Russian Counter-Sanctions and Smuggling: Forensics with Structural Gravity Estimation*

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Abstract

Trade and other economic sanctions are a common foreign policy instrument, but their effectiveness can be blunted by trade deflection and smuggling. We develop a novel methodology to study the effect of the food embargo imposed by Russia on Western countries after the annexation of Crimea in 2014. We construct predicted trade flows for the post-sanctions period using an estimated structural general equilibrium gravity model with many industry sectors and compare those predictions with actual trade flows. We identify a substantial value of suspicious trade flows which we associate with smuggling; especially importing banned goods through third countries such as Belarus. The structural gravity model systematically under-predicts trade volumes for country-product combinations used as channels for smuggling of the banned goods. We identify a substantial quantity of smuggling. An ability to quickly evade sanctions must decrease their efficacy.

JEL Classification: F10

Keywords: Conditional General Equilibrium, Sanctions, Structural Gravity Model, Trade.

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1 Introduction

Economic sanctions are a common foreign policy instrument. Countries initiating sanctions ("sanctioning countries" or "sender") usually seek to coerce behaviours or policies of the "sanctioned" or "target" countries. Travel bans, financial sanctions, trade restrictions, and military sanctions are the most common types of economic sanctions. The Global Sanctions Data Base (GSDB) records 1101 sanctions from 1950 to 2019, of which approximately 20 percent are trade sanctions (Kirilakha et al. (2021)). The frequency of sanctions fluctuates considerably, with the GSDB recording sharply increased sanction activity in the 1990s and 2010s (Figure 1), with the 1990s surge also present in the Threat and Imposition of Sanctions (TIES) database covering 1945 to 2005 (Morgan et al. (2014)).

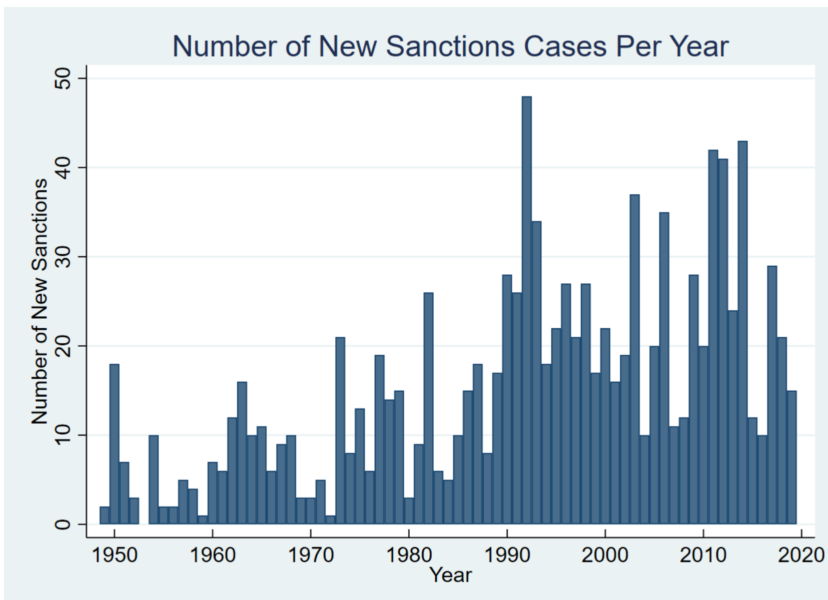

Figure 1

The effectiveness of sanctions in coercing their target remains doubtful; roughly one-third of sanctions appear to help bring about their intended effect (Felbermayr et al. (2021)). The effectiveness of sanctions can be very important; we can currently see that even the survival of nations can be at stake. How effective sanctions are partly depends on how much harm parties incur because of sanctions (Eaton and Engers (1992)). Sanctions potentially inflict harm on targets by impeding useful exchanges. Harm is mitigated if substitute exchanges are readily available. For example, the imposition of trade sanctions naturally leads to a reorientation of international trade, much as trade adjusts after the imposition of a tariff. But harm may also be mitigated if the restricted exchanges still manage to take place, such as goods being smuggled following trade sanctions. Targets may evade sanctions through smuggling directly from the sanctioning countries or indirectly smuggling from the senders via a third country as a transshipping hub (Drezner (2000); Frankel (1982)). To design and enforce effective sanctions, it is crucial for policymakers to understand how exchanges will reorient following the imposition of sanctions, but also how to detect and impede sanctions-induced smuggling, including the channels through which smuggling takes place.

International trade sanctions are especially amenable to analysis. Developments in trade models and quantitative trade policy analysis have long enabled us to estimate how trade sanctions will affect trade flows and welfare. Policymakers can therefore estimate how much harm trade sanctions will cause if they are fully implemented. However, these same developments also give us powerful tools for detecting smuggling, because the trade models generate predictions for what trade flows should look like after the imposition of sanctions, and these predictions can be compared with realised trade flows. Since trade flows are usually measured and reported by two countries, the fingerprints of much smuggling activity may be apparent even if one country ceases to accurately report data. That recognition together with developing techniques for finding those fingerprints is the key innovation of this paper.

Relatively little literature studies the extent of smuggling during sanctions episodes. We study a sanctions episode following Russia's 2014 invasion of Ukraine. In response to Western sanctions, Russia placed counter-sanctions on a range of food exports from those countries, affecting roughly $9 billion in trade. The Russian counter-sanctions mostly correspond very neatly to Harmonised System (HS) international trade categories, facilitating analysis. We employ recent developments in estimating and simulating structural gravity models that developed following seminal papers by Anderson (1979) and Anderson and Van Wincoop (2003). We estimate structural gravity equations for approximately 1,000 HS 4-digit headings, generating detailed predicted trade values that we compare with actual 2015 trade data. We systematically study the deviations between actual and predicted trade values to find evidence of smuggling.

Russia's food embargo, which is a partial embargo, is suitable for this study for four reasons. First, the severity and scope of this episode increases the probability of identifying illegal trading activities.[1] The constraints of partial embargoes on trade are severe enough to incentivize smugglers to invest in constructing smuggling channels. Partial embargoes do not ban all trade with the target countries, potentially providing more avenues for smuggling. For example, smugglers might relabel sanctioned products to a similar but non-sanctioned category to pass customs enforcement of the sanctioning country. Second, relatively disaggregated trade data is available for almost all countries, enabling us to match trade flows to

[1] News agencies and the Russian government have already revealed the existence of smuggling after the imposition of the food ban; see Section 2.1.

the sanctions list. Third, embargoes should decrease the trade of sanctioned goods to zero, simplifying the process of deriving the imputed amount of smuggling. Finally, this sanction episode was of considerable duration, is still active, and remains at the centre of public discourse. This research may help with more effective enforcement of economic sanctions. We identify around $1.7bn in smuggled agri-food products.

A large body of literature on sanctions has developed in economics and political science; a recent overview can be found in Felbermayr et al. (2021). Political science studies are primarily concerned with whether sanctions achieve their political objectives and what factors determine their effectiveness, while economists tend to focus on the economic impacts of sanctions (Felbermayr et al. (2021)). Relatively few authors have explicitly studied smuggling. Frankel (1982) studied the effectiveness of the Embargo Act of 1807 using British trade statistics and concluded that enforcement became sufficiently effective so that smuggling was insignificant compared with previous trade. Crozet et al. (2021) found that the effect of trade sanctions on exporting firms is larger if those firms also serve a country adjacent to the target country, indirectly suggesting exporting through that adjacent country. Haidar (2017) studied Iranian firm-level data to establish that two-thirds of exports "destroyed" by sanctions were deflected to third-countries, which may or may not indicate smuggling. Andreas (2005) argues that sanctions may bring about smuggling and the development of underground economies, which is supported by the study of trade and financial sanctions on Iran by Farzanegan (2013). A large volume of smuggling arose in Iran, although most of the smuggling was not directly connected to the sanctions but was a product of several price subsidies and a misalignment of the official exchange rate and the black-market exchange rate.

Several studies use empirical gravity models to estimate the effect of US economic sanctions on US aggregate bilateral international trade flows (Caruso (2003); Hufbauer et al. (2003); Yang et al. (2004)), while Frank (2017) extends this to study the trade effects of a more extensive set of sanctions. These studies find that sanctions tend to depress trade between the sender and target countries, but find mixed evidence on trade between the target and other countries. Larch et al. (2022) study the effect of sanctions on mining and energy trade, a sector frequently targeted by sanctions, and also find a significant reduction in trade between sender and target countries.

Our research is also related to studies that employ general equilibrium analysis to study the effects of international conflicts and trade policies, such as Glick and Taylor (2010) studying the cost of lost trade due to World Wars I and II, and Costinot and Rodríguez-Clare (2014) studying the welfare consequences of globalization. Anderson and Yotov (2016) employ a structural gravity model approach on 2 digit ISIC manufacturing sectors to estimate the general equilibrium trade and welfare effects of Free Trade Agreements (FTA). Felbermayr et al. (2020) use similar structural gravity modelling to estimate the general equilibrium effects of sanctions on aggregate bilateral trade and welfare, and also use that modelling to perform counterfactual analysis of the removal of a trade sanction. Our paper most directly descends from this line of analysis, and our methodology for constructing predicted trade flows most closely follows the conditional general equilibrium approach of Anderson et al. (2015).

Since our paper examines the difference between actual and predicted trade values to find evidence of smuggling, it is related to a strand of literature that detects smuggling or tariff evasion. Feenstra et al. (1999) and Feenstra and Hanson (2004) studied discrepancies between exporter and importer trade reports that might in part be due to tax and trade barrier evasion. Fisman and Wei (2004) and Javorcik and Narciso (2008) use those discrepancies to find evidence of tariff evasion, either by misclassifying products so they are charged a lower tariff rate or by under-reporting the value of imports. Fisman and Wei (2009) use the difference between the exporting country's recorded export and the importing country's recorded import to estimate the value of smuggling of cultural property and antiques. Berger and Nitsch (2008) find that gaps between exporter and importer trade reports are highly correlated with the level of corruption in the two countries, suggesting tariff evasion or smuggling. DellaVigna and La Ferrara (2010) study how stock prices respond to changed conflict intensities to detect illegal arms trade. Liu and Shi (2019) find evidence of Chinese firms evading anti-dumping duties by using intermediates in third countries.

Several papers also study the same Russian counter-sanctions that we study. Cheptea and Gaigné (2018) apply a triple difference econometric approach to estimate that the Russian embargo led to an 80 percent reduction in EU exports of banned products to Russia. Crozet and Hinz (2016) estimate that sanctions and counter-sanctions led to a 7.4 percent reduction in Russian exports and a 0.3 percent reduction in exports by Western sanctioning countries, with most of the latter effect in products NOT directly targeted by Russian retaliation. Hinz and Monastyrenko (2022) find that Russian consumers pay higher food prices due to their government's policy, leading to a significant loss of welfare. Bělín and Hanousek (2021) find that Russia's agri-food sanctions caused an 8 times larger decline in trade than Western sanctions on exports of oil and gas extraction equipment. Several scholars conduct computable general equilibrium analyses to estimate the impacts of the embargo on production, trade and welfare.[2] Ahn and Ludema (2020) study U.S.-EU sanctions against Russia and find that targeted firms suffered substantially in terms of revenue, value and

[2]See, for example, Havlik (2014); Oja (2015); Kutlina-Dimitrova (2017); Boulanger et al. (2016); Gohin (2017).

employment relative to their non-targeted peers, though Russia was able to shield firms it considered “strategic”.

Targeting individual firms is one example of “smart” sanctions designed to place pressure on specific groups and/or limit more widespread harm in the sender or target country. Besedeš et al. (2017) study financial sanctions and find that while they do depress capital flows, they are easily evaded if only a subset of countries applies them. Besedeš et al. (2021) examine firm-level data to find that financial sanctions have a limited effect on non-financial firms in the sanctioning country, so might legitimately be labelled “smart”.

The remainder of the paper is structured as follows: Section 2 briefly introduces the sanction episode - the embargo and counter-embargo between Russia and the Western countries, and describes the data. Section 3 details our structural gravity modelling and the construction of trade discrepancies. Section 4 seeks to identify smuggling and smuggling mechanisms. Section 5 discusses limitations and potential future research, while Section 6 concludes.

2 Russian Agri-food Ban and Smuggling

2.1 Western Sanctions and Russian Counter-sanctions

Moret et al. (2016) and Crozet and Hinz (2016) provide a thorough description of the 2014 Russian-Ukranian crisis; we therefore limit our discussion of the crisis that led to Russian counter-sanctions. In 2008, the EU proposed a Stabilization and Association agreement to Ukraine, ratification of which was postponed multiple times until 2014 when the pro-Russian president of Ukraine, Viktor Yanukovych, announced that Ukraine quits this arrangement. This decision led to unrest and further riots in Ukraine, called “Euromaidan”. In February 2014, president Yanukovich fled Ukraine and found asylum in Russia, while Ukraine was led by the interim government.

Following these events, Russian troops annexed Crimea in February and March of 2014. Additionally, there was unrest in Donetsk and Luhansk provinces of Ukraine; in May of 2022 the separatist governments of these two states announced independence from Ukraine and called themselves Donetsk and Luhansk People’s Republics (DNR and LNR). These republics were recognized as independent states by the Russian government and were supported financially and militarily by Russia. The military conflict on the border between DNR, LNR, and Ukraine escalated. On July 17, Malaysian Airlines flight MH17 was shot down over the Donbas region, killing all 283 passengers and 15 crew members.[3]

[3]Crash of Malaysia Airlines flight MH17 Hrabove, Ukraine, 17 July 2014

US and European countries reacted to Russian interference with Ukranian sovereignty with two rounds of sanctions against Russia. These sanctions primarily targeted three sectors: finance, energy, and defence. The sanctions included travel bans on influential Russians, bans on transferring technology for energy extraction, and financial sanctions on some significant Russian institutions. Following the crash of MH17, these targeted sanctions were expanded to cover more individuals and entities, financial sanctions on state-owned banks, and embargoes on exports of goods including arms, other goods with military use, and equipment for the energy industry.[4,5]

In response to these sanctions, on August 6 president Putin signed an executive order on special economic measures to protect Russia's security, which banned imports of selected food and agricultural products from most countries that imposed sanctions on Russia. The embargo covered most meat, fish, dairy products, vegetables, and fruits, henceforth "agri-food" products.[6] The order was introduced for one year, but it has been repeatedly extended with minor changes and remains active up to this date.

Since the embargo, Russian government declarations and news reports have revealed smuggling of banned agri-food products into Russia. Russia has repeatedly censured Belarus.[7] Russian officials have destroyed many banned agri-food products, suggesting that smuggling is likely a common phenomenon.[8] We will investigate how significant a phenomenon smuggling is and try to shed light on smuggling channels.

2.2 Data

The 2014 Decrees of the Russian Government N 778 and N 842 embargoed agri-food products that mostly map neatly into the 4-digit Harmonized System (HS) classification. Appendix Table A1 lists HS headings that are entirely or almost entirely embargoed. This facilitates analysis of the embargo using the Comtrade database and derivatives of that data such as the BACI database (Gaulier and Zignago (2010)).

While detailed monthly international trade data is available for many countries, there is no need for us to use that frequency. The effect of Russia's agri-food ban on reported data is readily apparent in annual UN Comtrade data, which is available for almost all countries. Figure 2 graphs reported exports of "embargoed" agri-food products to Russia for 2012 to

[4] https://eur-lex.europa.eu/eli/reg/2014/833/oj

[5] https://home.treasury.gov/policy-issues/financial-sanctions/sanctions-programs-and-country-information/ukraine-russia-related-sanctions

[6] http://en.kremlin.ru/events/president/news/46404

[7] Belarus appears to have wholeheartedly seized smuggling opportunities, see for example https://belarusdigest.com/story/belarus-and-russian-food-embargo-a-success-story/ and https://www.bbc.com/news/blogs-news-from-elsewhere-37166353.

[8] One example is https://www.bbc.com/news/world-europe-33818186.

2020. A product is considered embargoed if it falls within one of the HS headings listed in Appendix Table A1. We graph two measures for each year: the solid bars are values reported by the Western countries subject to the sanctions; while the lighter bars are from Russian data.

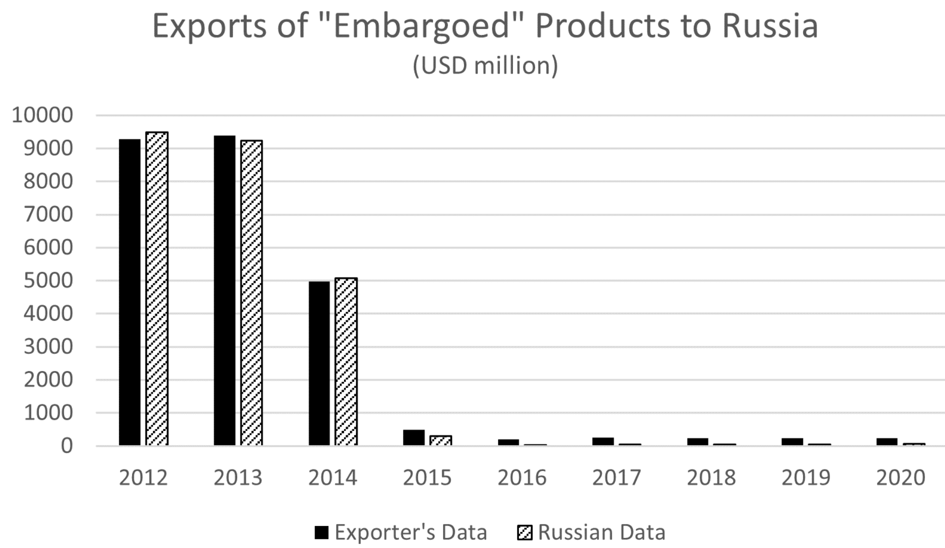

Figure 2

The two series are roughly balanced from 2012 through 2014, but the relative values diverge from 2015, the first full year of the sanctions. Russian reported data soon becomes negligible, down from over $9 billion annually to as little as $30 million in 2016. Interestingly, the exports reported by the sanctioned countries are nearly seven times that size in 2016, and are nearly $200 million higher than Russian reported data every year from 2015 to 2020. A Fisman and Wei (2009) style measure of smuggling would pick up this number. Opportunities for smuggling might leave far more subtle fingerprints in international trade data. Consider trade in the embargoed HS 6-digit product 080930 Peaches, Including Nectarines, Fresh.[9] Figure 3 graphs Russian reported imports of peaches from embargoed countries and other sources for 2012 to 2020. Prior to the embargo, Russia sourced most of its peach imports from the EU. After the embargo, these quickly disappeared in the Russian data, though other imports failed to make up for most of the embargoed trade until 2017.

[9] Yeliseyeu (2017) studied this example.

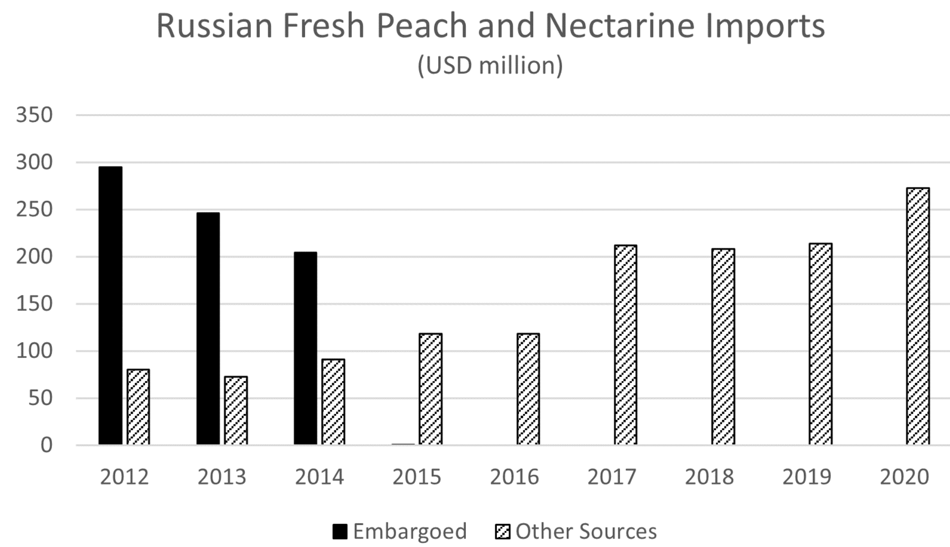

Figure 3

Now look to the curious behaviour of Belarusian reported data for the same period in Figure 4. Belarus, with a population 1/15th that of Russia, apparently absorbed much of the embargoed trade in 2014, before their new taste for imported peaches suddenly switched to sources not embargoed by Russia in 2015, with the value of this trade roughly comparable to the destroyed trade between the West and Russia.

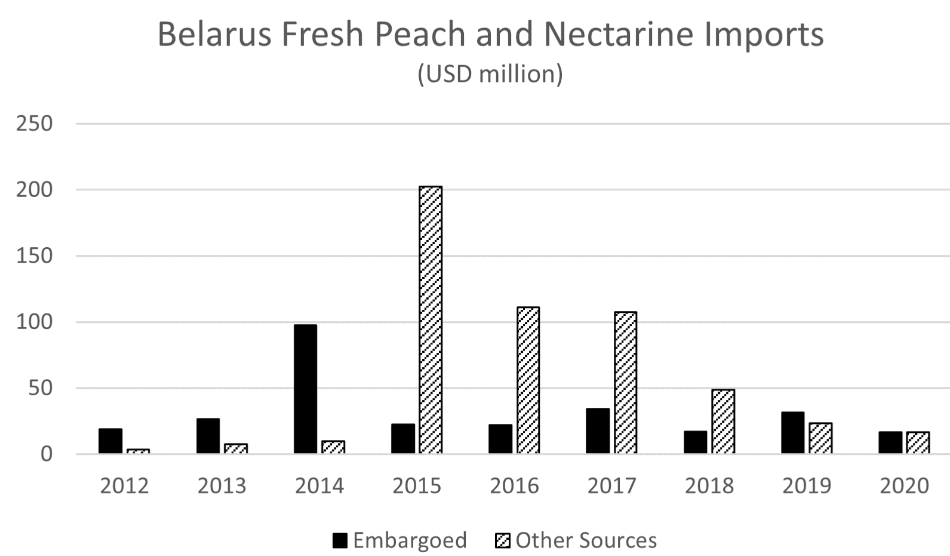

Figure 4

Closer examination of the Belarusian trade data reveals that it aligns especially poorly with data reported by the exporting countries. Of the top ten exporters to Belarus according to Belarusian data in Table 1, only three countries themselves report exports of peaches to Belarus, and even for these countries the values match poorly. Only two of the top ten exporters according to Belarusian data are subject to Russian sanctions. According to exporting countries' data, seven of the top ten exporters of peaches to Belarus are subject to Russian sanctions. The Belarusian data may not be entirely fictional; Belarus may well have been importing large quantities of peaches, but the origins are most likely countries subject to Russian sanctions, and the destination may not be consumers in Belarus.

Top 10 Exporters of Peaches to Belarus in 2015 ($m)		
Exporter	Belarusian Data	Exporter's Data
Greece	5.2	1.0
Brazil	5.6	0.0
Bosnia Herzegovina	9.6	0.0
Peru	9.8	0.0
Spain	14.7	2.9
Ecuador	16.4	0.0
Egypt	18.5	0.0
South Africa	23.5	0.0
Turkey	42.8	0.1
Morocco	64.5	0.0

Table 1

The trade of one possible transit country in just one embargoed HS 6-digit product may have involved smuggling equal in value to the entire Fisman and Wei (2009) measure of smuggling for all of the embargoed products. There is a need to develop a forensic method for statistically identifying smuggling that can detect a wider range of smuggling activity. We now turn to developing such a measure. We begin by estimating expected international trade flows following the imposition of sanctions. We need to commence with data that has not already been distorted by the sanctions; we use 2009 through 2013 international trade data to construct these estimates. It has long been noted that discrepancies exist between importers' and exporters' reports of trade flows,[10] sometimes for legitimate reasons such as trade costs and shipping times, sometimes to evade taxes or other trade restrictions, not to mention simple reporting and data collection errors. The most systematic approach to reconcile this reporting mismatch is by Gaulier and Zignago (2010), who produced the BACI trade database based on Comtrade data. They use a statisitcal approach to estimate the reliability of each country's trade reports, and then use those reliability estimates to weight each report.

We then employ structural gravity modelling following Anderson et al. (2015) to estimate

[10]See Feenstra et al. (1999) for one example.

counterfactual trade flows following the imposition of trade sanctions. The discrepancy between actual trade flows in 2015 (the first full year of data following the agri-food sanctions) and the counterfactual trade flows is our raw proxy for smuggling. Statistical analysis of these trade discrepancies will reveal whether they are systematically related to the trade sanctions, so that smuggling is a reasonable inference for some of these discrepancies. The exact manner by which observed trade differs from counterfactual trade flows can also shed light on smuggling channels.

One shortcoming of international trade data for structural gravity modelling is that it does not include information on purely domestic trade. Omitting domestic trade will affect our counterfactual exercise. We address this by including information on domestic trade flows from the Eora multi-region input-output table (Lenzen et al. (2012)). While the Eora data roughly corresponds to 2-digit ISIC classifications, we take the ratio of domestic trade to exports plus imports in the Eora data for each sector in each country, and multiply that ratio by exports plus imports at the HS 6-digit level to get corresponding estimates of domestic trade.[11] Those HS 6-digit estimates are then aggregated to HS 4-digit headings.

3 Estimation of Smuggling

To estimate the amount of smuggling, we commence with the discrepancy between the observed trade flows in sanction periods and counterfactual trade flows in a hypothetical scenario where Russia imposes the embargo in a pre-sanction period. The counterfactual trade flows will quantify the expected changes in bilateral trade flows in the hypothetical scenario, including trade destruction, trade creation and trade deflection,[12] but not smuggling. On the other hand, the observed trade flows capture trade destruction, trade creation, trade deflection as well as smuggling. Therefore, the discrepancy is a proxy for the magnitude of the embargo-induced smuggling, where the quality of the proxy depends on how well the counterfactual quantifies the trade destruction, trade creation and trade deflection induced by the sanctions. Recent developments in the evaluation of trade policy have shown that structural gravity models can be used for counterfactual analyses to evaluate hypothetical trade policies (Anderson et al. (2015); Costinot and Rodríguez-Clare (2014)). We use the structural gravity model to compute counterfactual trade flows and obtain an estimate of

[11] Unfortunately, Eora domestic trade data appears to be particularly poor for Belarus, dramatically understating Belarusian GDP and domestic trade. We use Belarusian input-output tables to improve that data.

[12] Bown and Crowley (2007) define these factors given an increase in the tariff of A against country B. Trade destruction refers to a decline in country B's exports to country A; trade deflection refers to an increase country B's exports to a third nation; trade creation refers to country A's increase in imports from a third nation.

smuggling. We briefly review the structural gravity model in Section 3.1 and the estimation procedure in Section 3.2.

3.1 Structural Gravity with Fixed Effects

Empirical gravity models of international trade have a long history, dating back to Ravenstein (1885)'s study of immigration patterns. Anderson (1979) provided the first theoretical foundation for the gravity model by assuming that consumers had identical Constant Elasticity of Substitution (CES) preferences over products that were differentiated by country of origin (Armington (1969)), which was further developed in Anderson and Van Wincoop (2003). Arkolakis et al. (2012) proved that a range of modern international trade models provide foundations for a structural gravity model. We closely follow the CES-Armington formulation in Anderson et al. (2015), only applied to each sector. Consumers in each country have nested CES preferences, where the upper-tier is Cobb-Douglas across sectors, and the lower tier has the Armington-CES structure. Exports from country i to j in sector k at destination prices are:

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y^k}\left(\frac{t_{ij}^k}{\mathbf{\Pi}_i^k \boldsymbol{P}_j^k}\right)^{1-\sigma^k} \tag{1}$$

where t_{ij}^k are iceberg variable trade costs for exports from i to j; Y_i^k are country i sales to all destinations at destination prices; Y^k are worldwide sales at destination prices; E_j^k is expenditure in j; σ^k is the elasticity of substitution across varieties in sector k; and $\boldsymbol{P}_j^k$ and $\mathbf{\Pi}_i^k$ are, respectively, the "inward multilateral resistance" and "outward multilateral resistance" terms defined immediately below. Outward multilateral resistance aggregates country i's outward trade costs relative to destination price indexes, and is a measure of how remote a country is from its export markets:

$$\mathbf{\Pi}_i^{k\,1-\sigma^k} = \sum_j \left(\frac{t_{ij}^k}{\boldsymbol{P}_j^k}\right)^{1-\sigma^k} \frac{E_j^k}{Y^k} \tag{2}$$

Inward multilateral resistance is the CES price index for sector k and aggregates inward trade costs for each country, and measures how remote a country is from its import suppliers:

$$\boldsymbol{P}_j^{k\,1-\sigma^k} = \sum_i \left(\frac{t_{ij}^k}{\mathbf{\Pi}_i^k}\right)^{1-\sigma^k} \frac{Y_i^k}{Y^k} \tag{3}$$

The outward and inward multilateral resistance terms actually solve the set of equations given by equations (2) and (3) conditional on Y_i^k and E_j^k, and are therefore a conditional general equilibrium concept (Anderson et al. (2015)). Two countries will trade more with each other if they have low trade costs with each other or if they are more remote from the rest of the world. Consistent accounting for this intuition is a feature of theoretically consistent gravity models. The equilibrium supply price (exclusive of trade costs) is derived from market-clearing conditions and is given by Equation (4), where the parameter α_j^k can be thought of as an (inverse) taste or quality parameter in the CES utility function:

$$p_j^k = (\frac{Y_j^k}{Y^k})^{\frac{1}{1-\sigma^k}} \frac{1}{\alpha_j^k \mathbf{\Pi}_j^k} \tag{4}$$

There are many empirical challenges to obtaining consistent estimates of the structural gravity model, while there are corresponding solutions to handle them. Many economists have contributed to the recommendations of properly accounting for the multilateral resistance terms.[13] The generally accepted rules are to use directional (exporter and importer) fixed effects when using a single cross-section of data, and to use exporter-time and importer-time fixed effects with panel data. To control for the endogeneity of trade policy, Baier and Bergstrand (2007) suggest including country-pair fixed effects. Silva and Tenreyro (2006) recommend using a PPML estimator to exploit the information in zero trade flows and to obtain better estimates given the heteroskedasticity present in trade data.

3.2 Estimation and Construction of the Trade Discrepancy Measures

In this section we describe how we construct the trade discrepancy measure for our further analysis. Our goal is to use pre-embargo data to construct predicted post-embargo trade flows. The first step of our analysis is the construction of predicted trade volumes in the absence of the embargo.[14] We estimate the standard gravity equation on 2009 to 2013 HS 4-digit data using high-dimensional PPML estimation using the command ppmlhdfe from Correia et al. (2020):

$$X_{ijt}{}^k = exp(\gamma_{ij}^k + \pi_{it}^k + \chi_{jt}^k) + \epsilon_{ijt}^k$$

where γ_{ij}^k, π_{it}^k, and χ_{jt}^k are country-pair, exporter-year, and importer-year fixed effects. This specification not only allows us to obtain all of the estimates required for further

[13] See, for example, Feenstra (2004) and Olivero and Yotov (2012).

[14] Alternatively, we could have used trade flows from 2013 as a predictor of trade in 2015. This approach, however, has two major disadvantages. First, compared to predicted values, observed trade data includes an error term and, as a result, is generally a worse and noisier predictor of future trade flows. The second reason is that this approach utilizes only one year of data, while the predicted value approach allows us to use any available pre-embargo data.

procedures but also impose no structural form on the effects of control variables on the sectoral trade flows. We use the high dimensional fixed effects to replace the standard time-variant country and pairwise variables such as GDP and FTAs. We perform this analysis for each industry k separately, using trade data for 2009-2013. We then use our estimates of the fixed effects to construct predicted values of trade flows:

$$\hat{X}_{ijt}^{k} = exp(\hat{\gamma}_{ij}^{k} + \hat{\pi}_{it}^{k} + \hat{\chi}_{jt}^{k})$$

In the next step, we construct the partial effect of the sanctions on trade volume. As our goal is to predict the effects of the embargo in 2015, we focus on the prediction for the last available pre-embargo flows, $\hat{X}_{ijt}^{k}$ for $t = 2013$. Note that the data for the previous years was still informative as it allowed us to estimate the country-pair specific component $\hat{\gamma}_{ij}^{k}$. Unlike most applications, where the effect of the intervention has to be estimated first, here we are dealing with an embargo and thus know the exact intended effect of this intervention.[15] The counterfactual flows in partial equilibrium $\hat{\hat{X}}_{ij}^{k}$ will then coincide with the predicted flows $\hat{X}_{ij}^{k}$ for unaffected industries and country-pairs and will be equal to 0 for flows from embargoed countries to Russia in embargoed sectors.

We then construct the general equilibrium ("GE") effects of the embargo. The logic behind the GE changes in trade flows in embargoed sectors is the following: partial equilibrium changes in trade flows lead to changes in both export sales and hence the output Y_i^k and imports, hence the expenditure E_j^k of directly affected countries. These changes then affect the outward and inward multilateral resistance terms for both directly and indirectly affected countries through equations (2) and (3). These indirect changes may be positive or negative depending on the pre-embargo trade patterns of the country.

We solve the system of equations (1)-(4) using the gegravity Stata implementation from Baier et al. (2019) separately for each industry k affected by the embargo and using the elasticity $\sigma = 5.8$ as used by Caliendo et al. (2022) for agricultural sectors. The GE counterfactual flows $\tilde{X}_{ij}^{k}$ coincide with the predicted flows for the non-affected sectors $\hat{X}_{ij}^{k}$, are equal to zero (and $\hat{\hat{X}}_{ij}^{k}$) for affected sectors and country-pairs, and differ from the previous values of trade flows for the bilateral flows in embargoed sectors that are not subject to the embargo.

$\tilde{X}_{ij}^{k}$ then represent the expected trade flows after the embargo and accounting for the GE adjustment. Now we construct the discrepancy in trade flows by comparing these expected trade flows with actual trade data from 2015. Note that $\tilde{X}_{ij}^{k}$ does not account for changes in total volumes of trade and in relative sizes of countries that happened between 2013 and

[15] Alternatively, we could have got identical estimates of the GE effect of the embargo by allowing trade costs between the affected countries to approach infinity.

2015.[16] To account for these changes, we adjust expected trade volumes by the aggregate volume of trade of each country: $\tilde{\tilde{X}}_{ij}^k = \tilde{X}_{ij}^k \frac{X_j^{2015}}{\tilde{X}_j}$, where $X_j^{2015} \equiv \sum_{i=1}^{I} \sum_{k=1}^{K} X_{ij}^{k,2015}$ and $\tilde{X}_j \equiv \sum_{i=1}^{I} \sum_{k=1}^{K} \tilde{X}_{ij}^k$ are the total observed and counterfactual imports of country j. We then define the raw discrepancy D_{ij}^k as the simple difference between the observed and predicted trade flows: $D_{ij}^k = X_{ij}^{k,2015} - \tilde{\tilde{X}}_{ij}^k$.

We also prepare to conduct comparisons similar in spirit to placebo tests. For our counterfactual exercise above, we used 2009 to 2013 data to estimate counterfactual trade flows following the imposition of an embargo, that we then compare to actual 2015 trade data. For our placebo exercises we bring everything forwards by two years, using 2007 to 2011 data to estimate trade flows for 2013, which we will compare with actual 2013 trade flows. To make our results comparable between 2013 and 2015, we use trade flows that were observed in the both years. Ideally, our methods for identifying suspicious trade flows in 2015 will identify a far lower volume of suspicious trade flows in the 2013 comparison.

4 Detecting Smuggling

4.1 Suspicious Trade Triads into Russia

Motivated by our peek at Belarusian trade data, our first pass at detecting smuggling will focus on the rerouting of sanctioned products through transit countries. Such sanctions evasion is related to Liu and Shi (2019) finding evidence of anti-dumping duty evasion through use of intermediates in third countries. We initially examine the raw differential D_{ij}^k between actual 2015 trade data and our structural gravity model trade estimates. These raw values are simply ranked, and a trade triad involving a transit country (not being Russia or a Western country subject to sanctions) is considered suspicious if the following three conditions hold: (i) the export trade discrepancy D_{ij}^k from the transit country i to Russia is in the top 10 percent of all trade discrepancies; (ii) there is an export trade discrepancy in the same product k from a sanctioned country to i that also falls within the top 10 percent of all trade discrepancies; and (iii) product k is a sanctioned product. The twin-unlikelihood in (i) and (ii) is the essence of this measure.

For trade triads identified as suspicious, we take the potential quantum of smuggling to be the minimum of the outward trade discrepancy in (i) and the sum of the inward trade discrepancies in (ii), since exports from multiple sanctioned countries may be laundered through the same transit country. The value of these transactions is listed in column 1 of

[16] For example, the dollar value of Russia's aggregate trade and GDP decline in 2014 after oil prices and the value of the ruble fall.

Table 2, while the number of suspicious flows is listed in column 1 of Table 3, with the top 10 transit countries listed along with the total for all transit countries. Two-hundred suspicious triads are identified with a total value of \$476m. China and Belarus are the top two transit countries for these suspicious triads for both value and number.

We note, however, that this is a purely statistical procedure that would likely identify some transactions as suspicious even if no sanctions were imposed. We perform a placebo test by applying the same statistical approach to the discrepancy between 2013 trade data and structural gravity model trade estimates for 2013 but with no sanctions imposed. The placebo test identifies a notably smaller set of transactions (116) worth a proportionally even smaller \$189m. The coincidence of unlikely imports of sanctioned products matched with unlikely exports of those same products to Russia surged following the imposition of the sanctions.

Top 10 Smuggling "Transit" Countries to Russia in 2015 ($m)

Transit Country	Raw	Raw Placebo	Normalised	Normalised Placebo	Residual	Residual Placebo
China	149.5	68.0	149.5	67.2	133.6	67.2
Belarus	74.9	38.2	74.9	34.9	70.0	34.5
Vietnam	30.9	16.4	30.3	16.4	29.5	6.3
Chile	22.2	4.5	18.5	4.7	18.5	1.2
Israel	19.9	1.3	20.4	1.3	20.4	0.0
Turkey	19.2	5.7	16.8	4.6	16.8	3.5
Brazil	19.2	0.0	19.2	0.0	19.2	0.0
India	18.4	8.5	17.0	8.7	14.0	6.6
Thailand	15.7	4.7	12.7	1.0	12.7	0.0
U.A.E.	11.5	5.1	11.5	4.6	11.5	4.6
TOTAL	476.0	188.9	445.9	170.3	417.0	138.5

Table 2

Top 10 Smuggling "Transit" Countries to Russia in 2015 (Number of Suspicious Triads)						
	Raw	Raw	Normalised	Normalised	Residual	Residual
Transit Country		Placebo		Placebo		Placebo
China	22	10	21	8	10	7
Belarus	19	18	20	10	17	7
Turkey	14	4	6	3	4	2
Vietnam	13	12	6	7	5	3
Iran	12	0	9	0	6	0
Brazil	11	0	9	0	6	0
Japan	10	0	9	0	6	5
Hong Kong	9	5	5	3	1	3
India	9	6	3	7	2	2
Israel	9	1	10	1	8	0
TOTAL	200	116	144	66	126	38

Table 3

We now seek to refine the procedure for identifying statistically unlikely trade triads. The procedure above took no account of differences between trade patterns for each HS 4-digit product. We now adapt the above procedure by dividing each discrepancy by the average non-zero trade value for each HS 4-digit heading in 2015. These "normalised" discrepancies $\tilde{D}_{ij}^k$ are then ranked, and suspicious trade triads are then identified from this ranking. We report the results in columns 3 and 4 of Tables 2 and 3. The number of suspicious triads identified in 2015 falls by 28 percent to 144, but the number of suspicious triads in the placebo test falls even more substantially, by 54 percent to 66. We interpret this as suggesting that the slightly revised procedure is likely to give fewer false-positives when identifying suspicious trade triads. The value of suspicious triads falls more modestly, to \$446m for 2015 trade and to \$170m for the 2013 placebo.

We now make a further refinement to the procedure to further account for potential systematic features of the trade discrepancies. We regress the normalised discrepancies $\tilde{D}_{ij}^k$ on a set of standard "gravity" covariates (distance, contiguity, common language, colonial relationship) from the CEPII Gravity database (Conte et al. (2022)) and full sets of exporter, importer, and HS 4-digit fixed effects:

$$\tilde{D}_{ij}^k = \beta_1 \ln DIST_{ij} + \beta_2 CNTG_{ij} + \beta_3 LANG_{ij} + \beta_4 COLONY_{ij} + \beta_5 BRDR_{ij} + \kappa_i + \mu_j + \zeta_k + \nu_{ij}^k.$$

Trade discrepancies tend to be larger for more proximate country pairs, especially those sharing a common border. We then rank the residual trade discrepancies $\hat{\nu}_{ij}^k$ and identify suspicious trade triads from this ranking. The number of suspicious triads identified in 2015 falls a further 12 percent to 126, but the number of suspicious triads in the 2013 placebo test again falls even more substantially, by 42 percent to 38. We believe that this further revised procedure gives even fewer false-positives. The value of suspicious triads again falls modestly, to \$417m for 2015 trade and to \$138m for the placebo.

We now conduct a further test of our methodology to reassure us that we are picking up smuggling behaviour and not some artifact of our data such as especially volatile 2015 trade patterns. We repeat the last refinement of our methodology but study residual trade discrepancies $\hat{\nu}_{ij}^{k}$ in products that were not subject to the agri-food sanctions. The procedure identifies 7,240 "suspicious" triads in 2015 worth \$14.6 billion compared with a similarly-large 7,978 "suspicious" transactions worth \$12.9 billion in the 2013 trade data. The uptick in suspicious triads appears to be confined to sanctioned products. We therefore believe that roughly two-thirds of the suspicious triads we identify in agri-food products are true positives, worth approximately \$280m. While this trade may overlap with the nearly \$200m of smuggling that would be identified by a Fisman and Wei (2009) style estimate, there is no particular reason for it to do so, and it might be largely cumulative. We will later discuss how we believe we can further improve the true-positive rate, but we next turn to identifying other smuggling activity.

4.2 Suspicious Trade Triads into Belarus

Relative to its size, Belarus appears to be playing a large role in smuggling. Belarus is part of the Eurasian Customs Union with Russia, and the Belarus-Russia border appears to be quite porous. While we have seen that Belarus does not appear to be very truthful about the origins of its imports of agri-food products, the BACI data partially corrects for this because it is a weighted average of the importing country's trade report and the exporting country's trade report depending on the statistically estimated reliability of each trade report. Where Belarus's trade partners have more reliable data, BACI trade data will more closely resemble their reports. We repeat our suspicious trade triad analysis, only looking for goods "smuggled" into Belarus, from where they may find their way into Russia.[17] We report our results in Table 4. Using the residual trade discrepancies again seems to minimise the risk of false positives, with the value of 18 suspicious triads worth \$90m, while the procedure identifies 5 suspicious triads worth \$7m in the 2013 data. This suggests that roughly \$80m of sanctioned Western agri-food products were "smuggled" into Belarus, not necessarily ending up with Belarusian consumers.

[17] See Yeliseyeu (2017).

Top 10 Smuggling "Transit" Countries to Belarus in 2015 ($m)						
Transit Country	Raw	Raw Placebo	Normalised	Normalised Placebo	Residual	Residual Placebo
China	37.3	5.4	36.7	2.6	32.4	0.0
Brazil	19.3	0.0	18.6	0.0	17.1	0.0
Ukraine	10.4	1.3	10.4	1.3	10.4	0.0
Turkey	9.6	1.5	8.3	2.6	8.3	0.0
Mexico	7.9	0.0	7.9	0.0	7.9	0.0
Bosnia Herzegovina	5.1	0.0	2.4	0.0	2.4	0.0
Peru	5.1	0.6	5.1	0.0	5.1	0.0
Serbia	4.7	1.4	4.1	0.0	3.1	0.0
South Africa	3.5	0.7	2.5	0.0	2.5	0.0
India	3.0	8.1	0.9	5.8	0.0	4.0
TOTAL	114.0	25.6	100.1	18.8	90.4	6.8
Number of triads	55	51	24	25	18	5

Table 4

We check whether this suspicious trade behaviour was evident in Belarus's imports of non-sanctioned products, which might indicate some legitimate reason reason for the behaviour. Applying the same methodology to non-sanctioned products shows 3,260 "suspicious" trade triads in 2015 worth $2.6 billion, but the placebo test on 2013 data yields an even larger number, with 5,011 suspicious triads worth $3.2 billion. Belarus's imports of sanctioned agri-food products is behaving very differently from its imports of other products as the pronounced uptick in suspicious trade triads is evident in sanctioned products and not in non-sanctioned products. If we attribute the uptick for sanctioned products to smuggling (with the ultimate destination being Russia), then this adds a further $80m to our estimate. We examined whether other members of the Eurasian Customs Union (Armenia, Kazakhstan, and Kyrgyzstan) were behaving similarly to Belarus, but we found no evidence of this.

4.3 Relaxing Country of Origin

The Belarus peach and nectarine example suggests that Belarusian data is not particularly accurate about the origin of its imports. If that is true for Belarus, or Russia, then despite the features of the BACI data, our trade triad measures will miss some smuggling through intermediate countries. To potentially capture more smuggling, we now relax our identification mechanism for suspicious trade triads. A trade triad involving a transit country (not being Russia or a Western country subject to sanctions) is now considered suspicious if the following three conditions hold: (i) the export trade discrepancy from the transit country i to Russia is in the top 10 percent of all trade discrepancies; (ii) there is an export trade discrepancy in the same product k from any country to i that also falls within the top 10 percent of all trade discrepancies; and (iii) product k is a sanctioned product. The twin-unlikelihood in (i) and (ii) is still the essence of this measure, but the measure now allows for mislabeling of the origin country in (ii). We present the results for suspicious triads into Russia in Table 5 and into Belarus in Table 6.

In both cases there is a substantial uptick in the value of suspicious trade triads in embargoed goods following the imposition of sanctions. Again, the procedure based on residual trade discrepancies appears to result in far fewer false-positives. The suspicious agri-food trade triads into Belarus increase from 43 worth \$53m in the 2013 placebo exercise to 161 worth \$308m in the 2015 data. The potential value of the smuggling compared with Table 4 has increased dramatically. The value of suspicious agri-food triads into Russia in Table 5 grows less dramatically. These upticks are only evident for the sanctioned products. If we apply the same procedure to the non-sanctioned products, the number of suspicious trade triads into Russia decreases from 17,578 worth \$19.5 billion in the 2013 placebo exercise to 15,116 worth \$25.4 billion, while those into Belarus decrease from 11,002 worth \$3.6 billion to 7,000 worth \$3.2 billion. If we attribute the uptick for sanctioned products entering Russia or Belarus to smuggling, then our smuggling estimate becomes \$650m.

Relaxing Origin: Top 10 Smuggling "Transit" Countries to Russia in 2015 ($m)

Transit Country	Raw	Raw Placebo	Normalised	Normalised Placebo	Residual	Residual Placebo
China	162.9	72.9	163.5	72.0	149.2	72.0
Belarus	155.1	67.4	155.4	66.6	154.7	63.7
Vietnam	34.2	22.8	34.2	22.8	34.2	12.3
Chile	32.2	9.9	31.6	9.4	22.9	4.2
Turkey	26.5	5.7	23.4	4.6	20.1	3.5
Thailand	24.9	5.2	24.0	2.0	24.0	0.0
Israel	21.0	4.6	21.5	3.5	21.5	1.7
Serbia	19.3	5.0	19.6	4.0	17.8	0.0
India	19.3	32.7	17.8	31.6	17.8	28.7
Brazil	19.2	0.0	19.2	0.0	19.2	0.0
TOTAL	696.2	290.9	660.7	267.6	610.6	216.0
Number of triads	648	387	453	254	353	134

Table 5

Relaxing Origin: Top 10 Smuggling "Transit" Countries to Belarus in 2015 ($m)						
Transit Country	Raw	Raw Placebo	Normalised	Normalised Placebo	Residual	Residual Placebo
China	84.2	5.4	83.6	2.7	78.2	0.0
Russia	79.0	40.4	73.4	36.5	79.6	32.9
Brazil	65.0	0.0	64.2	0.0	62.5	0.0
Ukraine	16.5	1.3	16.0	1.3	14.5	0.0
Moldova	11.6	0.0	11.3	0.0	11.1	0.0
Turkey	11.3	6.8	10.0	6.8	10.0	4.9
Israel	9.6	1.8	9.6	1.8	9.6	1.8
Bosnia Herzegovina	8.9	0.0	6.1	0.0	6.1	0.0
India	8.1	9.1	7.5	9.1	6.6	6.9
Peru	8.0	0.7	7.0	0.0	7.0	0.0
TOTAL	338.5	79.4	316.1	69.2	308.4	53.1
Number of triads	191	195	102	91	161	43

Table 6

4.4 Moving beyond Triads

Our forensic exercise employing both actual trade data and counterfactual trade data is detecting a pronounced uptick in suspicious trade triads involving sanctioned agri-food products, without a corresponding uptick in triads for non-sanctioned products. Further, the methodology has detected a special role for Belarus in smuggling, a role that has been corroborated by other reports (see discussion in Section 2). We interpret these findings as suggesting that there is substantial information content in our trade discrepancy measures when it comes to identifying smuggling. We will now move on from the triad methodology and instead directly study trade discrepancies into Russia and Belarus.

Our work on trade triads strongly suggested that our "residual" normalised trade discrepancies were the least likely to give rise to false positives in our identification of suspicious trade triads. We now focus on the top 1 percent of these residual trade discrepancies and study the value of the trade discrepancies associated with them for both sanctioned and non-sanctioned products and for 2015 (post-embargo) and 2013 (pre-embargo). Since we are no longer relying on the "twin unlikelihood" approach of the triad methodology, we narrow our attention to the most extreme discrepancies.

We summarise the results for Russia and Belarus in Table 7. Following Russia's agri-food product sanctions, the number of Russian HS 4-digit agri-food import lines in the top 1 percent of worldwide trade discrepancies doubled in number from 10 to 21, with the associated value of the discrepancies increasing from $583m to $1,785m. For Belarus, the increase was much more astounding, with a ten-fold increase in number from 2 to 21 and an eighteen-fold increase in value from $51m to $906m. Of the 215 regions in the BACI trade data, Belarus ranked equal-first for the increase in the number of sanctioned HS 4-digit agri-food import lines in the top 1 percent of worldwide trade discrepancies, while Russia ranked fifth. For non-sanctioned products the proportional changes are much more modest, with a 10 percent increase in number for Russia and a 30 percent increase in associated value, and a 3 percent decrease for Belarus but a 125 percent increase in value.

Top International Trade Discrepancies

Importer	Sanctioned HS	Top	Value 2015 ($m)	Number 2015	Value 2013 ($m)	Number 2013
Russia	Yes	1%	1,785	21	583	10
Russia	No	1%	39,551	802	30,288	734
Belarus	Yes	1%	906	21	51	2
Belarus	No	1%	2,456	61	1,084	63

Table 7

The extraordinary nature of the Belarus results strongly suggests that many hundreds of millions of dollars of embargoed products may have found there way into Russia via this channel. If we estimate the likelihood of false-positives based on the relative number of discrepancies identified in the 2013 placebo exercise, then we would attribute roughly half of the 2015 Russian trade discrepancy to smuggling and 90 percent of the 2015 Belarusian trade discrepancy to smuggling, or $1.7 billion. This amounts to a little under 20 percent of imports prior to the sanctions.

5 Discussion

We have found evidence of a significant amount of smuggling of banned agri-food items following the Russian embargo, which would reduce the impact of the embargo. Are there reasons to believe that we might be overstating smuggling? Yes. If international trade adjusts more flexibly than our model structures and parameters assume, then this will likely lead to an overstatement of smuggling because some actual trade flows may end up significantly exceeding predicted trade flows. One feature that we noticed when studying "false positives" in our placebo exercises was that the bulk of cases were crustaceans, molluscs, frozen fish, dried vegetables and dried legumes. International markets for seafood may be especially well developed, and dried vegetable products may be especially substitutable. In either case, the international pattern of trade could reorganise quite quickly in response to sanctions or other market disruptions, and what we are detecting as smuggling could just be commodity markets quickly reallocating. This is addressable in our model structure, because we can vary the elasticity parameter σ^k by detailed sector.

Another reason why we might over-estimate smuggling is because our model does not include intermediate inputs in an input-output structure like Caliendo and Parro (2015) or Caliendo et al. (2022). Our model does not capture all margins of international trade adjustment from the sanctions. The cost of using an input-output structure is the lack of sector detail in most input-output tables. What we gain from modelling intermediate inputs may be more than offset by the loss of sector detail. Since most of the embargoed agri-food products seem to be close to final goods, we decided that it was more valuable to keep the rich sector detail rather than model intermediate inputs. However, in future research we may be able to adapt trade models with intermediate goods to match more detailed trade data.

Are there any reasons why we might be underestimating smuggling? Yes. One argument is simply the reverse of an argument above; we may be overstating how flexible trade is in some products, so our model expects to see a substantial increase into Russia from some non-sanctioned sources. In this case, we may set the bar too high to statistically identify smuggling. But there are other more basic reasons. While we do not require data to be wholly accurate (in fact, inconsistencies can help us spot smuggling), we do require that the smuggled goods leave some fingerprint in data. In some sense it must always leave a fingerprint, since even a completely unrecorded smuggling transaction affects demand for legally traded products. However, we have chosen to identify smuggling from positive trade discrepancies, rather than infer smuggling from a much wider range of negative ones (the expected trade displaced by the smuggling). Non-reporting will often hinder our task regardless of the efforts of the creators of the BACI database. We leave as an open question whether the BACI database creators can, by understanding the motives for misreporting, improve on their estimates of detailed trade flows.

Besides non-reporting, there are other types of misreporting that we have not identified, in particular, misreporting of product code. Our analysis has focused on misreporting the true country of origin. We miss the potential of relabeling banned products to non-banned product codes. When we studied goods that we considered "similar" to the sanctioned goods, such as non-banned goods in the same or related HS 2-digit chapters, we did not see strong evidence of an uptick in large positive trade discrepancies, but we are necessarily restricted in our analysis because it is hard to pinpoint what the banned products might be relabeled as.

We further note that the only trade policy intervention that we explicitly modelled was the Russian counter-sanctions. While some trade policy changes might be adequately modelled by our high-dimensional fixed effects, our modelling would be improved if we incorporated more policy data, including sanctions data, and especially including new policies affecting trade in agri-food products during our sample period.

We consider our smuggling finding to be of significance. One might wonder why we would be concerned. Russian consumers are better off. Banned Western suppliers are better off. In the context of the ongoing Ukraine crisis and other crises, the effectiveness of sanctions may be very important. Note that these are goods that the Russian government does not want to enter Russia, and yet a significant value finds its way in anyway. A large component of current Western sanctions on Russia involves impeding its access to certain goods (and services). Once those goods leave customs areas of countries that are imposing the sanctions, they may be difficult to trace and control. Better recording of export and import transactions by more countries would make it easier to find the fingerprints of smuggling, both because we should have a better idea of what trade should look like following the imposition of sanctions, and because it will be easier to detect departures from those expected patterns.

6 Conclusion

Recent developments in structural gravity modelling of international trade flows have enhanced our ability to model changes in international trade following a shock or a policy intervention. This improves our ability to analyse such shocks, with trade sanctions currently being a policy intervention of particular interest. We use structural gravity modelling at a detailed sector level to model the effects of the Russian agri-food embargo. We interpret deviations of observed trade flows from predicted trade flows as potential evidence of smuggling. There was a large uptick in large positive deviations for Russian and Belarusian imports in sectors subject to Russian sanctions, whereas trade in other sectors did not exhibit this pattern. This was partly corroborated by news reports of extensive smuggling. We interpreted the evidence as suggesting smuggling of around $1.7 billion in banned goods, or around 20 percent of the pre-embargo trade. This smuggling is of considerable concern, not because of the direct implications of this particular episode, but because it suggests that without tight enforcement, a considerable quantity of smuggled goods will find their way across borders. If goods that the Russian government wants to ban are finding their way into Russia, how long before current Western export controls intended to punish Russia are severely undermined? Once goods have left the customs control of countries imposing sanctions or of countries that collect good international trade data, the fingerprints of smuggling will become increasingly difficult to detect.

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