The Unintended Consequences of Financial Sanctions

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Abstract

This paper examines the economic impact of the U.S. financial sanctions against Russian companies in the aftermath of Russia's 2014 annexation of Crimea. It shows that this sanctions program, which primarily cut off sanctioned firms' access to international financial markets, produced the unintended consequence of strengthening the sanctions targets relative to their unsanctioned peers. Specifically, while the policy successfully halted new international borrowings by sanctioned companies, the spillover impact of the policy resulted in these targets shrinking in size by *less* than unsanctioned Russian firms. To explain these results, I argue that sanctions led to a reallocation of domestic resources in favor of sanctioned firms. I present a heterogeneous firm model with segmented capital markets and a borrowing constraint in which sanctions against international borrowers led to capital crowding out and credit rationing among domestic borrowers. This research highlights the limitation of targeted sanctions, identifies factors for policymakers to consider in calibrating future programs, and analyzes policy alternatives. It also offers insights for the 2022 sanctions and sheds light more broadly on the impact of international financial integration and capital flows on firm size dynamics.

Keywords: Credit Rationing, International Currency, International Financial Integration, Russia, Sanctions, Segmented Capital Markets
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1 Introduction

Against the backdrop of rising geopolitical tensions, financial sanctions have emerged as an important tool of economic statecraft.[1] Analogous to trade sanctions which restrict the exchange of goods and services with the targets, financial sanctions restrict the targets' access to international capital. The policy relies on the segmented nature of domestic versus international capital markets, presumes the benefits of foreign market access, and ventures that a large country such as the United States can leverage its dominance in global finance to dictate agents' access to foreign capital (Maggiori [2022], Clayton, Maggiori and Schreger [2023]). The recent extensive use of financial sanctions by the United States and many western nations in response to Russia's invasion of Ukraine in 2022 and its annexation of Crimea in 2014 has raised the need to better understand sanctions mechanisms and its effectiveness. More broadly, financial sanctions episodes could also offer a glimpse into how firms and countries access international capital markets and what happen when they lose such access.

This paper seeks to understand how financial sanctions work by studying a specific sanctions episode: the U.S. financial sanctions on Russian companies after the annexation of Crimea in 2014. This program, which prohibits U.S. investors from extending long-term financing to specific Russian firms, is one of the largest sanctions programs on major economies thus far.[2] The targeted nature of the policy also makes this sanctions episode ideal for an event study to identify the causal effects of sanctions on targeted versus untargeted firms. Additional, an estimate of the relative impact of sanctions would also allow me to quantify the aggregate impact of the policy—or financial autarky more generally—and offer insights for future policy designs.

The empirical analysis in the study reveals that this sanctions program produced the unintended consequence of strengthening the sanctions targets relative to their unsanctioned peers. Specifically, while the policy yielded the intended *direct* effect of halting new international borrowings by sanctioned companies, it also produced an inadvertent *indirect* effect in which sanctioned companies shrank in size by *less* than unsanctioned Russian firms—on average by 29%. The spillover impact of the U.S. sanctions has essentially rendered the Russian economy more reliant on sanctioned companies, a consequence that presumably ran counter to U.S. policymakers' intention.

To explain these results, I argue that sanctions precipitated a reallocation of domestic resources in favor of sanctioned firms. In particular, the policy drove the crowding out of, and credit rationing to, unsanctioned firms in the domestic capital market. Prior to sanctions, the Russian economy consisted of a handful of soon-to-be-sanctioned firms that borrowed cheaper funds abroad and

[1] Based on the Global Sanctions Data Base (GSDB) (Felbermayr et al. [2020] and Kirilakha et al. [2021]), there have been 1,101 sanctions programs implemented by 145 sanctioning countries since the end of World War II. Among these, 549 programs involved financial sanctions, 409 involved trade sanctions, and 621 involved other sanctions approaches (arms, military, travel, and other).

[2] For comparison, total revenues of sanctioned Russian firms (including interest income of sanctioned Russian banks) amounted to approximately $633 billion. Another major sanctions program during this time was against Iran, which had a GDP of $493 billion in 2013.

a large number of unsanctioned firms that borrowed domestically. As sanctions forced target firms to borrow in the domestic market, increased reliance on domestic capital raised the domestic interest rates and created a spillover impact on unsanctioned domestic borrowers. While this spillover impact alone would still have resulted in sanctioned firms shrinking by more than their unsanctioned peers given greater increases in the costs of capital of the former versus the latter, the higher domestic interest rates also induced domestic investors to allocate capital in favor of sanctioned firms and away from unsanctioned ones. Domestic investors did so because they viewed sanctioned firms to be higher-quality borrowers, especially in the face of heightened economic risks, potentially given their larger sizes and their significance in the Russian economy. This resulted in credit rationing to unsanctioned firms and ultimately in these firms shrinking by more than their sanctioned counterparts.

These outcomes ultimately shows that sanctions targets did not bear the brunt of sanctions burden. The spillover effect shifted the sanctions burden to smaller and less productive domestic borrowers that suffered severe credit rationing. These results also highlight the *intensive* margin of sanctions impact on domestic capital allocation. In particular, sanctions exacerbate the misallocation of domestic resources by shifting resources away from more productive sanctioned firms to other less productive firms in the economy. This is different from the *extensive* margin of sanctions impact arising from the deprivation of foreign resources. Both of these mechanisms are relevant not only for the 2014 program but also for other sanctions episodes as well, including the one in 2022. In a broader context, the study also sheds light on the costs and benefits of international market access given that sanctions have the direct effect of removing such access (Midrigan and Xu [2014], Gopinath et al. [2017], Bau and Matray [2020]). Even though sanctions capture only such removal by the United States as the international currency issuer, understanding the effects of this policy could help us understand global capital market integration more generally.

The empirical analysis in this paper utilizes a novel data set developed from multiple data sources. I extract the list of U.S. sanctions actions from publicly available data from OFAC; firm-level data from Bureau van Dijk's Orbis, FactSet, and companies' financial reports; and debt issuance data from Refinitiv SDC Platinum and FactSet. My sample includes Russian companies and Russian operations of foreign companies; therefore, my study observes the relative impact of sanctions within the Russian economy. With this data set, I use a difference-in-differences approach to analyze the impact of sanctions on the targets relative to other unsanctioned firms. For the *direct* effect of sanctions on international borrowings, I find that while external and foreign-currency borrowings—especially those in the G10 markets and the G10 currencies—by unsanctioned firms have declined after the sanctions program started in 2014, such borrowings by sanctions targets came to an immediate and complete stop, barring very few exceptions.[3] For the *indirect* effect

[3]I classified firms' borrowings into G10 versus non-G10 market/currency borrowings because in concert with the United States, the European Union and several U.S. allies (henceforth all together classified as "G10" countries) also imposed sanctions against Russia that were closely similar to the U.S. actions. Section 2 discusses sanctions by other countries in more detail.

of sanctions on firm sizes, I find that, on average, sanctioned firms shrank by 29% *less* than unsanctioned firms in terms of assets. In other words, sanctioned firms surprisingly *expanded* relative to their unsanctioned peers as a result of the U.S. policy.

My analysis rests on two key identifying assumptions. The first is the parallel trend, which requires that sanctioned and unsanctioned firms would have progressed similarly had sanctions not been imposed. Confining my sample to firms operating in the Russian economy, I minimize the potential confounding impact of macroeconomic shocks that could affect firms across different countries differently. I also confirm parallel pre-trends and conduct several robustness tests controlling for firm characteristics including firm sizes, industries, and state connections. The second assumption is that firms did not anticipate the sanctions or react preemptively. The short interval between the initial move by the Kremlin to annex Crimea and the first round of sanctions by the United States offered little room for anticipatory reaction by Russian firms.[4] The evaporation of foreign borrowings by the targets post 2014, even though some firms were explicitly sanctioned later, also eases the concern that target firms might have raised foreign financing in anticipation of impending sanctions and hence survived them less scathingly. These assumptions allow me to identify the reduced-form causal effect of sanctions on firm outcomes.

To explain the indirect effect of sanctions on firm sizes, I examine the allocation of domestic capital post sanctions and find that sanctioned firms increased their domestic borrowings relative to their unsanctioned peers. This, coupled with limited capital raising by Russian companies in non-sanctioning markets and currencies (such as borrowings from Chinese banks or in the Chinese renminbi), point to an increased reliance on domestic capital with sanctioned firms securing more allocations. Furthermore, based on hand-collected annual reports of major sanctioned banks, I find that these banks played a crucial role in prioritizing credit to larger and more resilient borrowers, many of which were sanctioned firms. I also explore other potential explanations including the potential Kremlin's support to firms, the spillover through the supply chain channel, the impact from concurrent macroeconomic shocks, and the exchange rate revaluation effect, and I determine that while other factors contribute partially to the results, none can explain all the outcomes. Ultimately, I conclude that the reallocation of domestic capital in favor of sanctioned firms driven largely by the market incentives led to the unintended consequences of the policy.

Next, I formalize this mechanism with a heterogeneous firm model with entry into international capital markets. Adapting elements from Melitz [2003], Neumeyer and Perri [2005], and Crouzet and Mehrotra [2020], I show that the interaction between size/productivity dynamics in segmented capital markets and the borrowing constraint leads to the unintended consequences of the policy. At the aggregate level, the model also reveals that sanctions hurt the Russian economy by exacerbating an inefficient allocation of productive assets, and I estimate that the policy impaired the welfare of Russian households by approximately one percent. Additionally, I apply the quantitative model to

[4]Russia's annexation of Crimea started in late February 2014, and the first executive order authorizing sanctions based on this situation was signed by President Obama on March 6, 2014 (EO 13660).

evaluate alternative sanctions approaches. To the extent policymakers seek to minimize the spillover impact, they may levy foreign-borrowing surcharges on, or impair the productivity of, sanctions targets. Conversely, if policymakers aim to inflict the most damage to the target economy, raising foreign interest rates for all international borrowers in the economy—for instance, by forcing a sovereign default by the target government—is the most effective.

This paper is the first to explore the spillover effect of targeted sanctions and to reveal that the U.S. sanctions program on Russia might have inadvertently "missed its targets." Ultimately, the paper offers three contributions. First, the direct effect of sanctions confirms the power of the United States to exclude agents from international financial markets and inflict damage on its adversaries. This arises from global reliance on the U.S. dollar and the dollar-based financial system. Second, targeted sanctions can produce spillover effect that runs counter to policymakers' intention in some cases. For the 2014 episode, sanctions have inadvertently bolstered target firms relative to their peers and made the Russian economy more reliant on sanctioned companies and ultimately on the Kremlin. Should the United States be concerned with the spillover effect, as I argue in Section 7 that it should be, future sanctions require calibration that takes into account the degrees to which credit rationing can occur. Conversely, if policymakers seek to maximize damages on the target economy, as with the 2022 episode, the spillover effect could in fact work in their favor. Third, while sanctions may prove effective in harming the targets in the short run—albeit with spillover effect—the model suggests that over time, the economy adjusts to a new equilibrium that defuses the sanctions impact and stands more resilient to subsequent sanctions of the same fashion. The Russian economy, for example, has become less reliant on foreign capital since 2014, which leaves fewer potential targets available for financial cutoff in the 2022 sanctions round.

Finally, although this study focuses on sanctions, it also sheds light on the impact of foreign capital flows on domestic economies more generally. Conceptually, sanctions are equivalent to the reverse of financial liberalization. Supposing the impacts of capital inflows and outflows are equivalent but reciprocal, the unintended consequences of financial sanctions suggest that small domestic borrowers may benefit more from financial liberalization even though such firms do not directly have access to foreign capital. This is because foreign capital inflows to large international borrowers create a spillover impact on other firms and ease domestic financial constraints. The easing of domestic financial frictions in turn alleviates the inefficient allocation of domestic resources. Foreign capital inflows hence not only add capital to the domestic economy but also produce distributional and efficiency consequences.

Related Literature. My paper contributes to the burgeoning literature on sanctions by studying the effect of financial sanctions, documenting their unintended consequences, and explaining the results through capital crowding out and credit rationing. Prior to Russia's invasion of Ukraine in 2022, the literature on the economic impact of sanctions has been limited. The central role of sanctions to deter and punish Russia for its aggression in 2022 has since spurred the literature on

the topic (Bachmann et al. [2022], Balyuk and Fedyk [2022], Bianchi and Sosa-Padilla [2022], Hausmann [2022], Itskhoki and Mukhin [2022], Lorenzoni and Werning [2022], Sturm et al. [2022]).[5,6] Nevertheless, these studies analyze the implications from trade sanctions and reserves restrictions, while I focus on financial sanctions that entail cutting off access to international financing. Ahn and Ludema [2020] also study the 2014 sanctions episode, but they compare the performance of sanctioned Russian firms against their unsanctioned peers including foreign companies. In contrast, my study looks at the heterogeneity within Russia, which allows for credible causal identification. In complementary work, Nigmatulina [2021] studies the effect of sanctions on the (mis)allocation of resources within Russia. Whereas I emphasize how a reallocation of large sanctioned firms borrowing to the domestic market worked to crowd out unsanctioned domestic borrowers, her focus is on the role of the state's reallocation of resources in response to sanctions.

More broadly, my paper is related to the literature that studies interaction between domestic economies and international financial markets. I explore the interplay between international and domestic financing constraints, similar to Caballero and Krishnamurthy [2001, 2002]. I contribute to this literature by studying such interaction in the heterogeneous firm context. In my model, sanctions-induced financing constraints on international borrowers impaired the target economy by tightening the borrowing constraints of domestic borrowers through capital crowding out and credit rationing (Stiglitz and Weiss [1981], Petersen and Rajan [1994], Chakraborty et al. [2018], Huang et al. [2020], Chodorow-Reich et al. [2021]). My discussion on the firm size dynamic also explores capital allocation across firms and how such allocation is affected by financial frictions (Gertler and Gilchrist [1994], Moll [2014], Gopinath et al. [2017], Begenau and Salomao [2019], Bau and Matray [2020], Crouzet and Mehrotra [2020], Ottonello and Winberry [2020]).

Conceptually, the United States' power to impose sanctions relies on the dominant roles of the U.S. dollar in international trade and finance (Farhi and Maggiori [2018], He et al. [2019], Maggiori et al. [2019],Gopinath and Stein [2021], Drenik et al. [2022], Choi et al. [2022]). Such reliance enables the United States to limit dollar funding to sanctions targets, thereby limiting their international market access. This is also linked to the "exorbitant privilege" of the United States (Gourinchas and Rey [2007], Gourinchas et al. [2010], He et al. [2019]), which features investor preference for dollar-based assets and hence the low cost of dollar borrowings. I contribute to this line of literature by reaffirming the dollar dominance through evidence of the direct effect of sanctions and the lack of competition from alternative international currencies. The broader insight from this research on the impact of foreign capital flows is also related to the literature on financial liberalization (Laeven [2003], Forbes [2003], Gupta and Yuan [2009]), international financial integration (Gourinchas and

[5]On the other hand, political scientists have long debated the effectiveness of sanctions. However, they focus on measuring political outcomes rather than economic impacts, and they rely on aggregate statistics, while my paper utilizes firm-level data for identification. See Hufbauer et al. [1990], Pape [1997], Morgan and Schwebach [1997], Baldwin [1999], McLean and Whang [2010]) and best approaches to the policy (Cortright and Lopez, eds [2002], O'Sullivan [2003], Kaempfer and Lowenberg [2007], Bapat and Morgan [2009], Drezner [2011], and Bapat et al. [2013], for example.

[6]There are also papers that study the effects of sanctions in Iran, including Draca et al. [2018] and Ghasseminejad and Jahan-Parvar [2019].

Jeanne [2006], Hoxha et al. [2013], Coeurdacier et al. [2020]), sudden stops, and capital controls (Lorenzoni [2008], Korinek [2010], Mendoza [2010], Bianchi [2011], Jeanne and Korinek [2019], Benigno et al. [2013]). Finally, sanctions are a tool of geopolitics and presume a translation of economic results into political consequences, and this notion is linked to the literature that relates geopolitics and political institutions with economic outcomes (Aguiar and Amador [2011], Acemoglu et al. [2011], Funke et al. [2020], Clayton et al. [2023]).

The rest of the paper is organized as follows. Section 2 provides background information on the U.S. sanctions on Russia that started after the 2014 Russian annexation of Crimea. Section 3 describes the data and methodology for the analysis. Section 4 presents the empirical results, and Section 5 offers an explanation of the results. Section 6 formulates a model to explain the mechanism and quantify the impact. Section 7 discusses policy implications and evaluate policy alternatives, and Section 8 concludes.

2 Background Information on the U.S. Sanctions on Russia

Sanctions represent a central element of U.S. policy toward Russia. In the wake of Russia's annexation of Crimea in February 2014, President Obama issued a series of executive orders (EOs) that authorized sanctions on individuals and entities responsible for the aggression against Ukraine.[7] The policy aimed to "increase Russia's political isolation as well as the economic costs to Russia, especially in areas of importance to President Putin and those close to him" (White House [2014b]). Rather than adopting a country-wide embargo, the United States employed *targeted sanctions* on Russia to "focus pressure on bad actors and create clear incentives to end malign behavior, while limiting collateral impact" (Lew [2016]).[8] In fact, targeted (or smart) sanctions have become modus operandi for the U.S. sanctions policy, as traditional *comprehensive sanctions* are viewed as inflexible, incurring disproportionate costs on innocent civilians, and ultimately ineffective.[9] The following remark by Jacob Lew, the U.S. secretary of the treasury at the time the policy was

[7] Sanctions related to Russia's invasion of Ukraine in 2014 are based on national emergency authorities granted to the office of the president in the National Emergencies Act (NEA; P.L. 94-412; 50 U.S.C. 1621 et seq.) and the International Emergency Economic Powers Act (IEEPA; P.L. 95-223; 50 U.S.C. 1701 et seq.) and initially exercised by President Obama through four executive orders: EO 13660 (March 6, 2014), EO 13661 (March 16, 2014), EO 13662 (March 20, 2014), and EO 13685 (December 19, 2014). Subsequently, Congress passed and President Obama signed into law two acts establishing sanctions in response to Russia's invasion of Ukraine: the Support for the Sovereignty, Integrity, Democracy, and Economic Stability of Ukraine Act of 2014 (SSIDES; P.L. 113-95/H.R. 4152) and the Ukraine Freedom Support Act of 2014 (UFSA; P.L. 113-272/H.R. 5859). In 2017, Congress also passed and President Trump signed into law the Countering Russian Influence in Europe and Eurasia Act of 2017 (CRIEEA; P.L. 115-44/H.R. 3364, Countering America's Adversaries Through Sanctions Act (CAATSA), Title II), which codified Ukraine-related and cyber-related EOs, strengthened sanctions authorities initiated in Ukraine-related EOs and legislation, and identified several new targets for sanctions. The legislation also established congressional review of any action the president takes to ease or lift any sanctions. See Office of Foreign Assets Control [2016] and Congressional Research Services [2020] for more details.

[8] The United States also imposed comprehensive restrictions on economic investment and trade with the Crimea region.

[9] See Weiss [1999], Cortright and Lopez, eds [2002], Brzoska [2003], Staibano and Wallensteen, eds [2005] for a discussion on targeted sanctions as a preferable approach.

implemented, best describes the approach and objective of the U.S. sanctions on Russia:

> "We moved quickly to impose sanctions on key officials and entities linked to the crisis in Ukraine, with a particular focus on the inner circle of Russia's leadership and associated companies. ... [We] sought out asymmetries ... where sanctions would have the smallest possible spillover effects on us, our allies, and the Russian people." (Lew [2016])

Responsible for policy implementation, OFAC imposes sanctions by adding individuals and entities to sanctions lists. In the case of Russia, there are primarily two sanctions lists: (a) the Specially Designated Nationals and Blocked Persons (SDN) list and (b) the Sectoral Sanctions Identifications (SSI) list. SDN sanctions—also called "blocking sanctions"—impose asset freezes, travel bans, and restrictions of all trade, financial transactions, and other activities with a U.S. person on individuals and entities on the SDN list. Individuals and entities on the SSI list, on the other hand, face limitations on long-term financing (EO 13662, Directives 1–3) or provisions of goods, services, or technology in support of oil & gas exploration and production by U.S. persons (EO 13662, Directive 4). Note that despite its name, sectoral sanctions target specific companies rather than all companies within a sector. Essentially, SDN sanctions are equivalent to trade and financial autarky, whereas SSI sanctions are equivalent to financial autarky only.

In selecting the sanctions targets, OFAC followed the criteria set forth by the EOs.[10] Initially, this included persons who the secretary of the treasury, in consultation with the secretary of state, deemed to be involved in the aggression in the Crimean region or to constitute a threat to the national security and foreign policy of the United States (EO 13660). The list comprised "named officials of the Russian government, any individual or entity that operates in the Russian arms industry, and any designated individual or entity that acts on behalf of, or that provides material or other support to, any senior Russian government official," many of which were pinpointed by the White House (White House [2014a]). Subsequently, the criteria were expanded to include entities operating in certain sectors of the Russian economy—specifically financial, energy, and defense and related material sectors—that either assisted or supported, or were owned or controlled by, a sanctioned person (EO 13662). Entities that met these latter criteria were added to the SSI list and generally included major companies in the specified and related sectors with leadership connection to Vladimir Putin.[11] Besides being explicitly added to the sanctions lists, an entity is also subject to sanctions if it (a) facilitates a significant transaction for or on behalf of a sanctioned person, or (b) is 50% or more owned by a sanctioned person.

[10] White House [2014a] provides a broad description of sanctions targets according to the criteria set forth by EO 13660, EO 13661, EO 13662, and EO 13685.

[11] Not all major companies within the specified sectors were added to the same sanctions lists. For instance, while Rosneft, the second-largest energy company in Russia, is subject to sectoral sanctions under both Directive 2 (limitation on long-term financing) and Directive 4 (limitation on other non-financial services), Gazprom, the largest energy company in Russia, is subject to sectoral sanctions under Directive 4 only; in other words, Gazprom can still obtain foreign financing. Also, although the sanctions criteria only name certain sectors, sanctioned firms in my sample span across almost all sectors of the economy. Appendix Table F.1 reports the number of sanctions actions by industry.

On March 20, 2014, Bank Rossiya became the first Russian company to be added to the SDN list in connection with the crisis in Crimea for "providing material support to Russian government officials ... [and] being controlled by designated inner circle member Kovalchuk" (U.S. Department of the Treasury [2014]). On July 16, 2014, OFAC added the first wave of companies to the SSI list, including some of the largest Russian firms, such as Novatek, Rosneft, VTB Bank, and Vnesheconombank. Over the next few years, more companies were added to both the SDN and SSI lists, with most additions occurring in 2015 and 2016, as shown in Figure 1. Based on my sample, targets that were added to the sanctions lists in 2014 and 2015 were generally larger, presumably because OFAC identified obvious targets first.[12] In aggregate, OFAC has explicitly imposed 415 sanctions actions between 2011 and 2020, 365 of which were related to Russia's annexation of Crimea.[13,14]

In concert with the United States, several developed countries and the European Union (EU) also imposed sanctions on Russia in manners closely similar to the U.S. actions.[15] This coordination with the EU is important given that the EU is the biggest trading partner of, and the largest investor in, Russia (European Commission [2021]).[16] These combined efforts aimed to avoid leakages, simplify compliance, and produce "an even bigger bite" for the policy (White House [2014c]).

3 Data & Methodology

3.1 Data

I build a novel data set based on multiple sources. First, I extract the list of U.S. sanctions actions from publicly available OFAC data. Particularly, I parse the text archives of changes to the sanctions lists, which OFAC summarizes annually.[17] Each archive reports the type of sanctions (SSI

[12] Appendix B.8 discusses summary statistics of sanctioned companies by the year in which such companies were added to the sanctions lists.

[13] Other bases for sanctions on Russia include election interference and other malicious cyber-enabled activities, human rights abuses, chemical weapon use, weapons proliferation, illicit trade with North Korea, and support to Syria and Venezuela. I consider all sanctions in my analysis, including those unrelated to the Ukraine situation, since they imposed the same restrictions on the targets.

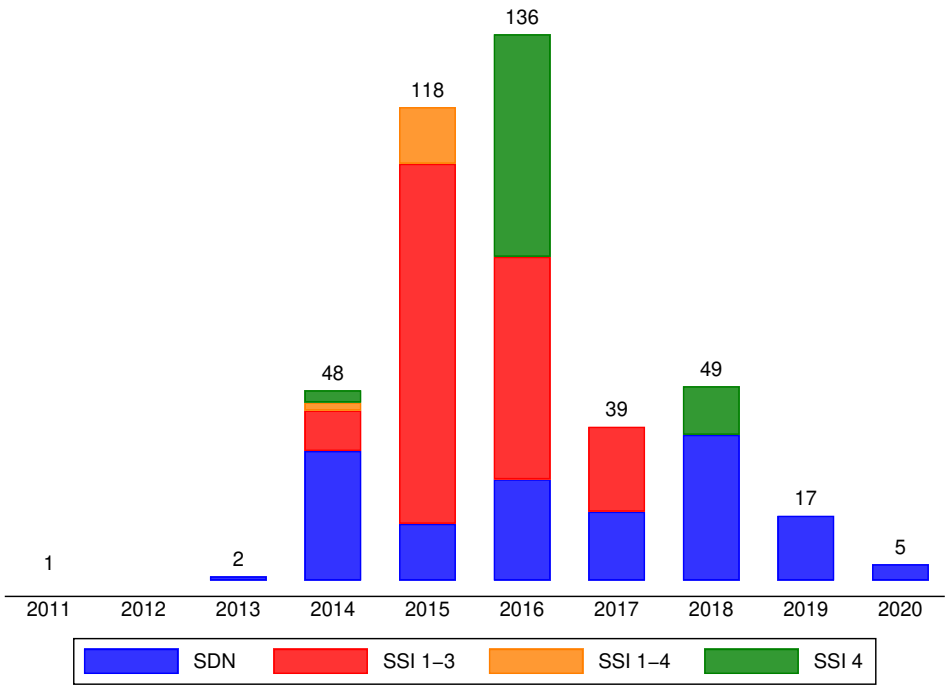
[14] Appendix Table F.1 tabulates the number of sanctions actions by sanctions type, year, and industry.

[15] For instance, the EU's *restrictive measures* on Russia were analogous to the U.S. sectoral sanctions, with only minor differences. Despite their close similarities, the United States' and the EU's actions were not identical, because the EU's measures required agreements among EU member states. One example of the difference concerns the issue of existing sales and service contracts on energy development projects. While the EU allowed for the continuation of existing contracts, the United States generally prohibited it, except for a brief wind-down period. As a result, Eni, an Italian energy company, was able to continue its partnership with Rosneft, a sanctioned Russian oil company, on deepwater exploration in the Black Sea, while ExxonMobil had to wind down its joint venture with Rosneft in 2018. See Congressional Research Services [2020] for more details. In this research, I identify sanctions actions by the United States and assume other sanctioning countries pursue identical actions.

[16] The EU accounted for 42% and 31% of Russia's export and import in 2014, respectively, per International Monetary Fund [2022a]. In 2014, the EU including (and excluding) tax havens accounted for 78% (and 23%) of total inward investment in Russia per Central Bank of Russia [2014].

[17] OFAC frequently updates the list of currently sanctioned entities posted on its website (U.S. Department of the Treasury [2022]). However, the list omits the date on which each entity was initially added to sanctions lists and excludes formerly sanctioned entities. I therefore rely on the archives of changes to collect the data.

Figure 1: Number of Russian entities added to the sanctions lists by year



Notes: This graph reports the number of Russian entities added to the sanctions lists by year. SDN denotes the Specially Designated Nationals and Blocked Persons list, which prohibits a U.S. person from all dealings with sanctioned entities. SSI 1–3 denotes the Sectoral Sanctions Identifications (SSI) list under Directives 1–3, which prohibits a U.S. person from extending medium- or long-term financing to sanctioned entities. SSI 4 denotes the SSI list under Directive 4, which prohibits the provision and exportation of goods and services (except for financial services) in support of exploration or production of deepwater, Arctic offshore, or shale projects by a U.S. person to sanctioned entities.

or SDN), the dates of modifications, the modification actions (add, remove, change), and the lists of affected entities for each type of action. Each listing entry contains the name of the sanctioned entity (and alternative names, if any), sanctions bases (for example, Ukraine-EO 13662), entity type (individual, company/organization, or vessel), and any available information about the entity, such as addresses, email addresses, tax/registration/trade identification numbers, and SWIFT code.[18] I also make available an updated list of sanctions actions by OFAC on my website[19]

[18]Below displays a sample extract from an OFAC's archive of changes to the Sectoral Sanctions List:

07/30/15:

The following [UKRAINE-EO13662] entries have been added to OFAC's Sectoral Sanctions Identifications List:

ACHINSK REFINERY (a.k.a. OAO ACHINSK OIL REFINERY VNK; a.k.a. OJSC ACHINSK REFINERY), Achinsk Refinery industrial area, Bolsheuluisky district, Krasnoyarsk territory 662110, Russia; Email Address sekr1@anpz.rosneft.ru; Executive Order 13662 Directive Determination - Subject to Directive 2; alt. Executive Order 13662 Directive Determination - Subject to Directive 4; For more information on directives, please visit the following link: http://www.treasury.gov/resource-center/sanctions/Programs/Pages/ukraine.aspx#directives. [UKRAINE-EO13662] (Linked To: OPEN JOINT-STOCK COMPANY ROSNEFT OIL COMPANY).

[19]See https://sites.google.com/view/rkeerati/data.

I rely on entities' addresses to identify that they are Russian, and I only include organizational entities in my analysis (persons and vessels are excluded).[20] To take into account the 50% ownership rule, I use the ownership-structure data from the Orbis database to identify entities that were sanctioned by association.[21] Through this process, I identify 415 Russian entities that were *explicitly* subject to the U.S. sanctions between 2011 and 2020—of which 154 were on the SDN list (prohibiting all dealings with a U.S. person); 175 on the SSI list, Directives 1–3 only (restricting access to long-term financing); 86 on the SSI list, Directive 4 only (limiting access to goods, services, and technology related to oil & gas exploration and production); and 16 on the SSI list, Directives 1–4. Appendix Table F.2 lists the 20 largest sanctioned Russian firms by assets.

For firm-level data, I rely on the Orbis database, which contains financial data for publicly traded and private firms globally. I augment the data from Orbis with data from FactSet and companies' International Financial Reporting Standard (IFRS) reports, obtained from companies' websites. My sample includes Russian companies and Russian operations of foreign companies with financial information during 2013–2016 and at least $50 million of assets as of December 31, 2013.[22] These restrictions aim to ensure that my sample includes companies with sufficient financial information during the period with most U.S. sanctions activities and excludes very small companies. Based on these restrictions, my sample consists of 8,596 companies, including 650 sanctioned companies (inclusive of subsidiaries)—representing 8% of the sample—and 7,946 unsanctioned companies.

To explore companies' financing, I obtain bond and syndicated loan issuance data from Refinitiv SDC Platinum New Issues Database (SDC) and FactSet. I classify the currency denomination of each issuance per SDC and FactSet, and I use the International Securities Identification Number (ISIN) to identify the marketplace in which each bond was issued.[23] For syndicated loans, I use the target market description per SDC to classify the marketplaces of the loans. I include (a) all ruble-denominated corporate issuances by any company; these were presumably funded by Russian investors given investors' home currency bias (Lane and Shambaugh [2010], Bénétrix et al. [2015], Burger et al. [2017], and Maggiori et al. [2020]); (b) all foreign-currency-denominated corporate issuances by Russian companies, or by entities whose ultimate parents were Russian companies, or by Russian operations of foreign companies; and (c) all corporate issuances in the Russian marketplace.[24] This scope aims to include all debt financing funded by investors or sought by companies

[20] By excluding persons from my list of sanctioned entities, it is possible that my sanctions lists may omit companies that were majority owned by sanctioned persons but not explicitly added to the sanctions lists. However, such omissions likely represent a minor concern, given that OFAC's sanctions lists generally include both the persons and the companies that were majority owned by such persons.

[21] I consider a subsidiary to be sanctioned either on the same date on which its parent became subject to sanctions if that subsidiary had been majority owned by the parent prior to that date, or on the date on which the subsidiary became majority owned by the sanctioned parent if such event happened after the parent's sanctions date.

[22] My sample also includes Russian companies that domiciled abroad, such as United Company Rusal, which domiciled in Jersey until September 2020 when it redomiciled to the Russian Special Administrative Region (SAR).

[23] An ISIN is a 12-digit alphanumeric code that uniquely identifies a specific security. The first part of an ISIN code is a two-letter country code (ISO 3166). For instance, "US" denotes securities issued in the United States, and "XS" denotes international securities cleared through pan-European clearing systems like Euroclear and CEDEL.

[24] For SDC, I include all corporate issuances for which either (a) the denominated currency is the Russian ruble,

residing or operating in Russia.

Given that companies commonly finance themselves in foreign markets through foreign subsidiaries, including shell companies in tax havens (Lane and Milesi-Ferretti [2018], Tørsløv et al. [2018], Coppola et al. [2020]), I aggregate issuances at the closest primary parents of the issuing subsidiaries.[25] Through this process, I identify 5,612 bond and syndicated loan issuances in my sample, of which 4,455 are issuances in the domestic capital market by 958 unique issuing parents and 1,157 are issuances in foreign capital markets by 216 unique issuing parents.[26]

To integrate data across databases, I manually match companies and issuers by names and key attributes, such as tax/registration identification numbers, email addresses, and website domains. I also obtain additional information from other websites and data sources to assist in the matching.[27] This process allows me to manage complexities in the data integration—such as different English spelling of Russian names, multiple companies with similar names, or multiple names for the same company—and to confirm the accuracy of my data set.

3.2 Summary Statistics

Table 1 reports summary statistics of firms in my sample. Sanctioned firms were generally larger than unsanctioned firms, with the average assets of $3.2 billion (median of $205 million) for the former and $514 million (median of $104 million) for the latter. Firm size distributions are also skewed by the presence of a few very large firms, many of which were sanctioned, such as Sberbank, VTB Bank, and Rosneft, among others.

Despite their larger sizes, sanctioned firms were comparable to their unsanctioned peers in terms of leverage, with average debt-to-assets ratios of 30% for the former and 32% for the latter. Among the approximately three-quarters of firms with positive borrowings, the average debt-to-assets ratios were also comparable at 41% for the sanctioned firms and 40% for the unsanctioned. In terms of foreign borrowings, 145 firms in my sample (36 sanctioned and 109 unsanctioned) borrowed in the G10 markets.[28] This highlights the fact that only a few large firms had access to

(b) the marketplace or the governing law is Russian, or (c) the nation of the issuing entity or the ultimate parent of the issuing entity is Russia. For FactSet, I include all corporate issuances for which the country of risk is Russia.

[25]For example, Rosneft, a Russian state-owned energy company, borrowed through Rosneft Finance SA, a Luxemburg subsidiary, and Rosneft International Finance Designated Activity Company (DAC), an Ireland subsidiary. TNK-BP, a wholly-owned subsidiary of Rosneft, borrowed through TNK-BP Finance SA, a Luxemburg subsidiary. Hence, borrowings by Rosneft Finance SA and Rosneft International Finance DAC (as well as other financing subsidiaries of Rosneft) are counted as borrowings by Rosneft, while borrowings at TNK-BP Finance SA are counted as borrowings by TNK-BP; Appendix Figure F.1 illustrates this structure.

[26]I include only debts with maturities longer than 30 days. Overnight borrowings are rolled together when possible, with balances calculated as the average borrowing amounts.

[27]For example, I extract the tax identification number of the issuer associated with each debt issuance from the Russian National Settlement Depository (NSD), accessible at https://isin.ru. This allows me to match each debt issuance with the correct issuer. If that issuer is a financing subsidiary, I then use Orbis's ownership-structure data to identify its proper operating parent.

[28]This includes firms with parents that borrowed internationally but excludes firms that borrowed in foreign currencies in the domestic market. For foreign-currency borrowings, 192 firms in my sample (42 sanctioned and 150

Table 1: Summary statistics of Russian firms

	Sanctioned firms			Unsanctioned firms		
	N	Mean	Median	N	Mean	Median
Sizes ($MM):						
Assets	650	3,166	205	7,946	514	104
Debt	650	665	34	7,946	125	24
Equity	650	733	60	7,946	200	22
Net Income	649	104	4	7,929	18	1
Balance Sheet (% of Assets):						
Debt	650	30	15	7,946	32	20
Debt (> 0)	481	41	30	6,276	40	34
External Debt (> 0)	36	10	10	109	16	9
Equity	650	33	29	7,946	27	17
Profitability (%):						
Return on Assets (ROA)	649	5	2	7,931	3	1
Return on Equity (ROE)	570	16	12	6,979	24	12
Observations	650			7,946		

Notes: This table reports summary statistics of sanctioned and unsanctioned firms in my sample as of December 31, 2013. The sample includes all Russian banks and non-banks with asset statistics during 2013–2016 and at least $50 million of assets as of December 31, 2013. Sanctioned firms include entities that have been added to either the SDN list or the SSI list, Directives 1–3. Gross amounts are in millions of U.S. dollars.

foreign capital. Nevertheless, the large sizes of these firms made the issuance amount substantial, representing 15% of all borrowings by Russian firms in my sample. In terms of profitability, the average return on assets (ROA) of sanctioned firms was slightly higher at 5% versus 3% for the unsanctioned firms, but the median return on equity (ROE) was comparable at 12% for both groups of firms.[29] Appendix Tables F.3 and F.4 also report summary statistics of the non-banks and banks in my sample separately, suggesting that a similar narrative still applies for both groups of firms.[30]

For syndicated borrowings, Figure 2 plots the aggregate volume of new debt issuances denominated in foreign currencies by sanctioned versus unsanctioned firms by year.[31] Each issuance is classified into either (a) issuance denominated in a G10 currency raised in a G10 marketplace, (b) issuance denominated in a G10 currency raised in a non-G10 marketplace, or (c) issuance denominated in a non-G10 currency, which was most likely raised in a non-G10 marketplace. Such classification aims to differentiate issuances denominated in the currencies, or raised in the mar-

unsanctioned) borrowed in the G10 currencies in both domestic and international markets.

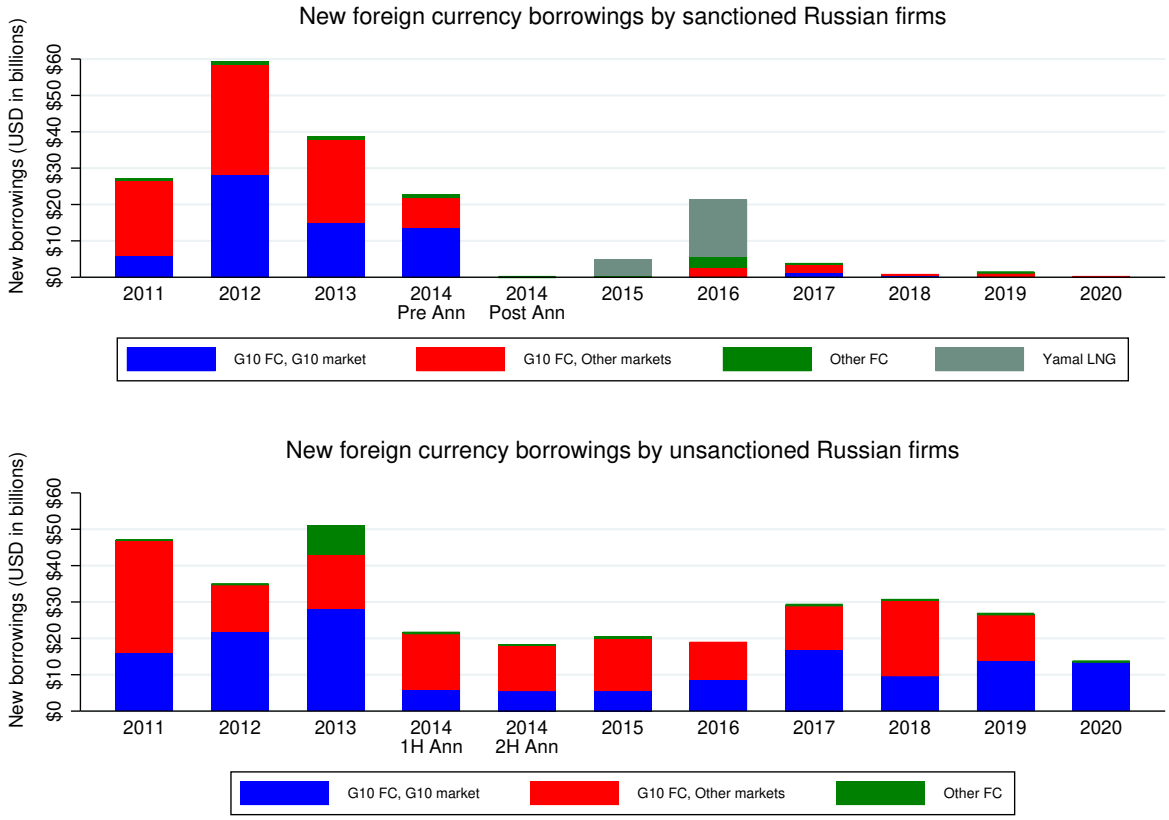
[29] Note that the average ROE for sanctioned firms at 16% was lower than 24% for unsanctioned firms in my sample, but ROE statistics are noisy, especially for small firms.

[30] My bank subsample includes all firms with the following SIC codes: 602 - Commercial banks, 603 - Savings institutions, 606 - Credit unions, 608 - Foreign banking and branches and agencies of foreign banks, 609 - Functions related to depository banking, 61 - Non-depository credit institutions, 62 - Security and commodity brokers, dealers, exchanges and services; Appendix Table F.5 lists the 20 largest Russian banks by assets, their market shares, and sanctions statuses. My non-bank subsample includes other companies that are not banks.

[31] Appendix Table F.9 also reports these statistics.

kets, of sanctioning versus non-sanctioning countries.[32] Appendix Figure F.2 also plots the maturity schedule of external borrowings in the G10 markets.

Figure 2: New syndicated borrowings in foreign currency by Russian firms by year



Notes: The graphs report issuance volume of corporate bonds and syndicated loans denominated in foreign currencies by Russian firms by year. The top panel reports the issuance volume by sanctioned Russian firms, and the bottom panel by unsanctioned Russian firms. For each group of firms, the graph plots issuances denominated in the G10 currencies in the G10 markets (blue), issuances denominated in the G10 currencies in non-G10 markets (red), and issuances denominated in non-G10 currencies (green). Grey bars indicate borrowings by the Yamal liquefied national gas (LNG) project, which are deemed an exception. Sanctioned firms include entities that have been added to either the SDN list or the SSI list, Directives 1–3. Gross amounts are in billions of U.S. dollars. For borrowings by unsanctioned companies, I use June 30, 2014, as the dividing point as that is near the date of the first major round of sanctions. For borrowings by sanctioned companies, I use the actual dates the firms were sanctioned in 2014. Figures for 2014 represent annualized numbers.

Prior to 2014, Russian companies that raised capital in foreign currencies did so primarily in the G10 currencies—mostly USD or EUR—both in the G10 and non-G10 markets. The financing denominated in the G10 currencies and raised in the G10 markets was mostly done in the United

[32]The G10 currencies include AUD, CAD, CHF, DKK, EUR, GBP, ISK, ITL, JPY, NOK, NZD, SEK, and USD. The G10 marketplaces include Australia, Canada, Denmark, Estonia, France, Germany, Great Britain, Italy, Japan, Luxembourg, New Zealand, Norway, Spain, Sweden, Switzerland, United States, and the pan-European market ("XS" country code in ISINs).

States or in the pan-European markets. The financing denominated in the G10 currencies but raised in non-G10 markets was mostly done domestically as syndicated loans, whereby Russian companies borrowed in USD or EUR from domestic banks, which in turn raised such capital either internationally, or domestically as foreign-currency deposits. The financing denominated in non-G10 currencies was insignificant and mostly done in the Polish zloty (PLN) or the Czech koruna (CZK) by subsidiaries that operated in those countries.

After sanctions started in 2014, financing denominated in the G10 currencies by sanctioned firms came to an almost complete stop. Although sanctioned firms de jure were still able to raise capital denominated in the G10 currencies in non-G10 markets, such issuances also dropped after 2014. While unsanctioned firms also reduced their G10 currency borrowings after 2014, the decline was not to the same degree as that for sanctioned firms. Finally, borrowings in non-G10 currencies by both sanctioned and unsanctioned firms remained immaterial after 2014. One notable exception was the borrowings in RMB by Yamal LNG, which raised RMB 9.8 billion from China Development Bank and the Export-Import Bank of China in 2016.[33] Besides this, other foreign borrowings in non-G10 currencies by Russian firms were de minimis.

3.3 Empirical Methodology

With firm-level data, I use difference-in-differences regressions to analyze the impact of sanctions on the targets relative to their untargeted peers. My regression specification is:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot \text{Sanctioned}_{i,t} + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is the outcome of firm i in year t, $\text{Sanctioned}_{i,t}$ is an indicator of whether firm i was sanctioned in year t, and Firm_i and Year_t are firm and year fixed effects, respectively.[34] The outcomes of interest include (a) new external and foreign-currency borrowings, and (b) firm financial performance. The parameter of interest is β_1, which captures the relative impact of sanctions on firm outcomes. For the regressions of firm financial performance, I cluster standard errors at the firm level to account for potential serial correlation of firm outcomes. For the regressions of new debt issuance, I cluster standard errors at the year level to account for potential correlation of new issuances across firms within the same period.[35]

[33] Yamal LNG is a national gas production, liquefaction, and shipping project, formed as a partnership between Novatek (60% ownership per Novatek's 2014 annual report), China National Petroleum Corporation (20%), and Total (20%). Given its majority ownership by Novatek (added to the SSI list in 2014), Yamal LNG was also subject to sanctions. Yamal LNG placed a USD 2.3 billion bond with the National Welfare Fund of Russia and secured a EUR 3.6 billion loan from Sberbank and Gazprombank in 2015. It also secured loans of EUR 9.3 billion and RMB 9.8 billion from China Development Bank and the Export-Import Bank of China in 2016. The borrowing amounts and currency denominations are per Novatek's press release (Novatek [2016]) and National Settlement Depository, Moscow Exchange Group [2020].

[34] Note that since I only focus on the impact of financial sanctions, sanctioned firms include entities that have been added to either the SDN list or the SSI list, Directives 1–3.

[35] For the regressions of firm financial performance, I do not also cluster standard errors at the year level because my sample comprises a small number of periods, while clustering of standard errors assumes the number of clusters

My analysis rests on two key identifying assumptions. The first is that had sanctions not been imposed, sanctioned and unsanctioned firms would have progressed similarly—the parallel trend assumption. Confining the sample to a set of Russian firms, I ensure that my treatment and control groups were subject to the same macroeconomic factors that impacted the Russian economy. This mitigates a potential concern of confounding macroeconomic shocks affecting firms across different countries differently. Even though sanctions targets were on average larger than their unsanctioned peers, both groups of firms were comparable in terms of leverage and profitability, as discussed in Section 3.2. An analysis controlling for firm sizes, industries, and state connection in Appendix B.1, B.2 and B.3 also help mitigate the concern related to these differences.

Second, firms should not have anticipated sanctions, or such anticipation, if occurred, should not have affected firm behaviors. Had firms anticipated they would become sanctions targets, they might have borrowed abroad in advance to secure cheaper capital. However, the empirical evidence does not show anticipatory foreign borrowings by sanctioned firms, potentially because the first round of sanctions occurred within one month after the initial move by the Kremlin to annex Crimea. While it was possible that firms that were sanctioned in 2015 and 2016 might have anticipated the sanctions far in advance, such considerations were likely shared by foreign investors, making such preemptive efforts implausible. As a result, foreign borrowings by sanctions targets evaporated post 2014, even though several targets only became explicitly sanctioned later. Conversely, while sanctions targets might have borrowed funds domestically in advance of sanctions, nothing precluded unsanctioned firms from following suit.

Recently, a number of papers have shown that two-way fixed effects (TWFE) specification as in Equation 1 can suffer from bias in settings with staggered treatment (Borusyak et al. [2017], Borusyak et al. [2021], Callaway and Sant'Anna [2021], de Chaisemartin and D'Haultfœuille [2020, 2022], Goodman-Bacon [2021], Sun and Abraham [2021]). Such bias arises from the potential negative weights assigned by the TWFE regressions to certain group-time treatment effects; in some cases, such negative weights may even cause the TWFE estimators to yield the wrong sign.[36] In Appendix A, I perform additional analyses to address this concern. In particular, the decomposition of the TWFE estimator (Goodman-Bacon [2021]) of the impact of sanctions on relative firm sizes reveals that the significant presence of never-sanctioned firms allows these firms to serve as a proper control group and minimizes the potential negative weights issue. As such, the baseline result in Table 3 largely captures the weighted average treatment effect of sanctions on target firms relative to their never-sanctioned peers. I also apply the estimators proposed by Borusyak et al. [2021], Callaway and Sant'Anna [2021], de Chaisemartin and D'Haultfœuille [2020, 2022], and Sun and Abraham [2021] to address this concern and confirm the magnitude and statistical significance of the results. Lastly, I use the estimator proposed by Roth [2019] to address another potential

goes to infinity (Cameron et al. [2011]). For the regressions of new issuances, I do not also cluster standard errors at the firm level because new issuances are only included on the years of the issuances themselves and serial correlation of new issuances is less of a concern.

[36]For example, a TWFE estimator may suggest a positive average impact of sanctions on relative firm sizes even when the group-specific impact by each sanctions cohort hypothetically suggests a negative impact.

bias from pre-trend testing and validate my findings with respect to the parallel trend assumption. Ultimately, these robustness tests confirm the unintended consequences of sanctions on firm sizes.

4 Empirical Results

4.1 The Effect of Sanctions on International Borrowings

Table 2 and Figure 3 show the *direct* effect of sanctions on new foreign borrowings by Russian firms. Confining my sample to all syndicated issuances by Russian firms between 2011 and 2020, I find that sanctioned firms significantly reduced their new external and foreign-currency borrowings relative to their unsanctioned peers. Relative to the average existing-external-borrowings-to-assets ratio of sanctioned firms prior to sanctions of 10% (see Table 1), the results suggest that external and foreign-currency borrowings by sanctioned firms essentially evaporated.

Table 2: Impact of sanctions on new foreign borrowings by Russian firms

	Borrowings in the G10 Markets	Borrowings in the G10 Currencies
Sanctioned	-0.097***	-0.107***
	(0.0171)	(0.0161)
Observations	7,232	7,175
Adjusted R^2	0.360	0.359

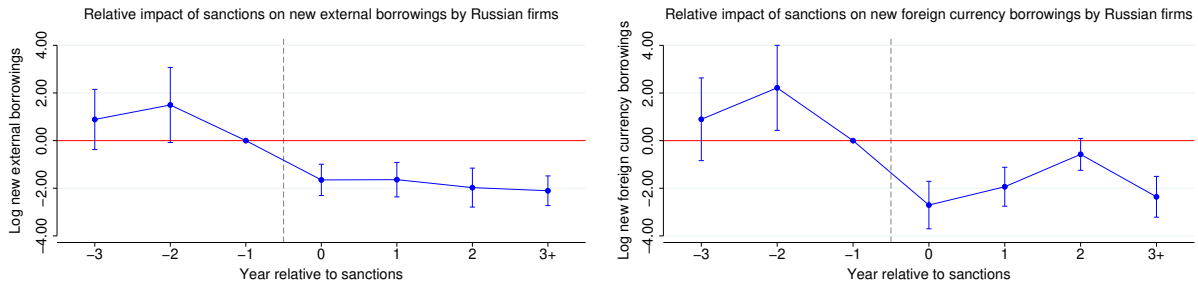
Notes: This table reports the impact of sanctions on the new-borrowings-to-assets ratios for new borrowings in the G10 markets and the G10 currencies by Russian firms. Regressions include firm and year fixed effects. Standard errors clustered at the issuance period level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The fact that sanctioned firms reduced their borrowings in the G10 markets after sanctions is not surprising: this is precisely what the policy aimed to achieve. Sanctioned firms also reduced their borrowings in the G10 currencies, even though such borrowings could have been conducted outside the G10 markets. This is because most borrowings in the G10 currencies by Russian firms that were conducted outside the G10 markets were primarily done through domestic banks. Since most major Russian banks were subject to sanctions, they were precluded from obtaining and providing foreign-currency funding to other sanctioned borrowers. These results highlight the effectiveness of the U.S. (and more broadly the G10) sanctions in prohibiting the targets from borrowing abroad and hints at increased reliance on the domestic capital market after the policy.

4.2 The Effect of Sanctions on Firm Sizes

Table 3 and Figure 4 show the *indirect* effect of sanctions on firm sizes. Here, a surprising result emerges whereby sanctioned firms shrank by 29% *less* than their unsanctioned peers on average in

Figure 3: Impact of sanctions on new foreign borrowings by Russian firms



Notes: These figures plot the impact of sanctions on the new-borrowings-to-assets ratios for new borrowings in the G10 markets and the G10 currencies by Russian firms by relative event year. The figures plot the $\hat{\beta}_\tau$ coefficients of:

$$y_{i,t} = \alpha + \sum_{\tau=-3,\tau\neq-1}^{\tau=3} \beta_\tau \cdot \text{Sanctioned}_{i,\tau} + \phi \cdot \text{Firm}_i + \gamma \cdot \text{Year}_t + \epsilon_{i,t}$$

where $y_{i,t}$ refers to the new-borrowings-to-assets ratios for new borrowings in the G10 markets or the G10 currencies by firm i in year t, $\text{Sanctioned}_{i,\tau}$ is a dummy variable that takes a value of 1 for the relative year τ versus the year in which the sanctions on firm i started and 0 otherwise, and Firm_i and Year_t capture firm fixed effects and year fixed effects, respectively. The min-max ranges capture the 95% confidence intervals, where the standard errors are clustered at the issuance period level.

terms of assets. The fact that sanctioned firms lost access to international capital markets but still grew relative to their unsanctioned peers points to the spillover effect of targeted sanctions.

Table 3: Impact of sanctions on relative firm sizes

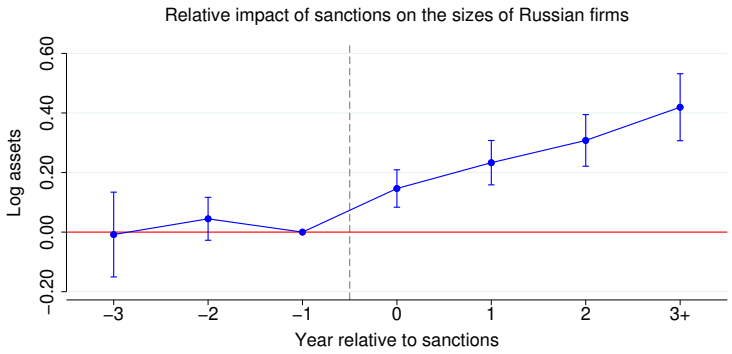
	Assets
Sanctioned	0.287***
	(0.044)
Observations	72,293
Adjusted R^2	0.653

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Next, I explore the relative impact of sanctions on other financial metrics, including in particular on firms' domestic and total borrowings. Tables 4 and 5 report the results for non-banks and banks, respectively. Besides assets, both groups of firms also grew relative to their unsanctioned peers in terms of other financial metrics—particularly, sales for non-banks and loans and deposits for banks. In terms of leverage, as sanctioned firms were no longer able to seek new financing abroad, these firms, especially the non-banks, borrowed more both domestically and across all markets combined.[37] Although the impact of sanctions on domestic and total borrowings by sanc-

[37]Note also that while the analysis in Section 4.1 focuses only on *new* syndicated borrowings by Russian firms,

Figure 4: Impact of sanctions on relative firm sizes



Notes: This figure plots the impact of sanctions on the log of total assets of Russian firms by relative event year. The figures plot the $\hat{\beta}_\tau$ coefficients of:

$$y_{i,t} = \alpha + \sum_{\tau=-3,\tau\neq-1}^{\tau=3} \beta_\tau \cdot \text{Sanctioned}_{i,\tau} + \phi \cdot \text{Firm}_i + \gamma \cdot \text{Year}_t + \epsilon_{i,t}$$

where $y_{i,t}$ refers to the log of total assets of firm i in year t, $\text{Sanctioned}_{i,\tau}$ is a dummy variable that takes a value of 1 for the relative year τ versus the year in which the sanctions on firm i started and 0 otherwise, and Firm_i and Year_t capture firm fixed effects and year fixed effects, respectively. The min-max ranges capture the 95% confidence intervals, where the standard errors are clustered at the firm level.

tions banks was not statistically significant, the coefficients are positive, and sanctioned banks also garnered more deposits (primarily in the domestic market), which represented the main sources of funding for Russian banks. These results suggest that as sanctioned firms were unable to borrow in the foreign markets, they relied more on the domestic capital marketl; Appendix Figure F.3, which shows that Russian firms, especially the sanctioned ones, shifted the composition of their syndicated borrowings toward the Russian market and the ruble, also conveys this finding. As firms competed for domestic capital post sanctions, sanctioned firms were able to secure more funding.

With regard to profitability, the impact of sanctions is less clear, with sanctioned non-banks experiencing lower return on assets (ROA) but higher earnings before interest and tax (EBIT) margin (albeit with no statistical significance) and sanctioned banks experiencing higher net interest margin (NIM) and ROA (both also with no statistical significance). Appendix Figures F.4 and F.5 show the event-study plots for these financial measures for both groups of firms.

the analysis in this section observes the *stock* of total borrowings including bank loans. This helps take into account the fact that although foreign borrowings were primarily conducted through syndicated financing, most domestic borrowings were done through banks. The existing-external-borrowings-to-assets ratios of sanctioned firms also only show a small decline in these tables as the stock of external borrowings might have taken time to adjust as existing borrowings only mature later.

Table 4: Impact of sanctions on the financial performance of Russian non-banks

			Capital Structure (% of Assets)				Profitability	
				Debt				
	Assets	Sales	Equity	External	Domestic	Total	EBIT Margin	ROA
Sanctioned	0.275***	0.475***	-0.004	-0.002	0.252***	0.251***	2.629	-0.968**
	(0.046)	(0.144)	(0.040)	(0.001)	(0.077)	(0.077)	(1.820)	(0.431)
Observations	69,404	69,403	69,404	69,473	69,473	69,505	73,557	68,980
Adjusted R^2	0.625	0.677	0.497	0.507	0.552	0.553	0.357	0.547

Notes: This table reports the impact of sanctions on the financial performance of Russian non-banks. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Impact of sanctions on the financial performance of Russian banks

				Capital Structure (% of Assets)				Profitability	
					Debt				
	Assets	Loans	Deposits	Equity	External	Domestic	Total	NIM	ROA
Sanctioned	0.430***	0.915***	0.469**	0.194	-0.009**	0.097	0.086	0.343	0.505
	(0.152)	(0.335)	(0.209)	(0.204)	(0.004)	(0.064)	(0.062)	(0.724)	(1.019)
Observations	2,889	2,886	2,889	2,889	2,983	2,983	3,003	2,878	2,876
Adjusted R^2	0.958	0.820	0.818	0.542	0.605	0.481	0.494	0.657	0.154

Notes: This table reports the impact of sanctions on the financial performance of Russian banks. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.3 Additional Empirical Results

Appendix B provides additional empirical results that observe how various factors affected sanctions outcomes. First, I confirm the robustness of the results by showing that the unintended consequences of sanctions remain significant after controlling for other potential factors. In particular, I find that sanctioned firms expanded relative to their unsanctioned peers after controlling for initial firm sizes (§B.1) and firm industries (§B.2). Additionally, I validate the results controlling for the possibility that some firms might have received governmental support (§B.3). Using firms' strategic statuses, state ownership, and political connection of firms' management to identify firms' likelihood of receiving governmental support, I still find that sanctioned firms shrank by approximately 20–24% *less* than their unsanctioned peers after controlling for these attributes.

Next, I explore the how firms' financing choices affected the outcomes. I find that sanctioned firms that relied more on external borrowings before sanctions suffered more post sanctions, while

Table 6: Robustness of the impact of sanctions on relative firm sizes

	Assets					
Sanctioned	0.287***	0.240***	0.225***	0.222***	0.199***	0.228***
	(0.044)	(0.043)	(0.044)	(0.044)	(0.044)	(0.045)
Industry × Year FE		✓	✓	✓	✓	✓
Size-Decile × Year FE			✓	✓	✓	✓
Strategic × Year FE				✓		
State-Owned × Year FE					✓	
Politically-Connected × Year FE						✓
Observations	72,293	72,288	72,288	72,288	72,288	72,288
Adjusted R^2	0.653	0.658	0.658	0.658	0.658	0.658

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms. Regressions include firm,year, and other fixed effects as shown. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

unsanctioned international borrowers benefited (§B.4). Sanctioned firms that relied more on domestic borrowings before sanctions also suffered slightly more post sanctions, but unsanctioned domestic borrowers suffered similarly regardless of their pre-sanctions domestic borrowing levels. Additionally, I find that non-banks that borrowed from sanctioned banks expanded relative to those that borrowed from unsanctioned banks (§B.5). These results point to the relevance of the credit channel in explaining the indirect effect of sanctions, with banks playing a crucial role in allocating domestic capital.

Finally, I consider other factors that might have affected the results. I find that the difference in supply chain exposure of sanctioned versus unsanctioned firms might have contributed partially to the outperformance of sanctioned firms, but only by a small degree (§B.6). In particular, sanctioned firms' higher exposure to customers and suppliers from non-sanctioning countries helped offset the negative impact from the exposure to customers and suppliers from sanctioning countries and allowed these sanctioned firms to remain more resilient. Further, I evaluate the effect of financial versus trade sanctions and find that financial sanctions drove most of the outcomes (§B.7). However, the ineffectiveness of trade sanctions could be because the sanctions targets in this sanctions episode did not rely much on international trade, unlike the targets in the 2022 sanctions round.

5 Understanding the Channel

Before addressing how sanctions resulted in the unintended consequence of sanctions targets shrinking by less than their unsanctioned peers, I first formulate how sanctions are *supposed* to work. Generally, a small number of firms in a country borrow internationally, primarily in USD and EUR,

to take advantage of cheaper financing abroad.[38] The reliance of international borrowers on USD- and EUR-denominated financing gives the United States and the European Union the power to exclude agents from international capital markets by prohibiting their citizens from providing funds to such targets. By imposing exclusions, sanctions force these targets to rely on more expensive capital, resulting in a detrimental impact on these firms.

Despite the targeted nature of the U.S. sanctions against Russia, unsanctioned firms still would have not survived the policy unscathed. After sanctions, as firms competed for domestic capital with imperfect elasticity of supply, domestic interest rates rose to temper the demand from more firms as evidenced by the increase in the average interest rate of RUB-denominated syndicated issuances in 2015 and 2016 in Figure 5. This resulted in a spillover impact on unsanctioned firms, which must also borrow more expensively post sanctions. Despite this spillover, if firms face no constraints, sanctions targets should still suffer more than their unsanctioned peers because the former borrowed more cheaply pre sanctions and should face larger increases in their costs of borrowing post sanctions.

Given the outperformance of the sanctions targets after the policy, I argue that this unintended consequence arose as sanctions caused a reallocation of domestic resources in favor of sanctioned firms. In particular, sanctions led to the crowding out of, and credit rationing to, unsanctioned firms in the domestic capital market. Before sanctions, large soon-to-be-sanctioned firms borrowed primarily from international capital markets and major state-owned banks, while smaller unsanctioned firms relied on other domestic banks. After sanctions, these targets were forced to rely on capital from domestic lenders. The following excerpts from Sberbank and VTB Bank describe the situation in 2014:

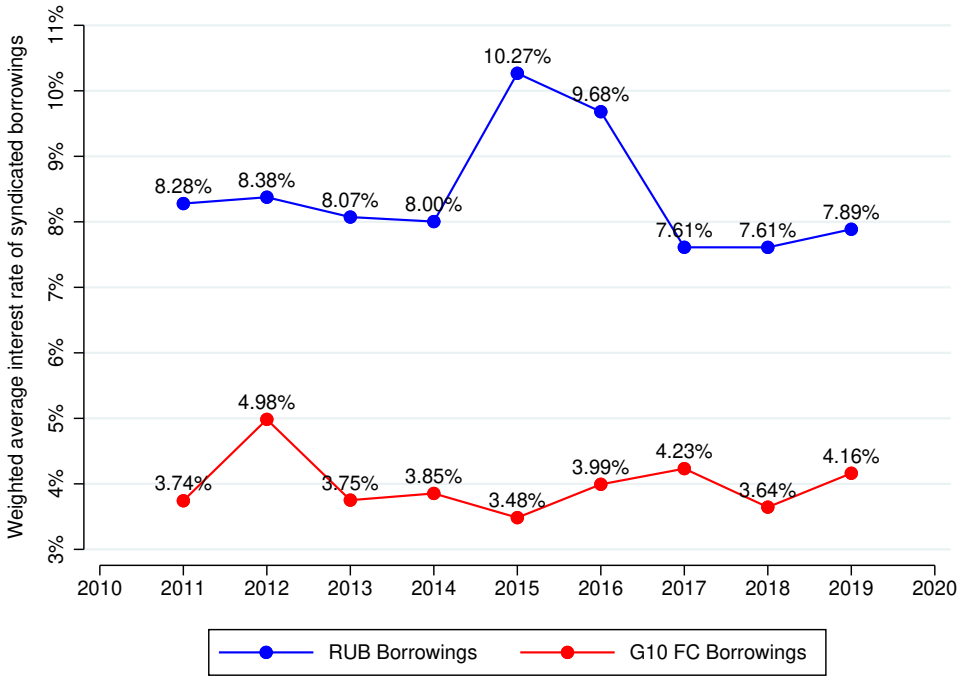
> "Key Russian borrowers were forced to turn to loans issued by Russian banks as a result of the unavailability of external funding sources and reduced possibilities for attracting funds from the Ruble bond market, which was the result of an outflow of non-resident funds and the transfer of pension savings for 2014 to the budget. Unlike previous periods, a significant part of the demand for new loans was generated by the largest Russian companies." (Sberbank of Russia [2014])

> "The Russian corporate lending market saw increased demand for credit from large, high-quality borrowers as international debt capital markets generally remained closed to issuers from Russia." (VTB Bank [2014])

Some of the largest borrowers described above undoubtedly included sanctioned firms. These firms sought capital primarily from sanctioned banks given their existing banking relationships and the

[38] Some Russian international borrowers also borrow in USD and EUR partly to hedge their currency exposure as several exporters earn revenues and hold assets in these currencies. Russian banks also tend to match the currency exposure of their assets and liabilities to minimize the need for derivative hedging. See discussions on firm foreign-currency borrowings in Gozzi et al. [2015], Varela and Salomao [2018], Maggiori et al. [2019, 2020], and Liao [2020].

Figure 5: Average interest rates of syndicated borrowings by Russian firms by currency



Notes: This graph plots the weighted average interest rates of syndicated borrowings in the G10 currencies and in the Russian ruble by Russian firms by year. The sample includes all bond and syndicated loan issuances by firms that were incorporated or are headquartered in Russia or have ultimate corporate parents with Russian nationality and did at least one syndicated borrowing during 2011–2019 as reported by SDC or FactSet.

fact that only these state-owned banks were large enough to provide them with credit.

Facing demand for capital from both sanctioned and unsanctioned firms, banks prioritized credit in favor of the former. The following excerpt from Gazprombank offers an insight into how Russian banks allocated capital in the aftermath of U.S. sanctions:

> "With the unstable economic situation and higher business risks, Gazprombank sees its priority interest in the sectors and individual companies that are most resistant to economic recession and external impact, as well as projects characterized by acceptable risk levels and stable income and backed by the government in the long run." (Gazprombank Group [2014])

Banks prioritized credit to sanctioned firms because they deemed these borrowers "safer" given their larger sizes and critical roles in the Russian economy. Given that supply of domestic capital was not perfectly elastic, prioritization of credit to sanctioned borrowers also led to credit rationing to their less productive unsanctioned peers and ultimately the relative resilience of sanctioned firms.

The allocation of domestic capital in favor of sanctioned firms was further amplified by the interdependency between sanctioned non-banks and sanctioned banks. As sanctioned banks sought more capital domestically, domestic investors and depositors supplied more funds to them at the expense of unsanctioned banks for the same aforementioned reasons. Since sanctioned non-banks were more likely to borrow from sanctioned banks than were unsanctioned non-banks, these sanctioned borrowers also benefited from the fact that their lenders were able to garner more capital and lend more to them.[39] Furthermore, the fact that sanctioned banks were more likely to lend to safer sanctioned non-banks also made these banks safer themselves, thereby bolstering the described capital reallocation mechanism.

Support by the Kremlin. Rather than attributing the unintended consequences of sanctions to my proposed market mechanism, an alternative argument could be made that these consequences emerged due to the Kremlin's allocation of resources to support the sanctioned firms. While the Kremlin indeed supported some firms after sanctions started in 2014, I argue that such support contributed little to the relative size outcomes, and the unintended consequences of sanctions remain after controlling for such potential state support.

Throughout 2014, the Russian government, especially the Central Bank of Russia (CBR), reacted promptly to fight deteriorating macroeconomic conditions and capital outflows as a result of both the U.S. sanctions and the declining oil price. This included floating the Russian ruble, implementing measures to increase USD liquidity such as FX repos and swaps, and raising the key interest rate from 5.5% to 17.0% in 2014. More importantly, to prevent a collapse of the Russian banking sector, the Ministry of Finance and the CBR also injected capital to shore up Russian banks. Specifically, CBR's loans to Russian banks increased from RUB 4.8 trillion to RUB 9.8 trillion in 2014, and its share in the liabilities of the Russian banking sector increased from 7.7% to 12% (Sberbank of Russia [2014]). Appendix Table F.10 summarizes the CBR's support to some of the largest sanctioned Russian banks. Besides capital injection, the Kremlin also pursued other actions to support banks and boost the economy; Appendix Table F.11 summarizes these measures.

Nevertheless, I argue that the state assistance only played a minor role in explaining the outperformance of sanctioned firms. This is because such support went to both sanctioned and unsanctioned firms, resulting in minimal relative size effect. For instance, while the incremental loans from the CBR would have added to the assets of the three largest sanctioned banks by 3-8%, such incremental loans would have also added to the assets of other banks by approximately 8% in aggregate, resulting in a neutral relative size impact resulting from such loans.[40] Analyses in

[39] Based on my sample, 46% of sanctioned non-banks versus only 33% of unsanctioned non-banks borrowed from sanctioned banks. Appendix B.5 also confirms that non-banks that relied more on sanctioned banks suffered less than their non-bank peers that relied more on unsanctioned banks.

[40] Sberbank's liabilities to the CBR increased to RUB 3.5 trillion in 2014 from RUB 2.0 trillion in 2013 compared to its assets of RUB 18.2 trillion in 2013; VTB Bank's liabilities increased to RUB 3.3 trillion from RUB 2.8 trillion compared to its assets of RUB 8.8 trillion in 2013; Gazprombank's liabilities increased to RUB 323 billion from RUB 209 billion compared to its assets of RUB 3.6 trillion in 2013. Total assets of all Russian banks were approximately

Appendix B.3 also confirm the unintended consequences of sanctions, controlling for the possibility that some firms might have received governmental support. Using firms' strategic status, state ownership, and political connection of the senior management teams to identify firms' likelihood of receiving state support, I find that sanctioned firms still outperformed their unsanctioned peers after controlling for firms' state connection statuses. These results suggest that state assistance contributed minimally to the main findings.

Ultimately, state directives from the market mechanism could also reinforce each other to benefit firms. For instance, the fact that some firms were more likely to receive governmental support might have incentivized investors to allocate more funds to these firms. The CBR's support to banks presumably also bolstered their health and allowed them to garner more deposits and lend more to their clients as well. Additionally, state support was likely driven largely by economic, and not just political, incentives. For instance, to stimulate the economy, one condition for additional capitalization to banks by the Deposit Insurance Agency (DIA) required minimum growth rates for lending to priority sectors. This condition benefited firms, including the sanctioned ones, albeit likely because of their dominance in the priority sectors of the Russian economy rather than their political ties. Finallly, it is worth noting that state supports to firms during a crisis is not unique to Russia. Although anecdotes of favors to oligarch-owned sanctions targets exist, the governmental responses generally aimed to prevent the collapse of the Russian banking system and shore up the economy. Such "bailouts" to large and important firms during a crisis are common in other countries, including the United States (Roubini and Setser [2004], Goolsbee and Krueger [2015], Acemoglu et al. [2016], Berger and Roman [2020]). Ultimately, both the state's directives and the market mechanism reinforces the notion that sanctions precipitated a reallocation of domestic capital in favor of sanctioned firms.

Other Potential Explanations. Besides the credit channel and the state's involvement, Appendix C also explores other potential explanations of the outcomes, including: (a) spillover through the supply chain channel, (b) concurrent macroeconomic shocks harming unsanctioned firms more severely, and (c) revaluation effect from the depreciation of the RUB. Although these factors *partially* contributed to the results, none explains all the outcomes, and the empirical evidence still supports the relevance of the capital crowding out and credit rationing mechanism.

6 Model

I formalize the aforementioned mechanism with a heterogeneous firm model with entry into international capital markets. Adapting elements from the Melitz [2003] model of trade in which a few largest firms select into exporting, this model features segmented capital markets in which most firms borrow domestically and only the largest firms borrow abroad. Firms borrow to finance

RUB 65 trillion. Figures are based on the respective banks' annual reports and consolidated financial statements.

their usage of capital goods in the style of Neumeyer and Perri [2005], and such borrowings in the domestic market are subject to a borrowing constraint similar to Crouzet and Mehrotra [2020].

In this model, the domestic interest rate facilitates the spillover of sanctions impact to unsanctioned firms. As sanctions force the targets to borrow domestically, increased competition for domestic capital raises the domestic interest rate, which forces both sanctioned and unsanctioned domestic borrowers to shrink on average. Without the borrowing constraint, the sanctions targets would shrink by more as they face higher increases in their costs of borrowings. With the borrowing constraint, the higher domestic interest rate also exacerbates credit rationing to less productive firms. For unsanctioned firms on which the borrowing constraint tightens sufficiently, they would shrink by more than their unconstrained sanctioned peers.

Section 6.1 presents a static model to explain the impact of sanctions on firm sizes, and Section 6.2 extends it to a dynamic setup to observe the adjustments over time and assess welfare consequences.

6.1 Static Model

6.1.1 Setup

The model is static and deterministic, except for sanctions which are the only shocks to the economy and are unanticipated by agents. The economy is endowed with aggregate capital goods K and aggregate savings B.

Firms. The economy is populated by a continuum of firms indexed by their productivity z, distributed according to a distribution $G(z)$. Firms rent capital k at a rental rate $R = r_K + \delta$, which is a combination of the interest rate on capital goods r_K and the depreciation rate δ. They produce final goods y, using a decreasing returns-to-scale technology $f(k; z) = zk^{\zeta}$, where $\zeta < 1$.

Similar to Neumeyer and Perri [2005], in order to transfer capital rent $(r_K+\delta)k$ to capital goods owners, firms need to set aside a fraction η of the capital rent before final goods are produced.[41] This requires firms to borrow debt $b = \eta(r_K + \delta)k$, funded by aggregate savings in the domestic market at an interest rate r_{dm}, which is the same for all firms. Firms' borrowings are also subject to borrowing constraint $\Gamma(r_{dm}, r_K, z)$, which is a function of firm productivity and the interest rates.

[41] Note that the model features financial frictions in which firms need to borrow to finance their usage of capital goods because this allows the model to more accurately capture the impact of sanctions on the aggregate economy. With this setup, sanctions affect the allocation of capital goods between firms without affecting the aggregate level of capital goods in the economy. Appendix D.4 also explores a model extension in which firms rent capital goods directly and foreign and domestic capital are not perfect substitutes.

Firms maximize profits subject to the borrowing constraint:

$$\begin{aligned} \pi(z) = \max_{b,k} \; & f(k;z) - (r_K + \delta)k - r_{dm}b \\ \text{such that} \quad & b \leq \Gamma(r_{dm}, r_K, z) \end{aligned} \tag{2}$$

Since firms borrow the exact amount of debt to settle capital rent, I can rewrite the problem as:

$$\pi(z) = \max_{k} \; f(k;z) - \underbrace{(1+\eta r_{dm})(r_K+\delta)}_{\text{effective capital rental rate}} k \tag{3}$$

$$= \max_{b} \; f\Big(\underbrace{\frac{b}{\eta(r_K+\delta)}}_{=k}; z\Big) - \underbrace{\frac{b}{\eta}}_{=(r_K+\delta)k} - r_{dm}b \tag{4}$$

$$\text{such that} \quad b \leq \Gamma(r_{dm}, r_K, z)$$

Equation 3 is the standard profit maximization problem in which firms face an effective capital rental rate $(1+\eta r_{dm})(r_K+\delta)$ rather than the nominal capital rental rate $r_K+\delta$, and Equation 4 restates the problem in terms of firm borrowings only.

Foreign-Market Borrowings. Firms may borrow debt b in international capital markets at an exogenous foreign interest rate $r_{fm} < r_{dm}$ by paying a fixed cost κ. The exogeneity of the foreign interest rate is based on the depth of the U.S. (and the G10) capital markets relative to the demand from Russian firms. The fixed cost of foreign borrowings represents, for example, the need for firms to have sophisticated treasury and legal departments to issue and potentially hedge these debts. With an option to borrow abroad, firm maximizes profits:

$$\begin{aligned} \pi(z) = \max_{b_{fm|dm}, k_{fm|dm}, \mathbb{1}_{fm}} \; & \mathbb{1}_{fm} \underbrace{\Big(y(k_{fm};z) - (r_K+\delta)k_{fm} - r_{fm}b_{fm} - \kappa\Big)}_{\text{firm borrows internationally}} \\ & + (1-\mathbb{1}_{fm}) \underbrace{\Big(y(k_{dm};z) - (r_K+\delta)k_{dm} - r_{dm}b_{dm}\Big)}_{\text{firm borrows domestically}} \\ \text{such that} \quad & b(r_{dm}, r_K, z) \leq \Gamma(r_{dm}, r_K, z) \end{aligned} \tag{5}$$

where $\mathbb{1}_{fm}$ is an indicator that takes a value of one if the firm borrows in international capital markets and zero otherwise; k_{fm} and b_{fm} denote the amount of capital goods and debt that firm uses if it borrows debt in international markets; and k_{dm} and b_{dm} denote such amounts if firm borrows debt in the domestic market.

A firm with productivity z will borrow abroad if its profit were it to do so exceeds its profit if it were to borrow domestically:

$$y(k_{fm};z) - (r_K+\delta)k_{fm} - r_{fm}b_{fm} - \kappa \; > \; y(k_{dm};z) - (r_K+\delta)k_{dm} - r_{dm}b_{dm} \tag{6}$$

This **foreign-market borrowing condition** allows me to solve for the **foreign-market borrowing productivity threshold** z_{fm}, whereby firms with productivity $z \leq z_{fm}$ borrow domestically (henceforth called "domestic borrowers") and firms with productivity $z > z_{fm}$ borrow internationally (called "foreign/international borrowers"). The selection into foreign borrowings in this model is analogous to the selection into export markets in the Melitz [2003] model of trade, in which only highly productive firms choose to do so.[42]

Borrowing Constraint. I make three assumptions on the borrowing constraint Γ as follows:

A1. Γ is more binding for less productive firms ($\frac{\partial \Gamma}{\partial z} > 0$).

A2. Γ is more binding when the interest rate on debt increases ($\frac{\partial \Gamma}{\partial r_b} < 0$).

A3. Γ is more binding for less productive firms when the interest rate on debt increases ($\frac{\partial^2 \Gamma}{\partial r_b \partial z} > 0$).

The borrowing constraint aims to capture investors' willingness to lend to firms. Investors are less willing to lend to less productive firms, deeming such firms riskier (A1). When the interest rate increases, investors are also less willing to lend to firms (A2).[43] Finally, investors ration credit to less productive firms more severely than to more productive firms when the interest rate rises (A3).

In this model, firm resource choices are dictated by the borrowing constraint. Specifically, a firm borrows the minimum of (a) the amount that the firm *wants* to borrow to maximize profit, $b^*(\cdot)$, and (b) the amount that the firm *can* borrow given investors' willingness to lend, $\Gamma(\cdot)$:

$$b(r_b, r_K, z) = \min\left(b^*(r_b, r_K, z), \Gamma(r_b, r_K, z)\right) \tag{7}$$

where $r_b = \{r_{dm}, r_{fm}\}$ for borrowings in the domestic and international markets, respectively. Once the borrowing amount is determined, the amount of capital goods that a firm rents follows.

With the borrowing constraint, less productive (and smaller) firms become more sensitive to interest rate changes than their more productive (and larger) peers. These results are consistent with the literature that finds small firms to be more sensitive to monetary policy (Gertler and Gilchrist [1994], Crouzet and Mehrotra [2020]). In aggregate, the constraint also produces a crowding out effect in which lenders prioritize credit to more productive (and larger) firms at the expense of the less productive (and smaller) ones (Chakraborty et al. [2018], Chodorow-Reich et al. [2021], Greenwald et al. [2021]).

Equilibrium. An equilibrium is the set of prices $\{r_{dm}, r_K\}$, productivity threshold z_{fm}, and sets of firm choices $\{b(z), k(z), \mathbb{1}_{fm}(z)\}$ with which (a) firms maximize profits given factor prices and

[42] Note that this model assumes perfect substitutability of foreign and domestic capital for simplicity; hence, firms only borrow either domestically or internationally, but not both. Appendix D.4 discusses a model extension in which domestic and foreign capital are not perfect substitutes.

[43] For example, one reason for investors to ration credit to firms when interest rates rise is to avoid adverse selection and moral hazard in the spirit of Stiglitz and Weiss [1981].

subject to the borrowing constraint, and (b) factor markets clear. The market-clearing conditions for capital goods and domestic savings, respectively, are:

$$K = \int_{z \leq z_{fm}} k(r_{dm}, r_K, z) dG(z) + \int_{z > z_{fm}} k(r_{fm}, r_K, z) dG(z) \tag{8}$$

$$B = \int_{z \leq z_{fm}} b(r_{dm}, r_K, z) dG(z) \tag{9}$$

Appendix D.1 describes the model solutions in detail.

6.1.2 Impact of Sanctions

Suppose a fraction θ of international borrowers are sanctioned before firms borrow and rent capital, forcing sanctioned firms to borrow only in the domestic market.[44] I can restate the market-clearing conditions for capital goods and domestic borrowings as:

$$K = \underbrace{\int_{z \leq z_{fm,post}} k(r_{dm,post}, r_{K,post}, z) dG(z)}_{\text{(a) capital used by unsanctioned domestic borrowers borrowing domestically post sanctions}} + \underbrace{\int_{z_{fm,post} < z \leq z_{fm}} k(r_{fm}, r_{K,post}, z) dG(z)}_{\text{(b) capital used by unsanctioned domestic borrowers borrowing internationally post sanctions}}$$
$$+ \underbrace{(1-\theta) \int_{z > z_{fm}} k(r_{fm}, r_{K,post}, z) dG(z)}_{\text{(c) capital used by unsanctioned international borrowers borrowing internationally post sanctions}} + \underbrace{\theta \int_{z > z_{fm}} k(r_{dm,post}, r_{K,post}, z) dG(z)}_{\text{(d) capital used by sanctioned international borrowers borrowing domestically post sanctions}} \tag{10}$$

$$B = \underbrace{\int_{z \leq z_{fm,post}} b(r_{dm,post}, r_{K,post}, z) dG(z)}_{\text{borrowings by unsanctioned domestic borrowers}} + \underbrace{\theta \int_{z > z_{fm}} b(r_{dm,post}, r_{K,post}, z) dG(z)}_{\text{borrowings by sanctioned borrowers}} \tag{11}$$

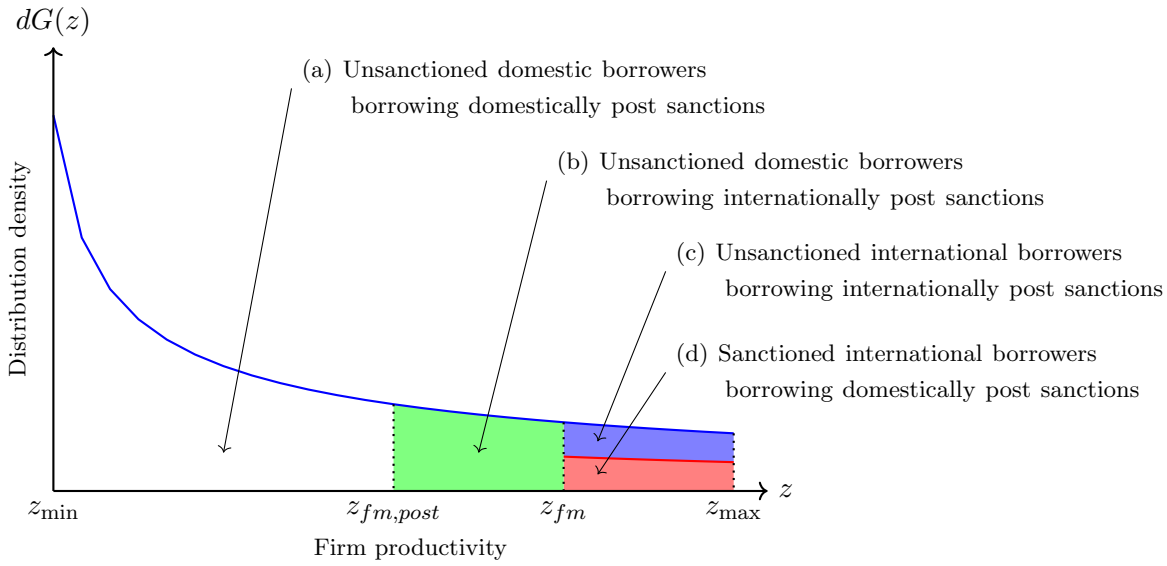
where $z_{fm,post}, r_{dm,post}$, and $r_{K,post}$ denote the post-sanctions foreign-market borrowing productivity threshold, post-sanctions interest rate on domestic borrowings, and post-sanctions interest rate on capital goods, respectively.

Note that as sanctions force the targets to borrow domestically, the post-sanctions domestic interest rate rises relative to the pre-sanctions level to clear the market for domestic borrowings ($r_{dm,post} > r_{dm}$). This induces some unsanctioned firms that borrowed domestically pre sanctions to borrow internationally post sanctions ($z_{fm,post} < z_{fm}$). The post-sanctions economy hence consists of (a) unsanctioned firms borrowing domestically pre and post sanctions, (b) unsanctioned firms borrowing domestically pre sanctions but internationally post sanctions, (c) unsanctioned firms borrowing internationally pre and post sanctions, and (d) sanctioned firms borrowing internationally pre sanctions but domestically post sanctions. This grouping is depicted in Figure 6 and

[44] I assume international borrowers are sanctioned proportionately across the productivity continuum; specifically, a fraction θ of firms with productivity $z, \forall z > z_{fm}$, are sanctioned.

Equation 10.

Figure 6: Firm productivity distribution and borrowing choices



Notes: This figure plots firm productivity distribution and firm borrowing choices. $z_{\min}$ and $z_{\max}$ denote minimum and maximum productivities of firms in the distribution, respectively. z_{fm} and $z_{fm,post}$ denote foreign-market borrowing productivity thresholds pre and post sanctions, respectively.

Impact on Firm Size. Measuring firm size in terms of its physical capital k, I can calculate the impact of sanctions on the size of a firm with productivity z as:

$$\Delta k(z) = \frac{k_{post}(z)}{k_{pre}(z)} - 1 = \frac{r_{K,pre}+\delta}{r_{K,post}+\delta} \cdot \frac{\min\left(b^*(r_{b,post}, r_{K,post}, z), \Gamma(r_{b,post}, r_{K,post}, z)\right)}{\min\left(b^*(r_{b,pre}, r_{K,pre}, z), \Gamma(r_{b,pre}, r_{K,pre}, z)\right)} - 1 \tag{12}$$

$$\approx -\frac{1}{1-\zeta} \cdot \Big(\underbrace{\eta \Delta r_b + \frac{\Delta r_K}{r_{K,pre}+\delta}}_{\text{change in effective capital rental rate}} + \underbrace{\Delta\Lambda(z)}_{\text{change in the borrowing constraint}} \Big) \tag{13}$$

where Equation 13 captures the log-linear approximation of the impact;

$$\Lambda(r_b, r_K, z) = \log \frac{b^*(r_b, r_K, z)}{\min\left(\Gamma(r_b, r_K, z), b^*(r_b, r_K, z)\right)} > 0 \tag{14}$$

measures the degree to which the borrowing constraint binds (a higher $\Lambda(\cdot)$ means the constraint is more binding); $\Delta\Lambda(z) = \Lambda(r_{b,post}, r_{K,post}, z) - \Lambda(r_{b,pre}, r_K, z)$ captures the change in the borrowing constraint; and $\Delta r_b = r_{b,post} - r_{b,pre}$ and $\Delta r_K = r_{K,post} - r_{K,pre}$ capture changes in the interest rates on borrowings and on capital goods post versus pre sanctions for the firm, respectively. Essentially, firm sizes are affected by changes in the effective capital rental rate, $\eta\Delta r_b + \frac{\Delta r_K}{r_{K,pre}+\delta}$, and changes

in the borrowing constraint, $\Delta\Lambda(z)$, faced by firms.

Impact on Relative Firm Sizes. For simplicity, suppose the borrowing constraint only binds in the domestic market, but sanctioned firms are sufficiently productive that they are never constrained. Using Equation 13, I can express the impact of sanctions on the size of a sanctioned foreign borrower with productivity z_s relative to that of an unsanctioned domestic borrower with productivity z_u as:[45]

$$\Delta k(z_s) - \Delta k(z_u) \approx -\frac{1}{1-\zeta} \cdot \left[\eta \cdot (\underbrace{r_{dm} - r_{fm}}_{>0}) - \underbrace{\Delta\Lambda(z_u)}_{>0}\right] \tag{15}$$

The impact of sanctions on relative firm sizes depends on (a) the difference in the pre-sanctions costs of borrowing of sanctioned versus unsanctioned firms and (b) the change in the borrowing constraint for unsanctioned firms. Based on Equation 15, sanctions will hurt an unsanctioned domestic borrower with productivity z_u more than a sanctioned international borrower with productivity z_s when the change in the borrowing constraint exceeds the pre-sanctions interest rate differential:

$$\eta(r_{dm} - r_{fm}) < \Delta\Lambda(z_u) \tag{16}$$

Illustration of the Effect on the Borrowing Constraint on Sanctions Impact. Figure 7 illustrates how sanctions affect firm sizes and how the borrowing constraint can cause unsanctioned firms to shrink by more than sanctioned firms. The figure plots firms' borrowings before and after sanctions versus their productivity. Since a firm borrows only to finance its usage of capital goods, the implication on firm sizes directly follows. For simplicity and without loss of generality, the figure assumes that all international borrowers are sanctioned, and therefore sanctions are equivalent to a complete financial autarky.

Without the borrowing constraint (the top panel), both sanctioned and unsanctioned firms reduce their borrowings (and shrink in size) as they face a higher domestic interest rate post sanctions.

[45] In this analysis, I compare the impact of sanctions on the size of a sanctioned international borrower (a firm in area (d) of Figure 6) to that of an unsanctioned firm that borrows domestically both pre and post sanctions (a firm in area (a)) because this group of unsanctioned firms constitutes the largest portion of the firm distribution. I can also calculate the impact of sanctions relative to an unsanctioned firm with productivity $z_{u,b}$ that borrows domestically pre sanctions but internationally post sanctions (a firm in area (b)) as:

$$\Delta k(z_s) - \Delta k(z_{u,b}) \approx -\frac{1}{1-\zeta} \cdot \eta \cdot \left(r_{dm,post} + r_{dm} - 2r_{fm} + \Lambda(r_{dm}, r_{K,pre}, z_{u,b})\right) < 0$$

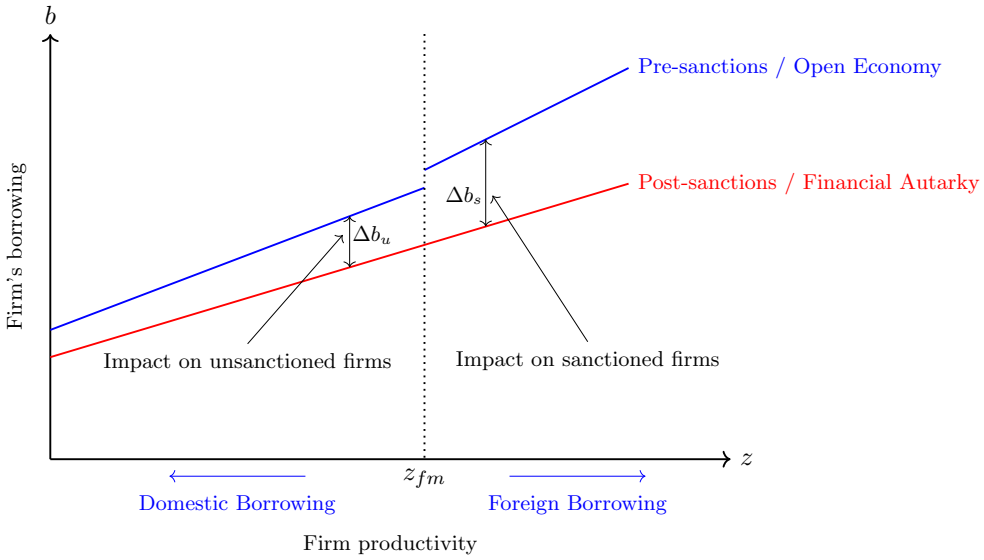
Similarly, I can calculate the impact of sanctions relative to an unsanctioned firm with productivity $z_{u,c}$ that borrows internationally both pre and post sanctions (a firm in area [c]) as:

$$\Delta k(z_s) - \Delta k(z_{u,c}) \approx -\frac{1}{1-\zeta} \cdot \eta \cdot \left(r_{dm,post} - r_{fm}\right) < 0$$

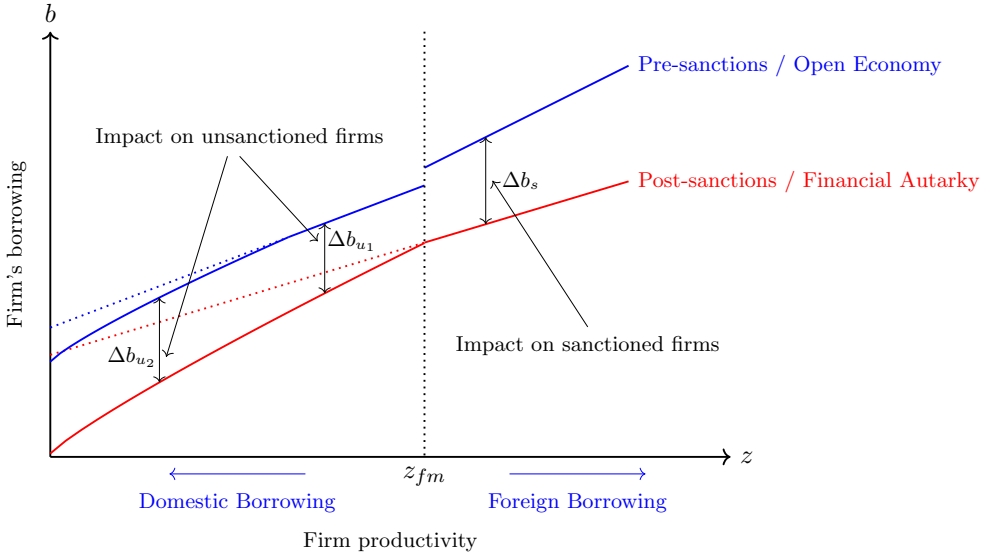
In these cases, the sanctioned firm shrinks by more than its unsanctioned peers as signified by the negative relative size impact. However, unsanctioned firms in area (b) and (c) constitute a small portion of the firm distribution.

Figure 7: Impact of sanctions on firms' borrowings

(A) Without Borrowing Constraint



(B) With Borrowing Constraint



Notes: These figures illustrate the impact of sanctions on firms' borrowings in the model without the borrowing constraint (top figure) and with the borrowing constraint (bottom figure). Each figure plots firm's borrowing before sanctions (solid blue line) and after sanctions (solid red line). The dotted blue and red lines in the bottom figure retrace firms' borrowings without the borrowing constraint. The figures assume that all international borrowers are sanctioned, and hence sanctions are equivalent to a financial autarky. z_{fm} denotes the foreign-market borrowing productivity threshold. Δb_s and $\Delta b_{u,\cdot}$ denote changes in borrowing by sanctioned and unsanctioned firms, respectively.

Since sanctioned international borrowers face a larger interest rate increase, they shrink proportionately by more than unsanctioned domestic borrowers ($|\frac{\Delta b_s}{b_{s,pre}}| > |\frac{\Delta b_u}{b_{u,pre}}|$). With the borrowing

constraint (the bottom panel), the constraint becomes more binding, especially for less productive unsanctioned domestic borrowers, as the domestic interest rate increases. Hence, although sanctioned international borrowers shrink post sanctions, some unsanctioned domestic borrowers shrink by more as the impact from the tighter borrowing constraint overwhelms the impact from the interest rate differential ($|\frac{\Delta b_s}{b_{s,pre}}| < |\frac{\Delta b_{u_1}}{b_{u_1,pre}}|, |\frac{\Delta b_{u_2}}{b_{u_2,pre}}|$).

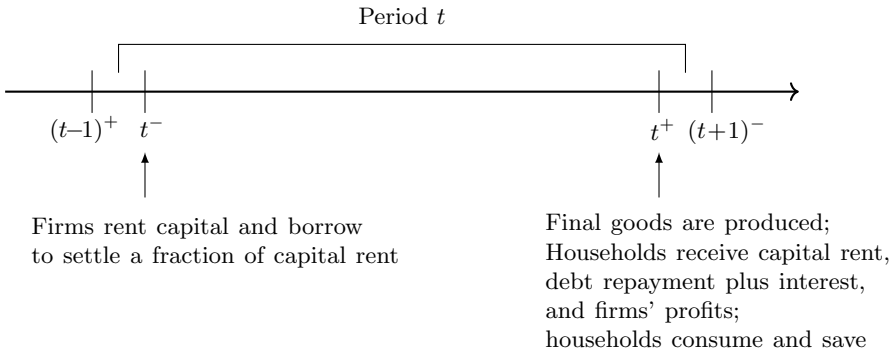
6.2 Multiperiod Dynamics

In this section, I extend the model to a dynamic setup and parameterize it to quantify the impact of sanctions, observe how the economy adjusts over time, and evaluate policy considerations.

6.2.1 Setup

Timing. Similar to Neumeyer and Perri [2005], time is discrete, and within each period t, there are two times: one at the beginning of the period, denoted by t^-, and one at the end of the period, denoted by t^+. Times t^+ and $(t+1)^-$ are arbitrarily close. Sanctions at time t occur after time $(t-1)^+$ and before time t^-. Figure 8 summarizes the timeline for the dynamic model.

Figure 8: Timeline of events



Firms. The setup for firms is the same as in the static model. Firms maximize profits period-by-period, taking into account the prevailing interest rates $r_{dm,t}$, $r_{fm,t}$, and $r_{K,t}$.

Household. A representative household owns aggregate capital goods K_t and aggregate savings B_t. At time t^-, the household supplies capital goods and lends to firms in competitive markets at a capital rental rate $R_t = r_{K,t} + \delta$ and a borrowing interest rate $r_{dm,t}$. It also owns all firms in the economy, from which it receives profits at time t^+. The household maximizes its lifetime utility:

$$\max_{t=0}^{\infty} \beta^t U(C_t) \tag{17}$$

where C_t denotes the household's consumption, and the utility function is given by $U(C_t) = \frac{C_t^{1-\sigma}-1}{1-\sigma}$, with σ capturing the inverse of the elasticity of intertemporal substitution. The household is subject to the sequence of budget constraints:

$$C_t + B_{t+1} + I_t + \Psi(K_{t+1}, K_t) \leq \Pi_t + (r_{K,t} + \delta)K_t + (1 + r_{dm,t})B_t \tag{18}$$

and the capital accumulation equation:

$$K_{t+1} = (1 - \delta)K_t + I_t \tag{19}$$

where $\Psi(\cdot)$ denotes the capital adjustment cost, I_t denotes the household's investment in capital goods, and $\Pi_t = \int \pi_t(z)dG(z)$ denotes aggregate profits from firms.

Equilibrium. An equilibrium is the set of prices $\{r_{dm,t}, r_{K,t}\}$, productivity threshold $z_{fm,t}$, sets of firm choices $\{b_t(z), k_t(z), \mathbb{1}_{fm,t}(z)\}$, and the household's consumption and investment choices $\{C_t, I_t\}$ with which (a) firms maximize profits given factor prices and subject to the borrowing constraint period-by-period, (b) factor markets clear period-by-period, and (c) the household maximizes its lifetime utility subject to budget constraints and the capital accumulation equation. The market-clearing conditions for capital goods and domestic savings, respectively, are:

$$K_t = \int_{z \leq z_{fm,t}} k_t(r_{dm,t}, r_{K,t}, z)dG(z) + \int_{z > z_{fm,t}} k_t(r_{fm,t}, r_{K,t}, z)dG(z) \tag{20}$$

$$B_t = \int_{z \leq z_{fm,t}} b_t(r_{dm,t}, r_{K,t}, z)dG(z) \tag{21}$$

6.2.2 Quantitative Analysis

Calibration. Table 7 lists parameter values for the model. There are three types of parameters: (a) preset parameters ($\zeta, \delta, \sigma, \eta$, and ψ), which are set to conventional values; (b) observed parameters ($r_{fm,pre}, r_{fm,post}, \theta$, and z_c), which are estimated from the data, and (c) calibrated parameters ($\beta, \gamma, \kappa, z_{\min}, z_{\max}$, and α), which are chosen to produce targeted moments that closely match the data in Table 8 ($r_{dm}, r_{dm,post}, \overline{\Delta k_s} - \overline{\Delta k_u}, k_{\min}, k_{\max}$, and Ω_{fm}). Appendix D.2 provides details on the calibration, and Appendix D.3 discusses the model without the borrowing constraint.[46]

[46]Three calibration details are worth noting. First, the model assumes firms need to settle all of their capital rent before final goods are produced ($\eta = 1$) per Neumeyer and Perri [2005]. While this implies sizable financial frictions, it allows the model to yield the debt-to-asset ratio $\frac{B+B_{fm}}{K}$ that is close to the data. Second, while β is commonly a preset parameter, this model requires it to be calibrated as it, together with γ, determine the domestic interest rates, r_{dm} and $r_{dm,post}$. Although my calibrated $\beta = 0.80$ is low compared to conventional values in the literature—for instance, Gopinath et al. [2017] assume $\beta = 0.87$—this is because I target the interest rates in my model to the average interest rates of syndicated borrowings by Russian firms, which include risk premiums. Note that because of the borrowing constraint, the equilibrium domestic interest rate is lower than $\frac{1}{\beta} - 1$, typically implied by a standard model. Finally, this calibration also matches the relative moments, particularly the relative size impact, to the empirical results, and the absolute moments, such as the impact on the sizes of sanctioned and unsanctioned firms, are outputs of the model.

Table 7: Model parameters

Parameter	Description	Value	Source
Preset Parameters:			
ζ	Production function's elasticity of capital	0.35	Gopinath et al. [2017]
δ	Capital depreciation rate	0.06	Gopinath et al. [2017]
σ	Household's CRRA coefficient	2.00	Gopinath et al. [2017]
η	Fraction of capital rent to be settled upfront	1.00	Neumeyer and Perri [2005]
ψ	Coefficient for capital adjustment cost	3.20	Gopinath et al. [2017]
Observed Parameters:			
$r_{fm,pre}$	Foreign interest rate, pre-sanctions	5.25%	Average interest rate of borrowings in the G10 currencies in 2013, plus 1.5% average annual RUB/USD depreciation
$r_{fm,post}$	Foreign interest rate, post-sanctions	6.00%	Pre-sanctions foreign interest rate, plus 0.75% post-sanctions incremental country risk premium
θ	Portion of international borrowers that were sanctioned	33.7%	The aggregate assets of sanctioned borrowers relative to the aggregate assets of all companies in the sample
z_c	Productivity threshold for borrowing constraint	z_{fm}	Assume all domestic borrowers are subject to borrowing constraints
Calibrated Parameters:			
β	Household's discount rate	0.80	
γ	Constraint shape parameter	5.86	
κ	Fixed cost for foreign borrowings	1.87	
$z_{\min}$	Minimum firm productivity	0.60	
$z_{\max}$	Maximum firm productivity	41.97	
α	Productivity distribution shape parameter	0.98	

Notes: This table lists the parameters, parameter values, and sources of the values for the dynamic model. The calibrated parameters are chosen to match the targeted moments in Table 8.

Based on Table 8, the model reasonably matches targeted and untargeted moments to the data. The model also accurately estimates the decline in aggregate foreign borrowings but underestimates the increase in domestic borrowings and the decline in GDP and consumption. This is presumably because the Russian economy also suffered other macroeconomic shocks concurrently with sanctions. Based on the actual drop in output and consumption in Russia in 2015 of 2% and 9%, respectively, these results suggest that sanctions explain approximately 20% of the drop in consumption and 50% of the drop in output of the Russian economy during that period.

Impulse Responses. Figure 9 illustrates the impulse responses of sanctions outcomes. Immediately post sanctions, sanctioned firms shrank by 7% (Panel B) but unsanctioned firms shrank by 27% (Panel C), resulting in a positive net impact of 20% (Panel A). The domestic interest rate rises by 2% (Panel D) given heightened demand for domestic capital. For macroeconomic impact,

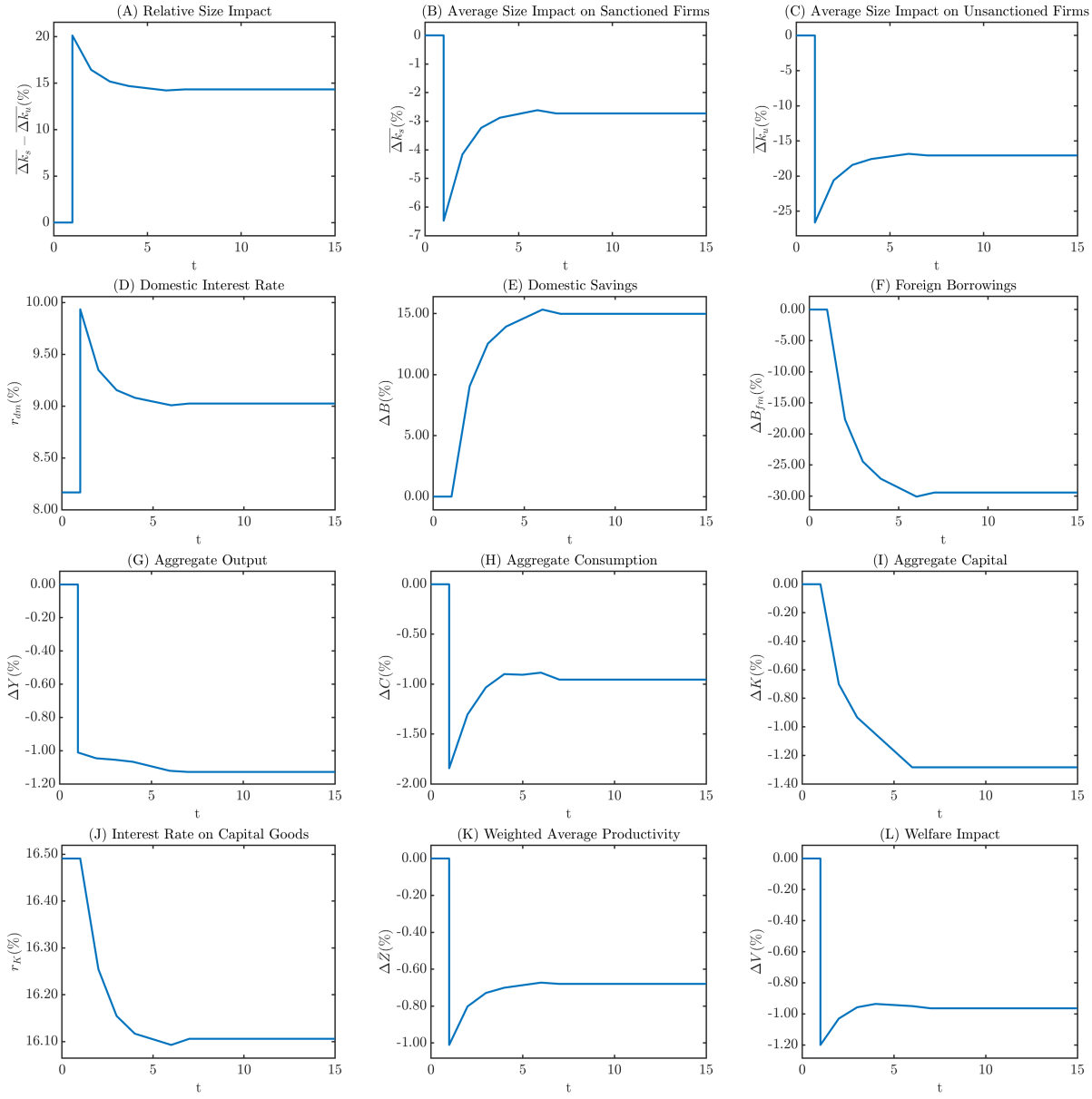
Table 8: Model moments

Parameter	Description	Model	Data	Source
Targeted Moments:				
r_{dm}	Domestic interest rate, pre-sanctions	8.2%	8.1%	Sample statistics for the average interest rate of borrowings in the Russian ruble in 2013
$r_{dm,post}$	Domestic interest rate, post-sanctions	9.9%	10.3%	Sample statistics for the average interest rate of borrowings in the Russian ruble in 2015
$\overline{\Delta k_s} - \overline{\Delta k_u}$	Relative impact of sanctions	20.1%	28.7%	Relative impact of sanctions per Table 3
$k_{\min}$	Minimum assets	0.05	0.05	Sample statistics as of December 2013
$k_{\max}$	Maximum assets	573	556	Sample statistics as of December 2013
Ω_{fm}	Portion of firms that borrow internationally	0.9%	0.9%	Sample statistics as of December 2013
Untargeted Moments:				
$\frac{B_{fm}}{B+B_{fm}}$	Foreign borrowings as a percent of total borrowings	40.4%	36.8%	Aggregate statistics as of December 2013 per Bank of Russia [2022a,b,c]
$\frac{B+B_{fm}}{K}$	Debt to asset ratio	22.5%	21.3%	Sample statistics as of December 2013
ΔB_{fm}	Change in external borrowings	-29.4%	-29.8%	Change in external borrowings for Russia from 2013 to 2016 per Bank of Russia [2022a]
ΔB	Change in domestic borrowings	15.0%	34.9%	Change in domestic borrowings for Russia from 2013 to 2016 per Bank of Russia [2022c]
ΔY	Change in real GDP	-1.0%	-2.0%	2015 statistics per International Monetary Fund [2022b]
ΔC	Change in real consumption	-1.8%	-9.4%	2015 statistics per International Monetary Fund [2022b]
Policy Considerations:				
θ^*_{LT}	Neutral sanctions proportion (LT)	41%		
θ^*_{ST}	Neutral sanctions proportion (ST)	12%		

Notes: This table lists targeted and untargeted moments for the quantitative model. The post-sanctions interest rate, the relative size impact, and changes in output and consumption are measured immediately post sanctions. Changes in foreign and domestic borrowings are based on the post-sanctions versus pre-sanctions steady states. Other model moments are based on the pre-sanctions steady state. Neutral sanctions proportions capture the portions of international borrowers that can be sanctioned such that unsanctioned firms on average are *not* harmed more than the sanctioned ones in the short run (ST) and in the long run (LT).

sanctions hurt aggregate output by 1% (Panel G) as the higher cost of domestic borrowings and credit rationing force sanctioned and unsanctioned domestic borrowers to reduce their output. The decline in output directly hits consumption by -2% (Panel H), which is more than the drop output in the short run given incremental savings by the household.

Figure 9: Impulse responses to sanctions



Notes: These figures plot the impulse responses to sanctions based on the baseline calibration. Time period is in years. Sanctions occur before the beginning of period 1.

In the long-run, the impact of sanctions partially dissipate as the household saves more (Panel E) to replace foreign capital (Panel F) with domestic savings and the domestic interest rate subsides. Nevertheless, sanctioned and unsanctioned firms remain 3% and 17% below their pre-sanctions sizes in the long run, respectively. Over time, the household also divests capital goods by 1% given lower long-term demand (Panel I), and this causes long-run output to remain

subdued. Consumption also partially rebounds as the need for incremental savings subsides and as firms pay less in foreign financing cost given lower foreign borrowings. Ultimately, sanctions reduce the household's welfare by 1% (Panel L).[47]

Intensive Margin of Sanctions Impact. The effect of sanctions on the target economy highlights the role of the domestic interest rate as an allocator of capital between firms. It also underscores the *intensive* margin of sanctions impact on domestic capital allocation. As the domestic interest rate rises post sanctions, capital goods are reallocated away from sanctioned international borrowers and unsanctioned domestic borrowers (firms in area [a] and [d] of Figure 6) toward unsanctioned international borrowers (firms in area [b] and [c]). This aggravates the inefficient allocation of productive assets, with firms operating at different marginal product of capital (MPK), resulting in a drop in aggregate productivity (Panel K).[48] As such, even though firm productivity is fixed, aggregate productivity is impaired by the capital misallocation. This effect partially dissipates over time as the economy accumulates more savings, the borrowing constraint eases, and capital goods are reallocated back in favor of more productive firms.

7 Policy Implications

The success of sanctions in halting international borrowings by the targets demonstrates the power of the United States to inflict damage on its adversaries through financial exclusion. Such power arises from global reliance on the dollar-based financial system, which remains supreme even in post-sanctions Russia. Nevertheless, the spillover impact of targeted sanctions and the impermanence of the policy impact should prompt policymakers to reevaluate how they implement the policy going forward.

Neutral Sanctions Proportions. To help calibrate future policy, I explore the extent to which sanctions can be imposed with limited spillover impact on untargeted firms. I solve for a *neutral sanctions proportion* θ^*, which captures the portion of international borrowers that can be sanctioned such that unsanctioned firms on average are not harmed more than the sanctioned ones.[49]

[47] Similar to Uribe and Schmitt-Grohé [2017], welfare impact is measured in terms of the change in the stream of consumption required to make the household as content as before sanctions.

[48] The aggregate productivity is defined as as the weighted average productivity of all firms in the economy: $Z_t = \int z\left(\frac{k(r_{b,t},r_{K,t};z)}{K_t}\right)^{\zeta} dG(z)$. In this manner, I have that $Z_t K_t^{\zeta} = \int zk(r_{b,t}, r_{K,t}; z)^{\zeta} dG(z)$, which describes aggregate output as a function of aggregate productivity and aggregate capital.

[49] Specifically, I recalculate the dynamic model using the same parameter values as in Table 7 but adjust the portion of international borrowers that were sanctioned (θ) such that the impact of sanctions on relative firm sizes ($\Delta\bar{k}_s - \Delta\bar{k}_u$) is zero. For neutral short-term impact (θ^*_{ST}), I target zero relative size impact immediately after sanctions. For neutral long-term impact (θ^*_{ST}), I target zero relative size impact after the economy has reached its post-sanctions steady state. Note that since the analysis assumes that international borrowers are sanctioned proportionately across the firm productivity continuum, the proportion reflects an asset proportion.

Excluding the impact of sanctions on the cost of foreign borrowings for other Russian firms, policymakers can sanction 12% of Russian international borrowers without ever harming untargeted firms on average more than the targets ($\theta^*_{ST} = 12\%$). This compares to the actual sanctions proportion of 34%. If policymakers are only concerned with the long-term impact, they can sanction 41% of Russian international borrowers with zero relative impact in the long run ($\theta^*_{LT} = 41\%$). Note that neutral sanctions proportions depend on the restrictiveness of the borrowing constraint. As the domestic capital market becomes less restrictive ($\gamma \downarrow$), more targets could be sanctioned without excessive spillover impact.[50]

Alternative Sanctions Approaches. I also consider how U.S. policymakers may impose sanctions more effectively. Using the model from Section 6.2.2, I observe how other sanctions approaches may affect firms and the target economy. Besides the incumbent approach of **(A) imposing financial autarky** ($r_{fm,i} \to \infty$), I also consider: **(B) raising the country premium** ($r_{fm} \uparrow$) to increase the foreign-borrowing cost for all international borrowers; **(C) imposing a foreign-borrowing surcharge** ($r_{fm,i} \uparrow$) to increase the foreign-borrowing costs for target firms; and **(D) impairing productivity** ($z_i \downarrow$) of the targets.[51]

Table 9 summarizes the trade-offs of these policy options. Ultimately, suitable policy choices depend on policymakers' objectives. If policymakers want to inflict the most damage on the targets regardless of the spillover impact, imposing financial autarky (A) proves the most powerful (-9.5% size impact on the targets and -17.7% on the non-targets); however, its effect dissipates. To also maintain the persistency of the impact, policymakers may instead levy foreign-borrowing surcharges (C) on the targets (-6.4% and -10.2% size impact on the targets and the non-targets, respectively, for a 1.7% interest surcharge). If policymakers also want to concentrate the damage on the targets, impairing the targets' productivity (D) are more appropriate (-6.5% size impact on the targets and de minimis impact on the non-targets for a 4.4% productivity hit).[52] Conversely, if the goal is to inflict the most damage on the target economy, increasing the country premium (B) is the most potent. Appendix E discusses these policy alternatives in detail.

Should policymakers care about spillover impact? Besides ethical grounds of limiting collateral damage on civilians, a principal motivation for targeted sanctions is that prior comprehensive sanctions efforts not only failed to turn the citizens of target nations against their governments but

[50] One way to measure the degree to which the domestic borrowing constraint binds is by observing the dispersion of firm MPKs, as suggested by Gopinath et al. [2017]. This is because the borrowing constraint forces firms to operate sub-optimally with MPKs that deviate from the average cost of capital. High dispersion of firm MPKs hence implies high degrees of constraint in the domestic capital market.

[51] For (B), one may consider the U.S. measures to force a Russian sovereign default or to cut off companies from the SWIFT transaction network in 2022 as equivalent to this approach since these measures make it more difficult and more expensive for firms to use and access foreign capital. For (C), if the target's borrowing costs are raised high enough, the target firms will borrow domestically, rendering this equivalent to the financial autarky approach. For (D), policymakers may limit supply of critical intermediate goods to target firms, rendering them less effective.

[52] Approaches (C) and (D) are calibrated to equalize their average short-term impacts on sanctions targets to that in the baseline model.

Table 9: Comparison of alternative sanctions approaches

			Policy Alternatives			
Parameter/Outcome	**Variable**	**Baseline Model**	**(A) Financial Autarky**	**(B) Country Premium**	**(C) Foreign Borrowing Surcharge**	**(D) Productivity Hit**
Sanctions Parameters:						
Country risk premium	$\rho_{country}$	0.75%	–	0.75%	–	–
Interest rate surcharge	ρ_{sanc}	∞	∞	–	1.65%	–
Productivity hit	Δz_{sanc}	–	–	–	–	-4.40%
Short-term Impact:						
GDP	Y_1	-1.0%	-0.5%	-0.7%	-0.3%	-0.4%
Consumption	C_1	-1.8%	-1.5%	-0.2%	1.1%	-0.0%
Size impact – Sanctioned	$\overline{\Delta k_s}$	-6.5%	-9.5%	2.6%	-6.4%	-6.5%
Size impact – Unsanctioned	$\overline{\Delta k_u}$	-26.6%	-17.7%	-14.4%	-10.2%	-0.1%
Size impact – Relative	$\overline{\Delta k_s} - \overline{\Delta k_u}$	20.1%	8.3%	17.1%	3.8%	-6.4%
Domestic interest rate	$r_{dm,1}$	9.9%	9.4%	8.9%	8.9%	8.2%
Long-term Impact:						
GDP	Y_{ss}	-1.1%	-0.4%	-0.8%	-0.2%	-0.4%
Consumption	C_{ss}	-1.0%	-0.2%	-0.9%	-0.9%	-0.5%
Size impact – Sanctioned	$\overline{\Delta k_{s\,ss}}$	-2.7%	-5.6%	2.7%	-6.6%	-6.7%
Size impact – Unsanctioned	$\overline{\Delta k_{u\,ss}}$	-17.1%	-3.6%	-15.1%	-22.2%	-2.3%
Size impact – Relative	$\overline{\Delta k_{s\,ss}} - \overline{\Delta k_{u\,ss}}$	14.3%	-2.0%	17.8%	15.6%	-4.3%
Domestic interest rate	$r_{dm,ss}$	9.0%	8.4%	8.9%	9.9%	8.4%
Welfare impact	ΔV_{ss}	-1.2%	-0.6%	-0.7%	-0.3%	-0.4%
Domestic Savings	ΔB	15.0%	17.8%	-4.5%	-26.1%	-4.2%
Foreign Borrowings	ΔB_{fm}	-29.4%	-26.7%	0.2%	48.7%	6.7%

Notes: This table compares the outcomes in response to different sanctions approaches. Short-term impact is measured immediately post sanctions. Long-term impact is measured after the economy has reached its new steady state. Welfare impact is measured as compensating variation (Uribe and Schmitt-Grohé [2017]), calculated based on the value function in the year immediately post sanctions. The changes in domestic savings and foreign borrowings are based on changes from the pre-sanctions steady state to the post-sanctions steady state. Approaches (A) and (B) capture the decomposition of the baseline model. Approaches (C) and (D) are calibrated to equalize their average short-term impacts on sanctions targets to that in the baseline model.

also ended up turning them against the United States (Weiss [1999], Cortright and Lopez, eds [2002], Brzoska [2003], Staibano and Wallensteen, eds [2005]). Targeted sanctions that ignore collateral damage hence risk repeating prior experiences. In particular, if the ultimate goal of sanctions is to influence political actions, it is plausible that a concentrated sanctions impact is required to overcome the collective action problem and instigate change (Olson [1971]).

However, ceratain circumstances may justify policymakers deprioritizing the spillover effect. For instance, in times of active warfare, policymakers may opt to maximize the economic harm on the target economy, regardless of the spillover impact, in order to weaken the target government's ability to wage war. The 2022 Russia's invasion of Ukraine may be deemed such circumstance.

2022 Sanctions. After Russia initiated its invasion of Ukraine in February 2022, the United States and its allies have launched a series of sanctions actions against Russia. In contrast to the 2014 episode in which sanctions were targeted, the 2022 measures have been more broad-based. This includes a blocking sanction on the CBR, bans on use of the SWIFT global messaging system, forcing a Russian sovereign default, and limitations on purchases of Russian oil and natural gas, among others.[53] Such a comprehensive approach is consistent with the stated objective per the current secretary of the treasury Janet Yellen, who indicated that the current sanctions round aims "to impose maximum pain on Russia, while to the best of [the policymakers'] ability shielding the United States and [its] partners from undue economic harm" (Rappeport and Rogers [2022]).

Despite different policy objectives, the current sanctions efforts rely on the same mechanism described in this paper. Thus, this study offers relevant insights as follows. First, policymakers can maximize damage on the Russian economy by capitalizing on the spillover impact to aggravate the inefficient capital allocation. This could be achieved by sanctioning the largest firms or firms for which the borrowing constraint is the most binding. Second, to make the sanctions impact persistent, policymakers should keep the targets reliant on foreign capital and prevent a substitution into domestic capital. This could entail targeting firms that rely on foreign currency for their operations or restricting the capacity of Russian institutions to expand the domestic capital market. Finally, policymakers must also consider the long-term implications of their efforts, in particular that over time the Russian economy will adjust and become more resilient to similar sanctions in the future.[54] In the context of repeated games in international affairs, policymakers may need to reconsider implementing sanctions simply because it is deemed "the best of a bad set of options."

[53] As of March 3, 2022, other announced measures include blocking sanctions on two Russian state-owned banks, VEB and Promsvyazbank (PSB), and prohibitions on transactions in Russian sovereign debt. Furthermore, foreign investors and businesses have also practically "shunned anything Russian." For instance, even though Russian oil was not yet sanctioned as of March 3, 2022, investors and businesses did not want exposure to it for fear of breaking existing sanctions (Egan [2022]).

[54] For instance, cross-border claims and liabilities of Russian banks in foreign currencies have declined by 48% and 22%, respectively, since 2014; in fact, the claims and liabilities in the U.S. dollar have declined by even more, by 80% and 43%, respectively (Bank for International Settlements [2021, 2015]). This leaves fewer targets available for subsequent sanctions and likely makes such actions less damaging.

Implications on the Dollar Dominance. Frequent use of U.S. sanctions also raise questions about the reliability of the U.S. dollar as an international currency. Even though the dominance of the U.S. dollar in Russia remains unchallenged post sanctions, its usage has declined, so far replaced by the euro and the Russian ruble as shown in Appendix Figure F.6. While the U.S. dollar represented 70% and 67% of Russia's external assets and liabilities in 2015, respectively, those ratios became 56% and 43% in 2021 (Central Bank of Russia [2022]). The declining role of the U.S. dollar in the Russian economy also spills over into trade; while the U.S. dollar represented 80% and 40% of Russia's trade inflows and outflows in 2013, respectively, those figures became 54% and 36% in 2021 (Central Bank of Russia [2022]). If another currency emerges to compete with the dollar as the international currency, the shift away from the U.S. dollar could be further expedited (Farhi and Maggiori [2018], Clayton et al. [2022]).

8 Conclusion

In this paper, I study the impact of the U.S. financial sanctions against Russian companies in the aftermath of Russia's annexation of Crimea in 2014. I find that while the sanctions program successfully curtailed foreign borrowings by sanctioned firms, it produced the unintended consequence wherein unsanctioned firms shrank by more than the sanctioned ones. I explain this result through an interaction between firm size and productivity dynamics, borrowing constraints, and state actions that resulted in crowding out of and credit rationing to unsanctioned firms. The research provides implications on how U.S. policymakers may calibrate future sanctions programs, discusses policy alternatives, and offers relevant insights for the 2022 sanctions episode.

Although this paper focuses on sanctions, it also offers broader insights into the implications of foreign capital flows on domestic economies. Since sanctions are equivalent to the reverse of financial liberalization, the results from this study suggest that domestic borrowers may benefit (lose) from foreign capital inflows (outflows) more than international borrowers that access such capital directly themselves. Such firm size dynamic supports the notion that financial liberalization benefits—and capital control hurts—small companies by affecting firm financial constraints. Policymakers hence need to consider the distributional consequences of foreign borrowings, and they may need to support small firms during sudden stops and promote domestic capital market development to ease financial frictions and allow for efficient capital allocation.

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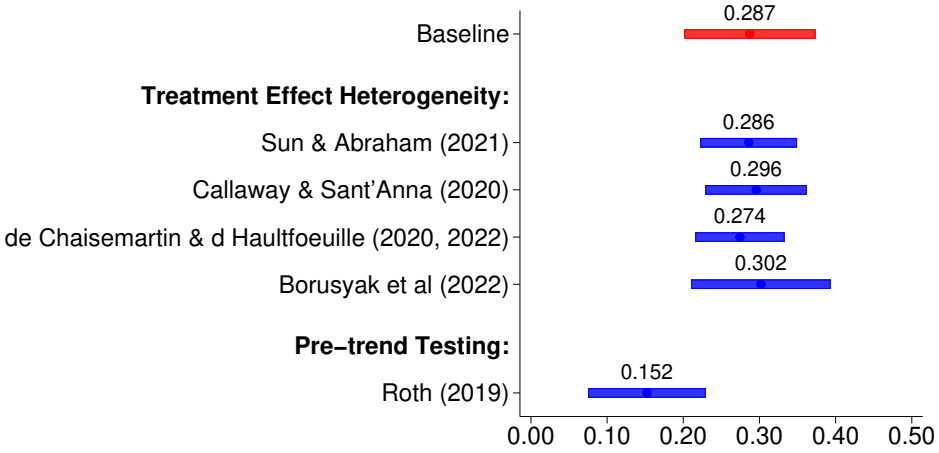
Appendices

A Robustness

The empirical analysis in this paper relies on a difference-in-differences (DD) research design with staggered treatment, in which firms were added to the sanctions lists at different times and generally remained on the lists once added. A number of recent papers argue that DD studies with two-way fixed effects (TWFE) specifications, such as the one in Equation 1, can suffer from bias in settings with staggered adoption, especially when the treatment effects are heterogeneous across groups and across periods (Borusyak et al. [2017], de Chaisemartin and D'Haultfœuille [2020], Borusyak et al. [2021], Callaway and Sant'Anna [2021], Goodman-Bacon [2021], Sun and Abraham [2021], Athey and Imbens [2022], de Chaisemartin and D'Haultfœuille [2022]). The criticism revolves around potential negative weights assigned by TWFE regressions to certain group-time treatment effects. The negative weights introduce bias and may even cause the estimator to yield the wrong sign.

To address these concerns, I first decompose the baseline TWFE estimator to examine the contributions to the aggregate result from each 2×2 DD regression using the procedure proposed by Goodman-Bacon [2021]. Then, I analyze the impact of sanctions on relative firm sizes using alternative estimators proposed by Sun and Abraham [2021], Callaway and Sant'Anna [2021], de Chaisemartin and D'Haultfœuille [2020], and Borusyak et al. [2021]. These alternative estimators allow for treatment effect heterogeneity and address other potential concerns related to TWFE specifications. Furthermore, I use the median-unbiased estimator proposed by Roth [2019] to address another potential bias arising from pre-trend testing. Appendix Figure A.1 summarizes the results, showing that these alternative estimators yield estimates that are in line with the baseline coefficient from Table 3. The results reaffirm the key finding that sanctioned firms shrank in size by *less* than their unsanctioned peers after sanctions. In the following subsections, I discuss each of these robustness tests in detail.

Figure A.1: Impact of sanctions on relative firm sizes – Alternative estimators



Notes: This graph reports the impact of sanctions on relative firm sizes based on various estimators. The min-max ranges capture the 95% confidence intervals, where standard errors are clustered at the firm level for the baseline estimator reported in Table 3 and the alternative estimators proposed by Sun and Abraham [2021], Roth [2019], de Chaisemartin and D'Haultfœuille [2020, 2022] and Borusyak et al. [2021]. The confidence interval for the estimator proposed by Callaway and Sant'Anna [2021] is based on simultaneous confidence bands for group-time average treatment effects, estimated by a wild bootstrap procedure.

A.1 Difference-in-Differences Decomposition (Goodman-Bacon [2021])

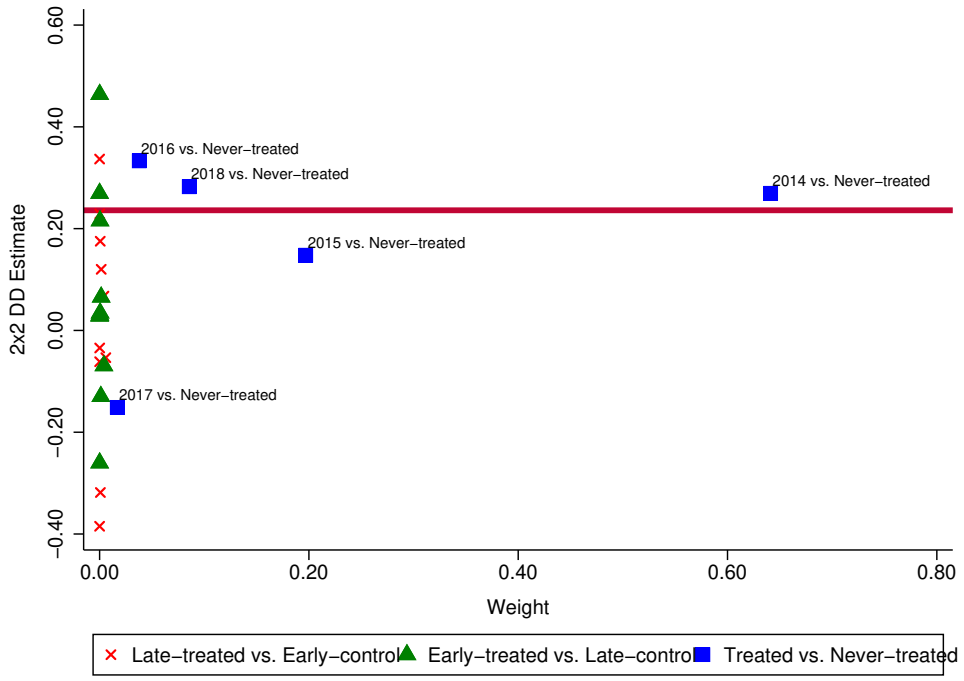
To assess the severity of the potential negative weight issue in my baseline result, I utilize the procedure introduced by Goodman-Bacon [2021] to decompose the TWFE estimator of the average impact of sanctions on relative firm sizes into a combination of 2×2 DD estimators that compare timing groups to each other.[55] Appendix Figure A.2 displays the results, plotting the 2×2 DD estimators for each timing group on the y-axis against their weights in the TWFE estimator on the x-axis. The results indicate that the TWFE estimator ascribes the most weight to the treatment effects of sanctions on target firms relative to never-sanctioned firms, especially for the 2014 and 2015 sanctions cohorts (64% and 20% weights, respectively).[56] The TWFE estimator also ascribes de minimis weight (less than 1%) to the treatment effects of the problematic comparisons of later-sanctioned groups as treated relative to earlier-sanctioned groups as control, as well as to the treatment effects of earlier-sanctioned groups as treated relative to later-sanctioned groups as control (also less than 1% weight). Furthermore, the treatment effects are positive and sizable for most sanctions cohorts relative to never-sanctioned firms, except for the 2017 sanctions cohort, but that 2×2 DD estimator carries a small weight (less than 2%) given that few firms were sanctioned

[55] Note that each of these 2×2 DD estimates captures the average treatment effect on the treated (ATT) of that treatment cohort against the specified control cohort.

[56] The TWFE estimate in this analysis of 0.236 is smaller than the baseline result of 0.287 as this analysis confines the sample to firms with assets statistics during 2013–2018 to ensure a balanced panel required by the procedure.

in that year.

Figure A.2: Difference-in-Differences Decomposition (Goodman-Bacon [2021])



	vs. Never-treated					Early-treated	Late-treated
	2014	2015	2016	2017	2018	vs. Late-control	vs. Early-control
β	0.270	0.148	0.333	-0.151	0.282	-0.025	-0.024
Weight	0.641	0.197	0.038	0.017	0.086	0.008	0.008

Notes: The graph reports the 2×2 DD estimators (y-axis) versus their weights in the TWFE estimator (x-axis). The red horizontal line indicates the overall average treatment effect on the treated. The sample is confined to firms with financial statistics during 2013–2018 to ensure a balanced panel.

Ultimately, these results suggest that the concern around potential negative weights in the TWFE estimator is immaterial, aided by the presence of a large number of never-sanctioned firms in my sample. Hence, one can interpret my baseline results primarily as the weighted average treatment effects of sanctions on target firms relative to never-sanctioned firms with emphasis on the 2014 and 2015 sanctions cohorts.

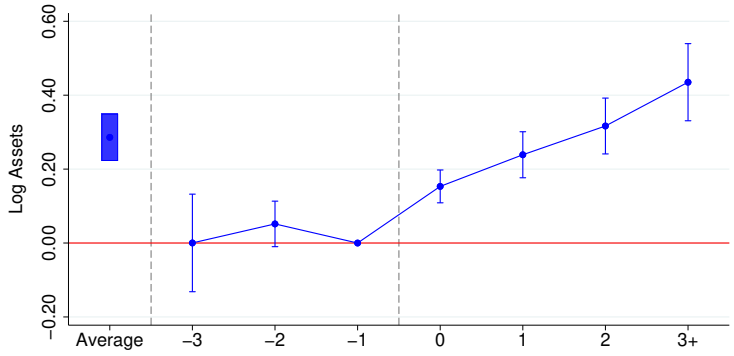
A.2 Contamination of Treatment Effects across Periods (Sun and Abraham [2021])

Besides the concern around potential negative weights, Sun and Abraham [2021] also show that TWFE regressions with dynamic specifications that include leads and lags of the treatment may yield coefficients on given leads or lags that are contaminated by effects from other periods,

particularly in settings with variation in treatment timing across units. Such contamination confounds the interpretation of relative period coefficients, including for the pre-treatment periods. To address such potential contamination in my study, I apply the interaction-weighted (IW) estimator proposed by Sun and Abraham [2021] to observe the impact of sanctions on relative firm sizes by relative event period. The IW estimator averages the cohort average treatment effects on the treated (CATTs) at each relative period using weights based on their sample shares.

Appendix Figure A.3 plots the results, including the average treatment effect for all post-treatment periods. The IW estimators do not differ much from the baseline results in Table 3 and hence confirm their robustness. Appendix Table A.1 also reports the CATTs and their associated weights in the aggregate estimators at each relative period in the brackets. Notice that the weights for the IW estimators (the first numbers) do not differ much from the weights for the TWFE estimators (the second numbers), thereby explaining the comparability of the two estimators. The table also shows that most of the weights in the IW estimators are attributable to the CATTs of the 2014 and 2015 sanctions cohorts, as similarly shown in Section A.1.

Figure A.3: Impact of sanctions on relative firm sizes (Sun and Abraham [2021])



	Average	$t-3$	$t-2$	t	$t+1$	$t+2$	$t+3+$
Sanctioned	0.286	0.000	0.052*	0.153***	0.239***	0.317***	0.435***
	(0.032)	(0.067)	(0.031)	(0.023)	(0.032)	(0.039)	(0.053)

Notes: Figure plots the impact of sanctions on the log of total assets of Russian firms by relative event year per Sun and Abraham [2021]. The min-max ranges capture the 95% confidence intervals. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.1: Impact of sanctions by cohort and associated weights on the aggregate estimators

	$t-3$	$t-2$	t	$t+1$	$t+2$	$t+3+$
2014 sanctions	0.058	0.082**	0.142***	0.233***	0.332***	0.454***
	(0.079)	(0.040)	(0.023)	(0.035)	(0.042)	(0.057)
	[0.68/0.64]	[0.70/0.65]	[0.72/0.68]	[0.73/0.68]	[0.81/0.79]	[0.89/0.86]
2015 sanctions	-0.095	-0.095	0.134	0.208**	0.262***	0.247*
	(0.144)	(0.069)	(0.085)	(0.097)	(0.095)	(0.144)
	[0.16/0.16]	[0.15/0.17]	[0.15/0.15]	[0.15/0.16]	[0.15/0.17]	[0.10/0.12]
2016 sanctions	-0.120	0.027	0.135	0.506**	0.509*	0.672**
	(0.101)	(0.119)	(0.198)	(0.246)	(0.277)	(0.306)
	[0.02/0.03]	[0.02/0.03]	[0.02/0.02]	[0.02/0.03]	[0.02/0.03]	[0.01/0.01]
2017 sanctions	0.087	-0.230	-0.082	-0.388	-0.375	
	(0.088)	(0.205)	(0.160)	(0.293)	(0.332)	
	[0.02/0.02]	[0.02/0.02]	[0.01/0.02]	[0.01/0.01]	[0.01/0.02]	
2018 sanctions	-0.232	0.090	0.302***	0.350***		
	(0.313)	(0.091)	(0.092)	(0.095)		
	[0.11/0.13]	[0.10/0.12]	[0.09/0.12]	[0.09/0.12]		
2019 sanctions	0.128	0.265	0.326			
	(0.162)	(0.201)	(0.340)			
	[0.01/0.02]	[0.01/0.02]	[0.01/0.01]			

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms for each sanctions cohort by relative event year and their weights in the aggregate estimators. Numbers in square brackets denote the weights that each sanctions cohort contributes to the aggregate estimators in their respective columns. The first numbers represent the weights for the IW estimators per Sun and Abraham [2021], and the second numbers represent the weights for the TWFE estimators. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.3 Alternative Aggregation of Treatment Effects (Callaway and Sant'Anna [2021])

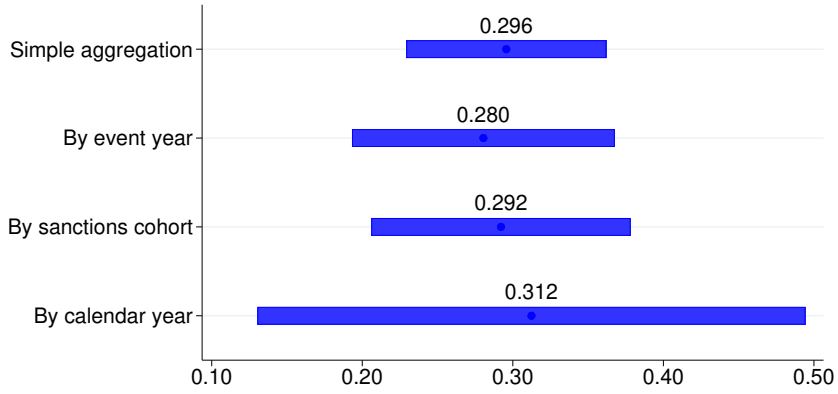
To address treatment effect heterogeneity, Callaway and Sant'Anna [2021] introduce group-time average treatment effects as building blocks to analyze the causal effects.[57] These group-time average treatment effects allow for heterogeneity with respect to observed covariates, treatment timing, and the evolution of treatment effects over time (dynamic treatment effects). The authors also propose alternative aggregation schemes to highlight treatment effect heterogeneity across different dimensions and suggest a bootstrap procedure to conduct asymptotically valid simultaneous (instead of pointwise) inference.

Appendix Figure A.4 summarizes the average treatment effects on the treated (ATTs) of sanctions on firm sizes under different aggregation schemes, including the aggregation for all sanctions cohorts across all periods (simple), for each sanctions cohort across all periods (sanctions year), for each calendar period across all sanctions cohorts (calendar year), and for each relative period across all sanctions cohorts (event year). These estimates are comparable to one another and to the

[57] The group-time average treatment effect in Callaway and Sant'Anna [2021] is equivalent to CATT at each relative time period in Sun and Abraham [2021].

baseline results in Table 3, and they are statistically significant under simultaneous inference, which takes into account potential dependency across different group-time average treatment effects.

Figure A.4: Impact of sanctions on relative firm sizes (Callaway and Sant'Anna [2021])

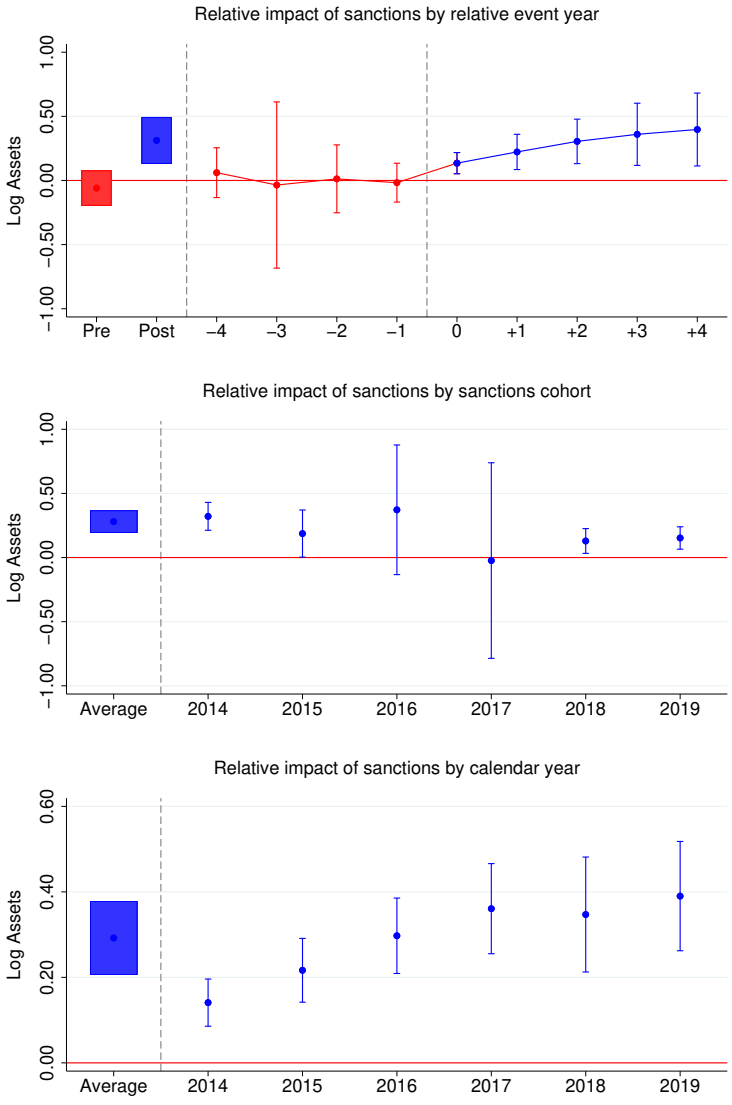


Notes: This figure plots the estimates of the impact of sanctions on the log of total assets of Russian firms under different aggregation schemes per Callaway and Sant'Anna [2021]. The min-max ranges capture the 95% confidence intervals based on simultaneous confidence bands for group-time average treatment effects, estimated by a wild bootstrap procedure. Aggregate estimates are calculated as the simple averages across all relevant periods or cohorts.

Appendix Figure A.5 and Appendix Table A.2 also report the ATTs of sanctions on relative firm sizes under different aggregation schemes in further detail. By relative event year, the average impact of sanctions increases gradually, potentially due to the fact that the sanctions impact took time to propagate. By sanctions cohort, the impact of the 2014 sanctions actions was the most pronounced, potentially because 2014 represents the first year of sanctions actions, and sanctions targets in that year were generally larger.[58] By calendar year, the impact of sanctions increases by year, potentially driven by the propagation of sanctions impact and the fact that more firms were added to the sanctions lists over time.

[58] Although the coefficient for the 2016 sanctions cohort is larger, it is not statistically significant given that few firms were subject to financial sanctions in that year.

Figure A.5: Impact of sanctions on relative firm sizes – Alternative aggregation



Notes: These figures report the estimates of the impact of sanctions on the log of total assets of Russian firms under different aggregation schemes per Callaway and Sant'Anna [2021]. The min-max ranges capture the 95% confidence intervals based on simultaneous confidence bands for group-time average treatment effects, estimated by a wild bootstrap procedure. Aggregate estimates are calculated as the simple average across all relevant periods or cohorts.

Table A.2: Impact of sanctions on relative firm sizes – Alternative aggregation

				95% wild bootstrap CI	
	β	SE	t-stats	Lower bound	Upper bound
Aggregate:					
Simple	0.296	0.035	8.447	0.229	0.362
By relative event year	0.312	0.037	8.398	0.130	0.494
By sanctions cohort	0.280	0.032	8.693	0.193	0.368
By calendar year	0.292	0.035	8.435	0.206	0.378
By relative event year:					
Pre-sanctions average	-0.060	0.028	-2.120	-0.198	0.078
Post-sanctions average	0.312	0.037	8.398	0.130	0.494
$t-3$	-0.036	0.132	-0.268	-0.684	0.613
$t-2$	0.013	0.054	0.231	-0.252	0.277
$t-1$	-0.017	0.031	-0.554	-0.169	0.134
t	0.135	0.017	8.008	0.053	0.218
$t+1$	0.222	0.028	7.928	0.085	0.360
$t+2$	0.305	0.035	8.603	0.131	0.478
$t+3$	0.360	0.050	7.267	0.118	0.602
By sanctions cohort:					
Cross-cohort average	0.280	0.032	8.693	0.193	0.368
2014 sanctions	0.321	0.040	7.995	0.213	0.430
2015 sanctions	0.187	0.068	2.750	0.003	0.371
2016 sanctions	0.372	0.187	1.991	-0.133	0.878
2017 sanctions	-0.023	0.282	-0.083	-0.786	0.739
2018 sanctions	0.129	0.036	3.617	0.033	0.226
2019 sanctions	0.153	0.032	4.732	0.065	0.240
By calendar year:					
Cross-year average	0.292	0.035	8.435	0.206	0.378
2014	0.141	0.022	6.343	0.086	0.196
2015	0.217	0.030	7.219	0.142	0.291
2016	0.297	0.035	8.379	0.209	0.386
2017	0.361	0.042	8.507	0.255	0.466
2018	0.347	0.054	6.418	0.213	0.481
2019	0.390	0.051	7.587	0.262	0.518

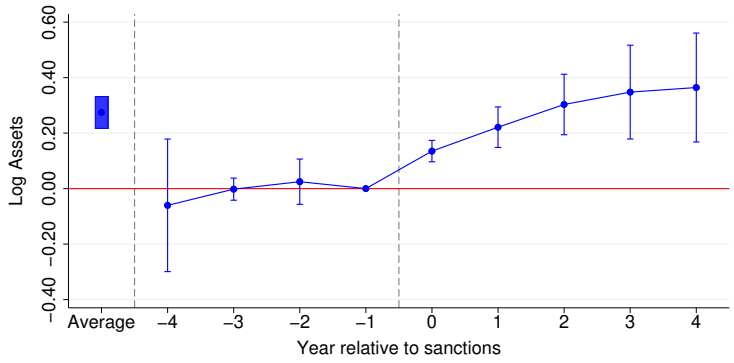
Notes: This table reports the estimates of the impact of sanctions on the log of total assets of Russian firms under different aggregation schemes per Callaway and Sant'Anna [2021]. The 95% confidence intervals reflect simultaneous confidence bands for group-time average treatment effects, estimated by a wild bootstrap procedure. Aggregate estimates are calculated as the simple average across all relevant periods or cohorts.

A.4 DID_M and DID_ℓ Estimators (de Chaisemartin and D'Haultfœuille [2022])

de Chaisemartin and D'Haultfœuille [2020] propose an alternative DID_M estimator that measures the average treatment effect across all group-time observations whose treatment changes from period $t-1$ to period t. The DID_M estimator similarly addresses potential negative weights arising from heterogeneous treatment effects and is applicable for any TWFE regressions, not only those with staggered adoption. In a subsequent paper, de Chaisemartin and D'Haultfœuille [2022] extend the DID_M estimator and introduce the DID_ℓ estimator that allows for an estimation of both instantaneous effect (the effect immediately post treatment) and dynamic effect (the effect of treatment on future outcomes).

Appendix Figure A.6 shows the event-study plot based on DID_ℓ estimators. These estimates are comparable to the baseline results in Table 3, thereby confirming their robustness. Additionally, placebo tests for the pre-treatment periods (marked red in Appendix Figure A.6) also confirm the parallel pre-trend and help validate the parallel trend assumption.

Figure A.6: Impact of sanctions on relative firm sizes (de Chaisemartin and D'Haultfœuille [2022])



	Average	$t-4$	$t-3$	$t-2$	t	$t+1$	$t+2$	$t+3$	$t+4$
Sanctioned	0.274	-0.060	-0.002	0.025	0.135***	0.221***	0.303***	0.348***	0.364***
	(0.030)	(0.122)	(0.020)	(0.042)	(0.020)	(0.037)	(0.056)	(0.086)	(0.100)

Notes: This figure plots the impact of sanctions on the log of total assets of Russian firms by relative event year per de Chaisemartin and D'Haultfœuille [2022]. The min-max ranges capture the 95% confidence intervals. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

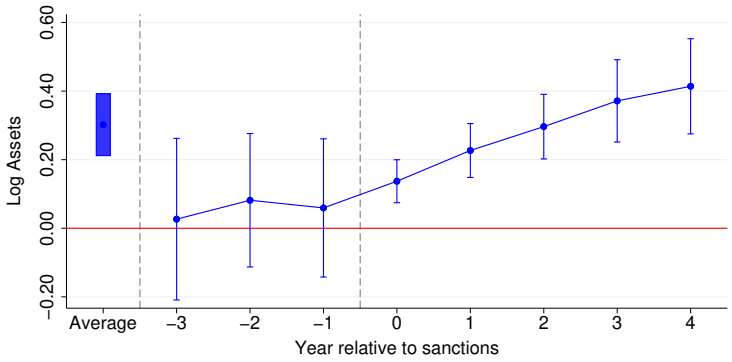
A.5 Imputation Estimator (Borusyak et al. [2021])

Spearheading the discussion on the shortfalls of event-study research design with staggered adoption and heterogeneous causal effects, Borusyak et al. [2017] highlight the under-identification problem in the presence of unit and time fixed effects in settings with no control group. They also recognize potential negative weights on some long-run treatment effects arising from "forbidden comparisons" of later-treated groups as treated against prior-treated groups as control, as discussed

previously. In a subsequent paper, Borusyak et al. [2021] introduce an imputation estimator, which derives treatment effects relative to untreated potential outcomes imputed from fitted unit and period fixed effects based on untreated observations. The estimator can address treatment effect heterogeneity and is also finite-sample efficient.

Appendix Figure A.7 shows the event-study plot using imputation estimators. The post-treatment coefficients are comparable to the baseline results in Table 3, confirming the robustness of the findings.

Figure A.7: Impact of sanctions on relative firm sizes (Borusyak et al. [2021])



	Average	$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$	$t+4$
Sanctioned	0.302***	0.027	0.082	0.059	0.137***	0.227***	0.296***	0.371***	0.414***
	(0.047)	(0.120)	(0.099)	(0.103)	(0.032)	(0.040)	(0.048)	(0.061)	(0.071)

Notes: This figure plots the impact of sanctions on the log of total assets of Russian firms by relative event year per Borusyak et al. [2021]. The min-max ranges capture the 95% confidence intervals. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.6 Median-Unbiased Estimator (Roth [2019])

Finally, a key identifying assumption for my empirical analysis—including for all the aforementioned alternative estimators—is that of the parallel trend. One specification for this assumption is that the means of the outcome for the treatment and control groups would have evolved in parallel had the treatment of interest not occurred. For this study, this means that had sanctions not been imposed, sanctions targets would have grown at the same rate as other unsanctioned firms. To justify this assumption, I rely on commonly used pre-trend tests to show that the differences in trends between sanctioned and unsanctioned firms were statistically insignificant prior to sanctions. The event-study plots in Figures 3 and 4 and Appendix Figures F.4 and F.5 generally show insignificant pre-trends, from which I postulate that sanctioned and unsanctioned firms would have evolved similarly had sanctions not occurred.

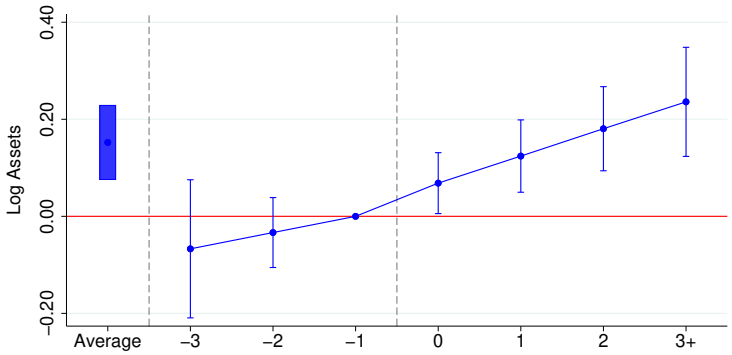
Despite insignificant pre-trends, my pre-trend tests face two potential shortcomings. First,

since my data set comprises firm financials starting from 2011 while the first sanctions actions related to the annexation of Crimea started in 2014, I could only estimate the pre-trend coefficients for two pre-sanctions periods, with the third period omitted to avoid collinearity. The small number of pre-treatment coefficients may limit my ability to interpolate the lack of pre-trends into the post-sanctions periods. Second, recent papers have warned that pre-trend tests are imperfect in finite samples (Roth [2019], Freyaldenhoven et al. [2019], Kahn-Lang and Lang [2020], Bilinski and Hatfield [2018]). Specifically, pre-trend tests may allow "noise that leads us to fail to detect a violation of parallel trends ... to amplify the bias in the treatment effect estimate created by the underlying trend" (Roth [2019]).

To address these concerns, I calculate the median-unbiased estimator, $\hat{\beta}_{0.5}$, proposed by Roth [2019], which removes potential bias in the observed estimator arising from the pre-trend testing. The median-unbiased estimator is chosen such that if the parameter of interest was in fact equal to this unbiased estimator, the original observed estimator would be at the median of the distribution conditional on passing the pre-test. In other words, given that the difference in the trends for the treatment and control groups may exist but be undetected in the pre-treatment periods by the observed estimator, the median-unbiased estimator removes potential biases arising from such underlying trends.

Appendix Figure A.8 shows the event-study plot based on the median-unbiased estimator. These estimates are lower than the baseline results but still statistically significant and positive in the post-sanctions period, with an average treatment effect of 0.159 compared to the baseline coefficient of 0.287. The reduction in the coefficients is because the median-unbiased estimator takes into account the possibility that sanctioned firms might have been growing faster than their unsanctioned peers (by approximately 5% per year at the median) but were undetected in the pre-trend tests. Although the event-study plot in Appendix Figure A.8 appears more trending than the baseline plot in Figure 4, this is a natural result of the median-unbiased estimator, which decreases the slope of the event-study plot in the post-treatment periods and increases it in the pre-treatment periods to account for the potential unobserved pre-trend. Altogether, these results reassert the key finding that sanctioned firms shrank by less than their unsanctioned peers post sanctions even after adjusting for potential faster underlying growth, unobserved by the TWFE estimators, of the sanctioned firms versus the unsanctioned ones.

Figure A.8: Impact of sanctions on relative firm sizes (Roth [2019])



	Average	$t-3$	$t-2$	t	$t+1$	$t+2$	$t+3+$
Sanctioned	0.152***	-0.067	-0.033	0.068**	0.124***	0.181***	0.236***
	(0.039)	(0.073)	(0.037)	(0.032)	(0.038)	(0.044)	(0.057)

Notes: Figure plots the impact of sanctions on the log of total assets of Russian firms by relative event year per Borusyak et al. [2021]. The min-max ranges capture the 95% confidence intervals. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Additional Empirical Results

B.1 What are the impacts of sanctions after controlling for firm sizes?

First, I explore whether the unintended consequences of sanctions would remain after one controls the analysis for firm sizes. I consider the possibility that sanctioned firms might have evolved differently than their unsanctioned peers because the former were generally larger than the latter. To address this concern, I run the following regression:

$$\text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Sanctioned}_{i,t} + \text{Size-Decile-Group}_i \cdot \text{Year}_t + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t} \tag{22}$$

where $\text{Assets}_{i,t}$ is the log of total assets of firm i in year t; $\text{Sanctioned}_{i,t}$ is an indicator of whether firm i was sanctioned in year t; and $\text{Size-Decile-Group}_i$, Firm_i, and Year_t are firm size decile group based on their 2013 assets, firm, and year fixed effects, respectively. The parameter of interest is β_1, which captures the average relative impact of sanctions after controlling for the possibility that firms of different sizes might have progressed differently.

Appendix Table B.1 reports the results. After controlling for firm sizes, sanctions targets still shrank by *less* than their unsanctioned peers by approximately 26% after the policy. The fact that these results do not differ much from the baseline results of 28% relative size impact in Table 3 suggests that initial firm sizes explain a small portion of the outcomes.

Table B.1: Impact of sanctions on relative firm sizes, controlling for firm sizes

	Assets
Sanctioned	0.262***
	(0.045)
Size-Decile-Group × Year FE	✓
Observations	72,293
Adjusted R^2	0.653

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms, controlling for initial firm sizes. Regressions include firm, year, and size-decile-group-year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B.2 Are the results affected by firm industries?

Next, I consider whether the results were industry dependent. I build on the analysis in Section B.1 by also controlling for firm industry in order to take into account the possibility that firms in different industries might have progressed differently. Specifically, I run the following regression:

$$\begin{aligned} \text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Sanctioned}_{i,t} + \text{Size-Decile-Group}_i \cdot \text{Year}_t \\ + \text{Industry}_i \cdot \text{Year}_t + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t} \end{aligned} \tag{23}$$

where $\text{Assets}_{i,t}$ is the log of total assets of firm i in year t; $\text{Sanctioned}_{i,t}$ is an indicator of whether firm i was sanctioned in year t; and Size-Decile_i, Industry_i, Firm_i, and Year_t are firm size decile group based on their 2013 assets, industry, firm, and year fixed effects, respectively. The parameter of interest is β_1, which captures the average relative impact of sanctions after controlling for firm sizes and industries.

Table B.2: Impact of sanctions on relative firm sizes, controlling for firm sizes and industries

	Assets
Sanctioned	0.225***
	(0.044)
Size-Decile-Group × Year FE	✓
Industry × Year FE	✓
Observations	72,288
Adjusted R^2	0.658

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms, controlling for firm sizes and industries. Regressions include firm, year, size-decile-group-year, and industry-year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table B.2 reports the results. After controlling for both firm sizes and industries, sanctions targets still shrank by *less* than their unsanctioned peers by approximately 23% after

the policy. A comparison to the baseline results in Table 3 suggests that parts of the unintended consequences of sanctions arise from the fact that some sanctioned firms operated in industries that performed better than other industries post sanctions. Nevertheless, this industry effect is small.

Next, I also explore how the magnitude of the size impact of sanctions varies across industries. To explore this question, I run the regression in Equation 1 industry by industry. Appendix Table B.3 reports the results, including the number of firms and the number of sanctioned firms within each industry in my sample. The results suggest that sanctioned firms shrank by less than their unsanctioned peers for most industries, particularly those in which more firms were sanctions. They also confirm that industry dynamics are not the key driver of the outcomes.

Table B.3: Impact of sanctions on relative firm sizes by industry

	Assets									
	Agriculture	Mining	Construction	Manufacturing	Transportation	Wholesale Trade	Retail Trade	Finance	Services	Public Admin
Sanctioned	-0.348	0.399***	0.045	0.135**	0.224*	0.089	0.070	0.295**	0.396***	NA
	(0.236)	(0.118)	(0.174)	(0.059)	(0.122)	(0.156)	(0.149)	(0.124)	(0.124)	NA
N Firms	383	440	1,020	1,749	883	1,128	302	1,468	1,217	5
N Sanctioned	4	86	36	153	83	45	19	92	132	0
% Sanctioned	1.0%	19.5%	3.5%	8.7%	9.4%	4.0%	6.3%	6.3%	10.8%	0.0%
Observations	3,337	3,856	8,463	15,071	7,680	9,302	2,581	11,735	10,222	41
Adjusted R^2	0.523	0.814	0.517	0.722	0.764	0.517	0.690	0.689	0.567	0.934

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms by industry. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B.3 Were the results driven by the Kremlin's support on sanctioned firms?

Next, I evaluate the possibility that the unintended consequences of sanctions might have been a result of the Kremlin reallocating resources in favor of sanctioned firms. Sanctioned firms might have benefited from such support because of their connection to the Russian government or to Vladimir Putin. This is related to the notion that politically connected firms tend to have better access to credit (Faccio et al. [2006], Leuz and Oberholzer-Gee [2006], Claessens et al. [2008], Li et al. [2008]) and are more likely to be bailed out (Khwaja and Mian [2005], Duchin and Sosyura [2012], Cingano and Pinotti [2013]). While this potential alternative explanation does not negate my key finding on the unintended consequences of sanctions policy, it could diminish the relevance of my proposed market mechanism.

To address this concern, I explore the impact of sanctions on firm sizes, controlling for the possibility that some firms might have received governmental support and progressed differently post sanctions. Since it is difficult to observe state support to firms, I utilize three measures for state connection to provide proxies for firms' likelihood of receiving governmental support.

The first measure is firms' *strategic statuses*. The Kremlin designates firms that "have a significant impact on the formation of [Russian] GDP, employment, and social stability and [a] operate in the sectors of industry, agro-industrial complex, construction, transport, and communications ... [, or] [b] are parts of industrial groups, holding structures, vertically integrated companies, ... [or] whose management companies are located in foreign jurisdictions" as "strategic organizations" (also called "backbone organizations"). If the Kremlin directed resources to counterweight sanctions impact, it likely would have done so in favor of these strategic firms, and these firms hence should have been less negatively impacted by sanctions than their non-strategic peers. As of February 2015, the list included 197 Russian entities (Government Commission for Economic Development and Integration [2015])[59] I augment this with the list of systemically important credit institutions as approved by the Central Bank of Russia, which included 10 banks as of July 22, 2015 (Bank of Russia [2015]). I also consider majority-owned subsidiaries of the listed institutions as strategic and include them in the list as well. Based on these criteria, I identify 816 strategic organizations and systemically important credit institutions (including majority-owned subsidiaries) in my sample, of which 179 were subject to sanctions. Appendix Table F.6 lists the largest organizations on this list.

The second measure is *state ownership*. It is possible that the Kremlin might have assisted state-owned firms to cushion the sanctions impact. I rely on Orbis's ownership-structure data to identify firms that were at least 10% owned by the Russian government (including ownership through the Ministry of Finance and the Federal Agency for State Property Management). I then use this state ownership status to signify firms' likelihood of receiving state support. Based on this criteria, my sample consists of 808 state-owned firms as of December 2013, of which 206 were sanctioned. Appendix Table F.7 lists the largest organizations on this list.

The last measure is *political connection*. The Kremlin might have assisted firms whose senior management have political connection to the state. To identify politically connected firms, I rely on the list of "politically exposed persons (PEPs)" per Anticorruption Action Centre [2023], which assembles a list of government, military, political party, and civil services officials of Russia and Belarus; senior management and members of the boards of directors of state enterprises and organizations in these countries; and their family members and other associated people. I manually match this list of PEPS to the list of members of management and board of directors of companies in my sample per Orbis, and I designate a firm to be politically connected if at least one member of the senior management team or the board of directors of the company is a PEP. Using this

[59]The list was first adopted in December 2008, and I obtain the list as of February 2015 as that is deemed the most relevant period. The current list of backbone organizations in Russia is also available at Government Commission for Economic Development and Integration [2022].

approach, I identify 1,396 political connected firms in my sample, of which 325 were sanctioned. Appendix Table F.8 lists the largest organizations on this list.

With these three measures, I analyze the impact of sanctions on relative firm sizes, controlling for state connection statuses of firms, as well as firm sizes and industries. Specifically, I run the following regressions:

$$\begin{aligned}\text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Sanctioned}_{i,t} + \text{Size-Decile-Group}_i \cdot \text{Year}_t \\ + \text{Industry}_i \cdot \text{Year}_t + \text{Strategic}_i \cdot \text{Year}_t + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}\end{aligned} \tag{24}$$

$$\begin{aligned}\text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Sanctioned}_{i,t} + \text{Size-Decile-Group}_i \cdot \text{Year}_t \\ + \text{Industry}_i \cdot \text{Year}_t + \text{State-Owned}_i \cdot \text{Year}_t + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}\end{aligned} \tag{25}$$

$$\begin{aligned}\text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Sanctioned}_{i,t} + \text{Size-Decile-Group}_i \cdot \text{Year}_t \\ + \text{Industry}_i \cdot \text{Year}_t + \text{Politically-Connected}_i \cdot \text{Year}_t + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}\end{aligned} \tag{26}$$

where $\text{Assets}_{i,t}$ is the log of total assets of firm i in year t, $\text{Sanctioned}_{i,t}$ is an indicator of whether firm i was sanctioned in year t; Strategic_i is an indicator of whether firm i was on the list of strategic organizations or systemically important credit institutions; State-Owned_i is an indicator of whether firm i was at least 10% owned by the Kremlin; $\text{Politically-Connected}_i$ is an indicator of whether firm i has at least one member of the management team or the board of directors being a politically exposed person; and Size-Decile_i, Industry_i, Firm_i, and Year_t are firm size decile group based on their 2013 assets, industry, firm, and year fixed effects, respectively. The parameter of interest is β_1, which captures the average relative impact of sanctions after controlling for firm sizes, industries, and state-connection.

Appendix Table B.4 reports the results. After controlling for firm sizes, industries, and state connection, sanctions targets still shrank by *less* than their unsanctioned peers by approximately 20-23% after the policy. A comparison to the results in Appendix Table B.2 suggests that parts of the unintended consequences of sanctions might have arisen because state-connected firms received governmental support and performed better than their unconnected peers post sanctions, and disproportionately more of sanctioned firms were state connected. Nevertheless, the fact that controlling for state connection of firms only reduces result coefficient by slightly implies that the impact of state support is small.

I also explore how the impact of sanctions on relative firm sizes differ for state-connected versus unconnected firms. To do so, I run the regression in Equation 1 for state connected and for unconnected firms separately, using each of the aforementioned state connection measure. Appendix Table B.5 reports the results, including the numbers of all firms and sanctioned firms within each sub-samples. The results suggest that sanctioned firms shrank by less than their unsanctioned peers for state-connected as well as unconnected firms. The coefficients are larger for sub-samples of unconnected firms than for those of state-connected firms. This is perhaps because the Kremlin might have supported state-connected firms generally, allowing them to withstand the impact of

Table B.4: Impact of sanctions on relative firm sizes, controlling for firm sizes, industries, and state connections

	Assets		
Sanctioned	0.222***	0.199***	0.228***
	(0.044)	(0.044)	(0.045)
Size-Decile-Group × Year FE	✓	✓	✓
Industry × Year FE	✓	✓	✓
Strategic × Year FE	✓		
State-Owned × Year FE		✓	
Politically-Connected × Year FE			✓
Number of State-Connected Firms	816	808	1,396
Number of State-Connected Sanctioned Firms	179	206	325
Observations	72,288	72,288	72,288
Adjusted R^2	0.658	0.658	0.658

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms, controlling for firm sizes, industries, and state connections. Regressions include firm, year, size-decile-group-year, and industry-year fixed effects. Regressions also include firms' strategic-status-year, state-ownership-year, and political-connection-year fixed effects for the first, second, and third columns, respectively. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

sanctions more resiliently, thereby resulting in a more subdued relative size impact for these firms. Ultimately, the results confirm that state connection alone does not explain the outcome, hence leaving room for my proposed explanation.

Table B.5: Impact of sanctions on relative firm sizes for state-connected versus unconnected firms

	Assets					
	Strategic Status		State Ownership		Political Connection	
	Strategic	Non-Strategic	State-Owned	Private	Connected	Not Connected
Sanctioned	0.216***	0.283***	0.142**	0.296***	0.255***	0.280***
	(0.072)	(0.054)	(0.071)	(0.055)	(0.063)	(0.064)
Number of Firms	816	7,780	808	7,788	1,396	7,200
Number of Sanctioned Firms	179	471	206	444	325	325
Observations	7,068	65,225	6,813	65,480	11,920	60,373
Adjusted R^2	0.893	0.601	0.876	0.621	0.804	0.595

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms in relation to firms' strategic statuses. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B.4 How do firms' capital structures affect the sanctions impact?

In this analysis, I evaluate the effectiveness of financial sanctions by exploring how firms' capital structure affected the sanctions outcomes. In particular, I explore whether firms that relied more on external and domestic borrowings suffered more from the policy post sanctions. My regression specification is:

$$\begin{aligned}\text{Assets}_{i,t} = \beta_0 &+ \beta_1 \cdot \text{Sanctioned}_{i,t} \\ &+ \beta_2 \cdot \text{Sanctioned}_{i,t} \times \text{External-debt-to-assets ratio}_{i,2013} \\ &+ \beta_3 \cdot \text{Sanctioned}_{i,t} \times \text{Domestic-debt-to-assets ratio}_{i,2013} \\ &+ \beta_4 \cdot \text{Never-sanctioned}_i \times \text{Post-2014}_t \times \text{External-debt-to-assets ratio}_{i,2013} \\ &+ \beta_5 \cdot \text{Never-sanctioned}_i \times \text{Post-2014}_t \times \text{Domestic-debt-to-assets ratio}_{i,2013} \\ &+ \text{Size-Decile-Group}_i \cdot \text{Year}_t + \text{Industry}_i \cdot \text{Year}_t + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}\end{aligned} \tag{27}$$

where $\text{Assets}_{i,t}$ is the log of total assets of firm i in year t; $\text{Sanctioned}_{i,t}$ is an indicator of whether firm i was sanctioned in year t; $\text{External-debt-to-assets ratio}_{i,2013}$ is the external-debt-to-assets ratio of firm i in 2013; $\text{Domestic-debt-to-assets ratio}_{i,2013}$ is the domestic-debt-to-assets ratio of firm i in 2013; $\text{Never-sanctioned}_i$ is an indicator that firm i was never sanctioned during the entire sample period; Post-2014_t is an indicator that year t is 2014 or after; and Size-Decile_i, Industry_i, Firm_i, and Year_t are firm size decile group based on their 2013 assets, industry, firm, and year fixed effects, respectively. The coefficients of interest are β_2 through β_4, which measure the degree to which firms' pre-sanctions international and domestic borrowings affected sanctioned firms and unsanctioned firms, respectively.

Appendix Table B.6 reports the results. On average, sanctioned firms that borrowed more in international and domestic capital markets before sanctions suffered more after sanctions than those that borrowed less ($\beta_2, \beta_3 < 0$). Based on the average external-debt-to-assets of sanctioned international borrowers of 10%, these sanctioned international borrowers suffered by approximately 9% more than their other sanctioned firms that relied only on the domestic capital market. For domestic borrowings, a sanctioned firm with a domestic-debt-to-assets ratio that is 10 percentage points higher than those of its peers shrank by 1% more. Although these coefficients are not statistically significant, they are consistent with my proposed explanation, in which sanctioned firms that borrowed more before sanctions—especially in the international capital markets—suffered more post sanctions.

For unsanctioned firms, those that borrowed more in the international capital markets before sanctions benefited after sanctions started in 2014 (β_4). Based on the average external-debt-to-assets ratio for unsanctioned international borrowers of 16%, these firms expanded by 2% relative to their unsanctioned domestic borrowing peers. On the other hand, the degree of reliance on domestic capital does not affect the sanctions outcomes for unsanctioned firms ($\beta_5 \approx 0$). Again, although these coefficients are not statistically significant, they support my proposed explanation

Table B.6: Impact of sanctions on relative firm sizes, interacting with firms' debt ratios

	Assets
Sanctioned	0.278***
	(0.060)
Sanctioned × External-debt-to-assets$_{2013}$	-0.802
	(1.104)
Sanctioned × Domestic-debt-to-assets$_{2013}$	-0.147
	(0.132)
Never sanctioned × Post 2014 × External-debt-to-assets$_{2013}$	0.138
	(0.211)
Never sanctioned × Post 2014 × Domestic-debt-to-assets$_{2013}$	0.009
	(0.045)
Size-Decile-Group × Year FE	✓
Industry × Year FE	✓
Observations	72,288
Adjusted R^2	0.658

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms in relation to firms' pre-sanctions external-debt-to-assets and domestic-debt-to-assets ratios. Regressions include firm, year, size-decile-group-year, and industry-year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

that unsanctioned international borrowers continued to benefit from cheaper financing abroad and were able to grow relative to their domestic-borrowing peers post sanctions. The fact that firms' reliance on domestic financing pre-sanctions does not affect sanctions severity is also consistent with my proposed explanation as these firms suffer similar increases in their costs of borrowings.

B.5 What are the effects of sanctions on firms versus on their lenders?

Next, I investigate how banks play a role in affecting sanctions outcomes. I confine my sample to Russian non-banks and compare the impact of sanctions on relative firm sizes when sanctions were imposed on firms versus on their lenders. To obtain borrower-lender relationships, I rely on the Orbis Historical Database, which reports the list of firms' financial advisors by year. Using this data, I run three regressions. The first regression (the first column of Appendix Table B.7) measures the impact of sanctions when they were imposed directly on firms—this is the same analysis as in Section 4.2. The second regression (the second column) measures the impact of sanctions when they were imposed on firms' lenders. The third regression (the third column) combines the two

impacts together. My regression specifications are:

$$\text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Firm-sanctioned}_{i,t} + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t} \tag{28}$$

$$\text{Assets}_{i,j,t} = \beta_0 + \beta_2 \cdot \text{Lender-sanctioned}_{j,t} + \text{Firm}_i + \text{Year}_t + \text{Lender}_j + \epsilon_{i,t} \tag{29}$$

$$\begin{aligned}\text{Assets}_{i,j,t} = \beta_0 &+ \beta_1 \cdot \text{Firm-sanctioned}_{i,t} + \beta_2 \cdot \text{Lender-sanctioned}_{j,t} \\ &+ \beta_3 \cdot \text{Firm-sanctioned}_{i,t} \times \text{Lender-sanctioned}_{j,t} \\ &+ \text{Firm}_i + \text{Year}_t + \text{Lender}_j + \epsilon_{i,t}\end{aligned} \tag{30}$$

where $\text{Assets}_{i,j,t}$ is the log of total assets of firm i in year t in which Lender j was one of its lenders; $\text{Firm-sanctioned}_{i,t}$ is an indicator of whether firm i was sanctioned in year t; $\text{Lender-sanctioned}_{j,t}$ is an indicator of whether lender j was sanctioned in year t; and Firm_i, Lender_j, and Year_t are firm, lender, and year fixed effects, respectively. Standard errors are clustered at firm level for the first column and at firm and lender levels for the second and third columns. The coefficients of interest are β_1, β_2, and β_3, which capture the impact of sanctions when they were imposed on firms, when they were imposed on firms' lenders, and their interactions, respectively.

Table B.7: Impact of sanctions on Russian firms versus sanctions on their lending banks

	Assets	Assets	Assets
Firm-sanctioned	0.275***		0.166
	(0.046)		(0.107)
Lender-sanctioned		0.096***	0.090**
		(0.035)	(0.036)
Firm-sanctioned × Lender-sanctioned			0.017
			(0.125)
Observations	69,404	120,914	120,914
Adjusted R^2	0.625	0.841	0.841

Notes: This table reports the impact of sanctions on the log of total assets of Russian firms when sanctions were imposed on firms versus on their lenders. Regressions include firm and year fixed effects for the first column; lender and year fixed effects for the second column; and firm, lender, and year fixed effects for the third column. Standard errors in parentheses are clustered at firm level for the first column, and firm and lender levels for the second and third column. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The first column of Appendix Table B.7 restates my prior finding that sanctioned non-banks shrank by *less* than their unsanctioned peers when sanctions were imposed directly on the firms. On average, sanctioned non-bank targets shrank by 28% *less* than non-targets post sanctions. The second column suggests that non-banks that borrowed from sanctioned banks also shrank by approximately 10% *less* than those that borrowed from unsanctioned banks, regardless of whether the borrowers themselves were sanctioned. The third column decomposes the sanctions impact, suggesting that approximately two-thirds of the impact on firm sizes depends on whether the firms themselves were sanctioned and one-third depends on whether the firms' lenders were sanctioned.

The fact that firms that relied on sanctioned banks shrank by *less* than those that relied on unsanctioned banks highlights the role that banks played in transmitting sanctions impact. This is expected, considering that bank borrowings represent the primary funding channel for most domestic borrowers. Based on the balance sheet statistics as of December 31, 2013, while 78% of non-banks in my sample had debt on their balance sheets, only 4% of them had syndicated bonds or loans, implying that most firms borrowed from banks rather than investors.[60] As sanctioned banks shrank by less than their unsanctioned peers (see Table 5), borrowers that relied on the former were also less negatively impacted than those that relied on the latter.

B.6 What are the effects of sanctions through the supply chain channel?

Sanctions could have also affected unsanctioned firms through the supply chain channel. Specifically, suppliers and customers of sanctioned firms could be affected as sanctioned firms adjust their production. To explore this potential spillover channel, I calculate firm exposure to different groups of suppliers and customers and estimate how such exposure might have affected sanctions impact.

I rely on the World Input-Output Database (WIOD) to identify industry supply chain exposure (Timmer et al. [2015]). The WIOD contains world input-output tables and factor requirements by country and by industry, and I focus on factor supply and usage by various industries in Russia. For each industry, I categorize firm suppliers and customers into (a) foreign firms in sanctioning countries, (b) foreign firms in non-sanctioning countries, (c) domestic unsanctioned firms, and (d) domestic sanctioned firms. To bifurcate between domestic unsanctioned and sanctioned suppliers/customers, I use the proportion of sanctioned firms by industry in my sample based on aggregate assets, as shown in Appendix Table B.8. Appendix Table B.9 summarizes the exposure of Russian firms to different groups of customers and suppliers by industry based on the WIOD data as of October 2014.

[60] Among the 8,173 non-banks in my sample, 6,399 of them had some borrowings but only 293 had syndicated borrowings as of December 31, 2013.

Table B.8: Proportions of sanctioned firms by industry based on number of firms and firm assets

	Number of Firms		Aggregate Assets		% Sanctioned	
	Sanc'ed	Unsanc'ed	Sanc'ed	Unsanc'ed	By Number	By Assets
Agriculture, Forestry, and Fishing	4	379	$1	$48	1%	1%
Mining	86	354	$189	$481	20%	28%
Construction	36	984	$13	$232	4%	5%
Manufacturing	153	1,596	$356	$514	9%	41%
Transportation, Communication & Utility	83	800	$119	$1,157	9%	9%
Wholesale Trade	45	1,083	$27	$319	4%	8%
Retail Trade	19	283	$3	$111	6%	2%
Finance, Insurance, and Real Estate	92	1,376	$1,315	$850	6%	61%
Services	132	1,085	$36	$365	11%	9%
Public Administration	0	5	$0	$6	0%	0%
Unknown	0	1	$0	$0	0%	0%
Total	650	7,946	$2,058	$4,082	8%	34%

Notes: This table reports the number and the aggregate assets of sanctioned and unsanctioned firms in the sample and the proportion of firms that are sanctioned by industry based on both metrics.

Table B.9: Firm supply chain exposure by industry

	Exposure to Customers in				Exposure to Suppliers in			
	Foreign		Domestic		Foreign		Domestic	
	Sanc'ing	Other	Sanc'ed	Other	Sanc'ing	Other	Sanc'ed	Other
Agriculture, Forestry, and Fishing	7%	2%	23%	67%	7%	7%	14%	72%
Mining	49%	23%	9%	19%	3%	5%	17%	75%
Construction	1%	0%	18%	81%	5%	6%	25%	64%
Manufacturing	9%	11%	19%	61%	6%	6%	20%	68%
Transportation, Communications, Utility	14%	6%	17%	63%	3%	4%	22%	71%
Wholesale Trade	23%	9%	17%	52%	3%	3%	17%	76%
Retail Trade	4%	1%	22%	74%	3%	3%	17%	76%
Finance, Insurance, and Real Estate	0%	0%	15%	85%	4%	4%	19%	74%
Services	0%	0%	13%	87%	3%	3%	19%	75%
Public Administration	0%	0%	18%	82%	4%	5%	19%	72%
Unknown	0%	0%	0%	100%	0%	0%	0%	100%
Russian Firms – Sanctioned	15%	11%	16%	58%	5%	5%	20%	70%
Russian Firms – Unsanctioned	15%	8%	16%	61%	4%	5%	20%	71%

Notes: This table reports firm exposure different groups of customers and suppliers by firm industry. Data per World Input-Output Database (WIOD). The aggregate statistics for sanctioned and unsanctioned Russian firms (last two rows of the table) are calculated based the industry compositions of both group of firms in the sample based on their aggregate assets.

Since I only have the industry supply chain statistics before sanctions, identifying the impact

of sanctions through the supply chain channel alone remains a challenge.[61] Nevertheless, these statistics allow me to explore how the change in firm sizes in the aftermath of sanctions varied with firm supply chain exposure. To do so, I run the following regression:

$$\begin{aligned}\text{Assets}_{i,t} = \beta_0 &+ \beta_1 \cdot \text{Sanctioned}_{i,t} \\ &+ \beta_2 \cdot \text{Post-2014}_t \times \text{Exposure-to-Sanctioning-Customers}_i \\ &+ \beta_3 \cdot \text{Post-2014}_t \times \text{Exposure-to-Other-Foreign-Customers}_i \\ &+ \beta_4 \cdot \text{Post-2014}_t \times \text{Exposure-to-Sanctioned-Customers}_i \\ &+ \beta_5 \cdot \text{Post-2014}_t \times \text{Exposure-to-Sanctioning-Suppliers}_i \\ &+ \beta_6 \cdot \text{Post-2014}_t \times \text{Exposure-to-Other-Foreign-Suppliers}_i \\ &+ \beta_7 \cdot \text{Post-2014}_t \times \text{Exposure-to-Sanctioned-Suppliers}_i \\ &+ \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}\end{aligned} \tag{31}$$

where $\text{Assets}_{i,t}$ is the log of total assets of firm i in year t; $\text{Sanctions}_{i,t}$ is an indicator of whether firm i was sanctioned in year t; Post-2014_t is an indicator that year t is 2014 or after; $\text{Exposure-to-Sanctioning-Customers}_i$, $\text{Exposure-to-Other-Foreign-Customers}_i$, and $\text{Exposure-to-Sanctioned-Customers}_i$ are the proportion of sales by firm i to customers in sanctioning countries, customers in other foreign non-sanctioning countries, and sanctioned domestic customers, respectively; $\text{Exposure-to-Sanctioning-Suppliers}_i$, $\text{Exposure-to-Other-Foreign-Suppliers}_i$, and $\text{Exposure-to-Sanctioned-Suppliers}_i$ are the proportion of purchases by firm i from suppliers in sanctioning countries, suppliers in other foreign non-sanctioning countries, and sanctioned domestic suppliers, respectively; and Firm_i and Year_t are firm and year fixed effects, respectively. The coefficients of interest are β_2 through β_7, which measure how firm sizes changed after 2014 based on firm exposure to different groups of customers and suppliers *relative* to firms that relied solely on unsanctioned domestic customers and suppliers. Note that in this regression I include sanctions treatment and interact firm supply chain exposure with the Post-2014 indicator to separate the impact of sanctions from the impact through the supply chain channel.

Appendix Table B.10 reports the results, suggesting that firms that were more exposed to customers and suppliers in sanctioning countries were more negatively impacted ($\beta_2, \beta_5 < 0$), while those that were more exposed to customers and suppliers in non-sanctioning countries were less negatively impacted ($\beta_3, \beta_6 > 0$). These results suggest that Russian firms might have reduced trade with sanctioning countries and expanded it with non-sanctioning countries. Additionally, firms that sold to sanctioned customers performed slightly better than their peers that sold to unsanctioned customers ($\beta_3 > 0$), which is consistent with the finding that sanctioned firms expanded, and therefore were able to maintain their purchases, while their unsanctioned peers shrank. Finally, firms that purchased from sanctioned suppliers also suffered more severely ($\beta_7 < 0$), potentially as

[61] The WIOD contains supply chain data only through 2014, with no change between 2014 and 2013. This precludes me from calculating changes in the supply chain of Russian firms as a result of sanctions and from isolating the impact of sanctions through the supply chain channel versus other channels.

Table B.10: Impact of supply chain exposure on firm performance post sanctions

	Assets
Sanctioned	0.266***
	(0.044)
Customer Exposure:	
Post-2014 × Exposure-to-Sanctioning-Customers	-1.451***
	(0.458)
Post-2014 × Exposure-to-Other-Foreign-Customers	3.058***
	(0.614)
Post-2014 × Exposure-to-Sanctioned-Customers	0.362
	(0.556)
Supplier Exposure:	
Post-2014 × Exposure-to-Sanctioning-Suppliers	-17.266*
	(10.089)
Post-2014 × Exposure-to-Other-Foreign-Suppliers	14.828*
	(8.289)
Post-2014 × Exposure-to-Sanctioned-Suppliers	-5.164***
	(1.286)
Observations	72,288
Adjusted R^2	0.654

Notes: This table reports the impact of supply chain exposure on the log of total assets of Russian firms after 2014. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

sanctioned firms prioritized sales to foreign customers in non-sanctioning countries at the expense of domestic customers.

To quantify the impact of supply chain channel, I apply the regression coefficients from Appendix Table B.10 to the differences in the supply chain exposure of sanctioned versus unsanctioned firms (the differences between the last two rows of Appendix Table B.9) and estimate that sanctioned firms expanded by 5% relative to their unsanctioned peers because of the differences in their supply chain exposure (compared to the baseline result of 29% per Table 3). Note that to the extent firms adjusted their supply chain after sanctions, these results could also be different.

B.7 What are the effects of financial versus trade sanctions?

Finally, I compare the impact of financial sanctions versus trade sanctions on firm outcomes to evaluate approaches to sanctions policy. Utilizing the fact that SDN sanctions are equivalent to a combination of both trade and financial sanctions and SSI sanctions are equivalent to financial

sanctions only, I run the following regression:

$$\begin{aligned}\text{Assets}_{i,t} = \beta_0 + \beta_1 \cdot \text{Financial-sanctions}_i + \beta_2 \cdot \text{Trade-sanctions}_i \\ + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}\end{aligned} \tag{32}$$

where $\text{Assets}_{i,t}$ is the log of total assets of firm i in year t, $\text{Financial-sanctions}_{i,t}$ is an indicator of whether firm i was subject to financial sanctions in year t (firm was on either the SDN list or the SSI list, Directives 1-3), $\text{Trade-sanctions}_{i,t}$ is an indicator of whether firm i was subject to trade sanctions in year t (firm was on the SDN list), and Firm_i and Year_t are firm and year fixed effects, respectively. The coefficients of interest are β_1 and β_2, which measure the impact of financial and trade sanctions, respectively.

Table B.11: Impact of financial versus trade sanctions on the sizes of Russian firms

	Assets
Financial sanctions	0.283***
	(0.055)
Trade sanctions	0.016
	(0.071)
Observations	72,293
Adjusted R^2	0.653

Notes: This table reports the impact of financial and trade sanctions on the log of total assets of Russian firms. Regressions include firm and year fixed effects. Standard errors clustered at the firm level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix Table B.11 reports the results, suggesting that firms that were subject to financial sanctions expanded by approximately 28% to 33% relative to unsanctioned firms, but those that were subject to trade sanctions, especially non-banks, did not perform differently from their peers. Although these results suggest that only financial sanctions had material impact on the targets relative to unsanctioned firms—albeit in the opposite direction than intended—and trade sanctions had minimal impact, this could be because the sanctions targets in this episode did not rely much on foreign trades. Unlike in the 2022 sanctions round in which the United States and its allies consider a ban on purchases of Russian oil and natural gas, major Russian energy companies were not put on the SDN list in the 2014 sanctions round; they were only added to the SSI list and were subject only to financial or technology sanctions.

Furthermore, there are also examples of firms that were added to the SDN list that received direct governmental support to offset the sanctions impact. The most notable example is Bank Rossiya, which was added to the SDN list on March 20, 2014. In April 2014, the bank was awarded an exclusive right to process payments for Russia's wholesale electricity market—a business worth approximately 2% of the country's GDP—and it also became the primary bank for state and local governments in the Crimea region (Myers et al. [2014]). This may explain the positive—albeit

quantitatively and statistically insignificant—coefficient for trade sanctions.

B.8 Summary Statistics of Sanctioned Firms by Sanctions Year

Appendix Table B.12 reports summary statistics of sanctioned firms by the year in which such firms were added to the sanctions lists. The size distributions of sanctioned firms have long tails, and firms that were sanctioned in 2014 were generally larger than those that were sanctioned later. This is presumably because U.S. policymakers identified obvious sanctions targets first. In terms of leverage, the average debt-to-assets ratios of the targets were comparable across sanctions years, although among firms with positive debt, the average leverage of the 2014 sanctions targets was slightly higher than those for the later-year sanctions targets. Furthermore, firms that were sanctioned in 2014 were the only ones in my sample that borrowed abroad before sanctions, and they were also slightly more profitable, as evidenced by their slightly higher average ROA and EBIT margin.

Table B.12: Summary statistics of sanctioned firms by sanctions year

	2014			2015			2016+		
	N	Mean	Median	N	Mean	Median	N	Mean	Median
Sizes ($MM):									
Assets	462	4,194	225	96	517	131	92	773	212
Debt	462	834	39	96	104	22	92	397	41
Equity	462	956	66	96	133	41	92	241	55
EBIT	431	136	7	89	41	4	83	2	5
Net Income	461	145	5	96	28	2	92	-21	3
Balance Sheet (% of Assets):									
Debt	462	31	13	96	28	15	92	31	21
Debt (> 0)	323	44	35	82	33	19	76	37	31
External Debt (> 0)	36	10	10	0	–	–	0	–	–
Profitability (%):									
ROA	461	5	2	96	3	1	92	4	2
ROE	396	19	15	88	-1	4	86	16	10
EBIT Margin	462	10	7	96	11	8	92	16	5
Net Margin	462	11	6	96	11	7	92	21	5
Observations	462			96			92		

Notes: This table reports summary statistics as of December 31, 2013, of sanctioned firms by the year in which such firms were added to the sanctions lists. Gross amounts are in millions of U.S. dollars.

C Other Potential Explanations

In this Section, I explore other potential explanations for the impact of sanctions on relative firm sizes. In particular, I show that while each of these explanations might have contributed to

the outcomes, none could alone explain all the results.

C.1 Unsanctioned Firms Suffered the Spillover Through the Supply Chain Channel

One potential explanation is that spillover impact occurred through the supply chain channel. As sanctions increased target firms' costs of capital and forced them to reduce production, lower demand for input might have undercut smaller unsanctioned suppliers even more as their customers depleted inventory or trimmed suppliers.

Although this mechanism was presumably relevant, the similar results for banks and the fact that banking relationships mattered to borrowers' outcomes (see Appendix B.5) suggest that capital crowding out and credit rationing likely pertained as well. Furthermore, Appendix B.6 also explores how supply chain exposure affected firm sizes after 2014. I find that the difference in the supply chain exposure of sanctioned versus unsanctioned firms could explain part of the outperformance of sanctioned firms, but the effect is small. More precisely, I estimate that of the 29% outperformance of sanctioned firms relative to their unsanctioned peers in Table 3, the difference in supply chain exposure contributes 5 percentage points.

C.2 Macroeconomic Shocks Affected Larger Sanctioned Firms Less Severely

Another potential explanation is that macroeconomic shocks—including the drop in oil price, devaluation of the ruble, increase in the key interest rate, and general market panics—might have harmed sanctioned firms less severely, partly because of their larger sizes. This explanation runs parallel to the literature on the business cycle that finds stronger cyclicality for smaller firms in response to monetary policy shocks (Gertler and Gilchrist [1994], Gopinath et al. [2017], Crouzet and Mehrotra [2020]).[62] To address this concern, I perform a robustness test controlling for pre-sanctions firm sizes and firm industries (Appendix B.1 and B.2). The analyses suggest that firm sizes and industries only explain part of the results. My explanation also describes how firm-specific shocks (sanctions) translated to a macroeconomic shock (an interest rate increase), instead of taking the macroeconomic shock as given.

C.3 Currency Devaluation Affected Unsanctioned Firms More Severely

Another possibility is that sanctioned firms might have owned a larger portion of their assets in foreign currencies, and the devaluation of the ruble in the aftermath of the U.S. sanctions might have benefited them more than their peers that owned most of their assets in local currency.[63]

[62] Note that there are also papers that find small and large firms to be equally responsive to monetary policy shocks (Chari et al. [2013], Kudlyak and Sanchez [2017]) and that find smaller ones to be less responsive (Moscarini and Postel-Vinay [2012]).

[63] The Russian ruble/U.S. dollar exchange rate depreciated from 32.57 RUB/USD at the end of 2013 to 53.84 RUB/USD at the end of 2014, and 72.23 RUB/USD at the end of 2015.

While this impact might be relevant for some firms, its magnitude was not large enough to explain the results.

For example, consider Novatek, a sanctioned natural gas producer which owned 15% of its assets in USD and EUR. A 50% depreciation of RUB against these currencies (approximately equal to the RUB/USD depreciation in 2014 and 2015 combined) would translate to a 15% expansion of Novatek's assets relative to those of its peers that owned all their assets in the Russian ruble. This compares to the average size impact of 29% per Table 3. Since the portion of foreign-currency assets for Novatek was likely high relative to other firms (for instance, that ratio was only 8% for Rosneft, the second-largest Russian energy company) and some unsanctioned firms also owned foreign-currency assets, the relative impact from currency devaluation should be lower on average across the sample and thus cannot explain all the results.

D Model Appendix

D.1 Model Solution

This section provides the solution for the dynamic model. The solution for the static model is the same without the household's choices and with $K_t = K$ and $B_t = B$, since firms maximize profits period-by-period.

Firm Optimization Problem. Firms maximize profits period-by-period:

$$\pi_t(z) = \max_{k_t, b_t} f(k_t; z) - (r_{K,t} + \delta)k_t - r_{b,t}b_t \tag{33}$$

$$= \max_{b_t} f\big(\frac{b_t}{\eta(r_{K,t} + \delta)}; z\big) - \frac{b_t}{\eta} - r_{b,t}b_t \tag{34}$$

subject to the borrowing constraint:

$$b_t < \Gamma(r_{b,t}, r_{K,t}; z) \tag{35}$$

where the second equation is derived by replacing $k_t = \frac{b_t}{\eta(r_{K,t}+\delta)}$.

Firm First-order Condition. For firms for which the borrowing constraint does not bind, their first-order condition is:

$$\frac{\zeta z}{\big(\eta(r_{K,t} + \delta)\big)^{\zeta}} b_t^{\zeta - 1} = (\frac{1}{\eta} + r_{b,t}) \tag{36}$$

Unconstrained firms borrow the optimal amount of debt that they wish to borrow:

$$b_t^{unconstrained} = b_t^*(r_{b,t}, r_{K,t}; z) = \eta \cdot \Big(\frac{z\zeta}{(1 + \eta r_b)(r_K + \delta)^{\zeta}}\Big)^{\frac{1}{1-\zeta}} \tag{37}$$

Firms for which the borrowing constraint binds borrow the maximum amount that lenders are willing to lend to them:

$$b_t^{constrained} = \Gamma(r_{b,t}, r_{K,t}; z) \tag{38}$$

Firm Solution. Hence, from the first-order condition, I can state the solution to the firm problem:

$$b(r_{b,t}, r_{K,t}; z) = \min\left(b^*(r_{b,t}, r_{K,t}; z), \Gamma(r_{b,t}, r_{K,t}; z)\right) \tag{39}$$

$$k(r_{b,t}, r_{K,t}; z) = \frac{b(r_{b,t}, r_{K,t}; z)}{\eta(r_{K,t} + \delta)} \tag{40}$$

$$y(r_{b,t}, r_{K,t}; z) = zk(r_{b,t}, r_{K,t}; z)^{\zeta} \tag{41}$$

where $r_{b,t} = r_{dm,t}$ for firms that borrow in the domestic market and $r_{b,t} = r_{fm,t}$ for firms that borrow in international markets. The amount of capital goods that firms rent follows directly, since firms only borrow to pay rent on capital goods.

Household Optimization Problem. A representative household maximizes its lifetime utility:

$$\max_{t=0}^{\infty} \ \beta^t U(C_t) \tag{42}$$

subject to the sequence of budget constraints:

$$C_t + B_{t+1} + I_t + \Psi(K_{t+1}, K_t) \leq \Pi_t + (r_{K,t} + \delta)K_t + (1 + r_{dm,t})B_t \tag{43}$$

and the capital accumulation equation:

$$K_{t+1} = (1 - \delta)K_t + I_t \tag{44}$$

where the utility function is given by $U(C_t) = \frac{C_t^{1-\sigma}-1}{1-\sigma}$.

I can restate the household's maximization problem as a Bellman equation:

$$V(K_t, B_t) = \max_{K_{t+1}, B_{t+1}} \Big[U(C_t) + \beta V(K_{t+1}, B_{t+1})\Big] \tag{45}$$

subject to the same budget constraints and capital accumulation equation, and the problem can be solved through a value-iteration procedure.

Household First-order Conditions. I can express the Lagrangian $\mathcal{L}$ for the household's problem as:

$$\begin{aligned}\mathcal{L} = \sum_{t=0}^{\infty} \beta^t \Bigg[\frac{C_t^{1-\sigma}-1}{1-\sigma} + \lambda_t \big(\Pi_t + (r_{K,t}+\delta)K_t + (1+r_{dm,t})B_t \\ - B_{t+1} - C_t + (1-\delta)K_t - K_{t+1} - \Psi(K_{t+1}, K_t) \big) \Bigg]\end{aligned} \tag{46}$$

$$\begin{aligned}= \sum_{t=0}^{\infty} \beta^t \Bigg[\frac{C_t^{1-\sigma}-1}{1-\sigma} + \lambda_t \big(Z_t K_t^{\zeta} - r_{fm,t} B_{fm,t} - \kappa \Omega_{fm,t} + B_t \\ - B_{t+1} - C_t + (1-\delta)K_t - K_{t+1} - \Psi(K_{t+1}, K_t) \big) \Bigg]\end{aligned} \tag{47}$$

where the second equation is derived by substituting:

$$\Pi_t = Z_t K_t^{\zeta} - (r_{K,t}+\delta)K_t - r_{dm,t}B_t - r_{fm,t}B_{fm,t} - \kappa\Omega_{fm,t} \tag{48}$$

with $\Omega_{fm,t}$ capturing the mass of firms that borrow in international markets, and the aggregate productivity Z_t is defined such that:

$$Z_t K_t^{\zeta} = \int z k(r_{b,t}, r_{K,t}; z)^{\zeta} dG(z) \tag{49}$$

I can derive the first-order conditions:

$$\lambda_t = C_t^{-\sigma} \qquad \text{(FOC w.r.t. } C_t\text{)}$$

$$\frac{1}{\beta} = \frac{\lambda_{t+1}}{\lambda_t} \cdot \frac{\zeta Z_{t+1} K_{t+1}^{\zeta-1} + \frac{\partial Z_{t+1}}{\partial K_{t+1}} K_{t+1}^{\zeta} + (1-\delta) + \Psi'\big(K_{t+2}, K_{t+1}\big)}{1 + \Psi'\big(K_{t+1}, K_t\big)} \qquad \text{(FOC w.r.t. } K_{t+1}\text{)}$$

$$\frac{1}{\beta} = \frac{\lambda_{t+1}}{\lambda_t} \cdot \Big(1 + \frac{\partial Z_{t+1}}{\partial B_{t+1}} K_{t+1}^{\zeta}\Big) \qquad \text{(FOC w.r.t. } B_{t+1}\text{)}$$

$$C_t = Z_t K_t^{\zeta} - r_{fm,t}B_{fm,t} - \kappa\Omega_{fm,t} + B_t - B_{t+1} + (1-\delta)K_t - K_{t+1} - \Psi(K_{t+1}, K_t) \qquad \text{(FOC w.r.t. } \lambda_t\text{)}$$

Notice that although firm-level productivity is fixed, the aggregate productivity is state-dependent since it depends on the allocation of capital goods between firms.

Steady State. Let the $*$ notation denote the quantities at steady state equilibrium. I can restate the first-order conditions with respect to K_{t+1} and B_{t+1} at the steady state as:

$$\frac{1}{\beta} - 1 = \zeta Z^* (K^*)^{\zeta-1} + \frac{\partial Z^*}{\partial K^*}(K^*)^{\zeta} - \delta \tag{50}$$

$$\frac{1}{\beta} - 1 = \frac{\partial Z^*}{\partial B^*}(K^*)^{\zeta} \tag{51}$$

The aggregate quantities follow directly from the market-clearing conditions:

$$\begin{aligned} K^* = &\int_{z \le z^*_{fm}} k(r^*_{dm}, r^*_K; z) dG(z) + \int_{z^*_{fm} < z \le z_{fm,pre}} k(r_{fm}, r^*_K; z) dG(z) \\ &+ (1-\theta) \int_{z > z_{fm,pre}} k(r_{fm}, r^*_K; z) dG(z) + \theta \int_{z > z_{fm,pre}} k(r^*_{dm}, r^*_K; z) dG(z) \end{aligned} \tag{52}$$

$$B^* = \int_{z \le z^*_{fm}} b(r^*_{dm}, r^*_K; z) dG(z) + \theta \int_{z > z_{fm,pre}} b(r^*_{dm}, r^*_K; z) dG(z) \tag{53}$$

$$B^*_{fm} = \int_{z^*_{fm} < z \le z_{fm,pre}} b(r_{fm}, r^*_K; z) dG(z) + (1-\theta) \int_{z > z_{fm,pre}} b(r_{fm}, r^*_K; z) dG(z) \tag{54}$$

$$\Omega^*_{fm} = \int_{z^*_{fm} < z \le z_{fm,pre}} dG(z) + (1-\theta) \int_{z > z_{fm,pre}} dG(z) \tag{55}$$

$$C^* = Z^* (Z^*)^{\zeta} - r_{fm} B^*_{fm} - \kappa \Omega^*_{fm} - \delta K^* \tag{56}$$

Note that the above conditions are stated for the post-sanctions equilibrium, but similar conditions also apply for the pre-sanctions equilibrium. Equation 50 and 51, together with the foreign-market borrowing condition in Equation 6, allow me to solve numerically for the equilibrium interest rates r^*_K, r^*_{dm} and foreign-market borrowing productivity threshold z^*_{fm}.

D.2 Model Calibration

Setup. I calibrate the model at an annual frequency. The state space is discretized by endogenous states K_t and B_t. For K_t, I used 101 equally spaced points between 8 and 9. For B_t, I used 201 equally spaced points between 0.8 and 1.6. Solving the model involves solving for an equilibrium state-by-state, followed by a fixed-point iteration to solve for the household's policy functions.

Firm Distribution. I assume firm productivity has a bounded Pareto distribution with the shape parameter α and the minimum and maximum productivity of $z_{\min}$ and $z_{\max}$, respectively. Hence, the density function $g(z)$ for firm productivity is given by:

$$g(z) = \frac{\alpha z^{\alpha}_{\min} z^{-\alpha-1}}{1 - \left(\frac{z_{\min}}{z_{\max}}\right)^{\alpha}} \tag{57}$$

Borrowing Constraint. The borrowing constraint is given by:

$$\Gamma(z, r_{dm,t}, r_{K,t}) = \left(\frac{z}{z_c}\right)^{\frac{\gamma r_{dm,t}}{1-\zeta}} b^*(r_{dm,t}, r_{K,t}; z) \tag{58}$$

where γ denotes the shape parameter of the constraint, z_c denotes the constraint productivity threshold, and $b^*(\cdot)$ denotes the optimal borrowing amount that firms want to borrow. Note that I assume the constraint only binds in the domestic market, and Equation 58 implies that the

constraint only binds for firms with productivities below the threshold z_c.

Capital Adjustment Cost. The capital adjustment cost takes the conventional form:

$$\Psi(K_{t+1}, K_t) = \frac{\psi(K_{t+1} - K_t)^2}{2K_t} \tag{59}$$

Parameters. Table 7 lists the parameter values for the dynamic model. Preset parameters are set to conventional values. Note that the fraction of capital rent to be settled upfront η is set to one, similar to Neumeyer and Perri [2005]. While this implies significant financial frictions in the economy as firms need to settle *all* of their capital rent before final goods are produced, this value allows the model to yield the debt-to-asset ratio $\frac{B+B_{fm}}{K}$ that is close to the data. Also, I take the calibrated value of ψ from Gopinath et al. [2017] as a preset parameter, and this parameter primarily affects the speed at which the economy adjusts to the new post-sanctions steady state equilibrium.

For observed parameters, the pre-sanctions foreign interest rate $r_{fm,pre}$ reflects the average interest rate of syndicated borrowings in the G10 currencies by Russian firms plus a 1.5% average annual depreciation of the Russian ruble relative to the U.S. dollar based on 2000–2013 statistics. The post-sanctions foreign interest rate $r_{fm,post}$ equals the pre-sanctions foreign interest rate plus a 75 basis point incremental risk premium based on an increase in the average risk premium above the 10-year U.S. Treasury yield for syndicated borrowings in the G10 currencies by Russian firms in 2016 versus 2013. The portion of international borrowers that were sanctioned is based on the aggregate assets of sanctioned borrowers relative to the aggregate assets of all companies in the sample. I set the productivity threshold for the borrowing constraint z_c to equal the foreign-market borrowing productivity threshold z_{fm}, implying that all domestic borrowers are subject to the borrowing constraint, albeit by different extents.

Calibrated parameters are estimated using the simulated method of moments (SMM) with an identity weight matrix. Note that while β is commonly a preset parameter, this model requires it to be calibrated because it, together with γ, determine the domestic interest rates, r_{dm} and $r_{dm,post}$. Although my calibrated $\beta = 0.80$ is also low compared to conventional values in the literature—for instance, Gopinath et al. [2017] assume $\beta = 0.87$—this is because I target the interest rates in my model to the average interest rates of syndicated borrowings by Russian firms, which include risk premiums. Note also that because of the borrowing constraint, my equilibrium domestic interest rate is lower than the $\frac{1}{\beta} - 1$ implied by a standard model. Similarly, $z_{\min}$ and $z_{\max}$ are calibrated because they, together with γ, determine firm sizes.

Moments. Table 8 lists all the moments in the model. For targeted moments, I match pre-sanctions moments—including minimum and maximum firm sizes ($k_{\min}$ and $k_{\max}$), domestic interest rate (r_{dm}), and portion of firms that borrow internationally (Ω_{fm})—to the 2013 statistics. I also

match the post-sanctions domestic interest rate to the 2015 statistics. For the impact of sanctions on relative firm sizes, I calculate the difference between the average size impact on sanctioned firms and the average size impact on unsanctioned firms, both measured immediately post sanctions, and match it to the reduced-form result in Table 3.

For untargeted moments, the debt-to-asset ratio ($\frac{B+B_{fm}}{K}$) and aggregate foreign borrowings as a percent of total borrowings ($\frac{B_{fm}}{B+B_{fm}}$) are based on the pre-sanctions steady state, and they are compared against the 2013 statistics. For macroeconomic impact, changes in domestic borrowings (ΔB) and external borrowings (ΔB_{fm}) are measured at the post-sanctions steady state relative to the pre-sanctions steady state, and they are compared against changes in aggregate statistics from 2013 to 2016. Changes in aggregate output and consumption are measured immediately post sanctions, and they are compared against the 2015 statistics.

D.3 Calibration for the Model without the Borrowing Constraint

In this section, I analyze the outcomes for the dynamic model without the borrowing constraint. In this model, sanctions hurt the targets with minimal spillover impact on the non-targets as the policy presumably intends. At the aggregate level, sanctions also have minimal impact on aggregate output, consumption, and welfare, as the policy induces little allocation inefficiency in the domestic economy without credit rationing. In fact, the household even becomes better off in the post-sanctions steady state, as sanctions have minimal impact on aggregate output and firms pay less in foreign financing costs, which represent a leakage for household income.

For this calibration, I match the same moments as in the model with the borrowing constraint, *except* for the impact of sanctions on relative firm sizes ($\overline{\Delta k_s} - \overline{\Delta k_u}$), which is excluded in the moment matching. This is because without financial frictions, sanctioned firms will shrink by more than unsanctioned firms, as discussed in Section 6.1.2. Appendix Table D.1 compares model parameters and moments for the models with versus without the borrowing constraint.

Impulse Responses. Appendix Figure D.1 plots the impulse responses for the model without the borrowing constraint. Immediately post sanctions, sanctioned firms shrank by 5% (Panel B) and unsanctioned firms shrank by only 1% (Panel C), resulting in a negative net impact of 4% (Panel A). Without the borrowing constraint, sanctions achieve the intended effect of harming sanctions targets with minimal spillover impact. The domestic interest rate rises by 2% (Panel D) given heightened demand for domestic capital. For macroeconomic impact, sanctions hurt aggregate output only marginally by .3% (Panel G). This is because the inefficient allocation of capital instigated by sanctions is not exacerbated by credit rationing. Consumption drops by 1% (Panel H), which is more than the drop in output, as household saves more to shore up savings.

In the long run, the spillover impact of sanctions dissipate as the domestic interest rate subsides. In fact, unsanctioned firms recover and even grow beyond their pre-sanctions sizes given

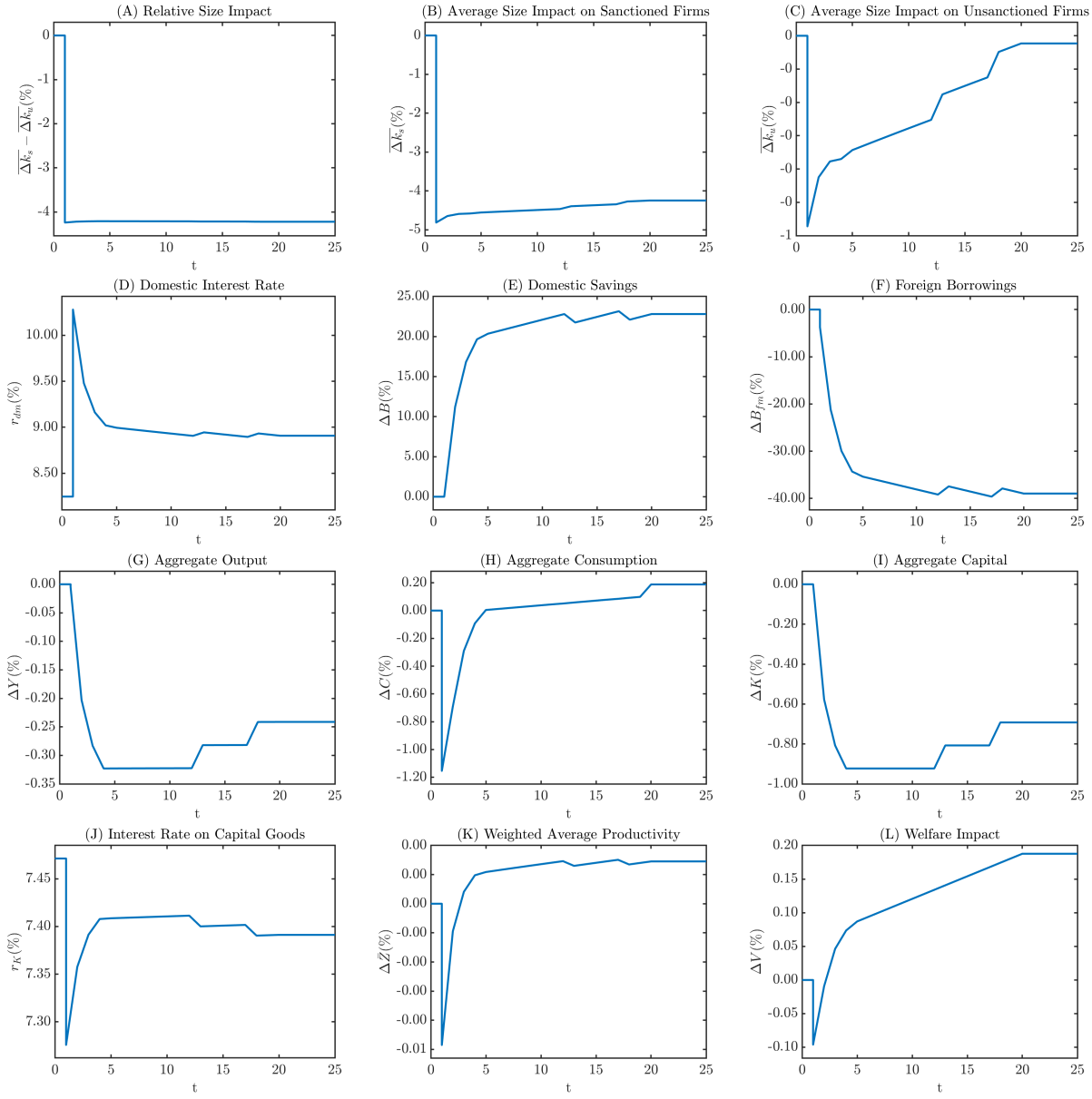
Table D.1: Comparison of model moments

Parameter	Description	Data	Model	
			With Constraint $\gamma>0$	Without Constraint $\gamma=0$
Calibrated Parameters:				
β	Household's discount rate		0.80	0.93
γ	Constraint shape parameter		5.86	0.00
κ	Fixed cost for foreign borrowings		1.87	0.99
$z_{\min}$	Minimum firm productivity		0.60	0.06
$z_{\max}$	Maximum firm productivity		41.97	24.78
α	Productivity distribution shape parameter		0.98	0.63
Targeted Moments:				
r_{dm}	Domestic interest rate, pre-sanctions	8.1%	8.2%	8.2%
r_{post}	Domestic interest rate, post-sanctions	10.3%	9.9%	10.3%
$\overline{\Delta k_s} - \overline{\Delta k_u}$	Relative impact of sanctions	28.7%	20.1%	-4.2%
$k_{\min}$	Minimum assets	0.05	0.05	0.05
$k_{\max}$	Maximum assets	556	573	560
Ω	Portion of firms that borrow internationally	0.9%	0.9%	0.9%
Untargeted Moments:				
$\frac{B_{fm}}{B+B_{fm}}$	Foreign borrowings as a percent of total borrowings	36.8%	40.4%	39.0%
$\frac{B+B_{fm}}{K}$	Debt to asset ratio	21.3%	22.5%	13.5%
ΔB_{fm}	Percentage change in external borrowings	-29.8%	-29.4%	-39.0%
ΔB	Percentage change in domestic borrowings	34.9%	15.0%	22.8%
ΔY	Percentage change in real GDP	-2.0%	-1.0%	-0.2%
ΔC	Percentage change in real consumption	-9.4%	-1.8%	-1.2%
Policy Considerations:				
θ^*_{LT}	Neutral sanctions proportion (LT)		41%	∞
θ^*_{ST}	Neutral sanctions proportion (ST)		12%	∞

Notes: This table compares the calibrated parameters, targeted moments, untargeted moments, and policy recommendations for the models with and without the borrowing constraint. The post-sanctions interest rate, the relative size impact, and changes in output and consumption are measured immediately post sanctions. Changes in foreign and domestic borrowings are based on the post-sanctions versus pre-sanctions steady states. Other model moments are based on the pre-sanctions steady state.

the lower capital rental rate (Panel J). On the other hand, sanctioned firms on average remain 4% smaller than before sanctions in the long run. Over time, the domestic interest rate subsides but remains above the pre-sanctions level as the household saves more (+23%, Panel E) to replace foreign capital (−39%, Panel F) with domestic savings. These moves in the domestic interest rate, domestic savings, and foreign borrowings are more pronounced than in the model with the borrowing constraint because at a given level of the domestic interest rate, domestic borrowers borrow more as they are not curtailed by credit rationing. For macroeconomic impact, aggregate output remains 0.2% below the pre-sanctions level in the long run, driven entirely by the decline in capital goods (−0.7%) given reduced demand from firms (Panel I). The household's consumption

Figure D.1: Impulse responses for the benchmark model



Notes: Figures plot the impulse responses to sanctions based on the benchmark calibration. Time period is in years. Sanctions occur before the beginning of the first period.

also rebounds and even exceeds the pre-sanctions level by approximately 0.2% as aggregate output rebounds and firms pay less in foreign financing cost. Ultimately, sanctions have minimal impact on the household's welfare (Panel L), which declines by only 0.1%, as the household eventually becomes better off post sanctions than before sanctions.

D.4 Imperfect Substitutability of Domestic and Foreign Capital

The baseline model in Section 6 assumes perfect substitutability of domestic and foreign capital, in which firms may borrow in either market to finance their usage of capital goods and the only difference between domestic and foreign capital is cost. While this assumption simplifies the analysis, one may argue that domestic and foreign capital are not perfectly substitutable. This is particularly the case for firms that need foreign capital to settle international trade given that international transactions are predominantly conducted in a handful of foreign currencies, especially the U.S. dollar (Amiti et al. [2020], Gopinath et al. [2020], Drenik et al. [2022], Gopinath and Itskhoki [2022]). This therefore necessitates the need for foreign capital that cannot be substituted by domestic capital.[64]

In this section, I explore how imperfect substitutability of domestic and foreign capital affects the impact of sanctions on firm sizes. In this model, firms can use both domestic and foreign capital for production, but the two types of capital are not perfect substitutes. Foreign capital charges a different interest rate and may also carry a different efficiency factor than domestic capital. With imperfect substitutability, sanctions harm international borrowing targets not only by raising their cost of capital but also by forcing them to substitute foreign capital with less efficient domestic capital, resulting in more damages on the targets. In aggregate, sanctions hurt the domestic economy both by depriving the economy of valuable foreign resources and by inducing inefficient allocation of domestic capital.

Setup. The analysis in this section follows the same structure as in Section 6. I only present a static model to illustrate the impact of sanctions on firm sizes. To simplify the analysis, I remove the financial frictions, in which firms need to borrow debt to finance their usage of capital goods; in other words, firms can rent capital goods directly in either domestic or international markets. The domestic economy is endowed with aggregate capital K, and the supply of foreign capital is perfectly elastic.

Firms. The economy is populated by a continuum of firms indexed by their productivity z, distributed according to a distribution $G(z)$. Firms use capital k to produce final good y using a decreasing returns-to-scale technology $f(k;z) = zk^{\zeta}$, where $\zeta < 1$. Firms may rent capital k_{dm} in the domestic market at a domestic rental rate $R_{dm} = r_{dm} + \delta$. Firms may also rent capital k_{fm} in a perfectly elastic international market at a foreign rental rate $R_{fm} = r_{fm} + \delta$ by paying a fixed cost κ. Domestic and foreign capital are partially substitutable with a substitution parameter ρ, implying the elasticity of substitution of $\sigma = \frac{1}{1-\rho}$. Foreign capital also has an efficiency factor of

[64] Even if firms are willing to bear an additional cost to settle international trade in local currency, such capacity is likely insignificant given the limited risk-bearing capacity of counterparties and international financial intermediaries (Kouri [1976], Gabaix and Maggiori [2015]).

$\alpha > 0$ relative to domestic capital.[65] I can express firm capital k as a composite of both domestic capital k_{dm} and foreign capital k_{fm}:

$$k = \left(k_{dm}^{\rho} + (\alpha k_{fm})^{\rho}\right)^{\frac{1}{\rho}} \tag{60}$$

Firms rent capital in the domestic market subject to the constraint $\Gamma(r_{dm}; z)$, which is a function of the domestic interest rate and firm productivity. Firms maximize profit:

$$\begin{aligned} \pi(z) = \max_{k_{dm}, k_{fm}} \; & z\left(k_{dm}^{\rho} + (\alpha k_{fm})^{\rho}\right)^{\frac{\zeta}{\rho}} - (r_{dm} + \delta)k_{dm} - (r_{fm} + \delta)k_{fm} - \kappa \cdot \mathbb{1}_{k_{fm}>0} \\ & \text{such that} \qquad k_{dm} \leq \Gamma(r_{dm}; z) \end{aligned} \tag{61}$$

where $\mathbb{1}_{k_{fm}>0}$ is an indicator function that takes a value of one if the firm uses foreign capital for production, $k_{fm} > 0$. This is the standard profit maximization problem with a constant elasticity of substitution (CES) production function and a constraint on domestic capital usage.

Foreign-Market Borrowing Condition. A firm with productivity z will rent capital both domestically and internationally if its profit were it to do so exceeds its profit were it to rent capital only in the domestic market:

$$\underbrace{z\Big(\overbrace{\left(k_{dm}^{\rho} + \alpha k_{fm}^{\rho}\right)^{\frac{1}{\rho}}}^{=k_{for}}\Big)^{\zeta} - (r_{dm} + \delta)k_{dm} - (r_{fm} + \delta)k_{fm} - \kappa}_{\text{rent capital both domestically and internationally}} \quad > \underbrace{zk_{dom}^{\zeta} - (r_{dm} + \delta)k_{dom}}_{\text{rent capital domestically only}} \tag{62}$$

where k_{dm} and k_{fm} denote the domestic and foreign capital choices for firms that rent their capital in both domestic and foreign markets, $k_{for} = \left(k_{dm}^{\rho} + \alpha k_{fm}^{\rho}\right)^{\frac{1}{\rho}}$ denotes the total capital of such a firm, and k_{dom} denotes the domestic capital choice for firms that rent their capital only in the domestic market. This **foreign-market borrowing condition** allows me to solve for the **foreign-market borrowing productivity threshold** $z_{fm}(\kappa, r_{fm}, r_{dm})$ whereby firms with productivity $z \leq z_{fm}$ rent capital only domestically (henceforth called "domestic borrowers") and firms with productivity $z > z_{fm}$ rent capital both domestically and internationally (called "foreign/international borrowers"). In this model, firms that are sufficiently productive ($z > z_{fm}$) rent efficiency-augmenting foreign capital, and the amount that firms borrow abroad increases with a higher efficiency factor ($\alpha \uparrow$) and a lower capital substitutability ($\rho \downarrow$).

Equilibrium. An equilibrium is the domestic interest rate r_{dm}, productivity threshold z_{fm}, and the set of firms' resource choices $\{k_{dm}(z), k_{fm}(z), k_{dom}(z)\}$ with which (a) firms maximize profits given the interest rate and (b) the domestic capital market clears. The market-clearing condition

[65] The efficiency factor α is comparable to the factor augmenting technology in David and van de Klundert [1965] where the efficiency coefficients are fixed for both domestic and foreign capital and the efficiency coefficient for domestic capital is normalized to one.

for domestic capital is:

$$K = \int_{z \leq z_{fm}} k_{dom}(r_{dm}; z) dG(z) + \int_{z > z_{fm}} k_{dm}(r_{dm}, r_{fm}; z) dG(z) \tag{63}$$

For simplicity, suppose only domestic borrowers are subject to the constrains. Solving the firm profit maximization problem, one can show that domestic borrowers rent domestic capital such that

$$k_{dom}(r_{dm}; z) = \min \Big(\underbrace{\big(\frac{\zeta z}{r_{dm} + \delta}\big)^{\frac{1}{1-\zeta}}}_{= k^*_{dom}(r_{dm}; z)}, \Gamma(r_{dm}; z) \Big) \tag{64}$$

and international borrowers rent domestic and foreign capital such that

$$k_{dm}(r_{dm}, r_{fm}; z) = k^*_{dom}(r_{dm}; z) \cdot \big(1 + (\alpha\nu)^\rho\big)^{\frac{\zeta - \rho}{\rho(1-\zeta)}} \tag{65}$$

$$k_{fm}(r_{dm}, r_{fm}; z) = k^*_{dom}(r_{dm}; z) \cdot \nu \cdot \big(1 + (\alpha\nu)^\rho\big)^{\frac{\zeta - \rho}{\rho(1-\zeta)}} \tag{66}$$

$$k_{for}(r_{dm}, r_{fm}; z) = \big(k_{dm}^\rho + (\alpha k_{fm})^\rho\big)^{\frac{1}{\rho}} \tag{67}$$

$$= k^*_{dom}(r_{dm}; z) \cdot \big(1 + (\alpha\nu)^\rho\big)^{\frac{1-\rho}{\rho(1-\zeta)}} \tag{68}$$

where

$$\nu = \frac{k_{fm}}{k_{dm}} = \Big(\alpha^\rho \cdot \frac{r_{dm} + \delta}{r_{fm} + \delta}\Big)^{\frac{1}{1-\rho}} \tag{69}$$

captures the ratio of foreign borrowings relative to domestic borrowings of international borrowers, and $k^*_{dom}(r_{dom}; z)$ denotes the optimal amount of domestic capital that firms want to borrow.

Impact of Sanctions on Firm Size. As in the baseline analysis, suppose a fraction θ of international borrowers are sanctioned and hence forced to rent capital only in the domestic market, but they are sufficiently productive that the domestic capital constraints do not bind for them. With increased demand for domestic capital, the domestic interest rate adjusts to $r_{dm,post} > r_{dm}$. Measuring firm size in terms of its physical capital k, I can calculate the impact of sanctions on the size of sanctioned international borrowers with productivity z_s as:

$$\Delta k(z_s) = \frac{k_{dom}(r_{dm,post}, r_{fm}; z_s)}{k_{for}(r_{dm}, r_{fm}; z_s)} - 1 \tag{70}$$

$$= \Big(\frac{r_{fm} + \delta}{r_{dm,post} + \delta}\Big)^{\frac{1}{1-\zeta}} \cdot \big(1 + (\alpha\nu)^\rho\big)^{-\frac{1-\rho}{\rho(1-\zeta)}} \tag{71}$$

$$\approx -\frac{1}{1-\zeta} \cdot \Big(\underbrace{\frac{r_{dm,post} - r_{fm}}{r_{fm} + \delta}}_{\substack{\text{impact from higher} \\ \text{cost of borrowings}}} + \underbrace{(1-\rho) \cdot \alpha\nu}_{\substack{\text{impact from} \\ \text{imperfect} \\ \text{substitutability}}} \Big) \tag{72}$$

With imperfect substitutability of domestic and foreign capital, sanctions harm the targets in

two ways. First, sanctions increase the costs of capital of the targets, which now must rent capital in the domestic market at the post-sanctions domestic interest rate $r_{dm,post} > r_{fm}$; this impact is captured by the first term of Equation 72. Second, sanctions prohibit target firms from utilizing efficient technology that requires foreign capital; this impact is captured by the second term of Equation 72. Sanctions are more damaging to target firms with a higher efficiency factor of foreign capital ($\alpha \uparrow$) or a lower substitutability of domestic and foreign capital ($\rho \downarrow$).

I can also calculate the impact of sanctions on the size of domestic borrowers with productivity z_u as:

$$\Delta k(z_u) = \frac{k_{dom}(r_{dm,post}; z_u)}{k_{dom}(r_{dm}; z_u)} - 1 \tag{73}$$

$$\approx -\frac{1}{1-\zeta} \cdot \left(\frac{r_{dm,post} - r_{dm}}{r_{dm} + \delta} + \Delta\Lambda(z_u) \right) \tag{74}$$

where

$$\Lambda(r_b; z_u) = \log \frac{k^*_{dm}(r_b; z_u)}{\min\left(k^*_{dm}(r_b; z_u), \Gamma(r_b; z_u)\right)} > 0 \tag{75}$$

measures the degree to which the constraint binds (a higher $\Lambda(\cdot)$ means the constraint is more binding) and $\Delta\Lambda(z_u) = \Lambda(r_{dm,post}; z_u) - \Lambda(r_{dm}; z_u)$ captures the change in the constraint.

Impact of Sanctions on Relative Firm Sizes. Using Equation 72 and 74, I can express the impact of sanctions on the size of a sanctioned international borrower with productivity z_s relative to that of an unsanctioned domestic borrower with productivity z_u as:

$$\Delta k_{z_s} - \Delta k_{z_u} \approx -\frac{1}{1-\zeta} \cdot \Bigg(\underbrace{\frac{(r_{dm,post} - r_{fm})(r_{dm,post} + \delta)}{(r_{fm} + \delta)(r_{dm} + \delta)}}_{\substack{\text{relative impact from} \\ \text{initial interest rate differential} \\ >0}} + \underbrace{(1-\rho) \cdot \alpha\nu}_{\substack{\text{impact from} \\ \text{imperfect} \\ \text{substitutability} \\ >0}} + \underbrace{\Delta\Lambda(z_u)}_{\substack{\text{impact from} \\ \text{financial} \\ \text{frictions} \\ <0}} \Bigg) \tag{76}$$

With imperfect substitutability of capital and financial frictions, the relative impact of sanctions on firm sizes depends on (a) the impact from the relative increase in interest rates, (b) the impact from imperfect substitutability of capital for sanctioned firms, and (c) the change in the constraints for unsanctioned firms. Based on Equation 76, sanctions will hurt an unsanctioned domestic borrower with productivity z_u more than a sanctioned international borrower with productivity z_s when the change in the constraint exceeds the impact of relative interest rate increases and the impact of imperfect substitutability of capital for sanctioned firms.

$$\frac{(r_{dm,post} - r_{fm})(r_{dm,post} + \delta)}{(r_{fm} + \delta)(r_{dm} + \delta)} + (1-\rho) \cdot \alpha\nu < -\Delta\Lambda(z_u) \tag{77}$$

Magnitude of Spillover Impact. In the model with imperfect substitutability, the incremental demand for domestic capital from a sanctioned firm with productivity z_s is:

$$\Delta k_{\text{imperfect substitutability}} = k_{dom,post} - k_{dm} \tag{78}$$

$$= \left(\frac{\zeta z_s}{r_{dm,post}+\delta}\right)^{\frac{1}{1-\zeta}} - \left(\frac{\zeta z_s}{r_{dm}+\delta}\right)^{\frac{1}{1-\zeta}} \cdot \left(1+(\alpha\nu)^{\rho}\right)^{\frac{\zeta-\rho}{\rho(1-\zeta)}} \tag{79}$$

$$= \left(\frac{\zeta z_s}{r_{dm,post}+\delta}\right)^{\frac{1}{1-\zeta}} \cdot \left[1 - \left(\frac{r_{dm,post}+\delta}{r_{dm}+\delta}\right)^{\frac{1}{1-\zeta}} \cdot \left(1+(\alpha\nu)^{\rho}\right)^{\frac{\zeta-\rho}{\rho(1-\zeta)}}\right] \tag{80}$$

This compares to the incremental demand for domestic capital in the baseline model:

$$\Delta k_{\text{perfect substitutability}} = k_{dm,post} = \left(\frac{\zeta z_s}{r_{dm,post}+\delta}\right)^{\frac{1}{1-\zeta}} \tag{81}$$

Suppose $\zeta > \rho$. Then the spillover impact of sanctions from incremental demand for domestic capital in the model with imperfect substitutability is *less* pronounced than in the baseline model, as evidenced by the fact that:

$$0 < \left(\frac{r_{dm,post}+\delta}{r_{dm}+\delta}\right)^{\frac{1}{1-\zeta}} \cdot \left(1+(\alpha\nu)^{\rho}\right)^{\frac{\zeta-\rho}{\rho(1-\zeta)}} < 1 \tag{82}$$

Discussions. The analysis in this section suggests that sanctions will damage target firms more severely and produce less spillover impact when sanctioned firms cannot substitute foreign capital with domestic capital. Despite the non-substitutability of capital within firms, sanctioned firms may instead pay a premium to obtain foreign capital from unsanctioned international borrowers that can afford capital substitutability, resulting in capital substitution across firms. This reaction undermines the imperfect substitutability of domestic and foreign capital, and the situation reverts back to the baseline model. In fact, such capital substitutability across firms indeed happened; for instance, Sberbank raised dollar funding in the domestic market post sanctions by paying higher interest rates (Doff and Galouchko [2014]). This highlights the difficulty in preventing leakages of financial sanctions posed by the fungibility of capital.

E Details on Alternative Sanctions Approaches

Table 9 summarizes the outcomes of different policy alternatives, compared to the baseline model. To allow for comparability, I bifurcate the baseline results into the impact from (A) financial autarky and (B) incremental country premium, and I calibrate the remaining approaches (C and D) to equalize their average short-term impacts on sanctions targets to that in the baseline model.

A. Financial Autarky ($r_{fm,i} \to \infty$): With this incumbent approach, sanctioned firms are prohibited from borrowing in international capital markets. This is equivalent to raising the foreign-

borrowing costs for target firms high enough to deter them from borrowing abroad.

This sanctions approach inflicts the most damage on the targets, especially in the short run (-10%), as target firms are forced to borrow more expensively in the domestic market. However, the approach is inflexible (a target is either sanctioned or unsanctioned), and it generates substantial spillover impact on unsanctioned firms (-18%) and household welfare (-0.6%). In the long run, the impact of sanctions dissipates (sanctioned and unsanctioned firms shrink by 6% and 4%, respectively) as the household accumulates more domestic savings ($+18\%$) to replace foreign capital (-27%). Hence, this makes subsequent sanctions less powerful, as previous targets cannot be sanctioned again and fewer potential targets remain available.

B. Incremental Country Premium ($r_{fm} \uparrow$): Policymakers may also raise the country premium of the target economy, thereby increasing the cost of international borrowings for all firms. This could be achieved, for instance, by forcing the target country into a sovereign default or by making it more difficult for firms in the target country to utilize and access foreign capital (such as by excluding them from the SWIFT transaction network).

Although this sanctions approach may afford policymakers some implementation flexibility as they may determine the magnitude of the increase in foreign-borrowing cost, the policy generates substantial spillover impact, not only on untargeted international borrowers but also on domestic borrowers (unsanctioned domestic and international borrowers on average shrink by 14%). This occurs as the higher cost of foreign borrowings induces marginal international borrowers—those that lie near the foreign-market borrowing productivity threshold—to switch to borrow in the domestic market, thereby crowding out unsanctioned domestic borrowers. The policy also inadvertently benefits productive sanctions targets ($+3\%$), as reduced demand for physical capital drives down the capital rental rate, which helps offset the impact from the increase in the interest rate on debt.

Ultimately, this sanctions approach hurts the household the most (-0.7%) as the higher effective costs of capital for firms leads to drops in output, consumption, and welfare. The impact is also persistent (the long-term impact is the same as the short-term impact), as the household cannot mitigate sanctions impact by accumulating domestic savings given that productive firms continue to borrow abroad, even at a more expensive rate. The economy's continued reliance on foreign capital also allows for potent future sanctions on both existing and new targets.

C. Foreign-Borrowing Surcharge ($r_{fm,i} \uparrow$): To achieve policy precision, policymakers may instead raise the cost of international borrowings for target firms only. This could be achieved by either imposing foreign-borrowing surcharges or heightening the risks of the targets. This analysis assumes the foreign-borrowing surcharges are imposed equally across all target firms.

As sanctions targets that borrow abroad face more expensive foreign interest rates, some firms opt instead to borrow in the domestic capital market. This creates a spillover impact on unsanctioned domestic borrowers, but to a lesser degree than under the financial autarky approach,

as some unsanctioned domestic borrowers also switch to borrow abroad in the face of a higher domestic interest rate. In the long run, the domestic interest rate remains elevated to maintain the foreign-market borrowing conditions for *both* sanctioned and unsanctioned firms.[66] This results in the economy being more reliant on foreign capital in the long run given the incremental demand from marginal borrowers that switch to borrowing abroad post sanctions.

Ultimately, although this sanctions approach harms the targets both in the short and long runs (-6%) by increasing their cost of international borrowings, it also harms unsanctioned firms (-10%) by raising the domestic interest rate. Nevertheless, the net impact on the household (-0.3%) is less than that under the financial autarky approach as lower demand for domestic savings enhances short-term consumption. The policy also allows for harsher and broader sanctions in the future as the economy remains reliant on foreign capital post sanctions.

D. Productivity Hit ($z_i \downarrow$): Finally, policymakers may reduce the productivity of target firms, thereby impairing their ability to use capital. An example of this approach is to prevent the targets from securing critical components for their production processes.

By reducing their productivity, this sanctions approach undermines the targets (-7%) with limited spillover impact on untargeted firms (-0.1%) and on household welfare (-0.4%). Although the policy also causes some sanctioned international borrowers to switch to borrowing domestically, some marginal domestic borrowers also switch to borrowing abroad in the face of a lower capital rental rate given reduced demand from firms. Ultimately, this policy proves to be the most targeted approach and allows for subsequent sanctions on both existing and new targets. However, this approach is also the most difficult to implement as it requires blocking critical supplies to specific firms while preventing policy leakage.

Appendix Table E.1 summarizes the trade-offs of these policy options.

[66] Note that sanctioned and unsanctioned firms face different foreign-market borrowing conditions since they encounter different foreign interest rates.

Table E.1: Trade-offs of different sanctions approaches

Sanctions Approach	Advantages	Disadvantages
Financial Autarky	• Maximum damage to the targets	• Inflexible (firms are either sanctioned or unsanctioned, but not somewhere in between) • Significant spillover impact • Sanctions impact dissipates over time • Diminished capacity for subsequent sanctions
Incremental Country Premium	• Maximum damage to the economy • Can adjust severity • Persistent impact • Allows for subsequent sanctions	• Imprecise (cannot target specific firms) • Significant spillover impact • Inadvertently benefit productive targets
Foreign Borrowing Surcharge	• Can adjust severity (size of surcharge) and precision (target specific firms) • Persistent impact • Allows for subsequent sanctions	• Significant spillover impact
Productivity Hit	• Significant damage to the targets • Limited spillover impact • Can adjust severity and precision • Allows for subsequent sanctions	• Must rely on trade channel

F Additional Tables & Figures

Table F.1: Number of Russian entities added to the sanctions lists by year and by sector

	SDN	SSI 1-3	SSI 4	Total
By year:				
2011	1	0	0	1
2012	0	0	0	0
2013	2	0	0	2
2014	33	12	5	48
2015	15	103	14	118
2016	26	55	55	136
2017	18	21	0	39
2018	37	0	12	49
2019	17	0	0	17
2020	5	0	0	5
Total	154	191	86	415
By sector:				
Agriculture, Forestry, and Fishing	0	1	0	1
Mining	2	11	17	24
Construction	11	3	3	17
Manufacturing	25	26	13	56
Transportation, Communications, Utility	18	24	23	65
Wholesale Trade	11	9	2	22
Retail Trade	3	1	5	9
Finance, Insurance, and Real Estate	35	79	8	120
Services	28	31	13	72
Public Administration	2	0	0	2
Unknown	19	6	2	27
Total	154	191	86	415

Notes: This table reports the number of Russian entities added to the sanctions lists by year. SDN denotes the Specially Designated Nationals and Blocked Persons (SDN) list, which prohibits a U.S. person from all dealings with sanctioned entities. SSI 1-3 denotes the Sectoral Sanctions Identifications (SSI) list under Directives 1–3, which prohibits a U.S. person from extending medium- or long-term financing to sanctioned entities. SSI 4 denotes the SSI list under Directive 4, which prohibits a provision and exportation of goods and services (except for financial services) in support of exploration or production of deepwater, Arctic offshore, or shale projects by a U.S. person to sanctioned entities. Note that the sum of sanctioned entities across each row may exceed the total because entities may be added to multiple sanctions lists.

Table F.2: Top 20 largest sanctioned Russian companies by assets

No.	Company name	Assets (USD in billions)	Sanctions type	Sanctions year
1	Sberbank of Russia	556	SSI 1-3	2014
2	Gazprom	411	SSI 4	2014
3	VTB Bank	268	SSI 1-3	2014
4	Rosneft	230	SSI 1-4	2014
5	Gazprombank	111	SSI 1-3	2014
6	Lukoil	109	SSI 4	2014
7	State Development Corporation	101	SSI 1-3	2014
8	Surgutneftegas	73	SSI 4	2014
9	Bank VTB 24	63	SSI 1-3	2014
10	Russian Agricultural Bank	51	SSI 1-3	2014
11	BM-Bank	50	SSI 1-3	2014
12	Gazprom Neft	48	SSI 1-4	2014
13	Transneft	28	SSI 1-3	2014
14	United Company Rusal	20	SDN	2018
15	Lukoil-West Siberia	20	SSI 4	2014
16	Gazprom Mezhregiongaz	20	SSI 4	2014
17	Novatek	18	SSI 1-3	2014
18	Transneft-Vostok	16	SSI 1-3	2014
19	Vankorneft	15	SSI 1-4	2014
20	Gazprom Export	14	SSI 4	2014

Notes: This table reports the 20 largest sanctioned Russian companies by assets. Assets are as of December 31, 2013.

Table F.3: Summary statistics of Russian non-banks

	Sanctioned non-banks			Unsanctioned non-banks		
	N	Mean	Median	N	Mean	Median
Size ($MM):						
Assets	603	1,262	192	7,570	451	101
Debt	603	402	33	7,570	118	25
Equity	603	550	56	7,570	198	20
Sales	603	834	108	7,570	299	60
Gross Profit	602	407	15	7,465	93	8
EBIT	603	103	6	7,553	27	3
Net Income	603	81	4	7,554	17	1
Balance Sheet (% of Assets):						
Debt	603	32	17	7,570	33	22
Debt (> 0)	437	44	36	5,962	42	36
External Debt (> 0)	20	10	9	79	19	9
Equity	603	34	32	7,570	27	18
Profitability (%):						
Return on Assets (ROA)	603	5	2	7,556	4	1
Return on Equity (ROE)	524	16	12	6,604	25	13
EBIT Margin	603	4	6	7,570	6	4
Net Margin	603	5	5	7,570	6	3
Observations	603			7,570		

Notes: This table reports summary statistics of sanctioned and unsanctioned non-banks in my sample as of December 31, 2013. The sample includes all Russian non-banks with asset statistics during 2013–2016 and at least $50 million of assets as of December 31, 2013. Non-banks are defined as firms with all SIC codes except those between 600 and 620. Sanctioned non-banks include entities that have been added to either the SDN list or the SSI list, Directives 1–3. Gross amounts are in millions of U.S. dollars.

Table F.4: Summary statistics of Russian banks

	Sanctioned banks			Unsanctioned banks		
	N	Mean	Median	N	Mean	Median
Size ($MM):						
Assets	47	27,596	1,658	376	1,768	244
Loans	47	18,437	723	376	1,072	130
Deposits	47	21,044	1,210	376	1,331	184
Debt	47	4,034	108	376	268	7
Equity	47	3,085	193	376	230	38
Net Income	46	397	5	375	21	2
Balance Sheet (% of Assets):						
Debt	47	9	7	376	8	3
Debt (> 0)	44	10	7	314	9	5
External Debt (> 0)	16	10	10	30	8	7
Equity	47	14	13	376	18	14
Deposits	47	77	80	376	76	80
Loan/Deposit	47	75	81	372	71	70
Profitability (%):						
Return on Assets (ROA)	46	1	1	375	1	1
Return on Equity (ROE)	46	8	4	375	6	7
Net Interest Margin (NIM)	46	5	5	374	6	6
Rate on assets	31	10	9	274	9	9
Rate on liabilities	31	5	5	274	5	5
Observations	47			376		

Notes: This table reports summary statistics of sanctioned and unsanctioned banks in my sample as of December 31, 2013. The sample includes all Russian banks with asset statistics during 2013–2016 and at least $50 million of assets as of December 31, 2013. Banks are defined as firms with SIC codes between 600 and 620. Sanctioned banks include entities that have been added to either the SDN list or the SSI list, Directives 1–3. Gross amounts are in millions of U.S. dollars.

Table F.5: Top 20 largest Russian banks by assets

No.	Company name	Assets (USD in billions)	Market Share	Sanctioned?
1	Sberbank of Russia	556	28.4	✓
2	VTB Bank	268	13.7	✓
3	Gazprombank	111	5.7	✓
4	State Development Corporation	101	5.2	✓
5	Bank VTB 24	63	3.2	✓
6	ABH Holdings	53	2.7	
7	Russian Agricultural Bank	51	2.6	✓
8	BM-Bank	50	2.5	✓
9	Alfa-Bank	49	2.5	
10	Bank Otkritie Financial Corporation	42	2.1	
11	UniCredit Bank	27	1.4	
12	Rosbank	26	1.3	
13	Promsvyazbank	23	1.2	
14	Raiffeisenbank	22	1.1	
15	Rossium Concern	14	0.7	
16	Credit Bank of Moscow	14	0.7	
17	Bank Rossiya	13	0.6	✓
18	Bank Saint-Petersburg	13	0.6	
19	Russian Standard Bank Group	12	0.6	
20	Bank Uralsib	11	0.6	
	Others	444	22.6	
	Total	1,962	100.0	

Notes: This table lists the top 20 largest Russian banks by assets. Assets are as of December 31, 2013.

Table F.6: Largest Russian strategic organizations and systemically important banks by assets

No.	Company name	Assets (USD in billions)	Sanctions type	Sanctions year
Strategic organizations:				
1	Gazprom	411	SSI 4	2014
2	Rosneft	230	SSI 1-4	2014
3	Russian Railways	140		
4	Lukoil	109	SSI 4	2014
5	Surgutneftegas	73	SSI 4	2014
6	Veon Ltd	50		
7	Sistema	43		
8	Atomic Energy Power Corporation	38		
9	Transneft	28	SSI 1-3	2014
10	Federal Grid Company of Unified Energy System	28		
11	RusHydro	26		
12	Tatneft	21		
13	Rusal	20	SDN	2018
14	Norilsk Nickel	19		
15	Novatek	18	SSI 1-3	2014
16	Evraz	18		
17	Rostelekom	17		
18	Novolipetsk Steel	16		
19	Inter RAO UES	16		
20	Vankorneft	15	SSI 1-4	2014
Systemically important credit institutions:				
1	Sberbank of Russia	556	SSI 1-3	2014
2	VTB Bank	268	SSI 1-3	2014
3	Gazprombank	111	SSI 1-3	2014
4	Russian Agricultural Bank	51	SSI 1-3	2014
5	Alfa-Bank	49		
6	Bank Otkritie Financial Corporation	42		
7	Unicredit Bank	27		
8	Rosbank	26		
9	Promsvyazbank	23		
10	Raiffeisenbank	22		

Notes: This table lists the top 20 largest Russian strategic organizations per Government Commission for Economic Development and Integration [2015] and the 10 systemically important credit institutions per Bank of Russia [2015], both with their sanctions statuses. Assets are as of December 31, 2013.

Table F.7: Largest Russian state-owned firms by assets

No.	Company name	Assets (USD in billions)	Sanctions type	Sanctions year
1	Sberbank of Russia	556	SSI 1-3	2014
2	Gazprom	411	SSI 4	2014
3	VTB Bank	268	SSI 1-3	2014
4	Rosneft	230	SSI 1-4	2014
5	Gazprombank	111	SSI 1-3	2014
6	Russian Agricultural Bank	51	SSI 1-3	2014
7	BM-Bank	50	SSI 1-3	2014
8	Gazprom Neft	48	SSI 1-4	2014
9	Bank Otkritie Financial Corporation	42		
10	Russian Concern for Production of Electric and Thermal Energy at Nuclear Power Plants	38		
11	Transneft	28	SSI 1-3	2014
12	Federal Grid Company of Unified Energy System	28		
13	Rosbank	26		
14	RusHydro	26		
15	Promsvyazbank	23		
16	Tatneft	21		
17	Inter RAO UES	16		
18	Transneft-Vostok	16	SSI 1-3	2014
19	Bashneft	14	SSI 14	2014
20	SIBUR Holding	13		

Notes: This table lists the top 20 largest Russian firms that were at least 10% owned by the Russian government and their sanction statuses. Assets are as of December 31, 2013.

Table F.8: Largest Russian politically-connected firms by assets

No.	Company name	Assets (USD in billions)	Sanctions type	Sanctions year
1	Sberbank of Russia	556	SSI 1-3	2014
2	Gazprom	411	SSI 4	2014
3	VTB Bank	268	SSI 1-3	2014
4	Rosneft	230	SSI 1-4	2014
5	Russian Railways	140		
6	Gazprombank	111	SSI 1-3	2014
7	State Development Corporation	101	SSI 1-3	2014
8	Surgutneftegas	73	SSI 4	2014
9	Russian Agricultural Bank	51	SSI 1-3	2014
10	BM-Bank	50	SSI 1-3	2014
11	Alfa-Bank	49		
12	Gazprom Neft	48	SSI 1-4	2014
13	Sistema	43		
14	Bank Otkritie Financial Corporation	42		
15	Russian Concern for Production of Electric and Thermal Energy at Nuclear Power Plants	38		
16	Atomic Energy Power Corporation	38		
17	Transneft	28	SSI 1-3	2014
18	Federal Grid Company of Unified Energy System	28		
19	Rosbank	26		
20	RusHydro	26		

Notes: This table lists the top 20 largest Russian "politically connected" firms and their sanction statuses. Assets are as of December 31, 2013.

Table F.9: Issuance volume of syndicated borrowings denominated in foreign currencies by Russian firms by year

	Sanctioned Firms			Unsanctioned Firms		
	G10 Currency			G10 Currency		
	G10 Market	Other Market	Other FC	G10 Market	Other Market	Other FC
2011	6,049	20,416	695	16,102	30,817	234
2012	28,181	30,380	882	21,825	12,998	123
2013	15,105	22,679	1,021	28,114	14,843	8,172
2014	6,878	8,012	596	5,688	14,087	140
2015	0	4,800	129	5,523	14,381	735
2016	0	18,350	2,972	8,664	10,407	0
2017	1,206	2,250	490	16,818	12,336	11
2018	500	422	0	9,584	20,808	468
2019	0	1,267	53	13,847	12,833	5
2020	0	250	0	13,589	0	52
Total	57,920	108,826	6,841	139,754	143,510	9,941

Notes: This table reports issuance volume of corporate bonds and syndicated loans denominated in foreign currencies by Russian firms by year. Issuance amounts denominated in the G10 currencies in other markets in 2015 and 2016 include borrowings by the Yamal liquefied national gas (LNG) project, which are deemed an exception. Sanctioned firms include entities that have been added to either the SDN list or the SSI list, Directives 1–3. Gross amounts are in millions of U.S. dollars.

Table F.10: The Kremlin's support to major sanctioned banks in 2014

Supported Entity	Measures
Sberbank of Russia	• Subordinated loans from CBR increased to RUB 503.9 billion as of December 2014 (from RUB 303.3 billion as of December 2013); 6.5% interest rate, maturing in 2019 • Short-term deposits from CBR increased to RUB 3.0 trillion as of December 2014 (from RUB 1.7 trillion as of December 2013); this compares to total deposits as of December 2014 of RUB 19.2 trillion • Utilization of CBR's refinancing instrument under Regulation No. 312-P
VTB Bank	• Conversion of RUB 214 billion subordinated loans from the Russian government into preference shares; this compares to total equity as of December 2014 of RUB 1 trillion • RUB 100 billion subordinated deposit from the Russian National Wealth Fund, recognized as Tier 2 capital • Extension of the deposit placed by the CBR under a plan approved by the DIA, resulting in a RUB 99.2 billion gain
Gazprombank	• Conversion of a subordinated loan received in 2008 from Vnesheconombank into preferred shares, increasing share capital by RUB 40 billion; this compares to total equity as of December 2014 of RUB 198 billion • Utilization of CBR's refinancing instrument under Regulation No. 312-P • Total liquidity sources in the CBR amounted to RUB 612 billion; actual borrowings remained moderate at RUB 323 billion
Russian Agricultural Bank	• Conversion of a subordinated loan received in 2008 from Vnesheconombank into preferred shares, increasing share capital by RUB 25 billion; this compares to total equity as of December 2014 of RUB 198 billion • RUB 5 billion capital injection from the Government of Russia • Allocation of RUB 68.8 billion in federal loan bonds (OFZ) in the form of subordinated loans to the bank by the DIA • Utilization of CBR's refinancing instrument under Regulation No. 312-P

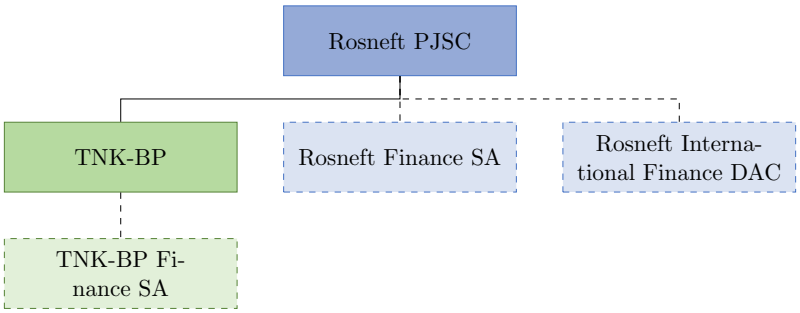
Sources: 2014 annual reports and consolidated financial statements of Sberbank, VTB Bank, Gazprombank, and Russian Agricultural Bank.

Table F.11: The Kremlin's responses to the U.S. sanctions in 2014

Supporting Entity	Measures
Central Bank of Russia (CBR)	• Increased loans to banks from RUB 4.8 trillion to RUB 9.8 trillion, particularly through loans secured by non-marketable assets in accordance with Regulation No. 312-P • Introduction of foreign-currency-denominated loans secured by foreign-currency-denominated receivables • Acceptance of Eurobonds as collateral under its repo deals with banks • Reduced discounts on securities accepted as collateral under repo deals by 5–5.5% • Extension of the terms on CBR's loans to banks covered by non-market assets, sureties, or gold from 1 to 1.5 years • FX liquidity to banks via USD/RUB swaps • FX repo auctions for a term of up to 1 year • Conversion of subordinated loans received by banks from the state in 2008–2009 into preferred shares
Ministry of Finance	• Recapitalization of several banks via the Deposit Insurance Agency (DIA)'s OFZ (federal loan obligations) scheme whereby DIA allocated OFZ as subordinated loans to banks • The DIA to receive federal loan bonds (OFZ) totaling RUB 1 trillion in 2014 and RUB 1.5 trillion in 2015 to boost banks' capital
Ministry of Economic Development	• Support of large investment projects to be financed initially by banks and refinanced by government funds

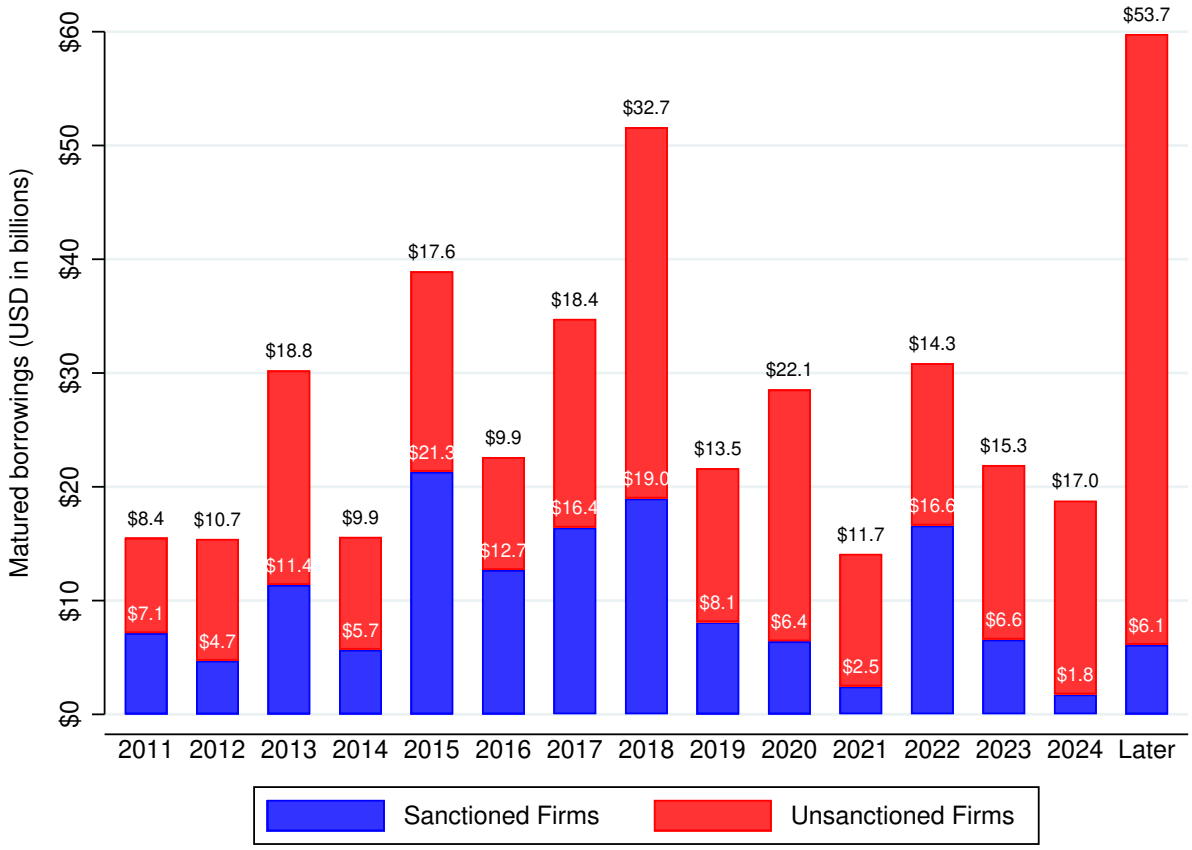
Sources: 2014 annual reports and consolidated financial statements of Sberbank, VTB Bank, Gazprombank, and Russian Agricultural Bank.

Figure F.1: Rosneft's Simplified Organizational Chart



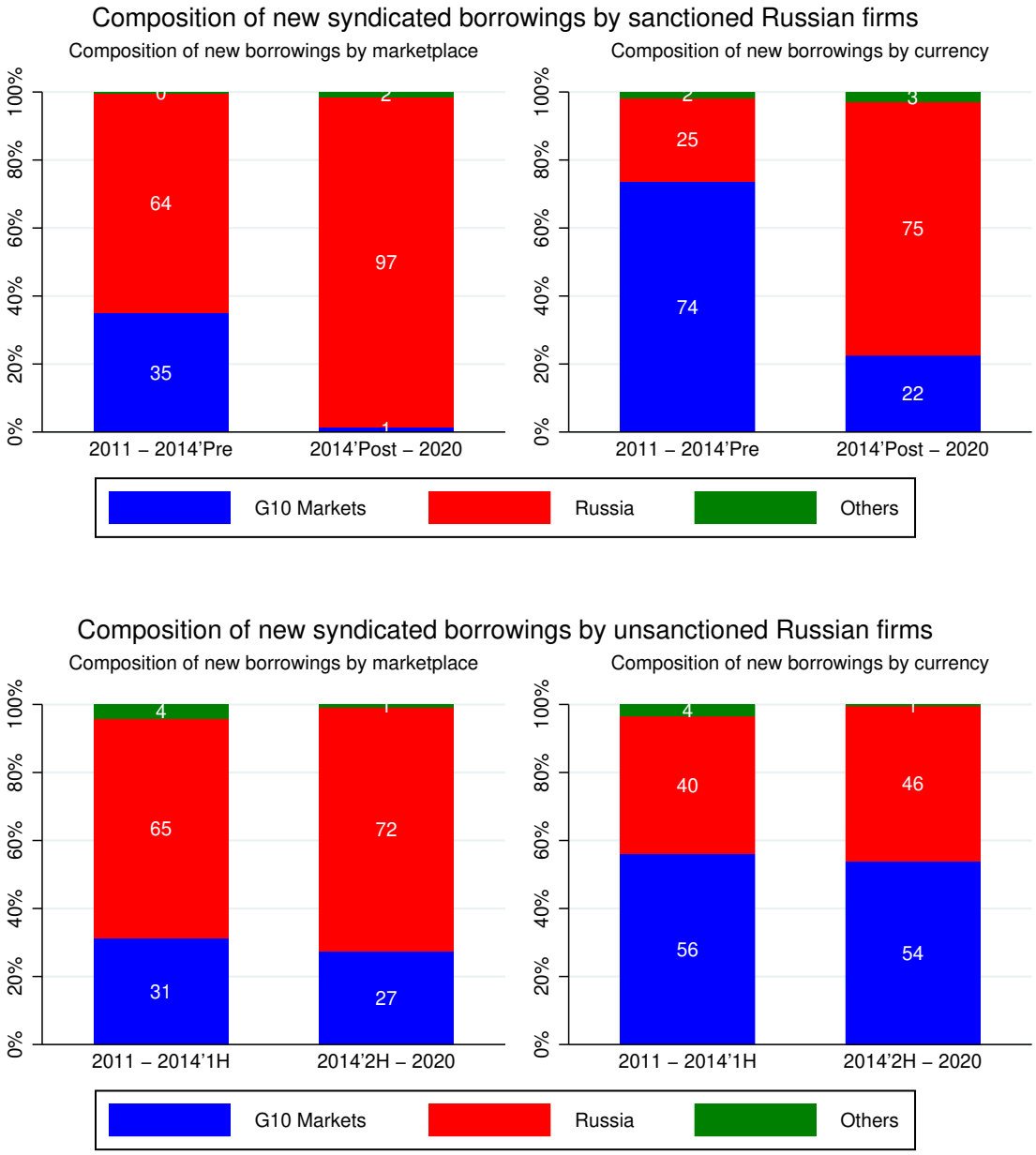
Notes: This figure illustrates Rosneft's simplified organizational chart. Solid line denotes ownership of an operating subsidiary. Dashed line denotes ownership of a financing subsidiary.

Figure F.2: Maturity schedule of borrowings in the G10 markets by Russian firms



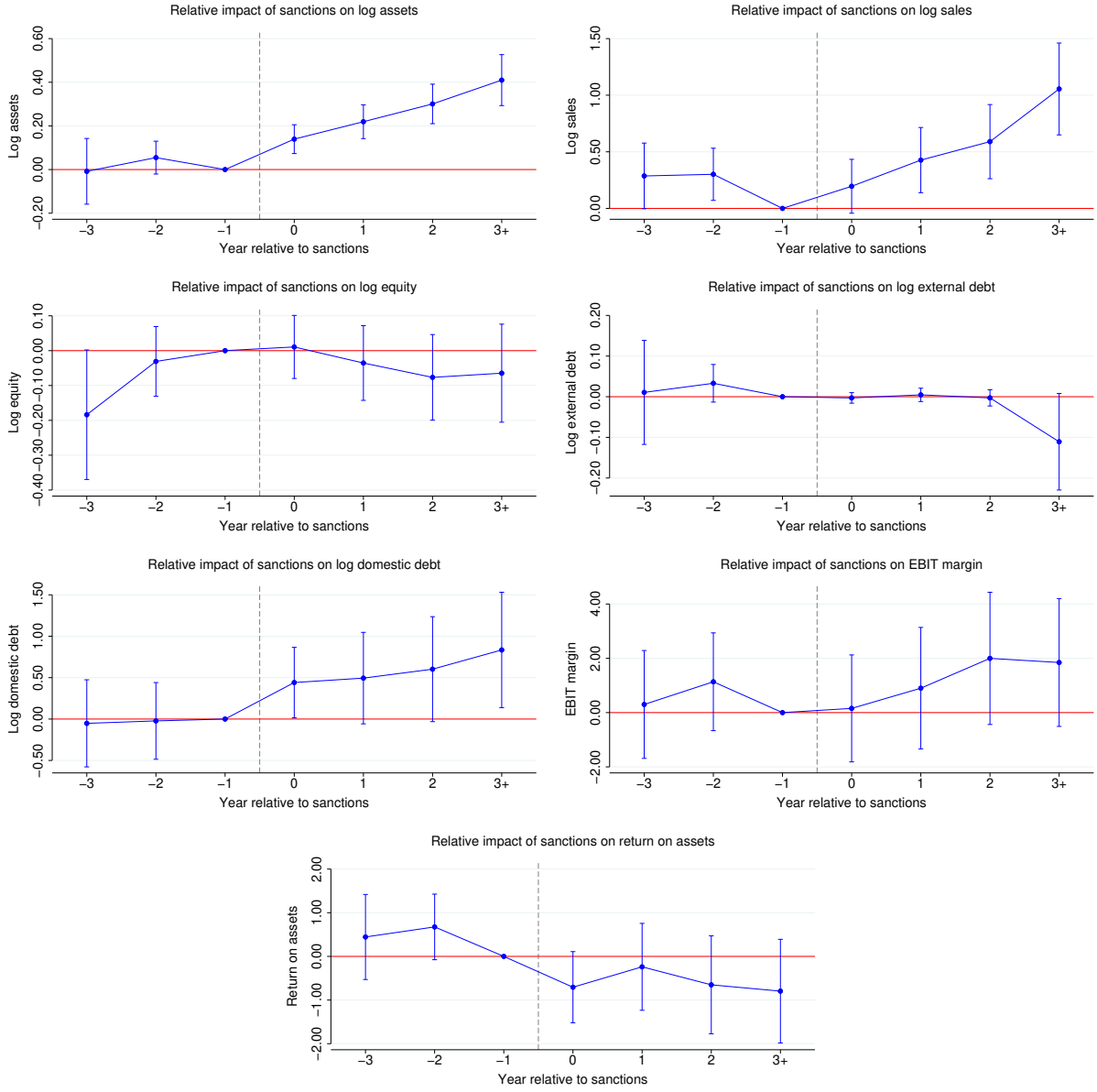
Notes: This figure illustrates the maturity schedule of syndicated borrowings in the G10 markets by Russian firms. Syndicated borrowings data from SDC Platinum and FactSet. Amount in billions of U.S. dollars.

Figure F.3: Marketplace and currency compositions of new syndicated borrowings by Russian firms



Notes: These graphs report marketplace and currency compositions of syndicated borrowings by sanctioned (top panel) and unsanctioned (bottom panel) Russian firms. Blue bars indicate borrowings in the G10 currencies/markets; red bars indicate borrowings in the Russian ruble/market; and green bars indicate borrowings in other currencies/markets. For issuances by unsanctioned companies, I use June 30, 2014, as the dividing point as that is near the date of the first major round of sanctions. For issuances by sanctioned companies, I use the actual dates the issuers were sanctioned in 2014. Borrowings data per SDC and FactSet.

Figure F.4: Impact of sanctions on the financial performance of Russian non-banks

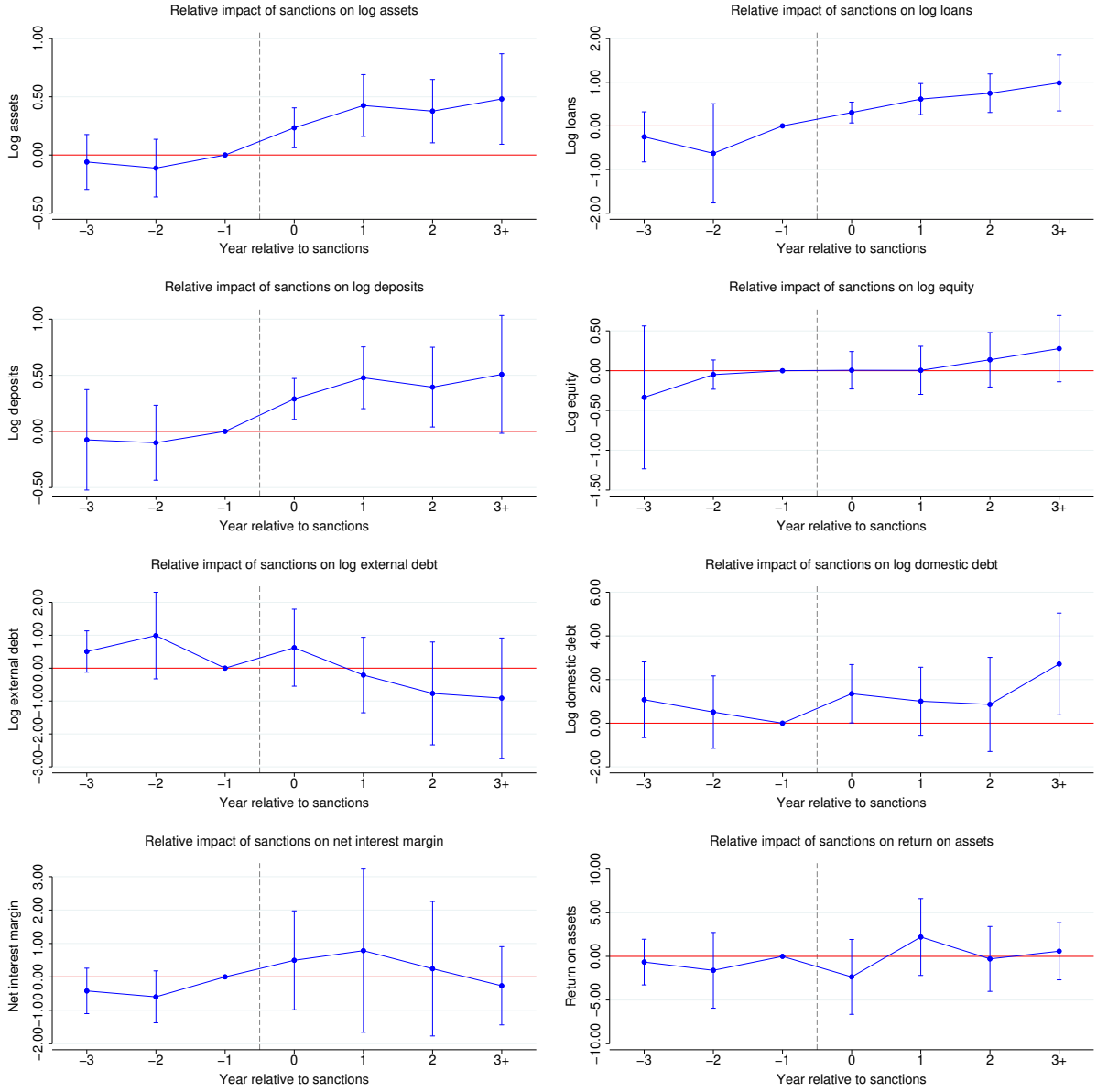


Notes: These figures plot the impact of sanctions on the financials of Russian non-banks by relative event year. The figures plot the $\hat{\beta}_\tau$ coefficients of:

$$y_{i,t} = \alpha + \sum_{\tau=-3, \tau \neq -1}^{\tau=3} \beta_\tau \cdot \text{Sanctioned}_{i,\tau} + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}$$

where $y_{i,t}$ refers to the financial variable of interest of firm i in year t, $\text{Sanctioned}_{i,\tau}$ is a dummy variable that takes a value of 1 for the relative year τ versus the year in which the sanctions on firm i started and 0 otherwise, and Firm_i and Year_t capture firm fixed effects and year fixed effects, respectively. The min-max ranges capture the 95% confidence intervals, where the standard errors are clustered at the firm level.

Figure F.5: Impact of sanctions on the financial performance of Russian banks

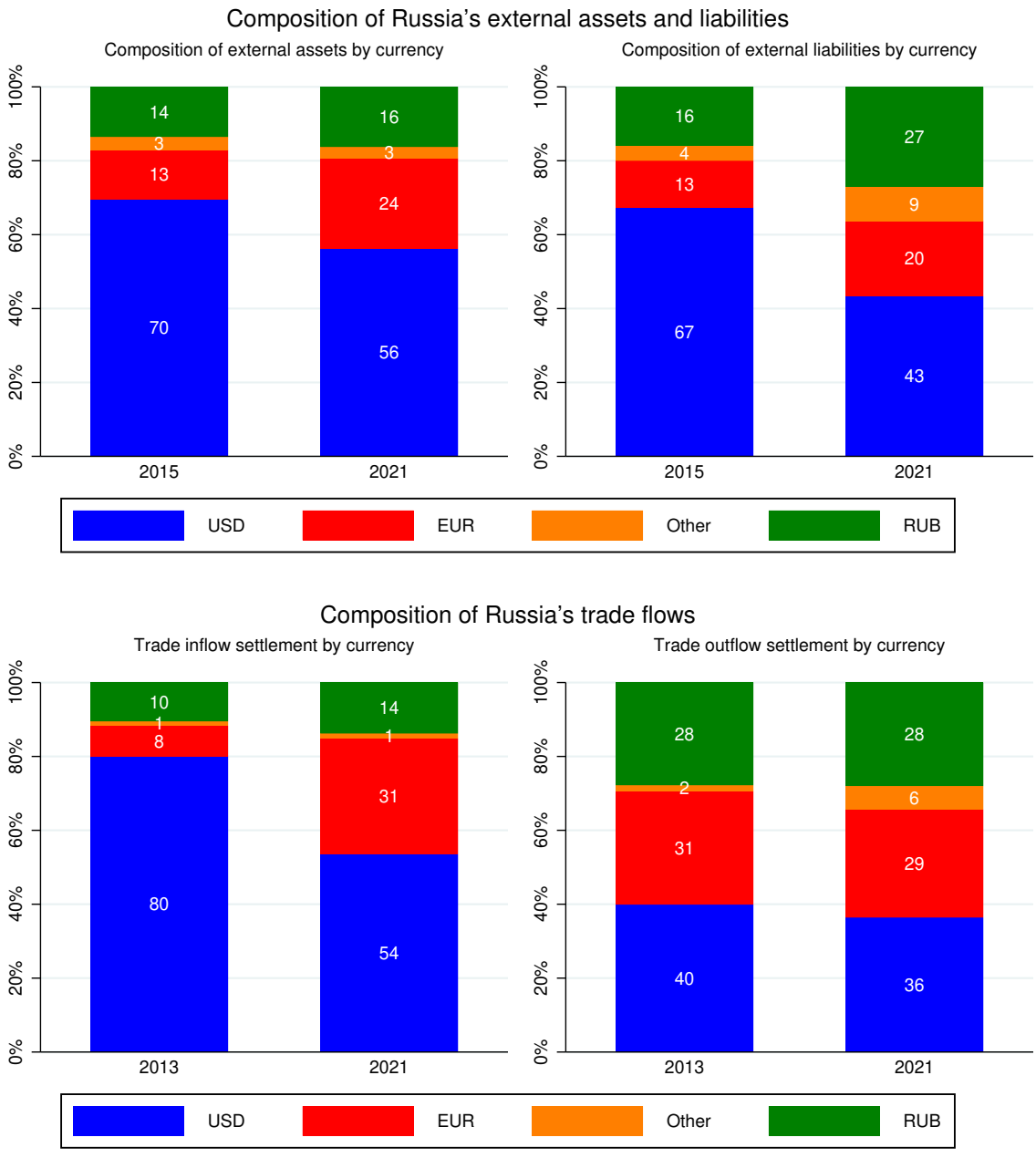


Notes: These figures plot the impact of sanctions on the financials of Russian banks by relative event year. The figures plot the $\hat{\beta}_\tau$ coefficients of:

$$y_{i,t} = \alpha + \sum_{\tau=-3, \tau \neq -1}^{\tau=3} \beta_\tau \cdot \text{Sanctioned}_{i,\tau} + \text{Firm}_i + \text{Year}_t + \epsilon_{i,t}$$

where $y_{i,t}$ refers to the financial variable of interest of firm i in year t, $\text{Sanctioned}_{i,\tau}$ is a dummy variable that takes a value of 1 for the relative year τ versus the year in which the sanctions on firm i started and 0 otherwise, and Firm_i and Year_t capture firm fixed effects and year fixed effects, respectively. The min-max ranges capture the 95% confidence intervals, where the standard errors are clustered at the firm level.

Figure F.6: Currency compositions of Russia's external balance sheet and trade flows.



Notes: These graphs report currency compositions of Russia's external balance sheet (top panel) and trade flows (bottom panel). Data is per Central Bank of Russia [2022]. 2015 statistics represent the earliest available data for external assets and liabilities.