell its goods in market j .

$$\rho_{j,t}^i(z) = \left(\frac{\theta}{\theta-1}\right) \frac{\tau_{j,t}^i mc_t^i(z)}{Q_{j,t}^i} \quad (8)$$

Exporting is expensive, and producers must pay an "iceberg" export fee.

$$\tau_{j,t}^i > 1 \text{ for } i \neq j \quad \text{and} \quad \tau_{j,t}^i = 1$$

and a per-period fixed export cost, $f_{X,t}$. The fixed export cost requires the use of consumption-sector labour with effectiveness determined by the aggregate shock Z_t^i . We assume that $f_{X,t}$ is in units of effective labour when $i \neq j$. Hence, the fixed export cost in units of consumption is $(w_t^i f_{X,t})/Z_t^i$ for firms located in region i . The fixed export cost implies that only firms with sufficiently high productivity z will export. In other words, there exists a cutoff z_i satisfying that a firm located in country, i sells its product and turns a positive profit in market j if $z > \underline{z}_{j,t}^i$ with $\underline{z}_{j,t}^i = z_{min}$.

Averages for the number of firms and exporters. Following Melitz (2003), define the market-share weighted productivity average \bar{z}_t^i for country i 's firms with non-negative sales in market j as follows Zlate (2016); Kim (2021) for a case with both upper and lower bounds of exporting firms.

$$\bar{z}_t^i \equiv \left[\frac{1}{\Phi(\bar{z}_{j,t}^i) - \Phi(\underline{z}_{j,t}^i)} \int_{\underline{z}_{j,t}^i}^{\bar{z}_{j,t}^i} z^{\theta-1} d\Phi(z) \right]^{\frac{1}{\theta-1}} \quad (9)$$

As $\bar{z}_{j,t}^i \rightarrow \infty$ and $\Phi(\bar{z}_{j,t}^i) \rightarrow 1$, when $i = j$. the market-share weighted productivity average \bar{z}_D for all producing firms $z_{i,t}^i = z_{min}$ and $\bar{z}_{j,t}^i \rightarrow \infty$ is

$$\bar{z}_t^i = \bar{z}_D \equiv \left[\int_{z_{min}}^{\infty} z^{\theta-1} d\Phi(z) \right]^{\frac{1}{\theta-1}} \quad (10)$$

Melitz (2003) demonstrated that the model is isomorphic to one in which $N_{D,t}^i$ firms with productivity \tilde{z}_D produce in country i , and $N_{j,t}^i$ firms with productivity $\tilde{z}_{j,t}^i$ export to country $j \neq i$. The expression of the country i 's price index P_t^i then implies

$$\sum_{j \in H,F,R} N_{j,t}^i (\tilde{\rho}_{i,t}^j)^{1-\theta} = 1, \quad \text{where } \tilde{\rho}_{i,t}^j \equiv \rho_{i,t}^j(\tilde{z}_{i,t}^i)$$

The average relative prices of producers of origin country j and destination country i . Furthermore, the average profits of Country i firms from the market j is

$$\tilde{d}_{j,t}^i \equiv \theta^{-1} (\tilde{\rho}_{j,t}^i)^{1-\theta} Q_{j,t}^i C_{j,t}$$

Therefore, the average total profits of country i firms are

$$\tilde{d}_t^i = \sum_{J=H,F,R} [\Phi(\tilde{z}_{j,t}^i) - \Phi(z_{j,t}^i)] \tilde{d}_{j,t}^i,$$

where $\Phi(\tilde{z}_{j,t}^i) - \Phi(z_{j,t}^i)$ is the proportion of firms that export $N_{j,t}^i / N_{D,t}^i$

Firm entry and exit. There is an unbounded mass of potential entrants in each country. Entry requires the use of consumption-sector labour with effectiveness determined by the aggregate shock Z_t^i . Before entry, all firms are identical and face a sunk entry cost $f_{E,t}$ in units of effective labour. The buried entry cost, expressed in units of consumption, is thus $w_t^i f_{E,t} / Z_t^i$. Upon entry, firms draw the firm-specific productivity level z from a cumulative distribution function $\Phi(z)$ with support (z_{min}, ∞) . This productivity level remains fixed thereafter. We assume that $f_{E,t} / Z_t^F > f_{E,t} / Z_t^H$, allowing for the possibility that the gas-rich country features fewer consumption-sector firms as a consequence of inefficiencies of various types that can characterize the firm creation process. We also assume a one-period time-to-build requirement: It takes one period between the time of entry and the time when firms start producing and generating profits. All firms in the economy, incumbent and new entrants are subject to an exogenous shock that causes them to exit with probability $\delta \in (0, 1)$ at the end of each period. then, the mass $N_{D,t}^i$ of producing Home firms in period t is determined by

$$N_{D,t}^i = (1 - \delta)(N_{D,t-1}^i + N_{E,t-1}^i)$$

is the number of firms that entered in period $(t - 1)$. Given these definitions, firm entry decisions are determined as follows. Prospective entrants are forward-looking and compute the expected stream of average total profits that they will generate post-entry. This determines the average value of an entrant, \tilde{v}_t , as:

$$\tilde{v}_t^i \equiv \mathbb{E}_t \left[\sum_{s=t+1}^{\infty} (\beta(1-\delta))^{s-t} \left(\frac{C_{i,s}}{C_{i,t}} \right)^{-1} \tilde{d}_s^i \right] \quad (11)$$

Until this value equals the sunk entrance cost, assuming the free-entry condition, entry happens.

$$\tilde{v}_t^i = w_t^i f_{E,t} / Z_t^i$$

Since macroeconomic shocks are never thought to be significant enough to result in zero, or $\tilde{v}_t^i < w_t^i f_{E,t} / Z_t^i$ so that the entry condition always holds with equality (in other words, there is always a positive number of entrants). Since both new entrants and incumbent firms face the same probability of exit, δ , at the end of each period regardless of their firm-specific productivity, \tilde{v}_t^i is also the average value of incumbent firms after production has occurred.

2.4 Asset Holdings and Household Budgetary Constraints

Since only non-contingent, riskless real bonds are traded abroad, global financial markets are insufficient. Bonds issued by nation j that are held by the representative country i household as of period t are designated with the letter $B_{i,t}^j$.

During the time period t , the household receives these bonds at a risk-free real interest rate of r_t^j . (Country j bonds and interest rates are in units of country j consumption). We assume that firms are fully owned domestically. Specifically, the country i representative households enter the period with shareholdings x_t^i in a mutual fund of $N_{D,t}^i$ producing firms in country i . During period t , the household receives dividends from its shareholdings, d_t^i per share, and the value of selling its share portfolio at the price \tilde{v}_t^i per share. Besides its financial assets and the income they generate, the representative household's resources in period t also includes the income from labour supplied in the gas production sector ($w_{G,t}^i L_{G,t}^i$) and the consumption sector ($w_t^i L r_t^i$). Last but not least, the household also receives a lump-sum refund of the fees it paid to financial intermediaries to enter period $(t + 1)$ (these fees have the function of stabilizing the holdings of domestic and foreign bonds at their steady-state values in the deterministic steady state of the model). The household uses its resources during period t to purchase consumption items and bonds with which it will begin the period $[t + 1 \{ (B_{i,t+1}^j)_{j=H,F,R} \}]$, to pay fees $\sum_{j=H,F,R} 0.5 Q_{j,t}^i (B_{i,t+1}^j - B_j^i)^2$, with $\eta > 0$ and to buy shareholding x_{t+1}^i in mutual fund $N_t^i = N_{D,t}^i + N_{E,t}^i$ firms. Only $1 - \delta$ of these N_t^i firms will be around to produce and generate profits in period $t + 1$. The household does not know which firms will be hit by the exitinducing shock and, therefore, it finances continued

operations by all currently producing firms and entry by all producers who choose to enter the market, with the risk of firm exit at the end of period t reflected in the share price that will be determined by the Euler equation for optimal shareholdings. The budget constraint of the representative household in country i is thus:

$$C_{i,t} + \tilde{v}_t N_t^i x_{t+1}^i + \frac{\eta}{2} \left(x_{t+1}^i - \frac{1}{\chi_i} \right)^2 + \sum_{j=H,F,R} Q_{j,t}^i \left[B_{i,t+1}^j + \frac{\eta}{2} (B_{t+1}^i - B_i^j)^2 \right]$$

$$= w_{G,t}^i L_{G,t}^i + w_t^i L_t^i + (\tilde{d}_t^i + \tilde{v}_t^i) N_{D,t}^i x_t^i + T_t^f + \sum_{j=H,F,R} Q_{j,t}^i (1 + r_t^i) B_{i,t}^j$$

$$\text{as } T_t^f = 0.5\eta \left\{ \left(x_{t+1}^i - \chi_i^{-1} \right) + \sum_{j=H,F,R} Q_{j,t}^i (B_{i,t+1}^j - B_i^j)^2 \right\}$$

in equilibrium. The country i representative household's Euler equation for optimal holdings of country j bonds is:

$$C_{i,t}^{-1} \{ 1 + \eta (B_{i,t+1}^i - B_i^j) \} = \beta (1 + r_{t+1}^j) \mathbb{E}_t \left\{ \frac{Q_{j,t+1}^i}{Q_{j,t}^i} C_{i,t+1}^{-1} \right\} \quad (13)$$

for each $j = H, F, R$. The Euler equation for optimal shareholdings implies:

$$\tilde{v}_t^i \left\{ 1 + \eta \left(x_{t+1}^i - \frac{1}{\chi_i} \right) \right\} = \beta (1 - \delta) \mathbb{E}_t \left\{ \left(\frac{C_{i,t+1}^i}{C_{i,t}^i} \right)^{-1} (\tilde{v}_{t+1}^i + \tilde{d}_{t+1}^i) \right\} \quad (14)$$

The formula for i in the free-entry condition of equation (11), implied by the forward iteration of this equation and the pertinent transversality condition, establishes the relationship in the general equilibrium between household decisions about entrance finance and company entry decisions.

2.5 Aggregate accounting and market clearing

The gas market clearing circumstances in a gas import country $i = H$ and R influence the price of useable gas, $\rho_{G,t}^i$:

$$G_{i,t}^i = G_N^i (\chi_i L_{G,t}^i) \quad (15)$$

$$\text{the gas demand satisfies } G_{i,t}^i + \frac{G_{i,t}^F}{\tau_{G,t}} = N_{D,t}^i \int_{z_{\min}}^{\infty} g_{i,t}(z) d\Phi(z) \quad (16)$$

$$\text{In a gas export country (F), the followings hold. } G_N^F (\chi_F L_{G,t}^F) = \sum_{j=H,F,R} G_{i,t}^F \quad (17)$$

$$G_{F,t}^F = N_{D,t}^i \int_{z_{min}}^{\infty} g_{i,t}(z) d\Phi(z) \quad (18)$$

The choice of the labour supply for gas production in country i ,

$$L_{G,t}^i = \left(\frac{w_{G,t}^i}{\kappa G_t^i} \right)^{\varrho} \left\{ (L_t^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,t}^i)^{\frac{1+\varrho}{\varrho}} \right\}^{\frac{\varrho(1+\varrho)}{\varrho}} \quad (19)$$

Let country i be a gas importer (H or R) and $\varrho = 1$. Therefore

$$L_{G,t}^i = \rho_G^i G_N^i / (\kappa G_t^i) \quad \text{and} \quad L_{G,t}^F = \rho_{G,t}^i G_N^F / (\tau_{G,t} \kappa Q_{F,t}^i C_{F,t})$$

where the equalities use the fact that

$$\rho_{G,t}^i = \tau_{G,t} Q_{F,t}^i \rho_{G,t}^F \quad \text{and} \quad w L_{G,t}^i = \rho_{G,t}^i G_N^i$$

Ceteris paribus, the amount of labour employed in gas production in each country is larger the country's endowment of natural gas and the higher the price of gas; instead, labour in the gas sector is smaller the higher the country's consumption and, intuitively, the higher the weight of the disutility of labour. Because a real depreciation of the country i 's currency (an increase in $Q_{F,t}^i$) causes a higher real price of usable gas in gas import country i , it causes a decrease in gas-sector employment in Foreign, as there is an incentive to shift production to country i . Market clearing for individual goods requires

$$y_{i,t}(z) = c_{H,t}(z) + c_{F,t}(z) + c_{R,t}(z)$$

for the product of a Home firm with specific productivity z . Market clearing conditions for individual goods of Foreign and Rest of the World firms are analogous. Labour market clearing in the consumption good sectors of country $i = H, F, R$ requires

$$\chi_i L_t^i = N_{D,t}^i \int_{z_{min}}^{\infty} I_{i,t}^P(z) d\Phi(z) + N_{E,t}^i \left(\frac{f_{E,t}^i}{z_t^i} \right) + \sum_{j \neq i} N_{j,t}^i \left(\frac{f_{X,t}^i}{z_t^i} \right) \quad (20)$$

$$L_t^i = \left(\frac{w_t^i}{\kappa C_t^i} \right) \left\{ (L_t^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,t}^i)^{\frac{1+\varrho}{\varrho}} \right\}^{\frac{\varrho(1-\varrho)}{1+\varrho}} \quad \text{labour satisfies} \quad (21)$$

Market clearing is necessary for bonds issued by country i .

$$\sum_{j=H,F,R} \chi_j B_{j,t+1}^i = 0$$

for each time. Each nation's stock market clearing requires

$$x_{t+1}^i = x_t^i = 1/\chi_i$$

in every period. Because costs of adjusting bond holdings are rebated back to households in

equilibrium, imposing equilibrium conditions on the household budget constraint yields:

$$GDP_{i,t} = C_{i,t} + \tilde{v}_t^i N_{E,t}^i \chi_F^{-1} + TB_{i,t} \quad (22)$$

$$\text{as } TB_{i,t} = \sum_{j=H,F,R} Q_{j,t}^i \{B_{i,t+1}^j - (1 + r_t^j) B_{i,t}^j\} \text{ and } GDP_{i,t} = w_{G,t}^i L_{G,t}^i + w_t^i L_t^i + N_{D,t}^i \tilde{d}_t^i \chi_i^{-1}$$

are the country i 's trade balance and GDP per capita, respectively.

2.6 The Sanctions

Three different sanctions are taken into consideration, along with their combinations. Specifically, trade (export/import) sanctions on consumer goods, financial sanctions, and trade sanctions on gas. Instead of only manipulating the prices of currently traded goods that are consumed by the sanctioned economy, we model sanctions in the form of exit at the extensive margin. “

The evidence demonstrates that sanctions were implemented through withdrawal from the Russian market. In an effort to supplement the restrictions being imposed by governments, Sonnenfeld et al. (2022) report that more than 1,000 companies voluntarily reduced their operations in Russia. We concentrate on the dynamics of the transition from the old steady state to the new steady state while under sanctions.”

By forcing producers of consumption goods with productivity above a predetermined level to leave the market, we simulate the effects of trade sanctions. Sanctions are thought to imply a decrease in the trade of the most productive producers. Our modelling strategy is informed by the fact that products from the EU and the US that are sanctioned for export to Russia are those that demand advanced technology to manufacture, such as luxury cars, quantum computers, sensors, and lasers, Congressional Research Service, (February 22, 2023). By simulating the exclusion of a portion of foreign households from global bond trading, we introduce financial market sanctions. All foreign households are not included in the cap. Our modelling strategy for financial sanctions is motivated by the Biden administration's restrictions on the exchange of Russian bonds.

Financial sanctions were imposed by the EU and the US in a variety of ways, including freezing central bank reserves, limiting the transactions of Russian financial institutions, and imposing limitations on global financial messaging systems like SWIFT. In this essay, we narrow our focus to financial sanctions by emphasizing the limitations on global bond trade. In our simulations, imports of foreign gas are permanently stopped due to trade sanctions. On

the modelling of sanctions, we go into more detail below.

trade sanctions for good consumption. By imposing a productivity upper bound, (\bar{z}_S), or what we refer to as the sanction productivity limit, we impose sanctions on the trade of consumption goods. Either domestic producers of consumer goods whose productivity levels are higher than the sanctioned productivity limit level stop exporting to foreign countries ($\bar{z}_{F,t}^H = \bar{z}_S$), or domestic producers whose productivity levels are higher than the sanctioned productivity limit level stop supplying domestic markets with their products ($\bar{z}_{F,t}^H = \bar{z}_S$). The percentage of exporting businesses from Region i (the sanctioning region) to region j (the sanctioned region) under the consumption good trade sanctions is as follows:

$$\frac{N_{j,t}^i}{N_{D,t}^i} = (1 - \mathbb{1}^S) + \mathbb{1}^S \Phi(\bar{z}_S) - \Phi(\bar{z}_{j,t}^i) \quad (23)$$

where $\mathbb{1}^S$ is an indicator function that has a value of 1 when sanctions are introduced and a value of 0 otherwise. Our selection of the sanction cut-off level takes into account Russia's post-Russian-Ukrainian War non-mineral fuel goods trade flows with the European Union, the United Kingdom, and the United States. (For more information, see Section 3. In particular, we establish that the top 0.5% of most productive producers of consumption goods are subject to sanctions. This identifies the sanction productivity limit productivity level.

In our model's initial steady state, the top 0.5% of Home firms account for 78% of aggregate exports to Foreign, but lower productive firms are increasingly exporting. Consequently, the overall decline in aggregate exports is less than 78%. Due to the asymmetry between Home and Foreign, in the initial steady state, the top 0.5% of Foreign firms account for 60% of total exports from Foreign to Home. The information is provided in Section 3.

No quantitative change in our findings is caused by the rise in lower productivity firms entering the export market. Regardless of whether lower-productivity firms continue to enter the export market or not, the average exporter's productivity declines after the sanctions.

The Financial sanctions. When Home imposes financial sanctions against Foreign, a fraction $\lambda > 0$ of Foreign households are excluded from international financial markets. Only RoW households and other foreign households may trade foreign bonds and shares with these households. The household structure that emerged as a result of the imposition of financial sanctions is comparable to that described in open economy HANK literature by Guo, Ottonello, and Perez (2023). Our research focuses on how household heterogeneity varies along the path between steady states, as opposed to previous research that examined the effects of shocks given the heterogeneous structure of households.

When $\lambda = 1$ and financial sanctions are applied to the entire Foreign economy, the Foreign experiences financial autarky. The representative-approved household's financial restrictions are as follows:

$$\begin{aligned} C_{F,t}^* + \frac{\eta}{2} \tilde{v}_t^F N_t^F (x_{t+1}^{F*} - \chi_F^{-1})^2 + \tilde{v}_t^F N_t^F x_{t+1}^{F*} + \sum_{j=F,R} Q_{F,t}^j \left\{ B_{F,t+1}^{j*} + \frac{\eta}{2} (B_{F,t+1}^{j*} - B_F^j)^2 \right\} \\ = w_{G,t}^F L_{G,t}^{F*} + w_t^F L_t^{F*} + (\tilde{d}_t^F + \tilde{v}_t^F) N_{D,t}^F x_t^{F*} + T_{F,t}^* + \sum_{j=F,R} (1 + r_t^j) Q_{F,t}^j B_{F,t}^{j*} \end{aligned} \quad (24)$$

The asterisk denotes Foreign households that are subject to sanctions. The sanctioned households cannot trade Home bonds along the transitional path, and their terminal steady-state holdings are equal to zero which is mean $B_H^{F,t+1} = B_H^F = 0$. If the RoW joins sanctions, the terminal steady state holdings of RoW bonds go to zero as well, which means $B_{R,t+1}^{F*} = B_R^F = 0$. The budget constraint of the representative non-sanctioned household is:

$$\begin{aligned} C_{F,t}^{**} + \frac{\eta}{2} \tilde{v}_t^F N_t^F (x_{t+1}^{F**} - \chi_F^{-1})^2 + \tilde{v}_t^F N_t^F x_{t+1}^{F**} + \sum_{j=F,R} Q_{F,t}^j \left\{ B_{F,t+1}^{j**} + \frac{\eta}{2} (B_{F,t+1}^{j**} - B_F^{j**})^2 \right\} \\ = w_{G,t}^F L_{G,t}^{F**} + w_t^F L_t^{F**} + (\tilde{d}_t^F + \tilde{v}_t^F) N_{D,t}^F x_t^{F**} + T_{F,t}^{**} + \sum_{j=F,R} (1 + r_t^j) Q_{F,t}^j B_{F,t}^{j**} \end{aligned} \quad (25)$$

The doubled asterisk denotes non-sanctioned households. The non-sanctioned households can trade Home bonds along the transitional path, but their terminal steady state holdings are zero, i.e. $B_H^F = 0$. ($B_H^F = 0$ the RoW joins sanctions.) Market clearing conditions for bonds and shares in the presence of financial market sanctions are as follows:

$$\chi_F (1 - \lambda) B_{F,t+1}^{H**} + \sum_{j=H,R} B_{j,t+1}^H = 0 \quad (26)$$

$$\chi_F \{ \lambda B_{F,t+1}^{F*} + (1 - \lambda) B_{F,t+1}^{H**} + \sum_{j=H,R} B_{j,t+1}^F \} = 0 \quad (27)$$

$$\chi_F \{ \lambda x_{t+1}^* + (1 - \lambda) x_{t+1}^{**} \} = 1 \quad (28)$$

Sanctions on Gas. By simulating a permanent decline in foreign gas imports in period 1, we may analyze gas sanctions. Market clearance for useable gas in Foreign is altered as follows when sanctions are imposed:

$$G_N^F \chi_F L_{G,t}^F = \min(\bar{G}_{H,t}^S, G_{H,t}^F) + \min(\bar{G}_{R,t}^S, G_{R,t}^F) + G_{F,t}^F \quad (29)$$

Where $\bar{G}_{H,t}^S$ and $\bar{G}_{R,t}^S$ denotes the relative quotas that the Home and RoW have placed on foreign gas imports. Under gas sanctions, we believe all gas trading must end. Means $\bar{G}_{H,t}^S = 0$. If RoW participates in sanctions, the gas import quota is $\bar{G}_{R,t}^S = \bar{G}_{H,t}^S$. Otherwise, there is no quota, $\bar{G}_{R,t}^S \rightarrow \infty$.

3. The Calibration

The model is calibrated using standard values from the literature on macroeconomics and international trade as well as by comparing the steady-state values of several variables to the data. The steady-state values of domestic GDP, domestic exports, and domestic imports are matched to replicate the average of Russian annual data for 2020–2021 and the EU27, UK, and US averages for the same period. When determining the steady-state bond holdings of Foreign, we also match the Russian net foreign position and the amount of Russian external assets. We first calibrate a few parameters using the data or earlier research (Table 1). This makes it possible for us to evaluate the effects of sanctions without having to worry that our conclusions were based on a strange calibration. We set the mass of foreign households to equal the proportional size of Russia's labour force and normalize the mass of domestic households to one. In comparison to the combined labour forces of the EU27, the UK, and the US, the data show that Russia's labour force is roughly 20% larger.

"The population of Russia between the ages of 15 and 64 will make up 71% of the total populations of the EU27, the UK, and the US in 2020 and 2021, according to the World Bank's World Development Indicators. According to modelled ILO estimates, the labour force participation rates in 2020 (2021) for Russia, the EU27, the UK, and the US are 61.9 (62.2), 56.6 (56.9), 62.8 (62.1), and 61.3 (62.2), respectively. "

Table 1: A Priori Parameters

Parameter	Notation	Value	Target
Mass of Foreign households	χ_F	0.2	Russian (relative) labour force size
Disutility from working	κ	0.75	Normalize $L_0^H=1$
Sectoral labour mobility	ϱ	1	Labour Mobility in the US
Discount factor	β	0.99	4% annual interest rate
Firm exit probability	δ	0.025	10% annual firm exit rate
The elasticity of substitution across products	θ	3.8	Markups
Pareto distribution			
Lower bound	z_{min}	1	Normalized
Shape	k	3.4	Firm domestic sales distribution
Production function (consumption goods sector)			
Gas share	α	0.05	Energy factor cost share
The elasticity of substitution (gas & labour)	ϵ	0.3	Elasticity b/w energy & other factors
Productivity (gas sector)			
Sunk entry costs	$f_{E,t}$	1	Normalized
Fixed Export costs	$f_{X,t}$	0.0045	Fraction of exporters in US

As a result, we set F to 0.20. We set the cost share of gas to ($\alpha = 0.05$ by Kim, Ozhan, and Schembri (2021)). We set the low elasticity of substitution between labour and gas, to zero.

The latter is consistent with the hypothesized estimates by Bachmann and colleagues. (2022). We chose the values $\beta = 0.99$ for the discount factor and $\delta = 0.025^\circ$, respectively. The former assumes a real interest rate in a steady state of 4% annually.

Among others in this literature, Ghironi and Melitz (2005) are used to set the latter. To normalize the labour supply for the consumer goods sector to one, the disutility parameter from working κ is set to 0.75. We adhere to the parameter of Horvath's (2000) sectoral labour mobility Cantelmo and Melina (2023) (for more information on our parameter selection and the sectoral mobility literature). Stationarity is brought about by setting the scale parameter for the costs of adjusting bond/shareholdings, η to 0.025. The non-stochastic steady state is determined by this value. Again, by Ghironi and Melitz (2005), we set the elasticity of substitution between varieties, θ to 3.8. We make the same assumption as Melitz (2003) that firm-level productivity z is drawn from a Pareto distribution with lower bound z_{min} and shape parameter k . We normalize z_{min} and f_E to 1 and set k to 3.4 in this example. As a result, the (domestic) sales distribution's Pareto shape parameter is 1.21. Since only 35% of businesses export, our calibration suggests that the top 1% of productive exporters account for 71% of all exports. The percentage of top 1% exporters in total exports is 81, 73, 69, 59, 73, and 81 percentage points in Germany, France, the UK, Italy, Belgium, and Norway, respectively, according to Mayer and Ottaviano (2008). Our model produces results that fall within their estimated range. We chose $f_X = 0.0045$ as the fixed cost of exporting, which results in an initial steady state where 34% of Home exports are made to RoW. Only 2% of domestic companies export to foreign markets due to the small size of those markets. In the initial steady state, 9 foreign firms export to the domestic market. The asymmetry between the three regions, which was already mentioned, is an essential component of our model. The productivity of the consumer goods sector, the endowment in gas, and the trade cost of each region are calibrated to reflect their respective economic sizes and export trends before the Russia sanctions, as shown in Panel B of Table 2.

We normalize Foreign Productivity and Domestic Natural Gas Endowment without losing generality to one, $Z_t^F = 0$ and $G_N^H = G_N^R = 1$. Home and RoW are gas importers and Foreign is a gas exporter. We set Foreign gas endowment G_N^F to 1.2 and Home and RoW aggregate productivity of consumption good production, $Z_t^H = Z_t^R$ to 1.2. In the gas sector, Foreign has a comparative advantage, while in the area of consumer goods, Home and RoW are at a comparative advantage.

“Home and RoW tend to be concentrated in the consumption goods sector due to their large market sizes, in addition to comparative advantages from endowments and productivities.

The home market effects of Krugman (1980) claim that countries with large market sizes are more desirable as a firm location for producing differentiated goods and economies of scale. See Hanson and Xiang (2004); Bak, Kim, and Mehra (2022), among many others, for a more recent discussion on the effects of product differentiation, trade costs, and economies of scale on the domestic market”.

Table 2: GDP and Trade Parameters from Initial Steady State Matching

Panel A. Calibrated Parameter	Notation	Value
Natural gas endowments (gas sector productivity)		
Home	$G_{N,t}^H$	1.0
RoW	$G_{N,t}^R$	$G_{N,t}^H$
Foreign	$G_{N,t}^F$	1.2
Productivity (consumption goods sector)		
Home	Z_t^H	1.2
RoW	Z_t^R	Z_t^H
Foreign	Z_t^F	1.0
Export (iceberg) costs (consumption goods)		
between Home & RoW	$\tau_R^H = \tau_H^R$	1.2
from Home & RoW to Foreign	$\tau_F^H = \tau_F^R$	1.3
from Foreign to Home & RoW	$\tau_H^F = \tau_R^F$	3.0
Gas import (iceberg) costs	$\tau_{G,t}$	1.3
Panel B. Target	Data	Model GDP
ratio of Home to Foreign	10.09%	10.30% Home
exports/GDP	26.70%	29.6% Foreign
exports/GDP	28.20%	34.6% Foreign gas
export share in total exports	57.20%	64.50%

Notes: We assemble data for Russia, the European Union, the United Kingdom, and the United States in the second column (data) of Panel B. The GDP ratio of Foreign to Home is computed by dividing the GDP of Russia (PPP, current international \$) by the GDP of the EU27, the UK, and the US combined.

The annual exports and GDP of the three nations (EU27, UK, and US) and Russia, in USD nominal terms, are used to calculate the domestic and international export-to-GDP ratios. We use information from the Russian Foreign Trade Tracker (17 May 2023) by Zsolt Darvas, Luca Lery Moffat, Catarina Martins, and Conor McCaffrey to determine the foreign gas export share by dividing Russia's monthly mineral fuel shipments by total goods exports. All figures are the 2020 and 2021 averages. The model values at the initial statbys are shown in the third column.

We normalize Foreign Productivity and Domestic Natural Gas Endowment without losing generality ments to one, $Z_t^F = 0$ and $G_N^H = G_N^R = 1$. Home and RoW are gas importers and Foreign is a gas exporter. We set Foreign gas endowment G_N^F to 1.2 and Home and RoW aggregate productivity of consumption good production, $Z_t^H = Z_t^R$ to 1.2. In the gas sector, Foreign has a comparative advantage, while in the area of consumer goods, Home and RoW are at a comparative advantage.

“Home and RoW tend to be concentrated in the consumption goods sector due to their large market sizes, in addition to comparative advantages from endowments and productivities. The home market effects of Krugman (1980) claim that countries with large market sizes are more desirable as a firm location for producing differentiated goods and economies of scale. See Hanson and Xiang (2004); Bak, Kim, and Mehra (2022), among many others, for a more recent discussion on the effects of product differentiation, and taxonomies of scale on the domestic market”.

According to our calibration, in the initial steady state with no sanctions, the Home GDP is roughly ten times larger than the Foreign GDP. This value is comparable to the ratio of the GDPs of the EU27, the UK, and the US at purchasing power parity (PPP) to the GDP at PPP of Russia in 2020 and 2021, according to the World Bank's World Development Indicators-DataBank. The GDPs of the combined EU27, UK, and US (which are indicative of Home) and China, India, and Turkey (which are indicative of RoW) differ slightly from the steady state implied by the model and the data. In the data, the former is 1.2 times larger than the latter, whereas, in the model, these regions are of equal size. The export-to-GDP ratios of the steady state of the model can be matched to data with the help of the calibration of iceberg trade costs. We set the iceberg trade costs at 30%, which means $\tau_{F,t}^H = \tau_{F,t}^R = \tau_{G,t} = 1.3$. These parameters were calibrated within the bounds of Anderson and van Wincoop (2004)'s estimates, which are frequently cited in the literature.

"review the literature on the estimation of trade costs attributable to tariff equivalents (i.e., iceberg trade costs), and our values fall within the parameters outlined in their paper as well, i.e. e. , ranging from 10% to 40%."

We set lower trade costs between Home and RoW i.e. $\tau_R^H = \tau_H^R = 1.2$, to match the model's Home exports-to-GDP ratio and the fraction of Home exporters to those of data, *(It is not unusual to calibrate the trade costs between Home and RoW to be low. The US is India's leading trading partner, the EU is Turkey's top trading partner, and the US and the EU are China's top two trading partners in 2021)*. Finally, the cost of trade for Foreign exporters is relatively higher in our calibration, i.e., $\tau_{H,t}^F = \tau_{H,t}^R = 3.0$.

These values are higher in terms of trade costs between the Home and RoW, but the fact that Foreign trade costs are higher helps to match the low exports of non-mineral fuels from Russia to the steady state of our model, specifically the ratio of exports to GDP and the proportion of gas exports to total exports. For more information, see Table 2. A key aspect of the Russian economy is the country's position as a net creditor on international markets. Therefore, we aim to value Russian net foreign position (NFA) and external assets to set the initial steady

state net foreign asset holdings of Foreign. (The International Investment Position database of the International Monetary Fund estimates that Russia's foreign assets will be 1,569 billion USD in 2020 and 1,652 billion USD in 2021. its net foreign asset positions in 2020 and 2021). The data shows that the former represents about 30% of the projected Russian GDP for 2021 and the latter represents about the same amount. Our calibration of steady-state asset holdings is shown in Table 3.

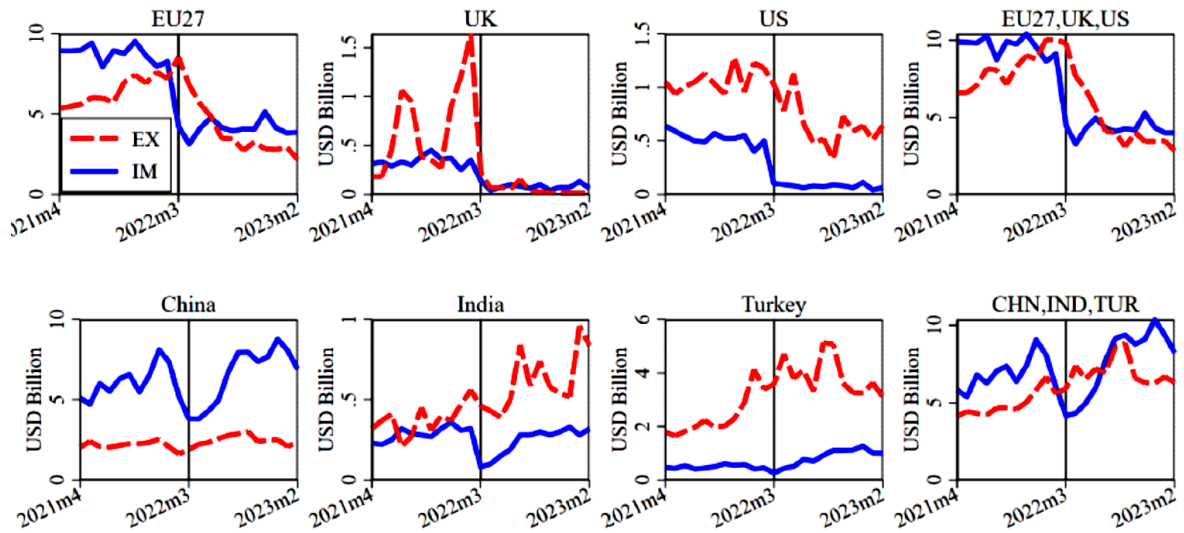
Table 3: Initial Steady State Matching Parameters External Resources

Panel A. Calibrated Parameter	Notation	Value
Foreign initial bond holdings		
Home bond	B_F^H	$1/\chi_F$
RoW bond	B_F^R	B_F^H
Foreign bond	B_F^F	$-1.3/\chi_F$
Home initial bond holdings		
Home bond	B_H^H	$-\chi_F B_F^H$
RoW bond	B_H^R	0
Foreign bond	RoW's	$-\chi_F B_F^F/2$
RoW initial bond holdings		
Home bond	B_R^H	B_R^H
RoW bond	B_R^R	B_H^H
Foreign bond	B_R^F	B_H^F
Panel B. Target	Data	Model GDP
Foreign's NFA/GDP	31.00%	29.40%
Foreign's External Assets/GDP	99.10%	98.80%

Notes: Data for Russia's annual external assets and net foreign assets (NFA) for 2020 and 2021 are taken from the International Investment Position database of the International Monetary Fund. The World Bank's World Development Indicators-DataBank is used to calculate Russia's nominal yearly GDP in USD for 2020 and 2021. The ratios are calculated for each year, then averaged. The model values at the initial state without sanctions are shown in the third column.

Parameters that affect Sanctions. We explain the calibration in relation to sanctions to conclude this section. We adjusted the sanction productivity limit for trade in consumer goods to reflect the observed modifications in Russia's trade flows of goods (aside from mineral fuels) following the start of the conflict in February 2022. The data are shown in Figure 2.

The top 0.5% of firms would be excluded from export markets because the implied sanction productivity limit (\bar{z}_S) is $(0.005^{-1/k})$. Our choices are indicative of financial and gas sanctions. Following financial sanctions, we set the percentage of foreign households not allowed to trade bonds internationally at (λ to 0.9).



(a) Goods Other than Mineral Fuels

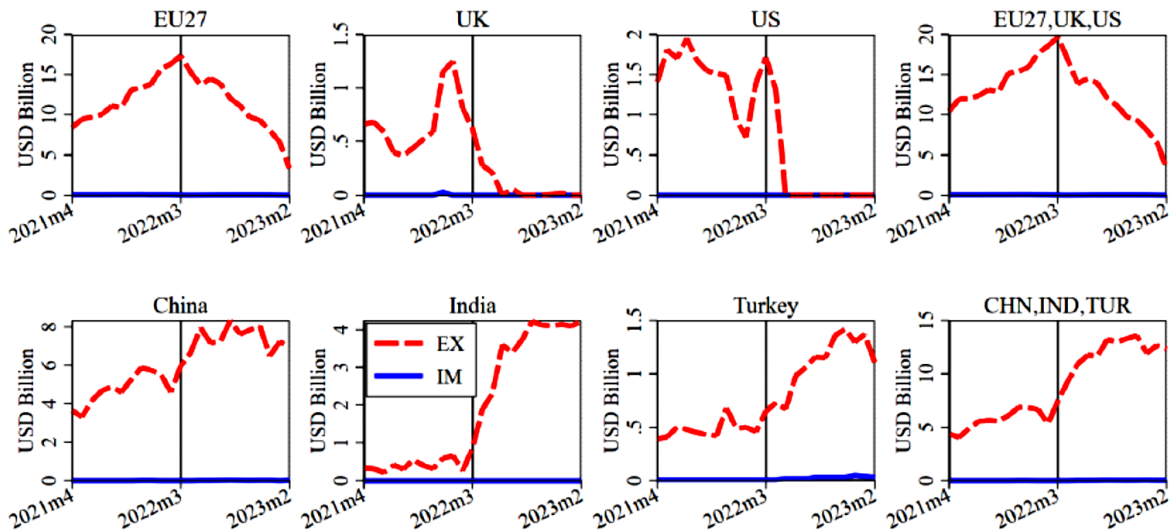


Figure 2: The Goods that Russia Exports and Imports.

Notes: The figure plots Russia's monthly exports of goods to the selected countries from April 2021 to February 2023, as well as its monthly imports of these goods from those countries (blue solid lines and red dashed lines, respectively). Data source: Zsolt Darvas, Luca Lery Moffat, Catarina Martins, and Conor McCaffrey's Russian Foreign Trade Tracker (17 May 2023).

For gas sanctions, we consider a complete halt of gas imports from Foreign ($\bar{G}_{H,t}^S = 0$), which is consistent with the data of the UK and US mineral fuel imports from Russia in Figure 2. (The EU27 mineral fuel imports from Russia did not fall to zero after the war, although there has been a substantial decrease in these imports).

After the sanctions, Figure 2 shows the change in Russia's imports (blue solid lines) and exports (red dashed lines) of goods other than mineral fuels. All figures are in US dollars. Following the sanctions, Russia's imports and exports of non-mineral goods to the EU, UK, and US fell by (66% and 55%), respectively (based on average annual growth rates for the

period of December 2022 to February 2023). To match these values, we chose the sanction productivity limit (\bar{z}_S). The new steady-state values of Foreign exports and imports with Home in our calibrated model are (62% and 64%) lower than the initial values in terms of Home currency when Home applies all of the sanctions without RoW's participation.

According to the corresponding sanction cut-off (\bar{z}_S), the top 0.5% of companies are shut out of export markets. On the other hand, Russia sees an increase in its non-mineral fuel exports and imports (in USD) from China, India, and Turkey between December 2022 and February 2023 of 7% and 23%, respectively, in terms of year-over-year growth rates (Figure 2-a). Our model is effective at producing similar behaviour even though it is not targeted, i.e., a rise in imports from a third region of the economy that has been sanctioned in response to uncoordinated sanctions. Following the arbitrary sanctions imposed by the Home, our model predicts a 23% increase (in Home currency value) in foreign imports from RoW. Following these sanctions, the foreign economy imports more goods from RoW and produces more consumer goods at home to replace the domestic products that were subject to sanctions. Higher domestic demand in Foreign implies lower exports to RoW. Foreign also increases labour employment in firm entry and production to substantially and heavily increase the production of final consumption goods.

The model predicts that when combined sanctions are imposed by the Home without consulting the RoW, imports of foreign final consumption goods from RoW rise by 23% (Home currency value). The Foreign economy's access to domestically produced goods has been restricted since the imposition of sanctions, which has increased imports from RoW and increased production of final consumer goods to take the place of domestic products. Foreign companies sell domestically rather than export to RoW due to increased foreign demand for locally produced goods. Foreign increases labour employment in firm entry and production as well, which significantly and vigorously increases the production of final consumption goods. As a result, the growth of wages, prices, and currency makes them less competitive in the RoW consumption goods market. Consequently, exports to RoW are significantly decreased by foreign companies. Contrary to the data's modest increase in Russia's exports to China, India, and Turkey, the value of exports from Foreign to RoW in terms of the Home currency decreases by just 4 percentage points. Because of this, the growth of wages, prices, and currency makes them less competitive in the RoW market for consumer goods. A trade deficit exists between Foreign and RoW as a result. (Foreign currency appreciation dampens this channel). As can be seen in (Figure 2-a), Russia's imports from Turkey, China, and India are growing faster than its exports to those nations. The red dotted lines in subfigure (b) of Figure 2 show how sanctions have nearly eliminated mineral fuel imports from Russia for the UK

and the US since the conflict. Mineral fuels are still imported by European economies from Russia, but their value has been steadily falling.

On the other hand, Russia saw an increase in the imports of mineral fuels from China, India, and Turkey. Particularly, Russia's mineral fuel exports (in USD) to the EU27, the UK, and the US decreased by 65% year over year, whereas its mineral fuel exports (in USD) to China, India, and Turkey increased by 99%. We use the same figures when calibrating our model's gas sanctions. According to our model, gas exports from abroad to the domestic market and the rest of the world decline by 100% and 64%, respectively, in terms of domestic currency. As the data indicates, none of the six nations exports any mineral fuels to Russia, so our model does not permit Home or RoW to export gas.

4. The Effectiveness of the Sanctions

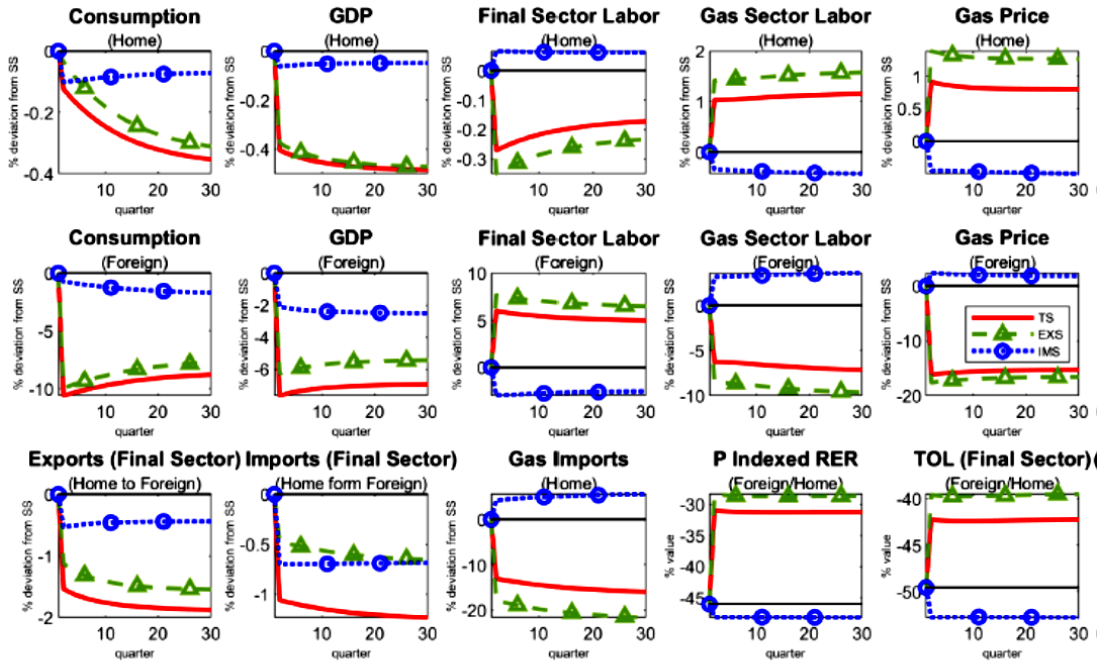
To look into the immediate, long-term, and medium-term effects of sanctions, we numerically solve our model. The model has reached the no-sanction equilibrium at time $t = 0$, to be exact. Upon the introduction of sanctions at time $t = 1$, the model converges to a new equilibrium that we refer to as the sanction equilibrium. We solve the model as a nonlinear, deterministic, forward-looking system using Dynare's nonlinear equation solver with line search.

In the first subparagraph, we first take into account how Home and RoW jointly impose sanctions against Foreign. This activity reminds me of simulations in a two-region environment. Later in the second subsection, we present and discuss dynamics when the Home sanctions Foreign but the RoW does not join the sanctions, in order to highlight the departure from the two-region setting.

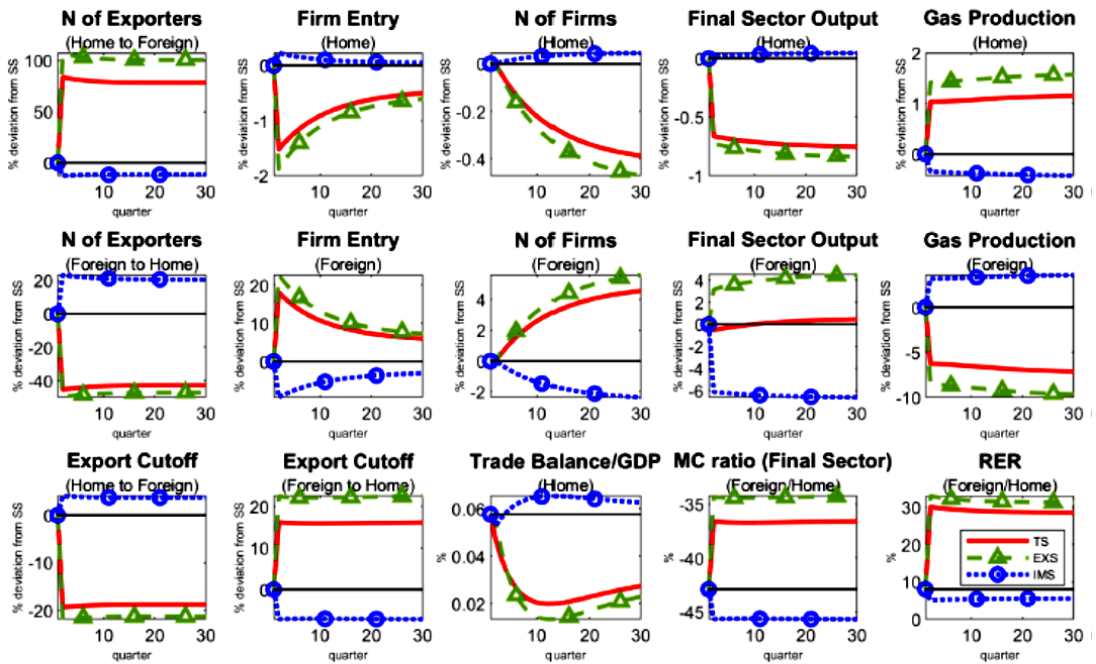
4.1 The Types of the Sanctions

Sanctions on financial transactions, trade in consumer goods, and trade in gas are the three categories we examine. While the decline in GDP and domestic consumption is caused by all of the sanctions, it is not as significant as the decline in foreign consumption. The most noticeable changes are caused by the impact of export restrictions on consumer goods. Additionally, we discover that sectoral reallocations influence real exchange rate movements, which do not, however, reflect the effectiveness of sanctions.

Consumption of Beneficial Trade Sanctions. Figure 3 depicts the transitional dynamics of a number of macroeconomic and trade variables from the no-sanction equilibrium to the



(a) Main Macro Variables



(b) Extensive Margins and Other Variables

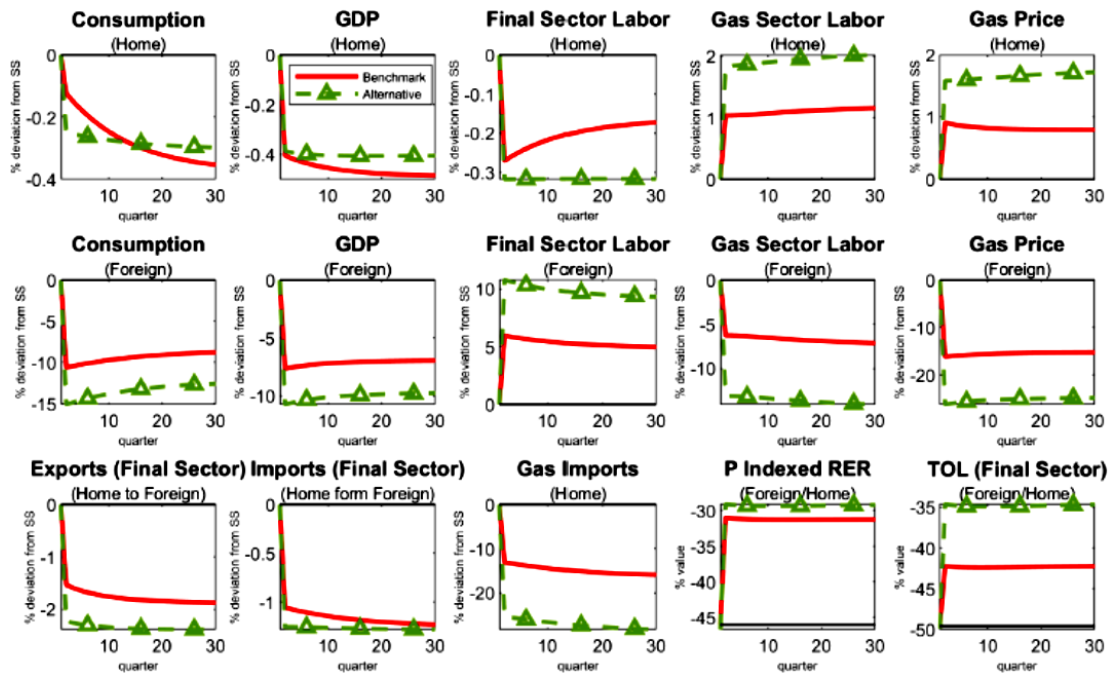
Figure 3: Transitional Dynamics under Trade Sanctions.

Notes: At time $t = 1$, when trade sanctions (TS, export and import sanctions) are implemented, the red solid lines plot the dynamics of the model transition. When export sanctions (EXS) are enacted at time $t = 1$, the model transition dynamics are plotted on the green dashed lines with triangles. When import sanctions (IMS) are enacted at time $t = 1$, the model transition dynamics are depicted as blue dashed lines with circles. With the exception of the last three numbers, all deviations are expressed as a percentage of the original steady state ($t = 0$) without penalty. The final two numbers, P indexed RER and TOL (Final Sector) in subfigure (a), and Trade Balance/GDP, MC ratio (Final Sector), and RER in subfigure (b), are expressed as percentage deviations from one, or $[100 * (x - 1)]$.

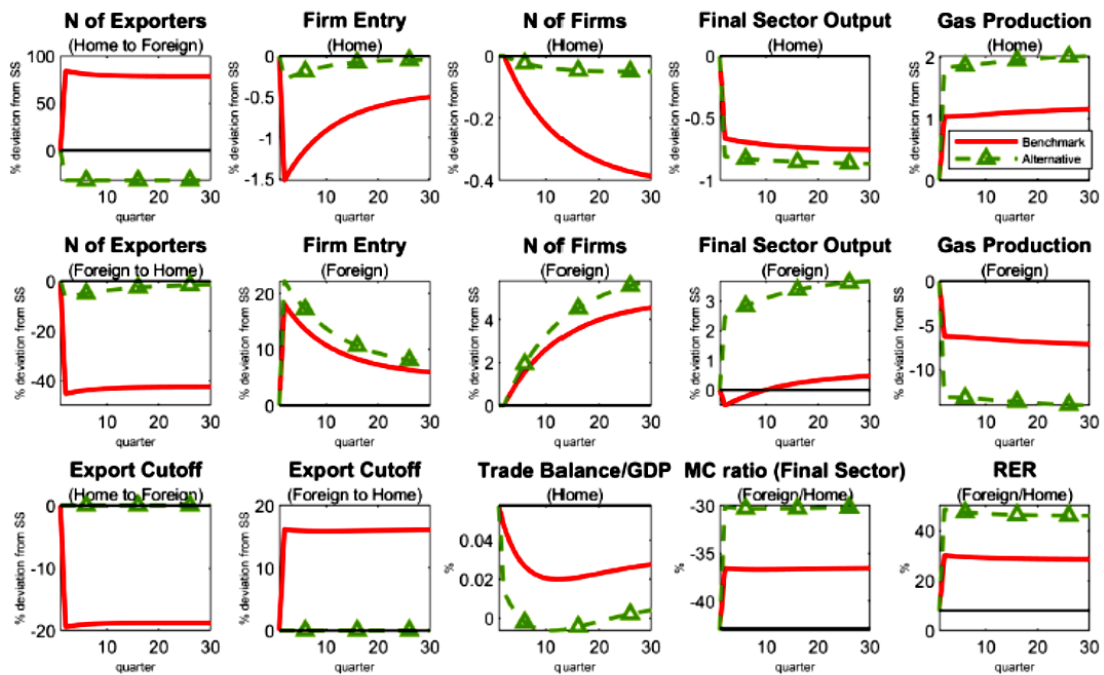
sanction equilibrium following the introduction of consumption good trade sanctions at time $t = 1$. The top 0.5% of productive Home and RoW firms in the green dashed lines with triangles represent simulations in which the imposition of export sanctions (designated EXS) causes them to stop exporting to foreign markets. In the simulations (labelled IMS) where the top 0.5% of productive foreign firms stop exporting to both the Home and RoW, blue dashed lines with circles are shown. Red solid lines that are labelled "trade sanctions" (TS) represent simulations that include export and import sanctions at the same time. Less productive foreign producers start exporting in response to import sanctions (IMS), which shows a decline in the cutoff productivity level for least productive foreign exporters. Exports of foreign consumer goods become more expensive as a result of the decline in the average productivity of exporters from abroad. Figure 3 illustrates how the home real exchange rate increases as the home consumption price index rises as a result of more expensive imports from abroad. Lower demand for labour in the consumer goods sector is implied by the decline in the supply of foreign-exported consumption goods.

As a result, there are fewer producers abroad. To make up for the decline in export earnings, resources from the foreign economy are reallocated to the gas industry. As a result, the foreign gas industry experiences an increase in labour demand. The price of gas in Home and RoW decreases as Foreign production of gas rises. Export sanctions (EXS) cause a reallocation of resources from the gas sector to the final good sector in the foreign economy. In contrast to import sanctions (IMS), resource allocation operates in the opposite direction. To make up for the decline in imports from Home and RoW, the foreign economy rebalances itself by producing more consumer goods. As a result, there is an increase in entry into the consumption sector and a rise in labour demand in the foreign consumer goods sector. Due to a reduction in the global supply of gas, the decline in the labour pool available for gas production in Foreign implies an increase in gas prices in Home and RoW. A higher consumer price index results from foreigners beginning to import more goods from lower productivity companies in the Home and RoW. The latter causes the Home real exchange rate to decline.

When we concentrate on how export and import sanctions affect GDP and per capita consumption, we see that Foreign suffers more in the short-, medium-, and long-term than Home and RoW combined. *"It is significant to note that Home and RoW are roughly 10 times as large as Foreign in terms of size, and this result holds true for both aggregate and per capita consumption dynamics"*. Furthermore, when compared to import sanctions (IMS), export sanctions (EXS) always result in a more significant decline in per capita consumption and GDP.



(a) Main Macro Variables



(b) Extensive Margins and Other Variables

Figure 4: Exporter Productivity Cutoffs Under Transitional Dynamics of Trade Sanctions

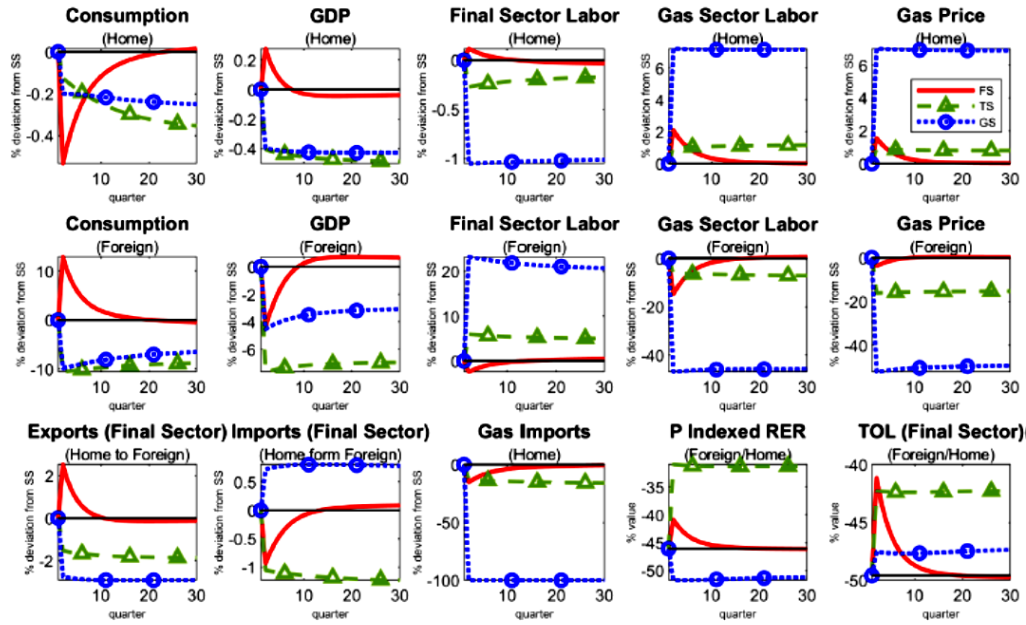
Notes: Transitional dynamics in the benchmark model under combined trade sanctions are indicated by the red solid lines. Transitional dynamics in the alternative model with invariant exporter entrance under combined trade prohibitions are plotted by the green dashed lines and triangles. At $t = 1$, sanctions are implemented. With the exception of the last three numbers, all deviations are expressed as a percentage of the original steady state ($t = 0$) without penalty. The final two numbers, P indexed RER and TOL (Final Sector) in subfigure (a), and Trade Balance/GDP, MC ratio (Final Sector), and RER in subfigure (b), are expressed as percentage deviations from one, or $[100 (x 1)]$.

The main finding of our study is the asymmetry in the production structure between the regions. Due to their comparative advantage in producing consumer goods, households in Home and RoW depend on imported goods less than those in Foreign countries. Losing the imports from Home and RoW forces the Foreign to shift resources to its less advantageous sector, which implies a loss of advantage in producing usable gas. The size of the foreign economy is constrained by this inefficient resource allocation. When we consider the combined impact of import and export sanctions, we also see that the effects of export sanctions predominate for the reasons mentioned above (for example, under combined trade sanctions, the foreign economy experiences an appreciation of the real exchange rate and terms of labour).

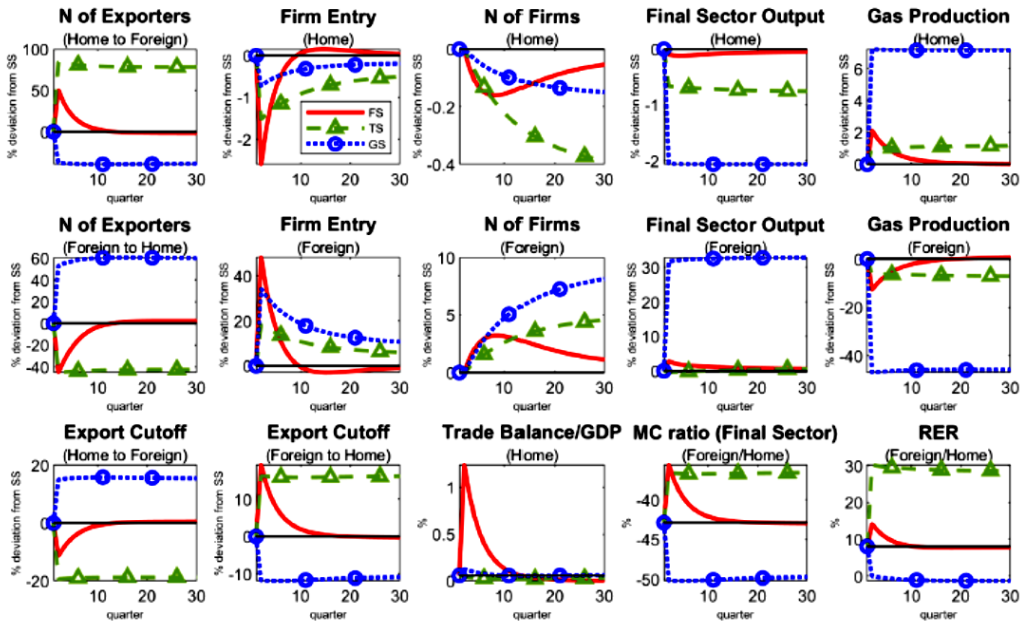
For a better understanding of the significance of producers of lower-productivity consumption goods entering export markets after sanctions, see Figure 4. To the best of our knowledge, there is no firm-level data for Russian exporters for the time following sanctions, and this exercise serves the purpose of understanding the impact of entry into export markets in determining the overall impact of trade sanctions. The dynamics of the combined trade sanctions are shown (TS in Figure 3) by the solid red lines. Triangle-shaped dashed lines in green indicate dynamics when firms' export productivity cutoffs following trade sanctions remain unchanged. The former we refer to as "Benchmark," and the latter as "Alternative.". "By fixing the Home and RoW exporter productivity cutoff (lower bound) at the initial steady state level, we disable entry into export markets. After the sanctions, only Home and RoW producers with productivity between $(\underline{z}_{F,0}^H)$ and (\bar{z}_S) export, as shown by the symbol (which means $\underline{z}_{F,t}^i = \underline{z}_{F,0}^i$ and $\bar{z}_{F,t}^i = \bar{z}_S$ for $i = H, R$ and $t \geq 1$). Our simulations are unaffected qualitatively by turning off changes in the export margin's lower bound. When the most productive producers leave the export market because of sanctions, the productivity of the average exporter still declines. As a result, as in the previous exercise, the responses of the prices and the exchange rate move in the same direction. When we disable lower productivity producers' access to export markets, the responses are, however, significantly amplified. The reason is that when we take into account entry margins into export markets by lower productivity firms, the collapse in aggregate trade becomes more significant.

The result of this trade collapse is seen in other indices like GDP and foreign consumption. Under invariant exporter entry, the Home GDP is the only variable with a softer response. It is a result of the gas industry's significant wage increase. Foreign gas exports are significantly reduced when there is a greater trade collapse because resources are reallocated more heavily to the consumer goods sector. In order to produce their gas, the Home and RoW gas sector must employ more people, which results in higher wages and a slower decline in GDP.

Figure 5: shows transitional dynamics with invariant exporter productivity cutoffs under trade sanctions.



(a) Main Macro Variables



(b) Extensive Margins and Other Variables

Notes: Under financial (FS), consumption good sector trade (TS), and gas sanctions (GS), respectively, the transitional dynamics are depicted as red solid lines, green dashed lines with triangles, and blue dashed lines with circles. At $t = 1$, sanctions are implemented. With the exception of the last three numbers, all deviations are expressed as a percentage of the original steady state ($t = 0$) without penalty. The final two numbers, P indexed RER and TOL (Final Sector) in subfigure (a), and Trade Balance/GDP, MC ratio (Final Sector), and RER in subfigure (b), are expressed as percentage deviations from one, or $[100 \times 1]$.

Sanctions on the Gas. In Figure 5, the transitional dynamics of a number of variables under gas sanctions are plotted as blue dashed lines with circles. Stopping foreign gas imports would shock foreign usable gas producers with a significant decrease in demand. The foreign gas industry shrinks, which lowers the need for labour. Labour supply shifts to the production of consumer goods. The international economy rebalances itself in favour of producing consumer goods and increasing export earnings in this sector to make up for the decline in export earnings in the gas production sector. Lower entry barriers for exporters and higher entry in the production of consumer goods are made possible by the economy's rebalancing. Less productive producers entering the export market for consumer goods from abroad imply a decline in the average productivity of foreign exporters, which translates into a higher consumer price index in Home and RoW. As a result, the foreign real exchange rate declines in comparison to the domestic and regional currencies.

Gas prices in Home and RoW rise as a result of the decline in Foreign gas demand, which also causes a decline in Foreign gas production. Because consumption goods manufacturing companies need more domestic gas to make up for lost imported gas, gas prices in the Home and RoW economies rise. High gas prices decrease a company's profitability, which deters new entrants into the market and lowers the overall number of producers in Home. Because of this, households at home contribute more labour to the production of gas and less labour to the production of consumer goods.

The Financial Sanctions. Figure 5's red solid lines depict transitional dynamics under financial sanctions, i.e. e. 90% of foreign households are not allowed to trade bonds internationally. Foreign has a positive net foreign asset position in the initial, no-sanction equilibrium, but Foreign has a negative net foreign asset position in the sanction equilibrium.

Our initial finding is that foreign consumption increases in the short term in response to financial sanctions but then declines over time. This behaviour is primarily driven by wealth effects. Foreign sells off its bond holdings after the sanction takes effect, which results in a temporary boost to income with little room for savings. As a result, demand for exports from the United States and the rest of the world also rises. The increase in foreign imports makes it easier for exporters to enter the domestic and regional markets, which affects the average export price and causes the foreign real exchange rate to increase. Foreign households have few opportunities to save money, so they hire more people to boost their income. Because of its relative size in the foreign economy, the foreign gas sector is better able to handle the increase in labour supply. Lower wages as a result of changes in the labour supply lead to a

decline in foreign GDP. Finally, we note that financial sanctions have a reduced long-term impact. The reason is that only a small portion of the population in Foreign is subject to financial sanctions, and the sanctioned portion can overcome the sanctions by engaging in transactions with those in Foreign who maintain their access to global financial markets.

4.2 The Sanctions that are Combined with/without Coordinated internationally

We examine the combined effects of the sanctions imposed on Russia in order to account for their overall effect. We pay particular attention to the differences in impact between sanctions that are coordinated (Home and RoW imposing sanctions together) and those that are uncoordinated (Home imposing sanctions alone). China, India, and Turkey did not impose any sanctions against Russia despite the EU, the UK, and the US doing so. We run simulations in which the Home imposes all of the sanctions listed in the previous subsection on the Foreign party, but the RoW chooses not to participate. This scenario is known as "uncoordinated sanctions.". Then, we contrast this result with what we refer to as "coordinated sanctions," in which the RoW and the Home impose sanctions on the Foreign party jointly.

The dynamics of the transition between the steady states of sanction and no sanction are shown in (Figures 6-a1). When only the Home sanctions the Foreign, this is known as uncoordinated sanctions, while when both the Home and the RoW sanction the Foreign, this is known as coordinated sanctions, red solid lines indicate dynamics. When sanctions are not coordinated, domestic and international consumption declines while consumption in the Rest of the World rises. Due to the substitution effects, uncoordinated sanctions increase RoW GDP. To meet the increased demand coming from abroad, RoW reallocates its economy toward the production of consumption goods. Additionally, RoW increases its gas imports from Foreign while expanding exports to Foreign. Although RoW does not participate in sanctioning, it is important to note that Foreign continues to suffer from Home sanctions. The sanctioned imports from Home are partially replaced by imports from RoW, but in order for exporters in RoW to access the export market, they must pay fixed trade costs. It is simpler for Foreign to transfer production factors to its comparatively unfavourable consumption good production sector. Sanctions continue to bite when resources are allocated inefficiently (in comparison to the initial steady state).

While strengthening the effects of sanctions against Foreign, coordination of sanctions enables Home to share the burden of sanctions with RoW. Both temporarily and permanently, there is a nearly two-fold loss in GDP and foreign consumption. However, the sanctions have the same negative effects on RoW consumption and GDP as they do on Home. RoW shifts

its economy toward gas production while subject to coordinated sanctions. It is assumed that domestic exporters will replace exports to the rest of the world, leading to convergence towards zero net foreign asset position and a positive trade balance. Whether the additional cost on RoW outweighs the additional effects of coordinated sanctions against Foreign is a crucial question. In the section that follows, we concentrate on welfare to offer a response to this query.

Table 4: Welfare and GDP Change Following Sanctions

Type of Sanctions	International Coordination	% Welfare Loss (Δ)			% Change of GDP per capita		
		Home	Foreign	RoW	Home	Foreign	RoW
Panel A. Individual Sanctions							
Gas	Yes	1.17	5.80	1.17	-0.43	-2.98	0.43
	No	1.14	2.02	0.67	-0.39	-1.20	0.29
C-good export	Yes	1.18	7.99	1.18	-0.48	-5.40	0.48
	No	1.31	20.00	0.69	-0.62	-2.83	0.24
C-good import	Yes	0.96	1.90	0.96	-0.06	-2.53	0.06
	No	0.96	1.06	0.87	-0.04	-1.24	0.00
C-good trade	Yes	1.22	9.03	1.22	-0.48	-6.92	0.48
	No	1.36	4.73	0.69	-0.64	3.66	0.23
Financial	Yes	0.88	0.44	0.88	-0.04	0.61	0.04
	No	0.89	0.30	0.88	-0.04	0.30	0.01
Panel B. Sanction Combinations							
Gas + Financial	Yes	1.16	6.13	1.16	-0.47	-2.12	0.47
	No	1.13	2.23	0.66	-0.43	-0.75	0.29
C-good trade + Financial	Yes	1.21	9.13	1.21	-0.50	-6.66	0.50
	No	1.30	4.64	0.73	-0.52	-3.39	0.12
Gas + C-good trade + Financial	Yes	1.42	13.37	1.42	-0.77	-9.07	0.77
	No	1.44	5.58	0.59	-0.79	-4.09	0.38
Panel C. Sanction Combinations under the Model Version with Invariant Export Cutoff							
C-good trade + Financial	Yes	1.16	12.92	1.16	-0.40	-9.65	0.40
	No	1.33	5.45	0.70	-0.52	-4.09	0.15
Gas + C-good trade + Financial	Yes	1.44	14.44	1.44	-0.80	-9.73	0.80
	No	1.46	6.28	0.57	-0.80	-4.70	0.40

Notes: Based on the per capita consumption determined by equation (33), the first three columns show the welfare (lifetime utility) loss resulting from sanctions. The last columns show the GDP per capita change in percentage between the initial era ($t = 0$) and the final period ($t = 201$). The weighted total of foreign families that have received financial sanctions and those that have not is used to assess the foreign welfare losses and changes in GDP per capita. By restricting less productive companies from joining the export market in reaction to trade penalties, the welfare and GDP changes are computed in Panel C.

5. The Welfare

The lifetime consumption utility and labour disutility are used to calculate welfare. In the first period, we take into account the effects of sanctions that have already been put in place, i.e., $t = 1$, transition dynamics up to $t = 201$, and the terminal impact. It only takes 200 simulations of our model for the economy to reach its new steady state. To measure welfare with sanctions, in particular, we compute the lifetime utility as follows.

$$\begin{aligned} \mathcal{W}_i^{Sanction} = & \sum_{t=0}^{200} \beta^t \left[\ln C_{i,t} - \frac{\kappa}{2} \left\{ (L_t^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,t}^i)^{\frac{1+\varrho}{\varrho}} \right\}^2 \left(\frac{\varrho}{1+\varrho} \right) \right] \\ & + \frac{\beta^{201}}{1-\beta} \left[\ln C_{i,201} - \frac{\kappa}{2} \left\{ (L_{201}^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,201}^i)^{\frac{1+\varrho}{\varrho}} \right\}^2 \left(\frac{\varrho}{1+\varrho} \right) \right] \end{aligned} \quad (30)$$

When there is no sanction, the welfare is

$$\mathcal{W}_i^{No Sanction} = \frac{1}{1-\beta} \left[\ln C_{i,0} - \frac{\kappa}{2} \left\{ (L_0^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,0}^i)^{\frac{1+\varrho}{\varrho}} \right\}^2 \left(\frac{\varrho}{1+\varrho} \right) \right] \quad (31)$$

Where $C_{i,0}$, $L_{i,0}$ and $L_{G,0}$ are country i 's consumption of good labour supply by households, consumption of good labour supply, and unrestricted employment in the gas sector. As of right now, we have calculated the welfare loss in terms of equivalent consumption:

$$\mathcal{W}_i^{Sanction} = \frac{1}{1-\beta} \left[\ln \{ (1 - \Delta_i) C_{i,0} - \frac{\kappa}{2} \left\{ (L_0^i)^{\frac{1+\varrho}{\varrho}} + (L_{G,0}^i)^{\frac{1+\varrho}{\varrho}} \right\}^2 \left(\frac{\varrho}{1+\varrho} \right) \right] \quad (32)$$

where Δ_i can measure the country i 's lifetime welfare losses in consumption per capita equivalent terms. After some algebra, it can be expressed by

$$\Delta_i = 1 - \exp \left[(1 - \beta) (\mathcal{W}_i^{Sanction} - \mathcal{W}_i^{No Sanction}) \right] \quad (33)$$

Foreign consists of two different types of households. To measure their aggregate welfare losses, we calculate Δ_i of equations (33) by using the weighted average of the welfare of sanctioned and non-sanctioned households indexed by S and NS , for example,

$$\mathcal{W}_F^{Sanction} = \lambda \mathcal{W}_{F,S}^{Sanction} + (1 - \lambda) \mathcal{W}_{F,NS}^{Sanction}$$

$$\text{and} \quad \mathcal{W}_F^{No Sanction} = \lambda \mathcal{W}_{F,S}^{No Sanction} + (1 - \lambda) \mathcal{W}_{F,NS}^{No Sanction}$$

Table 4 presents welfare losses and changes in GDP per capita in Home, Foreign, and RoW under sanctions. Panels A and B provide the numbers under individual and combined sanctions, respectively. As expected, sanctions generate welfare losses in the sanctioning and the sanctioned economies. Because of Home's larger size, welfare loss and the fall in GDP per capita are smaller than in Foreign under all scenarios.

The difference between coordinated and uncoordinated scenarios highlights the importance of international coordination in sanctions in Table 4. Coordinated sanctions result in significantly greater welfare losses in Foreign in comparison to unilateral sanctions. In most cases, coordination dampens the Home's negative effect of sanctions. The required rebalancing of the Home economy in response to sanctions is smaller when RoW joins sanctions (see the section above). This translates into smaller welfare and GDP losses in Home under sanctions when RoW joins. On the other hand, uncoordinated sanctions result in little welfare loss for RoW while simultaneously increasing its GDP per capita. Joining sanctions always come at a cost for RoW, both in terms of welfare and GDP.

The effects of coordinated versus uncoordinated sanctions differ more in Foreign than in the Home. In particular, under gas sanctions, the impact of coordinated sanctions against Foreign is more than double the impact of uncoordinated sanctions. This is due to the fact that the foreign economy is gas-intensive and dependent on gas exports because of the small size of the Foreign country and its comparative advantage in the gas sector.

In Panel C of Table 4, we evaluate welfare and GDP changes under a model version that does not allow the export cutoff to move in response to sanctions (labelled "alternative trade sanctions"). To be more precise, we only assume an invariant export productivity cutoff (lower bound) for the country (or countries) that impose(s) sanctions. Under the model with alternative trade sanctions, the collapse in trade is more significant due to the limit on exporter entry, and therefore the resource allocation in each country is stronger. Hence, we observe greater welfare losses and a more significant drop in the GDPs of all regions vis-a-vis the outcome from the baseline model.

6. Conclusions

The global economy is now significantly hampered by geopolitical conflicts. Geopolitical tensions are now seriously hindering the world economy. The world economy is now significantly hampered by geopolitical turmoil. Geopolitical tensions are currently posing a significant challenge to the global economy. Geopolitical conflicts are now seriously

impeding global economic growth.

In this essay, we add to the understanding of how economic sanctions impact macroeconomic aggregates, welfare, and relative prices across borders. We calibrate a three-country, two-sector model of the global economy in which one sanctioning bloc—the European Union, the United Kingdom, and the United States—targets Russia with trade and financial sanctions while a second bloc—China, India, and Turkey—does not. In our calibrated model, changes in producer entry into domestic and export markets, sectoral reallocation, and real exchange rate fluctuations are key factors in the transmission of sanctions. To evaluate the success or failure of sanctions, exchange rate fluctuations are not a reliable metric. The way economies rebalance themselves in response to sanctions by distributing resources among sectors determines the direction of the exchange rate's movement.

The calibrated model's welfare analysis reveals that coordination with the third bloc almost doubles Russia's welfare losses when sanctions are implemented. The detrimental effects of sanctions on Western nations are also lessened when they are implemented in a coordinated manner. Coordination is expensive for the third bloc, though, due to the lost benefits from substitution when sanctions are only imposed by the West. This demonstrates the value of and difficulty in coordinating sanctions across nations.

Future work will see us expanding our analysis in a number of different directions. Studying sanctions with uncertain, state-dependent durations and the endogenous selection of the best set of sanctions and policy responses will be particularly crucial. setting that is specifically game theoretic.

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Appendix A.

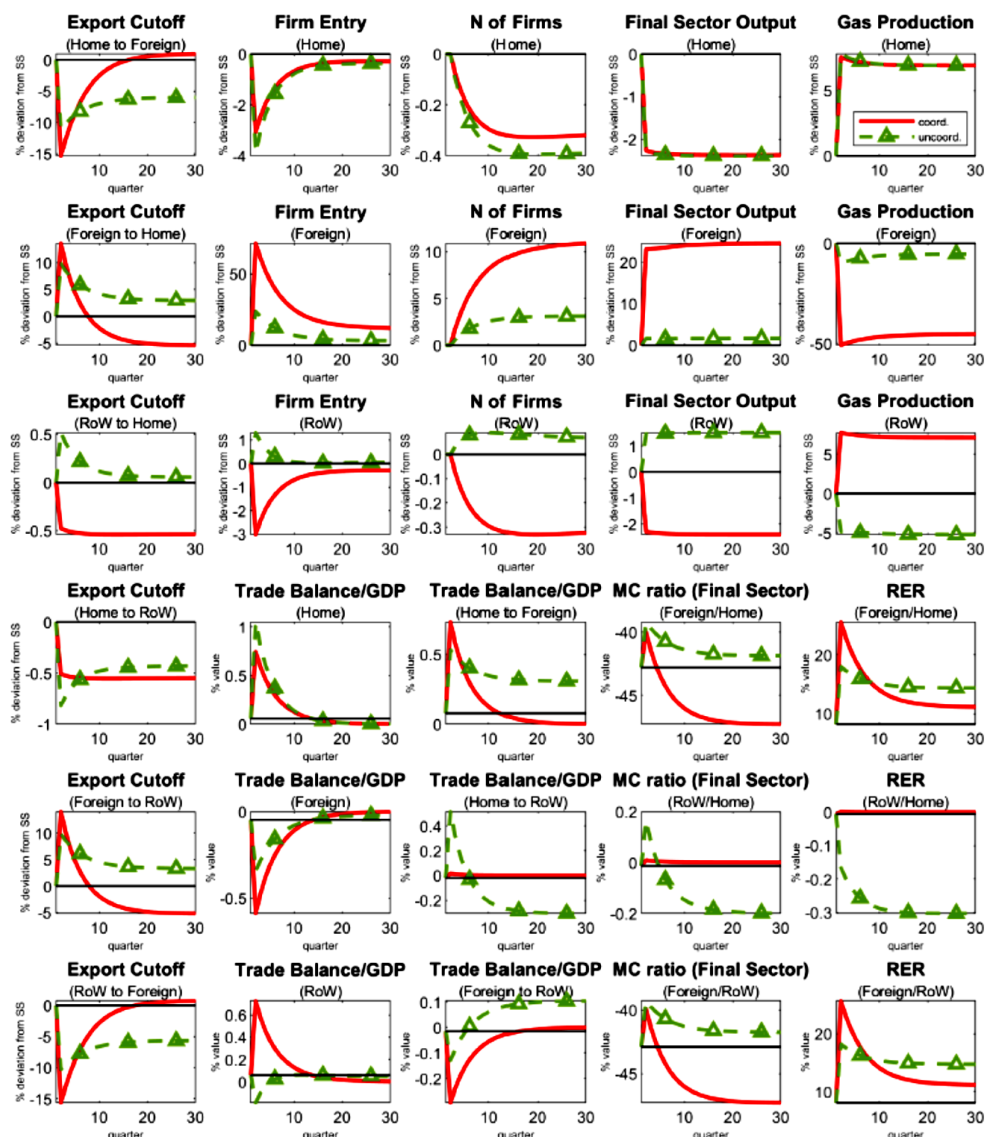


Figure A1: Transition Dynamics after the (Un-) Coordinated Sanctions: Extensive Margins and Other Variables

Notes: The red solid lines (labelled *coord.*) plot the model transition dynamics when all sanctions are imposed by Home and RoW at $t = 1$. The green dashed lines (labelled *uncoloured.*) with triangles plot the model transition dynamics when all sanctions are imposed by Home at $t = 1$, however, RoW does not participate in them. All deviations except for the figures of ratio variables are in units of percent deviation from the initial steady state without sanctions ($t = 0$). The figures of ratios, titled *Trade Balance/GDP*, *MC ratio (Final Sector)* and *RER*, are in units of percent deviation from one, i.e., $100 * (x - 1)$. See Appendix Figure 6 for the other variables' responses.

APPENDIX B.

The effects of European Leaders' policies on its economy in dealing with the Russian invasion

Economic sanctions are a well-liked tactic for pressuring other governments into altering their stances. According to a plethora of empirical data, sanctions can harm target nations significantly. They result in a decline in GDP per capita and its primary constituents, particularly private investment, consumption, and trade. For economic sanctions to be effective, these costs must be incurred. It is debatable whether sanctions can be regarded as effective in terms of consistently achieving the senders' goals. Additionally, empirical studies currently available suggest that sanctions may result in serious collateral damage because they negatively impact every area of population development in the target country and their civil and political rights are undermined.

This is especially troubling because sanctioned governments frequently lack democratic legitimacy. Economic sanctions do not necessarily need to be avoided, though, as this does not follow automatically. Countries are frequently subjected to sanctions to put an end to wars, stop the violation of human rights, or re-establish democracy. It is debatable whether the negative effects of sanctions will be worse than what will happen to the population if the international community does nothing. For instance, many believe that Russia's 2022 invasion of larger portions of Ukrainian territory, which could result in hundreds of thousands of deaths, was encouraged by the Western nations' measured response to Russia's occupation of Crimea in 2014. Furthermore, sanctions could provide a less harmful option to military conflict if governments are planning to intervene.

The policies pursued by European politicians are very clear they didn't have the slightest idea of the economic impact on their countries. Meantime could slip their countries into a direct encounter with the most dangerous possible war. We will review the economies of the European region after the Russian invasion and the sanctions imposed.

The conflict between Russia and Ukraine poses a risk to the recovery of Europe's economy. Rising energy prices and trade disruptions could exacerbate the effects of the pandemic on EU businesses, making them unstable. Additionally, according to the European Investment Bank's (EIB) economic models, more Europeans may experience poverty as a result of rising inflation. As opposed to the 4% estimate made by the European Commission before the war, real economic growth in the European Union is now projected to be below 3% in 2022. Additional trade disruptions or more severe economic sanctions would raise the risk to the

European economy in the event of a recession.

These are some of the main conclusions of a recent EIB report titled *How bad is the Ukraine war for the European recovery?* The new report examines the economic shock of the war and its effects on people, businesses, banks, and governments.

When the war started, the COVID-19 impact recovery of the EU economy was barely underway. EIB Vice President Ricardo Mourinho Félix said that "increased uncertainty and higher food, commodity, and energy prices are having an impact on investment and inclusive and sustainable economic development.". To keep the economic effects of the war to a minimum, public policy must be kept well-coordinated. Additionally, it will deliver a crystal-clear message to the markets, reducing uncertainty and the likelihood of a new recession. To ensure a clean and sustainable recovery and promote inclusive growth, the EIB Group is prepared to offer long-term financing at favourable rates. ”.

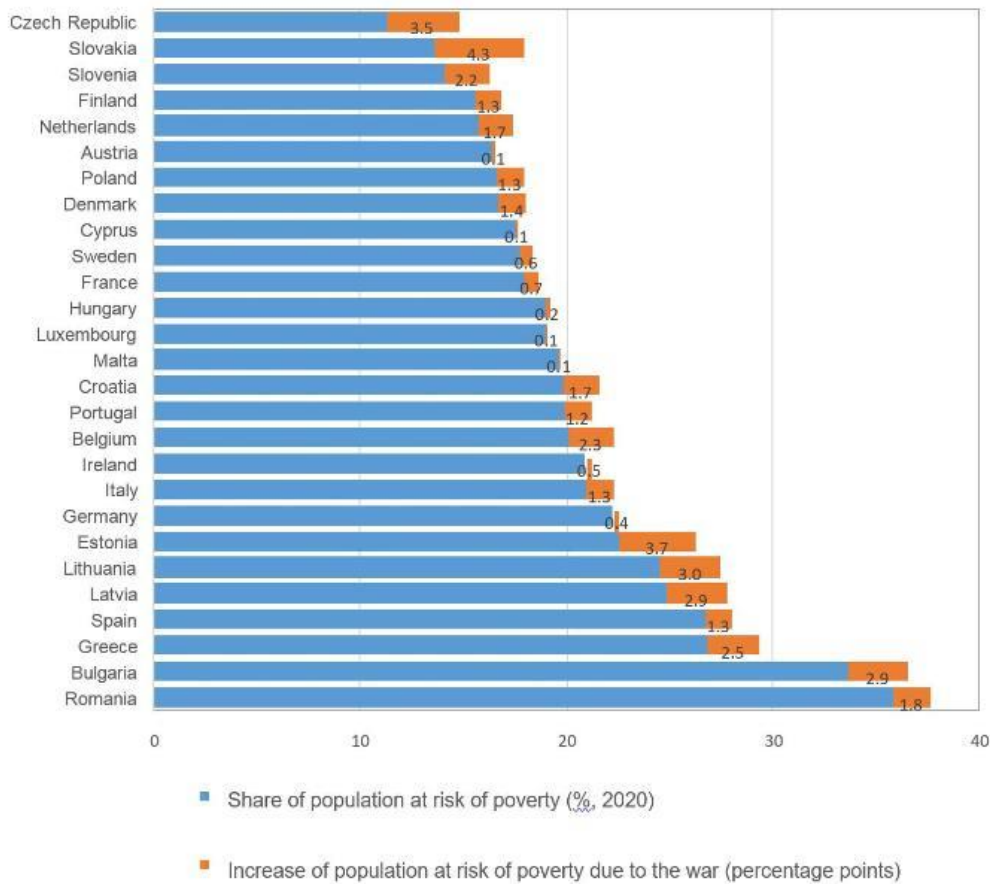
Businesses in the EU that have already been weakened by the pandemic face new threats from inflation and rising energy prices. According to our models, the proportion of firms that face a default risk will increase from 10% to 17% in a single year. Therefore, according to Debora Revoltella, chief economist at the EIB, whose team produced the report, we must put in place distinct policies to protect businesses and guarantee that public investment is fully utilized to catalyse private investment.

More households will be at risk of poverty, which will have different effects both at home and abroad.

Though the effects will vary by nation, inflation brought on by the war may result in a 1% decline in private consumption across the European Union. The effects will be more noticeable in nations with large populations at risk of poverty and where consumption is more susceptible to changes in energy and food prices. Most of the nations affected are located in Central and Southeast Europe.

Low-income households will be disproportionately impacted by price increases for food and energy, despite variations in severity across EU Member States. Due to higher savings rates and average incomes compared to households in Central and South-Eastern Europe, lower-income households in the wealthier nations of Northern and Western Europe are better able to withstand the price increase.

Figure B1: Price rises to increase the share of people at risk of poverty
 (% of people at risk of poverty for 2020 and increase in percentage points)



Source: EIB projections. Reported in per-cent, the percentage of the population at risk of poverty refers to the year 2020. The percentage points represent the growth brought on by the war.

The COVID-19 crisis was a time when preventing poverty required the implementation of policy initiatives. In order to maintain social inclusion and lower risks for vulnerable households during the current crisis, policies must be put into action.

Businesses in the EU are exposed to new risks as a result of the war's environment.

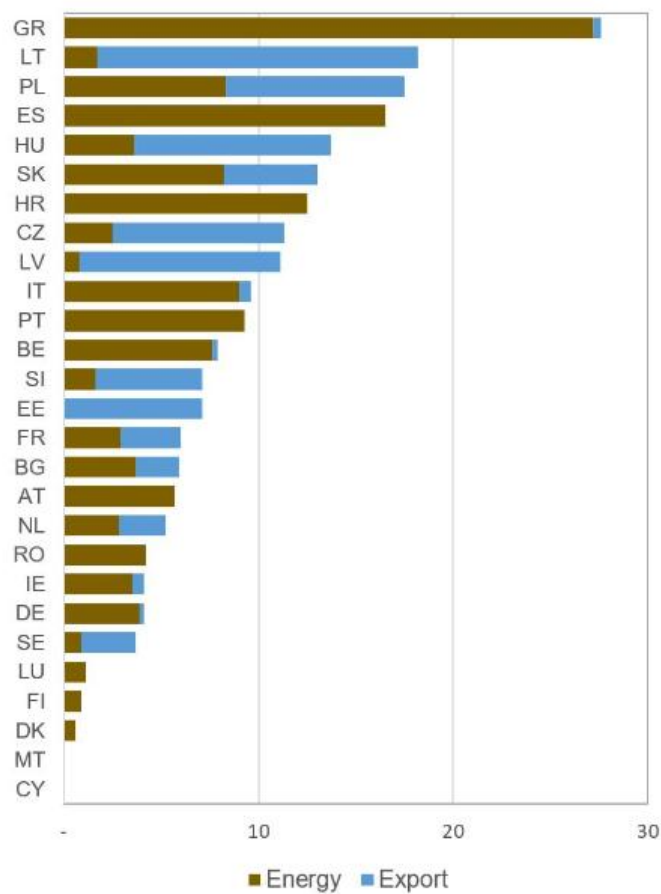
The COVID-19 crisis hurt EU companies, particularly smaller ones. Concerns about their resiliency in the face of declining policy support were present already. Three different ways exist for how the war will make businesses more vulnerable.

- (1) A decline in exports.
- (2) Lower revenue due to rising energy prices.
- (3) A challenge in obtaining financing because banks are risk-averse.

The EIB's simulations at the firm level show that over the course of a year, the percentage of

businesses experiencing losses will rise from 8% to 15%, while the percentage of businesses experiencing default will increase from 10% to 17%. The industries that have been most severely impacted include those in the food and agricultural, transportation, and chemical and pharmaceutical sectors. Companies in nations like Hungary, Poland, Latvia, and Lithuania that are nearer to Russia and Ukraine will feel the pressure. Companies in Greece, Croatia, and Spain will also suffer more than the average business in the EU.

Figure B2: An increase in the percentage of businesses reporting losses.



Source: EIB estimates.

Pressure is on the banks.

Banks should be relatively unaffected, but businesses may have more difficulty accessing outside sources of funding. The European banking system has little direct exposure to Ukraine, Russia, and Belarus, with a few exceptions. These banks have improved their capital reserves, though, so that they can withstand having some of their assets in Russia and Ukraine written down. The region of Central, Eastern, and South-Eastern Europe in particular has seen

a tightening of credit standards despite this.

The economic circumstances of EU members are probably going to get worse.

Spending may go up as countries take in refugees, implement redistributive measures to help households deal with rising energy costs, and increase military spending. Revenue will likely be less than expected due to the slowdown in economic activity and the upcoming increase in military spending. Budgets in EU countries bordering Ukraine and the Baltics are expected to be most impacted overall. Using money from the Recovery and Resilience Facility may give Governments financial flexibility