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Sanctions and Export Deflection: Evidence from Iran

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Abstract

Do export sanctions cause export deflection? Data on Iranian non-oil exporters between January 2006 and June 2011 shows that two-thirds of these exports were deflected to non-sanctioning countries after sanctions were imposed in 2008, and that at this time aggregate exports actually increased. Exporting firms reduced prices and increased quantities when exporting to a new destination, however, and suffered welfare losses as a result.

Key words: sanctions; trade policy; globalization; export deflection; Iran

JEL codes: F13; F14; F15; F23; F5; F6

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1 Introduction

Milton Friedman said: “[A]ll in all, economic sanctions are not an effective weapon of political warfare.”² Economic sanctions can target exports, imports, finance and banking, with different impacts. This paper investigates the effectiveness of export sanctions on Iranian exports and find that, at least in this case, Friedman’s dismissal of the impact of sanctions may not be accurate.³

Export sanctions seek to coerce the target government to change its political behavior by lowering the aggregate welfare of a target state.⁴ In theory they do this either directly, by persuading the target government that the issues at stake are not worth the price, or indirectly, by inducing a popular revolt that overthrows the government. In practice, we have lacked empirical evidence about how firms behave when they are faced with export sanctions. We do not know whether exporters stop exporting altogether, reduce exports to sanctioning countries, or deflect exports to new destinations.⁵ In an increasingly globalized economy, alternative destinations exist for exporters affected by export sanctions: in other words, export deflection can compensate export destruction.⁶ The fact that Iranian exports increased after sanctions (Figure 1) is intriguing, too.

This paper examines all Iranian non-oil export customs transactions data between 2006 and 2011, more than 1.81 million transactions. This data reveals the existence, extent, and mechanism of export deflection following the imposition of export sanctions against Iranian exporters.⁷

Iran is a suitable country for this study for several reasons. First, the *structure* of export sanctions imposed against Iran in March 2008 were typical, so understanding how Iranian exporters behaved helps us understand how exporters from other countries may behave in future. Second, the *scope* of export sanctions that Iranian exporters faced were unusual in that they did not involve all countries.

²‘Economic Sanctions,’ Newsweek, 21 January 1980, p. 76.

³Export sanctions are different from embargoes: while export sanctions represent higher export costs (they raise cost of exporting at the exporter-destination level), embargoes represent a shift to autarky via a trade blockade. Section 2 explains export sanctions against Iran in detail.

⁴For references, see Crawford and Klotz (2016), Davis and Engerman (2003), Doxey (1980), Drezner (1999), Eaton and Engers (1992, 1999), Hufbauer et al. (2007), Joshi and Mahmud (2016), Kaempfer and Lowenberg (1988), Levy (1999), Martin (1993), and Pape (1997).

⁵Following Bown and Crowley (2007), this paper defines ‘export deflection’ as a change in the destination of exports in response to an increase in a trade barrier in another market, as when a rise in a tariff on an export from *A* to *B* causes the exports to be sold instead to *C*.

⁶This paper defines ‘export destruction’ as a reduction in exports due to an increase in a trade barrier. For evidence on the extent to which discriminatory trade policy eliminate trade, see Besedes and Prusa (forthcoming).

⁷The impact of the financial sanctions on Iranian economy in 2012 is beyond the scope of this paper, especially as the dataset ends in 2011. In 2012 the sanctions moved from country-specific restrictions on Iranian exports to limiting Iran’s access to the global financial system, such as the SWIFT (see Section 2).

The imposition of export sanctions by the US, EU, Canada, and Australia in 2008 increased export costs for Iranian exporters to these destinations, but not to other destinations. Third, the export flow data is highly disaggregated, meaning it was possible to identify whether export sanctions caused export deflection in this case. Fourth, the imposition of export sanctions in 2008 created a point at which export costs increased at the exporter-destination level.

This analysis excludes Iranian oil exports for four reasons. First, sanctions which targeted companies that buy oil from Iran were imposed in 2012, after the (2006-2011) timespan of the dataset. Second, unlike non-oil exports, oil exports happen via long-term contracts: a study of their impact would require data from many years after sanctions were imposed. Third, Iranian oil is exported only by the government, but 35,953 non-oil exporters were targeted by the 2008 export sanctions. Fourth, according to the *Statistical Memorandum* of the Foreign Trade Regime of Iran in 2008, the oil sector accounts for 80% of exports, but only 0.7% of employment in Iran. Non-oil sectors represent 20% of Iranian exports and 38% of employment. (Remaining employment is mainly in the services and non-oil public sectors.)

Figures 2-4 provide empirical motivations for this study. Figure 2 shows total Iranian monthly exports⁸ between January 2006 and June 2011, to two groups of destinations, sanctioning countries (SCs) and to non-sanctioning countries (NSCs). Note that Iranian exports to SCs decreased after sanctions, but increased to NSCs. Figure 3 presents the entry and exit rates⁹ of Iranian exporters to different destination types. While entry (exit) rates of exporters decreased (increased) in SCs, they increased (decreased) in NSCs after the imposition of export sanctions in March 2008.¹⁰ Figures 4a and 4b show aggregate exports to selected SCs and NSCs.

This paper investigates export deflection within exporters and across destinations following export sanctions. Exporter-level data reveals the existence, extent, and mechanism of the export deflection following export destruction caused by the imposition of export sanctions. It shows how exporter size, past export status, and pricing strategy matter in the process of export deflection.

The main findings are as follows:

⁸Starting here and onwards in the paper, the term 'exports' refers to non-oil exports.

⁹'Entry' refers to the first time the exporter or product entered a given destination. 'Exit' refers to the last time the exporter or product was seen at destination, so there should be no confusion over exporters and products that exited and then entered the same destination.

¹⁰Following export sanctions, the number of exported products per exporter to SCs also decreased, but increased to NSCs. Export values per exporter increased to both types of destinations, however. This observation is consistent with the data presented in Appendix Tables A1 and A2, suggesting that smaller exporters exited SCs.

- (i) two-thirds of the value of Iranian exports destroyed by export sanctions were deflected to NSCs;
- (ii) exporters who traded with only NSCs increased exports significantly after sanctions;
- (iii) exporters reduced their product prices and increased their product quantities as they deflected exports to new destinations, suggesting export deflection caused welfare loss;
- (iv) exporters deflected more core and homogeneous products;
- (v) larger exporters deflected more of their exports than smaller exporters;
- (vi) new export destinations were more politically sympathetic to Iran;
- (vii) the probability that an exporter would deflect exports to another destination rose if the exporter already existed in that destination, suggesting that costs of exporting matter.

For policymakers these results imply that in this case export deflection undermined the goal of export sanctions as far as reducing overall exports from Iran. But if the goal of export sanctions was instead to cause inconvenience to Iranian economic agents so that they would lobby the government to change attitudes, export sanctions were effective. Deflecting exporters reduced prices and increased quantities of deflected exported products, and thus, faced welfare losses as they had either to pay more wages, or ask their employees to work more for same wages, given the need for increased production. Also, a reduction in product prices may have been associated with a decline in product quality, and export deflection caused more competition between those firms exporting to NSCs. Finally, although the data is not sufficient for us to determine net profits at the exporter level, we can assume that exporting firms would have deflected to NSCs even without sanctions (and before sanctions) if deflection would have raised profits. The revealed preference of exporting firms implies that sanctions *must have reduced profits*.

Other research has analysed the consequences of changes in cost of exporting. For example, Liu (2012) developed and estimated a dynamic model of firm sales in an open economy with capacity constraints, and showed that capacity-constrained firms face increasing marginal costs in the short run, and face a trade-off between sales in two different markets. Blum *et al.* (2013) showed that an increase in the cost of exporting to a given market causes export reallocation. The authors constructed a model in which exiting one export market for another is an optimal response for firms facing increasing costs. Lawless (2009) documented that firms that continue to export will regularly enter and exit export destinations. Morales *et al.* (2014) showed that exporting firms continuously change export destinations. They developed a model of export dynamics in which firm's exports in each market may depend on how similar this market is to the firm's home country, and to other countries to which the

firm had previously exported. Vannoorenberghe (2012) cast doubt on the standard hypothesis that firms face constant marginal costs and maximize profits on export markets independently. Using a model in which firms face market-specific shocks and short-run convex costs of production, he stressed that firms react to a shock in one market by adjusting their sales in another. These results complement this research, adding a theoretical backbone to the empirical conclusions.

This paper is organized into four further sections. The next section gives a brief timeline of the sanctions against Iran, with an emphasis on export sanctions, between January 2006 and June 2011. Section 3 introduces the disaggregated customs dataset used in this paper. Section 4 presents an empirical analysis of the existence, extent, and mechanism of export destruction and deflection following sanctions. Section 5 concludes.

2 The sanctions against Iran

2.1 Timeline of sanctions

On 4 February 2006, the International Atomic Energy Agency (IAEA) voted to report Iran to the United Nations Security Council (UNSC). Russia and China also voted in favor.¹¹ On 26 June, Germany argued that Iran should be allowed to enrich uranium, but under the scrutiny of the United Nations (UN) to ensure that Iran was not using uranium to build atomic weapons.¹² On 31 July, the UNSC demanded that Iran: “suspend all enrichment- and reprocessing-related activities, including research and development, to be verified by the IAEA”. On 23 December - having called on Iran to halt its uranium enrichment program in July - the UNSC voted to strengthen sanctions on Iranian imports of nuclear-related materials and technology, and freeze the assets of individuals involved with nuclear activities.¹³

On 24 March 2007, the UNSC voted to toughen the December 2006 sanctions by extending the freeze on assets and restricting the travel of individuals engaged in the country’s nuclear activities.¹⁴ The EU

¹¹‘Iran Reported to Security Council,’ BBC News, 4 February 2006.

¹²‘Germany could accept nuclear enrichment in Iran,’ Reuters, 26 June 2006.

¹³UNSC Resolutions 1696 and 1737.

¹⁴UNSC Resolution 1747.

published an expanded list of Iranian individuals deemed *persona non grata* in the union. On 27 August 2007, President Nicolas Sarkozy stated that France would not rule out the possibility of military action against Iran if Iran did not curtail its nuclear program. President Sarkozy praised the sanctions and diplomatic measures taken by the UN, but added that if Iran continued to be uncooperative alternatives should be considered, as a nuclear Iran would be “unacceptable” to France.¹⁵ Subsequently, in October, the US announced unilateral sanctions against Iran, the toughest since it had imposed sanctions on Iran following the Islamic Revolution in 1979 for “supporting terrorists”.¹⁶ The sanctions blocked access to the US financial system for more than 20 organizations associated with Iran’s Islamic Revolution Guard Corps.

Non-oil export sanctions against Iran were imposed in 2008. The UNSC passed Resolution 1803 on 3 March 2008, calling on member states to: “[E]xercise vigilance in entering into new commitments for financial support for trade with Iran, including the granting of credits, guarantees or insurance, to their nationals or entities involved in imports from Iran as well as tightening restrictions on cargos of Iranian origin.” Note the UN cannot impose sanctions itself, as it does not export and import, so its resolutions are merely recommendations that member states impose sanctions. The US, EU, Canada, and Australia accordingly imposed non-oil export sanctions against Iran in March 2008.

The goal of these sanctions was to put pressure on the Iranian economy, so that Iranian firms and citizens would in turn exercise internal pressure on the Iranian government. For example, in the US senator John McCain “wanted to form an alliance with European countries to put economic pressure on Iran” (MSNBC, 17 September 2007). According to him, and other policymakers, “[T]he goal [was] to impose significant, meaningful, and painful sanctions on the Iranians” (The New Yorker, 3 November 2008). Testimony to the US House Committee on Foreign Affairs on 22 July 2009 claimed that: “Iranian public opinion is likely to exaggerate the impact of the foreign pressure and to blame the Ahmadinejad government’s hardline stance for the country’s economic difficulties.”

Through the *Comprehensive Iran Sanctions, Accountability, and Divestment Act* (CISADA, 22 U.S.C. 8501), the US issued its Iranian Transactions Regulations. They increased the cost of importing from Iran to the US by: “[R]equiring US firms to obtain special federal authorization to import from Iran into United States.”¹⁷ The Council of the European Union adopted *Common Position 2008/652/CFSP*.

¹⁵French leader raises possibility of force in Iran,’ The New York Times, 28 August 2007.

¹⁶The Unites States and Iran cut diplomatic relationships in 1979, but trade continued between Iranian and US firms.

¹⁷Examples of imports violating these sanctions exist. For instance, Mahdavi’s A&A Rug Company of Georgia, US, was accused of violating sanctions by importing products from Iran to the US without obtaining special federal authorization. In 2008, Mahdavi’s A&A Rug Company paid a penalty of \$9,240 in settlement.

It required member states to: “[E]xercise restraint in entering into new commitments for public- and private-financial support for non-oil imports.” Australia imposed sanctions on imports from Iran as well as on the transit through Australia of products of Iranian origin.¹⁸ The Canadian Foreign Affairs and International Trade Department issued sanctions under its *Special Economic Measures (Iran) Regulations*. Canada prohibited providing services for the operation, or maintenance of, vessels owned by, or operating on behalf of, Iranian shipping companies. Although countries imposed sanctions in different ways against Iran in 2008, these export sanctions had a common goal: to pressurize on Iranian economic agents (that is, exporters).

On 20 March 2009 President Barack Obama offered Iran a “new beginning,” proposing that it engage in direct negotiations with the US, and discuss ending its nuclear program.¹⁹ On 8 April, the US, UK, France, and Germany offered Iran a “freeze-for-freeze” deal that no additional sanctions would be imposed on Iran if it agreed to freeze uranium enrichment.²⁰ As reality on the ground did not change, in June 2010 the UNSC recommended further sanctions against Iran over its nuclear program, expanding the arms embargo. These measures prohibited Iran from buying heavy weapons such as attack helicopters and missiles. At this time the US Congress imposed new unilateral sanctions targeting Iran’s energy sectors. This imposed penalties on firms that supplied Iran with refined petroleum products. In May 2011 the US blacklisted the Twenty-First Iranian State Bank and the Bank of Industry and Mines for transactions with previously banned institutions. On 17 March 2012, all Iranian banks were disconnected from SWIFT, the global hub for electronic financial transactions.

Sanctions imposed on Iranian imports of nuclear-related products (2006-2007) and financial (SWIFT/banking) sanctions on Iran (2012) are outside the scope of this paper: the dataset used covers only exporters, and only for the period between January 2006 and June 2011.

2.2 Iranian public perception of export sanctions

Iranians perceived the 2008 export sanctions as having limited negative effects. This perception was reflected in the media and in speeches given by groups in both the public and private sectors.²¹

¹⁸See the section on Australia’s autonomous sanctions on Iran, Department of Foreign Affairs and Trade.

¹⁹‘Obama offers Iran a new beginning,’ BBC, 20 March 2009.

²⁰‘Iran calls for nuclear talks as further sanctions loom,’ The Guardian, 1 September 2009.

²¹The Iranian public perceived the 2012 SWIFT/banking sanctions as much harsher.

Iranian government officials insisted that sanctions had no impact on the Iranian economy. For example, President Mahmoud Ahmadinejad said that international leaders who “still think sanctions are an effective means are politically retarded.”²² Speaker of Parliament Ali Larijani added that “sanctions will definitely be turned into opportunities.”²³ Iran’s deputy information chief Hossein Mazloumi claimed that sanctions have led to technological innovation in Iranian universities and industrial sectors by focusing efforts on domestic production.²⁴

Nematollah Poustindouz, the managing director of the SAIPA car-manufacturing company, declared that sanctions had no negative impact on SAIPA: “[T]hose who impose sanctions on Iran have in fact imposed restrictions on themselves,” he said.²⁵ Iran’s non-oil exports to China rose nearly 35% to \$5.9 billion after the imposition of export sanctions, and China replaced the EU as Iran’s top importer.²⁶ Between 2008 and 2012, the United Arab Emirates (UAE) had been an unofficial conduit for Iranian exports to destinations imposing export sanctions, as 400,000 Iranians were living in the UAE, 8,000 Iranian firms and 1,200 Iranian trading firms were active in the country. Esfandiar Rashidzadeh, who set up an affiliate of Iran’s Bank Melli in Dubai, said: “[T]he pressure of sanctions will not change regime behavior but only add to the cost of doing business.”²⁷

3 Data

This analysis employs a rich non-oil Iranian customs dataset that is disaggregated at the exporter-product-destination-day level, obtained from The Islamic Republic of Iran Customs Administration. To test data quality, it was successfully matched against UN-Comtrade data and mirror data (the data that each destination reports as imports from Iran). Aggregated Iranian Customs exports represent 98.5% of UN-Comtrade Iranian exports and 99.5% of mirror data at the product-destination level.

The dataset includes every Iranian non-oil exporting firm and export transaction, between 1 January 2006 and 30 June 2011. Observations are daily, and data includes exporter ID, product ID, destination of shipment, value of exports,²⁸ and date of transaction for every transaction. Iranian Customs also

²² Ahmadinejad calls UN Security Council “retards” over sanctions’, ADNKronos Int’l, 24 December 2010.

²³ Speaker: Iran turns threats into opportunities’, Fars News Agency, 20 September 2010.

²⁴ IRGC official: Sanctions caused technological growth blossoming’, Zawya, 9 December 2010.

²⁵ Iranian Carmaker: Sanctions Ineffective’, Fars News Agency, 11 August 2010.

²⁶ China overtakes EU as Iran’s top trade partner’, Financial Times, 8 February 2010.

²⁷ Dubai Helps Iran Evade Sanctions as Smugglers Ignore U.S. Laws’, Bloomberg, 25 January 2010.

²⁸ Export values deflated to their January 2006 equivalent using the monthly US consumer price index (from Global Financial Data).

report the weight of each shipment. In total, the dataset includes 1,814,146 transactions.²⁹ There were 35,953 exporters, although not all exported every month, and 3,865 products. The HS-6 digit level product classification illustrates the narrowness of product definitions and the richness of micro-level information available in the dataset.³⁰

This customs dataset has several advantages compared to UN-Comtrade data. It includes daily records, and so allows micro-level analysis of short-term dynamics such as entry and exit rates, export volumes and distributions, and prices and growth at the exporter-product-destination level. It allows us to see the number of products that are exported, by each exporter, to each destination (the extensive margin), and the export value, per product, per exporter, to each destination (the intensive margin). Exporter-level data makes it possible to calculate export margins with exporter-product-destination dimensions, which is not the case with product-level databases, such as UN-Comtrade). Between country pairs, this research calculates the extensive margin with an exporter-product dimension, rather than a simple product dimension, especially as the average exporter in the dataset exported more than one product.

If the purpose of export sanctions was to generate revolt, then export sanctions would have been sensible if small exporters accounted for a large share of employment. If, by contrast, the purpose was to affect aggregate exports, then export sanctions were less likely to be successful because large exporters, who accounted for the bulk of exports, deflected exports to other destinations. This granular data also makes it possible to calculate the type of firm that was most affected.

This dataset has three caveats as well. First, we cannot know the probability that a firm becomes an exporter, because (by definition) it records data on firms that export. This is not problematic if the investigation is restricted to the questions of whether, and how, existing exporters reallocated their exports. Second, the dataset does not include other characteristics of exporters, such as ownership, employment, capital, and access to finance. Again, this falls outside the scope of this analysis. Finally, the dataset captures data for three years after the imposition of export sanctions, so the empirical analysis considers only short-term changes in behavior.

For each quarter, Table A.I reports the number of exporters, as well as the average export value per exporter, the average number of products per exporter, and the average number of destinations per

²⁹To save space, descriptive statistics in the appendix are at exporter-product-destination-quarter level.

³⁰A small portion of transactions in the dataset includes HS-8 digit level product classification, but the majority of transactions uses HS-6 digit level product classification. To ensure consistency in the analysis, data was aggregated using the HS-6 digit level product classification.

exporter. The average number of exporters per quarter decreased by 22.6%, from 7,359 before the imposition of export sanctions (2006-Q1 to 2008-Q1) to 6,001 after the imposition of export sanctions (2008-Q2 to 2011-Q2). However, quarterly average export value per exporter increased from \$0.48 million to \$0.93 million, and the quarterly average number of products per exporter increased from 4.08 to 4.26 during the same period, suggesting that smaller exporters exited more than larger exporters. Table A.II reports annual descriptive statistics, following the decomposition format of Eaton *et al.* (2007).

Table A.III reports the numbers of Iranian exporters and exported products to SCs and NSCs. While the number of Iranian exporters to SCs dropped by 30.65% during the post-sanctions period, the number exporting to NSCs increased by 12.73%. While the number of Iranian products exported to SCs dropped by 11.58%, during the post-sanctions period, it increased by 5.04% to NSCs. Before the imposition of sanctions in March 2008, prepared food, tobacco, and chemical products such as fertilizers were more than half of Iranian exports to SCs while Iran's exports to NSCs were more diversified. For these destinations, metals, carpets, textiles, glass, stones, and foodstuff accounted for 60% of Iranian exports before sanctions.

4 Empirical analysis

The first part of this section demonstrates the existence of export destruction and deflection after sanctions. The second part highlights the mechanism through which export deflection occurred, as well as the extent to which export destruction was compensated by export deflection.

4.1 Existence of export destruction and deflection

I identify the effect of export sanctions on Iranian export destruction at the exporter-destination level. Figures 2, 5, 6, and 7 show that Iranian exports to SCs were steady before sanctions, but decreased afterwards. Figure 2 shows that Iranian exports to NSCs increased significantly after sanctions. Figures 5-7 distinguish between exports by exporters (i) only to SCs, (ii) only to NSCs, and (iii) to both SCs and NSCs between January 2006 and June 2011. This makes it possible to observe export deflection: exporters who exported only to SCs, or only to NSCs, by definition did not deflect exports. I test for whether the coefficients in the time series regressions vary after the known break date, the imposition

of sanctions in March 2008 ($t = 27$). In other words, I test for whether a structural break exists within the estimation coefficients using an autoregressive model of order 1, AR(1):

$$X_{et} = \left\{ \begin{array}{ll} \alpha_1 + \beta_1 X_{et-1} + \epsilon_{et} & \text{if } t \leq 27 \\ \alpha_2 + \beta_2 X_{et-1} + \epsilon_{et} & \text{if } t > 27 \end{array} \right\} \quad (1)$$

where X_{et} refers to different measures in the different estimations in Table 1. In (1) X_{et} refers to the total exports at time t . In (2) X_{et} refers to the total exports by exporters who exported only to NSCs at time t . In (3) X_{et} refers to the total exports to SCs at time t by (i) exporters who exported only to SCs and (ii) exporters who exported to both SCs and NSCs between January 2006 and June 2011. In (4) X_{et} refers to the total exports to NSCs at time t by exporters who exported to both SCs and NSCs between January 2006 and June 2011. Exports are aggregated by month, so t goes from $t = 1$ (January 2006) to $t = 66$ (June 2011). ϵ_{et} is the usual idiosyncratic error term.

Table 1 shows the change in exports of all Iranian exporters, and also of exporters who exported only to NSCs and therefore did not experience destruction or need to deflect exports. Row 1 of Table 1 shows the growth of overall exports before and after sanctions. Average monthly export growth rate increased after sanctions from 0.24% to 1.48%. This corresponds to Figure 1, which shows that overall exports increased following sanctions. Row 2 of Table 1 shows the growth of exports of exporters who exported only to NSCs. Again, average monthly export growth rate increased after sanctions from 0.71% to 2.64%. This corresponds to the red (dotted) line in Figure 5.

Export destruction is captured in the estimations in row 3 of Table 1. To reduce bias, it excludes exporters who exported only to NSCs. Including these exporters would bias estimates upward. Note the March 2008 export sanctions were against all Iranian exporters to certain destinations, and not differentiated between industries, therefore the empirical restriction is made at the exporter-destination level, and not also by sector. The coefficients in this row show a structural break after sanctions. Before sanctions, coefficient β_1 shows that X_{et} was on average, 100.54% of X_{et-1} . However, after sanctions, coefficient β_2 shows that X_{et} was on average, 94.81% of X_{et-1} . The coefficients are statistically significant at the 1% level. In addition, intercept α_2 is lower than α_1 , which strengthens the suggestion of a structural break. This pattern corresponds with the export destruction pattern seen in the blue lines in Figures 5 and 7.

Row 4 of Table 1 presents empirical evidence on the existence of export deflection following sanctions. To reduce bias it focuses on exports to NSCs by exporters who exported to both SCs and to NSCs

between January 2006 and June 2011. Again, the coefficients in this row show a structural break after sanctions. Before sanctions, coefficient β_1 shows that X_{et} was on average 90.23% of X_{et-1} . However, after sanctions, coefficient β_2 shows that X_{et} was on average, 3.11% higher than X_{et-1} . The coefficients are statistically significant at the 1% level. In addition, intercept α_2 is higher than α_1 strengthens the suggestion of a structural break. This pattern corresponds with the export deflection trend seen in the red line in Figure 7. These results highlight that those Iranian exporters exporting to both SCs and NSCs experienced an increase in exports to NSCs. Together the results in rows 3 and 4 of Table 1 show that when Iranian exporter-level exports to SCs declined because of export sanctions, there was an increase in Iranian exporter-level exports to NSCs (see Figure 7 for a graphical illustration).

Which exporters were affected most? While the results show that the imposition of sanctions had a significant negative impact on the *average* Iranian exporter to SCs, they hide the heterogeneity among exporters. One might expect larger and more experienced exporters to be affected differently: they are typically more productive, and can afford higher export costs. Therefore, it is useful to repeat estimations (3) and (4) in Table 1 to show separate impacts on small and large exporters. In this case, 'large' exporters are defined as those whose monthly export value to SCs was above the export value per average exporter before March 2008. 'Small' exporters had monthly export value to SCs below the export value per average exporter. Small exporters suffered from more export destruction than large exporters (rows 3a and 3b of Table 1). For small exporters, in (3a), before sanctions, coefficient β_1 shows that X_{et} was on average 99.16% of X_{et-1} . After sanctions, coefficient β_2 shows that X_{et} was on average 54.31% of X_{et-1} . For large exporters, in (3b) before sanctions, coefficient β_1 shows that X_{et} was on average 17.18% more than X_{et-1} . After sanctions, coefficient β_2 shows that X_{et} was on average 96.32% of X_{et-1} . Thus, the reduction in exports was relatively less for large exporters. Large exporters also achieved higher levels of export deflection than small exporters (rows 4a and 4b in Table 1). For small exporters, in (4a), before sanctions, coefficient β_1 shows that X_{et} was on average, 87.12% of X_{et-1} . After sanctions, coefficient β_2 shows that X_{et} was on average 101.41% of X_{et-1} . For large exporters, in (4b) before sanctions, coefficient β_1 shows that X_{et} was on average just 1.21% more than X_{et-1} . After sanctions, coefficient β_2 shows that X_{et} was on average 124.08% of X_{et-1} .

An assessment of the impact of sanctions on the rates of entry and exit of exporters at the destination level supports these findings. It uses the following estimating equation:

$$EAD_{dt} = \delta_1 + \eta_0 S_d + \eta_1 PS_t + \delta_2 S_d \cdot PS_t + Controls_{dt} + \epsilon_{dt} \quad (2)$$

where EAD_{dt} represent, in different estimations, the logs of $Entry_{dt}$ and $Exit_{dt}$ rates of exporters as well as the logs of ADD_{dt} and $Drop_{dt}$ shares at the destination-quarter level. ADD_{dt} is the share of exporters that added a new product to their product-mix at destination d at time t . $Drop_{dt}$ is the share of exporters that dropped an existing product from their product-mix at destination d at time t . To ensure the estimates are not driven by small-size destinations, entry and exit rates, as well as the ADD_{dt} and $Drop_{dt}$ shares, were weighted by aggregate destination-level exports of Iranian exporters before March 2008. Aggregate exports to a given destination before March 2008 were used to measure the size of that destination. S_d is a dummy variable that equals to 1 for SCs and zero otherwise, and PS_t is a dummy variable for the post-sanctions period. The coefficient of interest, δ_2 , multiplies the interaction term, $S_d.PS_t$, which is the same as a dummy variable that equals one for SCs after the imposition of sanctions. To reduce bias the estimation excludes firms that exported only to destinations not imposing sanctions. Including these exporters would bias the estimates upward. The estimation controls for logs of GDP, distance, number of immigrants, number of exporters, inflation rate, ease of imports, FDI (net flows), tariff rate, and growth of imports at the destination level. ϵ_{dt} is the usual idiosyncratic error term.

From the data, it is impossible to know whether an exporter with a positive export value in January 2006 (in 2006-Q1) was a new exporter or not. Therefore I considered only exporters that started exporting strictly after 2006-Q1 to estimate the effect of export sanctions on entry rates. Similarly, the data does not tell us whether exporters reporting a positive export value in June 2011 (in 2011-Q2) exited the next quarter, and so, I only consider exits that took place before 2011-Q2 in estimating the effect of export sanctions on exit rates. Column 2 of Table 2 shows that export sanctions reduced exporter entry rate by an average of 23% to SCs, compared to NSCs. Column 4 of Table 2 shows that export sanctions increased exporter exit rate by an average of 8.5% from SCs, compared with NSCs.

While $Entry_{dt}$ and $Exit_{dt}$ allow focusing on the extensive margin, ADD_{dt} and $Drop_{dt}$ allow looking at the intensive margin. Precisely, did exporters add to the products they exported to NSCs, and drop existing products that had been exported to SCs? Column 6 of Table 2 shows that export sanctions reduced the share of exporters that added new products to their product mixes at SCs by an average of 15.1%, compared to NSCs. Column 8 of Table 2 shows that export sanctions increased the share of exporters that dropped an existing product from SCs by an average of 24.6% compared to NSCs.

It is important to reflect on whether exports to SCs were going to fall regardless, for reasons such as the trade collapse that followed the global recession in 2008. Export sanctions preceded the global

economic crisis by only a few months. Traded goods sectors are procyclical, so exports to SCs would fall if there was a recession in these economies. The economic crisis may have obscured the effects of export sanctions on Iranian export deflection, given the countries that imposed sanctions were particularly affected by the crisis. Increasing trade frictions at international borders, broadly defined, might also affect exports. If export destruction was caused by the recession and not by export sanctions, then we would expect a similar pattern in the import data of SCs and NSCs from Iran. This is not the case. Figure 8 shows the growth rates of Chinese and US imports from Iran, as well as China and US total imports and economic growth over time. Clearly, the crisis affected Iranian exports to both US and China.³¹ Following the crisis, Iranian exports to China rose again. Imports to the US from Iran did not rise, although imports from other countries rose again. This suggests that the bulk of the decline in Iranian exports to specific destinations was attributable to the imposition of sanctions.

Also, we mention a note about export transshipments.³² Export sanctions resolutions do not have rules of origin. This may have created a loophole that helped Iranian exporters, for example allowing them to transship through UAE to SCs.³³ It may be the case that new businesses (not necessarily of Iranian origin) captured new business opportunity, started importing from Iran to the UAE, then re-exporting to destinations that imposed export sanctions on Iranian exporters. The data tracks Iranian exporters to the UAE and other destinations, but cannot identify which firms are exporting from the UAE, so it is not possible to rule out the possibility that exporters used transshipment following the imposition of sanctions. Table A.IV presents descriptive statistics on potential post-sanctions export transshipments through the UAE. It shows the percentage change in exports between pre- and post-sanctions periods by exporting firms that exited from or reduced their exports to the US, UK, Canada, and France. Also it tracks exports by the same firms, at the product level, to the UAE following their exit from, or reduction of, exports to the same destinations. Finally, it shows an aggregate measure of product-level re-exports from the UAE to these four destinations. The first two steps use Iranian Customs data, because the interest is primarily in exporter-level export transshipment. The final step uses UN-Comtrade data in the absence of UAE customs importer-exporter level data.³⁴ The results in Table A.IV show a trend (though not necessarily a causal relation) of export transshipment, at the

³¹Data only for US and China presented here, but the trend is similar for other destinations.

³²'Export transshipment' defined as shipment of product to an intermediate destination, then to another destination.

³³UAE used solely for illustrative purposes. Other countries may have fulfilled the same purpose.

³⁴Edwards and Lawrence (2016) and Frazer and Biesebroeck (2010) showed theoretically and empirically how US quotas on Chinese exports served as an implicit subsidy for African apparel exporters, and led Chinese exporters to transship their trade, following the imposition of US quotas, to US through African countries. These countries actually benefited from this 'African Growth and Opportunity Act'.

product-level, of Iranian exporters through UAE ports.

4.2 Mechanism of export deflection

The price of export deflection: If Iranian exporters reduced prices of products that they deflected, then the change in product prices should be reflected in the unit values of the products exported to NSCs after March 2008. We would not expect price changes in products introduced following export deflection to serve the needs of new customers at NSCs, so the analysis includes only the products that exporters deflected from SCs to NSCs. A change in the unit value of a product is consistent with a combination of a change of the product quality, other changes in product characteristics that make the product more desirable or affordable to consumers in lower income countries, or a change in the demand characteristics at the new market (Schott, 2004 and Hallak, 2006).

To check for evidence on changes in product prices following export deflection, I compare product prices of deflecting exporters in the first shipment to a NSC following March 2008 with the prices of same products by same exporters in their last shipment to a SC before March 2008. The average prices of the same products sold by other Iranian existing exporters in the NSCs before March 2008 was compared to the price at the time of the first shipment following export deflection. The dataset does not include product prices in each shipment transaction data report, but only total export value and weight of each shipment at the exporter-product-destination level, therefore unit prices were obtained by dividing the total value of shipment of exports of product p by the weight of shipment at the exporter-time level.

The results in Figure 9 indicate that deflecting exporters reduced their product unit prices by, on average, 7.4% in the first shipment following export deflection, when compared to prices of same products in the last shipment before export deflection. The right-hand bar in Figure 9 shows a 1.8% drop in the average price of the same products, as sold by existing Iranian exporters to that destination at the time of first shipment by deflecting exporters, after export deflection took place.³⁵ Price reductions can be explained as deflecting exporters reducing prices in an attempt to enter the new markets and capture new consumers. This created price competition with incumbent Iranian firms exporting to these NSCs.³⁶

³⁵The new product prices of deflecting exporters were, on average, 1.1% lower than the average prices of the same products sold by other Iranian existing exporters in the new destination at the time of the first shipment following export deflection.

³⁶Product prices of deflecting exporters did not change when deflecting exporters remained in new markets for a second year.

To check for evidence on changes in product prices following export deflection, I compare product prices of deflecting exporters in the first shipment to a NSC following March 2008 with the prices of same products by same exporters in their last shipment to a SC as follows:

$$P_{ept} = \begin{cases} \alpha_3 + \beta_3 P_{ept-1} + \epsilon_{et} & \text{if } t \leq 27 \\ \alpha_4 + \beta_4 P_{ept-1} + \epsilon_{et} & \text{if } t > 27 \end{cases} \quad (3)$$

where P_{ept} is the price of product p exported by exporter e at time t and P_{ept-1} is the price of product p exported by exporter e at time $t-1$. The focus is on exporters who cut their product exports to SCs after March 2008 and existed in NSCs after March 2008. Thus, this estimation captures the product price differences over time by the same exporter at SCs before sanctions ($t \leq 27$) as well as at NSCs after sanctions ($t > 27$). The results in Table 3 support the observed pattern from Figure 9. The coefficient β_4 shows that, after export deflection, deflecting exporters reduced their product prices by 8.1%.

The effect of sanctions on quantity sold by deflecting exporters: If Iranian exporters exported a higher volume of products that they deflected following sanctions, then the change in exported product volumes should be reflected in the quantity of the products exported to NSCs after March 2008. The focus again is on the products deflected from SCs to NSCs (no change is expected in new products which were introduced following export deflection to serve the needs of new customers in NSCs). The same methodology is used as for the drop in product prices. First, quantity of exported products by deflecting exporters in the first year of exporting to a NSC following March 2008 is compared with the quantity of same products, by the same exporters, in the last year, exporting to a SC before March 2008. This is compared to the quantity of the same products, as sold by other Iranian existing exporters in the NSCs before and after March 2008. The dataset does not capture product quantities in each shipment transaction, but it does record total weight in each exporter-product-destination shipment data report. As before, the quantity measurement was obtained by dividing the total value of shipment of exports of product p by the product unit price at the exporter-destination-time level.

The results in Figure 10 indicate that deflecting exporters increased the quantity of their deflected products by, on average, 12.43% in the first year following export deflection compared to the quantity they exported of same products in their last year before export deflection. Meanwhile, the right-hand bar in Figure 10 shows a 2.21% annual average increase in the quantity sold of same products by other

Iranian exporters that already existed in the new destination at the time of first shipment by deflecting exporters, after export deflection took place. One potential explanation for this increase in quantity is that deflecting exporters had to compensate destroyed exports by increasing quantity sold, especially as they also had to reduce product prices while deflecting exports to attract new customers.

Second, to check for evidence on changes in product quantity sold following export deflection, I compare product quantity sold by deflecting exporters in the first year to a NSC following March 2008 with the quantity sold of same products by same exporters in their last year to a SC as follows:

$$Q_{ept} = \left\{ \begin{array}{ll} \alpha_5 + \beta_5 Q_{ept-1} + \epsilon_{et} & \text{if } t \leq 27 \\ \alpha_6 + \beta_6 Q_{ept-1} + \epsilon_{et} & \text{if } t > 27 \end{array} \right\} \quad (4)$$

where Q_{ept} is the sold quantity of product p that is exported by exporter e at time t and Q_{ept-1} is the sold quantity of product p that is exported by exporter e at time $t - 1$. The data focuses on exporters who cut their product exports to SCs after March 2008 and existed in NSCs after March 2008. Thus, this estimate captures the product quantity differences over time by the same exporter at SCs before sanctions ($t \leq 27$) as well as at NSCs after sanctions ($t > 27$). The results in Table 4 support the observed pattern in Figure 10. The coefficient β_6 shows that, after export deflection, deflecting exporters increased their sold product quantities by 11.6%.

The role of exporter size: Exporters are not equal in their ability to deflect exports. When trying to understand the dynamics of export deflection, one must ask which exporters deflected exports from SCs to NSCs. We would expect the size and experience of exporters to affect their ability, willingness, and decision to deflect exports. The following model tests this hypothesis:

$$Deflect_{e|t>27} = \alpha_0 + \alpha_7 \ln X_{e|t \leq 27} + \alpha_8 \ln Experience_{e|t \leq 27} + \gamma_e + \kappa_t + \epsilon_{et} \quad (5)$$

where the dependent variable, $Deflect_{e|t>27}$, is equal to 1 if the exporter exited a SC and, afterward, entered a NSC after March 2008, and zero otherwise.³⁷ $\ln X_{e|t \leq 27}$ and $\ln Experience_{e|t \leq 27}$ represent the size and experience of the exporter before March 2008. I measure the size and experience of the exporter by, respectively, the log of export value and number of months of presence in export market between entry and March 2008.

³⁷This is an extreme case, used to form clearer picture of which firms are more able to deflect exports.

Column 1 of Table 5 shows that larger and more experienced exporters had a higher probability of deflecting exports following sanctions. This observation is consistent with the assumption that exporters have specific productivities and behave differently in export markets. Figure 11 complements this result by showing the volumes that deflecting exporters were able to deflect. In Figure 11 the exporters are divided into two groups: 'small' exporters whose monthly export value was below the export value per average exporter before sanctions, and 'large' exporters whose monthly export value was above the export value per average exporter in the SC (that they deflected from) during the month of their last shipment. Large deflecting exporters achieved higher levels of export deflection, on average, than small deflecting exporters. While large exporters deflected on average 86% of their exports, small exporters deflected on average 16% of their exports from SC to NSCs.³⁸

The role of past export status: Exporting to a destination requires incurring sunk and variable costs. If an exporter already exists in a market, then current export costs depend on past export status. To examine if past export status at NSC affected export deflection, I estimate different equations where the dependent variable is either the log of exports at the exporter-month level at NSC, $\ln X_{epNSCt}$, or a binary variable, $P(EXP)_{epNSC|PostS}$, that equals one if the exporter had exported product p to NSC after sanctions were imposed, and zero otherwise. The independent variables are separate interaction terms of $S_d.PS_t$ and $ExporterA$, $ExporterB$, and $ExporterC$ where $ExporterA$ is a dummy variable that equals one if the exporter had exported product p to a SC but had not exported at all to a NSC before March 2008, $ExporterB$ is a dummy variable that equals one if the exporter had exported product p to a SC but exported another product to a NSC before March 2008, and $ExporterC$ is a dummy variable that equals one if the exporter had exported a product to a SC as well as to a NSC before March 2008, respectively. An exporter-size control, $\ln X_{e|PreS}$, is included as larger firms are typically more productive and have better performance in export markets (Bernard and Jensen, 2004) which improve exporting activity. Firm size can be a proxy for past success.

Table 6 shows the results. Imposition of export sanctions resulted in a 65% [$100 * (\exp(0.501) - 1)$] increase in Iranian exporter-product level exports to an NSC given that the exporter had previously exported the same product to that NSC (column 1). This result shows that exporters increase their export values to alternative destinations that they are already existing in – along their intensive margin –

³⁸ Exports of large exporters dropped by \$0.29 billion in SC but increased by \$0.25 billion in NSCs per month following sanctions. Exports of small exporters dropped by \$0.12 billion in SC but increased by \$0.02 billion in NSCs per month following sanctions.

when they face export sanctions by a particular export destination. In addition, this result suggests that it would be easier for an exporter to deflect part or all exports from a SC to a NSC if the exporter already exists in the NSC. This is because, as well as sunk entry costs that have an effect on the extensive margin, exporters incur variable costs after entry. These variable costs at a given destination can be lower for exporters who already exist in that destination.

Column 2 of Table 6 shows the estimation result when the interaction of export sanctions with export status variables is included. The coefficient of *ExporterB* has a higher economic significance than the coefficient of *ExporterA*. This suggests that the probability that a firm deflects product exports to a NSC is higher if that exporter had previously served that destination. It shows that the probability of export deflection is lower for exporters that did not serve a NSC before March 2008. In economic terms: when export sanctions are imposed against an exporter by a particular destination, it increases the probability that a product is exported to a non-sanctioning destination by 9.2% provided the firm had already exported to that destination. If it had not exported at all to that destination before, the probability would rise only by 5.3%. The lower economic significance level of the coefficient of *ExporterA* interaction demonstrates that past export status matters in determining a sanctioned exporter's decision to deflect.

Figure 12 supports this interpretation. It shows the extent to which Iranian exporters were able to deflect exports after facing export sanctions in March 2008, and differentiates between exporters who exported only to SCs before March 2008 and exporters who exported to both SCs and NSCs before March 2008. The average monthly export value by both types of exporters to SCs decreased from 0.58 (blue bars) before March 2008 to 0.17 (red bars) after March 2008. The average monthly export value by both types of exporters to NSCs increased from 0.05 (green bars) before March 2008 to 0.32 (orange bars) after March 2008. We can conclude that two-thirds of the value of Iranian exports that were destroyed by export sanctions were deflected to NSCs.

Product selection during export deflection: The literature emphasizing heterogeneity at the product level predicts that 'core-competence' products are the most responsive to new export environments (Eckel and Neary, 2010). This implies that more of this category of products would be deflected by Iranian exporters.³⁹ In addition, products have different export trends and characteristics. For

³⁹In this case core competence products at the exporter-destination level are defined as the products with the highest sales volume.

example, some products are homogeneous while others are differentiated (Rauch, 1999).⁴⁰ The hypothesis would be that it is easier for exporters, following sanctions, to deflect homogeneous products to NSCs, because the cost of searching for consumers of these products is lower, given these products are typically standard in terms of content and quality and require less marketing as a result.

The hypothesis can be tested using this equation:

$$Deflect_{ep|t>27} = \alpha_0 + \alpha_9 X_{epPreS} + \alpha_{10} X_{share_{epPreS}} + \alpha_{11} Diff + \gamma_e + \kappa_d + \epsilon_{ept} \quad (6)$$

where $Deflect_{ep|t>27}$ equals one if the exporter dropped a given product from a SC and introduced it in a NSC after March 2008, and zero otherwise.⁴¹ X_{epPreS} is the log of exporter-level export value of a product to a SC before sanctions. $X_{share_{epPreS}}$ is the weight of the product in the exporter-level exports to a SC before sanctions. $Diff$ is a dummy variable set to one if the product is differentiated, and zero otherwise.

The results in column 1 of Table 7 show that higher export value and share of exports of a given product, by a given exporter, to a SC are associated with higher probability that the product gets deflected by the exporter to a NSC. Also, the movement of $Diff$ from 0 to 1 decreases the probability that the given product gets deflected by its exporter from a SC to a NSC. In other words, homogeneous products have higher export deflection probability. The results are significant at the 5% level. These observations support the assumption of product differentiation made by Eckel and Neary (2010) and Rauch (1999).

Destination selection after export sanctions: Did deflecting exporters target destinations randomly? How did exporters who exported only to NSCs perform after sanctions were imposed? Two equations help to understand the destinations by targeted Iranian exporters after sanctions. In the first one, the dependent variable is the log of total number of deflecting exporters to a given destination at a given month, N_{dt} . In the second one, the dependent variable is the log of growth rate of exports of Iranian exporters who exported only to NSCs, $XGrowth_{dt}$. The main independent covariates are a dummy variable for whether the destination received a high-level Iranian diplomatic delegation (president or government minister) after March 2008, and the correlation of positions during votes on

⁴⁰Copper is an example of a homogeneous product, carpet is an example of a differentiated product. Rauch (1999) goes into detail about the motivation of this product classification. In essence, differentiated products require more marketing.

⁴¹Again, an extreme case to demonstrate which products are easier to deflect.

resolutions in the General Assembly of the United Nations, a good measure of ideological, cultural, and historical affinity between countries that may affect bilateral trade.⁴² In both estimations, a vector of controls captures economic size, distance, price competitiveness, ease of imports, foreign direct investment net inflows, tariff rate, import growth, and the number of Iranian immigrants⁴³ and existing Iranian exporters at the destination level.

The coefficients in Table 8 show that more deflecting exporters targeted larger and closer markets, and markets with higher import, income, and FDI growth rates. They also chose destinations with fewer import restrictions, lower tariff rates, more Iranian immigrants, higher number of Iranian existing exporters. Countries that are politically friendly with Iran according to the UN vote-correlation test attracted more deflecting exporters. Exports by firms that exported only to NSCs grew annually after sanctions by an average of 11.4% [$100 * (\exp(0.108) - 1)$] more in destinations that welcomed Iranian diplomatic visits after sanctions, compared to other destinations. This result corresponds with the the red (dotted) line in Figure 5. While exports to NSCs increased, this increase again came at a cost represented (partially) by a need for more diplomatic effort (travel cost in terms of money and time) by Iran. These results are statistically significant and are independent of consumer price index changes at the destination. As expected, the inflation variable has a positive coefficient: an increase in prices at the destination creates more demand for imported products. Time fixed effects control for real exchange rate fluctuations in the Iranian currency against currencies of all destinations.

5 Conclusion

For trade economists, this data shows that export sanctions against Iran in 2008 led to export deflection to non-sanctioning countries. In aggregate, two-thirds of Iranian exports destroyed by sanctions were deflected to non-sanctioning countries. Exporting firms were able to redirect their exports towards politically-friendly destinations. This effect of export sanctions is heterogeneous, and depends on characteristics of the exporter (larger exporters were better able to deflect their exports), of the product (core and homogeneous products were more easily deflected), and of the destination country (countries in which the exporter is already present were more likely to become destinations for deflected exports).

⁴²This uses the voting similarity index of Strezhnev and Voeten (2013) dataset on the correlation between positions of countries during UN General Assembly votes.

⁴³The data on immigration stocks come from the Global Migrant Origin Database (GMOD) of the University of Sussex's Development Research Centre on Migration, Globalization and Poverty.

Exporters whose business was with non-sanctioning countries before sanctions increased their exports after sanctions too, thanks to additional Iranian diplomatic efforts. Export deflection imposed additional costs as exporters reduced prices and increased quantities when they deflected exports to new destinations. Thus, export deflection caused welfare losses.

For policymakers, the results show that while export sanctions against Iran did not reduce aggregate exports, they caused inconvenience by denying markets to many exporters, and imposing costs on others. Thus, export sanctions can be effective in putting pressure on exporters. If the goal is to reduce aggregate exports, sanctions may not be effective in a globalized economy in which deflection is possible.

This paper is the first to use firm-level data to understand the impact of sanctions on Iranian exporters. There are three directions for further research. First, there is a need for further theoretical and empirical investigations of the mechanisms by which sanctions succeed or fail in the presence or absence of international consensus and cooperation. Second, the impact of sanctions on the welfare of citizens at the aggregate and disaggregate levels (using household income and expenditure survey data): sanctions may differently affect different social, income, and regional groups. Third, the impact of the financial and banking sanctions imposed on Iran in 2012 and 2013.

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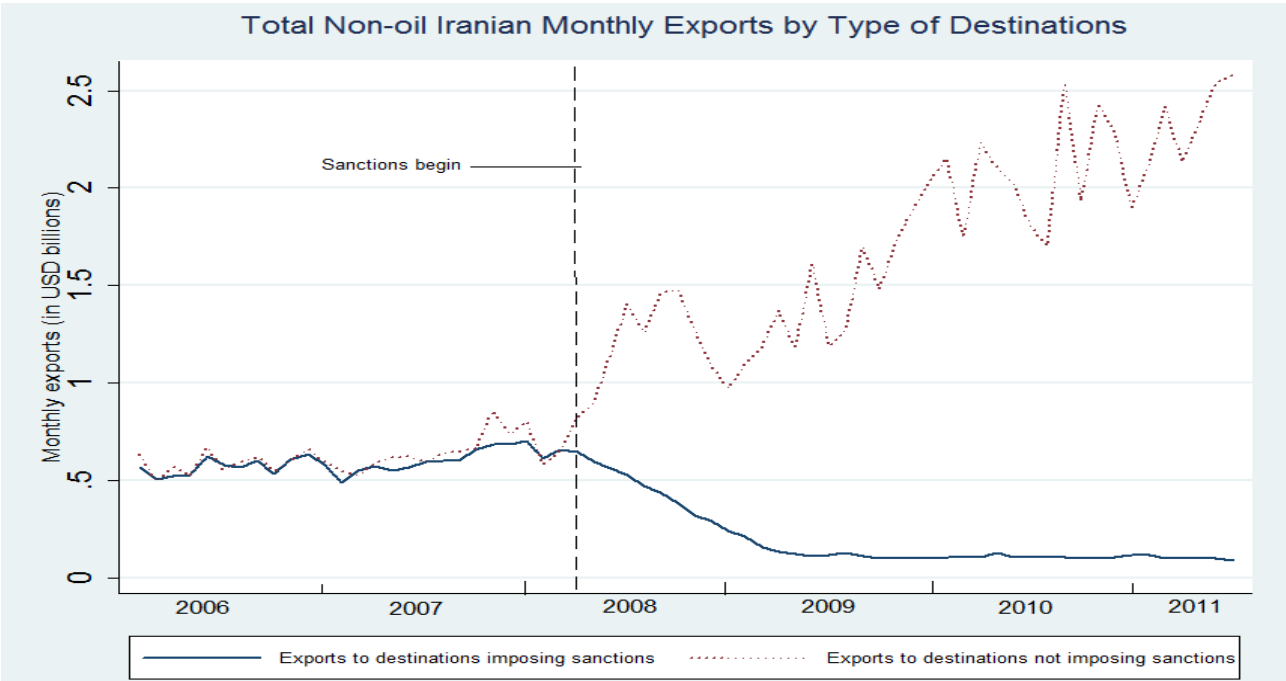
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Figure 1: Evolution of Iranian exports (Jan 2006 - Jun 2011)



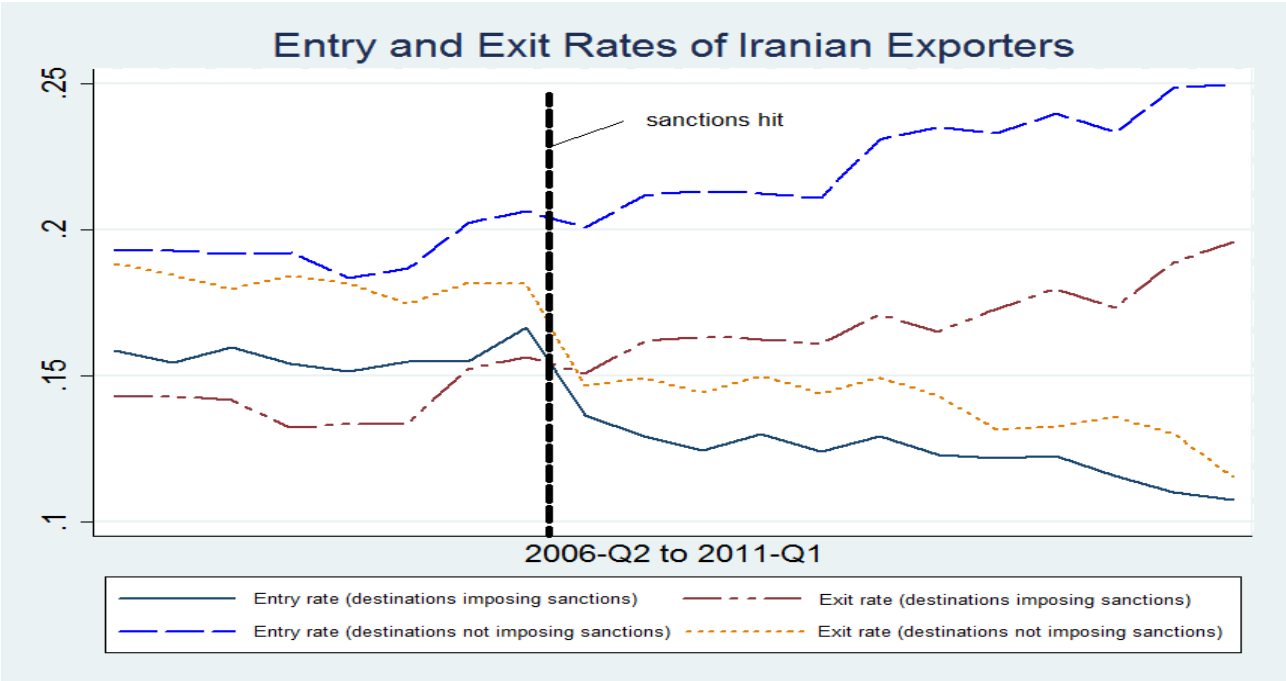
Note: This figure shows the total non-oil Iranian exports between January 2006 and June 2011. Sanctions against Iranian exporters were imposed in March 2008. Source: Author's calculations using Iranian Customs data.

Figure 2: Iranian exports, by type of destination (Jan 2006 - Jun 2011)



Note: This figure shows the total exports to different types of destinations between January 2006 and June 2011. Sanctions against Iranian exporters were imposed in March 2008. The blue line represents monthly exports to sanctioning countries. The red (dotted) line represents monthly exports to non-sanctioning countries. Source: Author's calculations using Iranian Customs data.

Figure 3: Exporter entry and exit, by type of destination (Apr 2006 - Mar 2011)



Note: This figure shows the entry and exit rates of Iranian exporters to different destinations at the quarterly level between April 2006 and March 2011. Sanctions against Iranian exporters were imposed in March 2008. 'Entry' refers to the first time the exporter entered a given destination. 'Exit' refers to the last time the exporter was seen at destination, so there should be no confusion with exporters that exited and then re-entered the same destination.

Source: Author's calculations using Iranian Customs data.

Figure 4a: Iranian exports to (selected) sanctioning countries

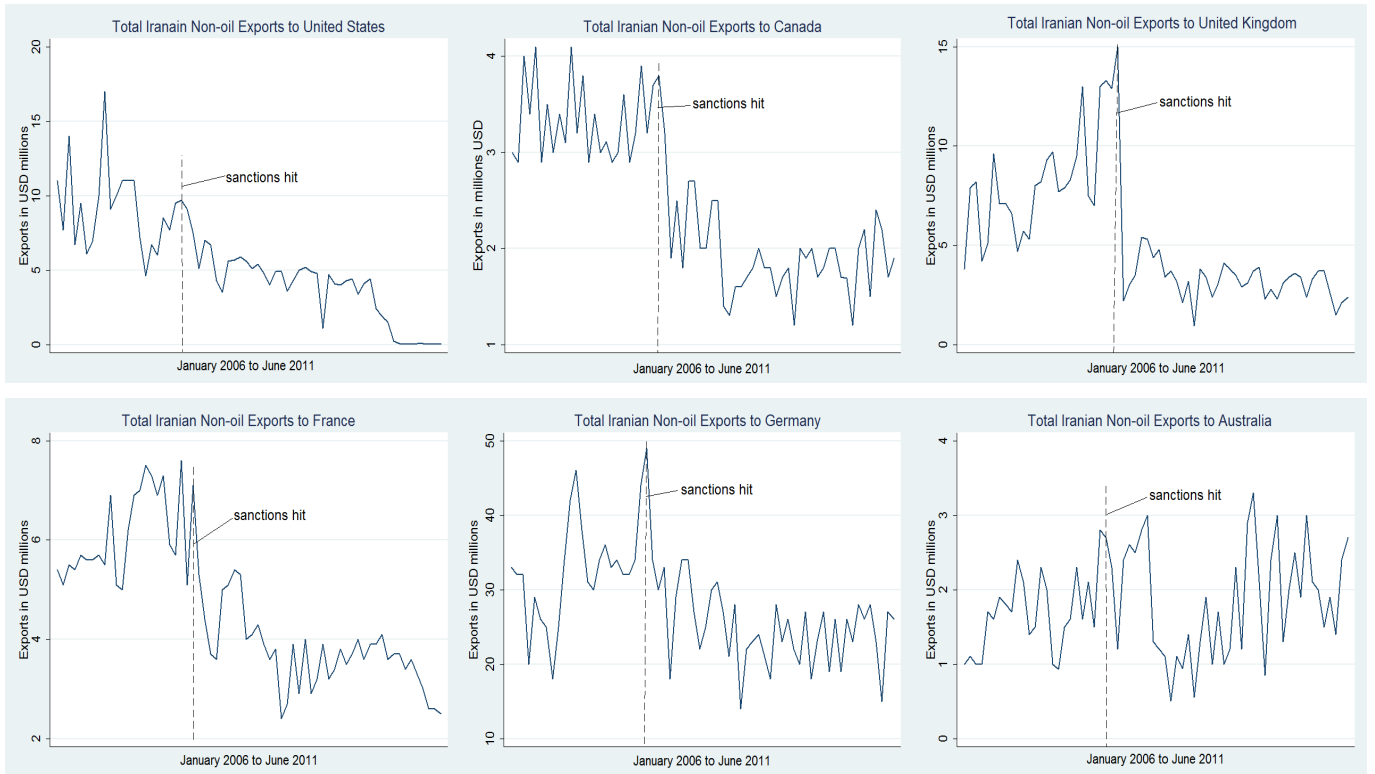


Figure 4b: Iranian exports to (selected) non-sanctioning countries

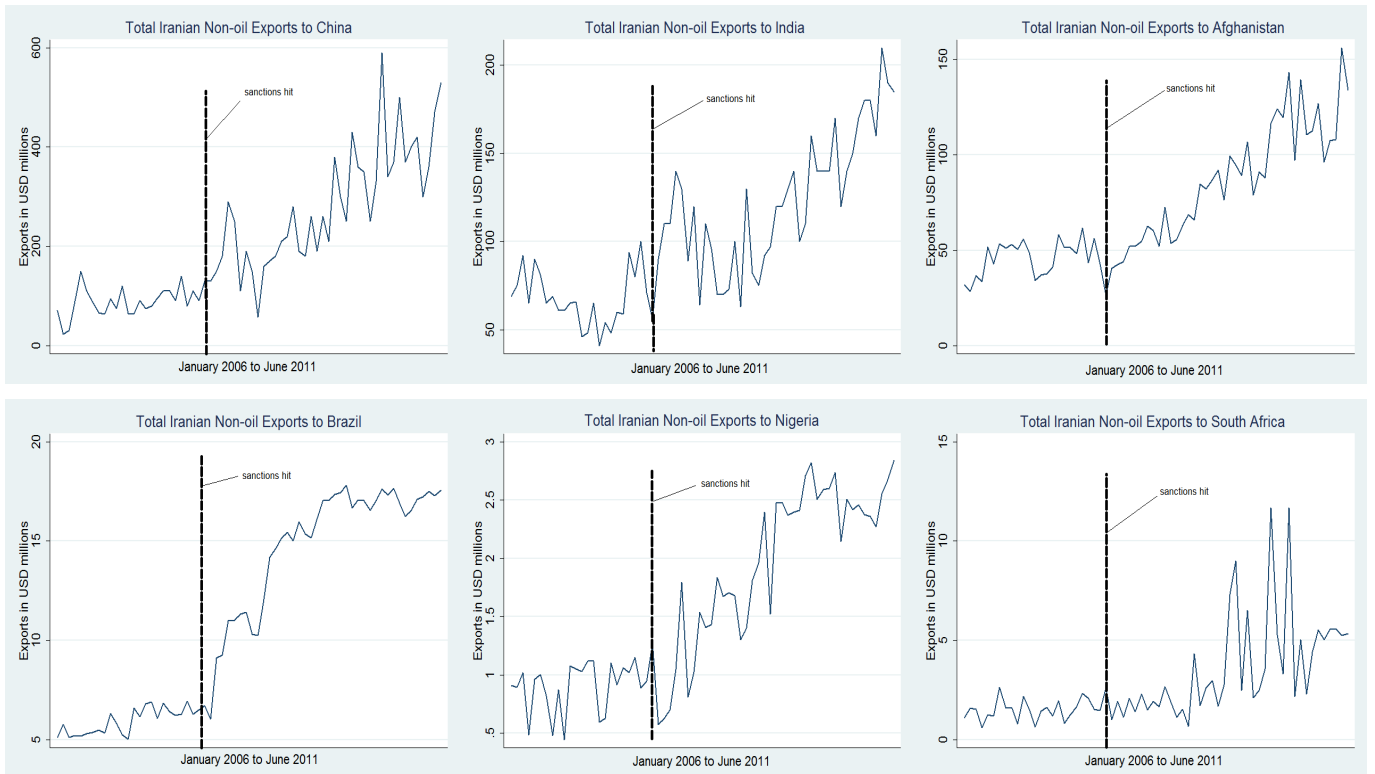
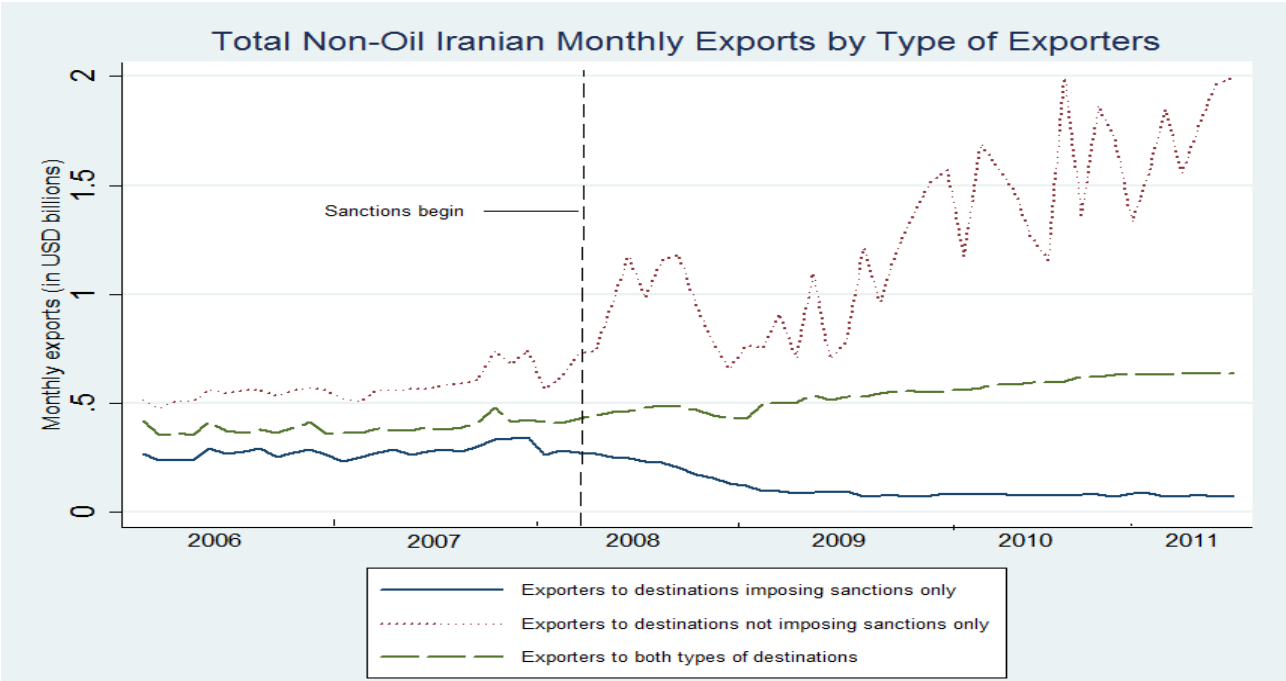


Figure 5: Iranian exports, by type of exporter (Jan 2006 - Jun 2011)



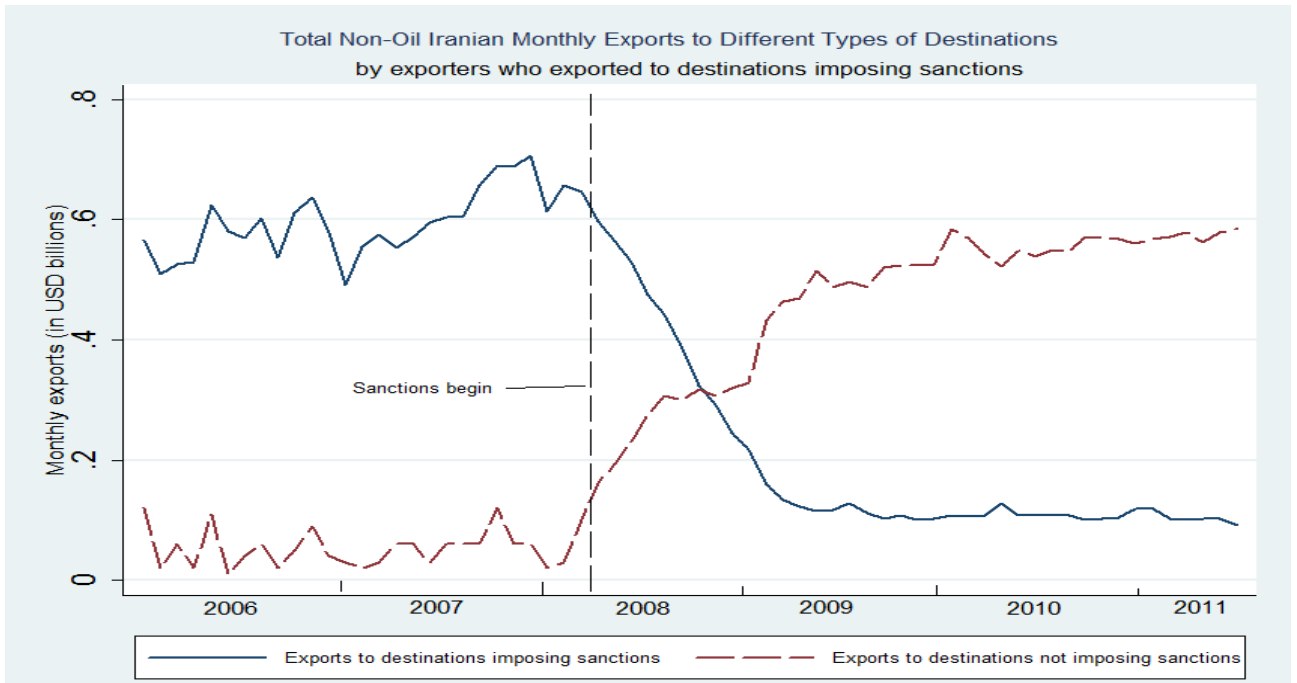
Note: This figure shows the total exports by different types of exporters between January 2006 and June 2011. Sanctions against Iranian exporters were imposed in March 2008. The blue line represents monthly exports by exporters who exported only to sanctioning countries. The red (dotted) line represents monthly exports by exporters who exported only to non-sanctioning countries. The green (dashed) line represents monthly exports by exporters who exported to both sanctioning countries and non-sanctioning countries. Source: Author's calculations using Iranian Customs data.

Figure 6: Iranian exports, by exporter to sanctioning countries (Jan 2006 - Jun 2011)



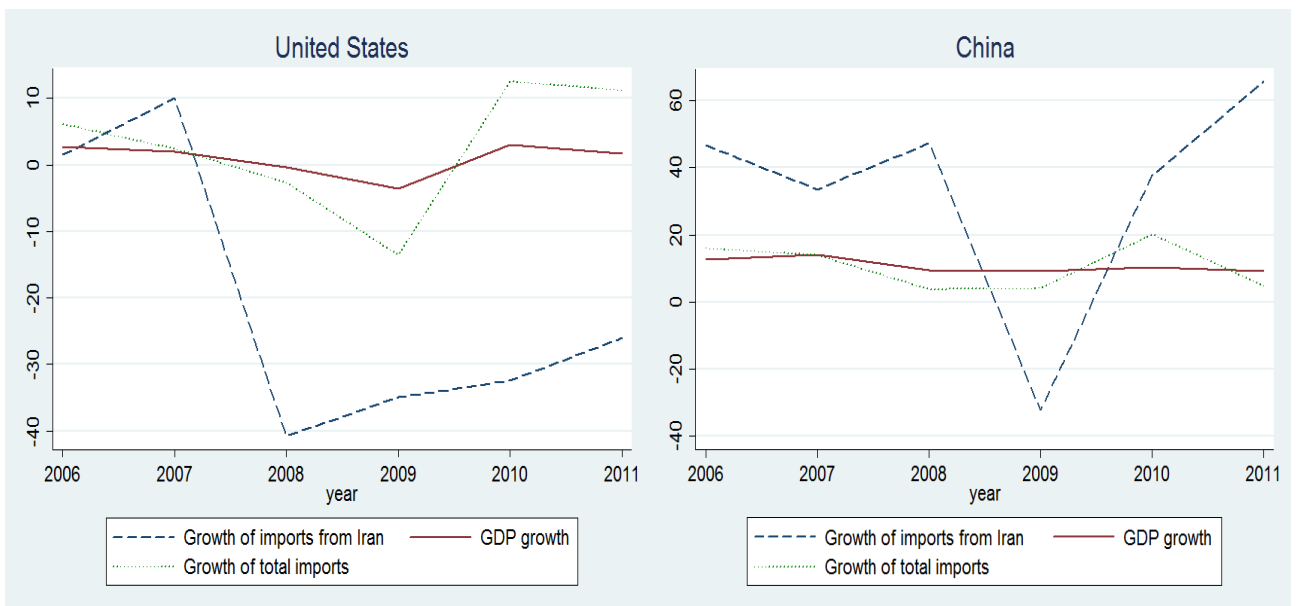
Note: This figure shows the total exports by exporters who exported to destinations imposing export sanctions between January 2006 and June 2011. Sanctions against Iranian exporters were imposed in March 2008. The blue line represents the monthly exports by exporters who exported only to sanctioning countries between January 2006 and June 2011. The green (dashed) line represents the monthly exports by exporters who exported to both sanctioning countries and non-sanctioning countries between January 2006 and June 2011. Source: Author's calculations using Iranian Customs data.

Figure 7: Existence and extent of export destruction and deflection following sanctions (Jan 2006 - Jun 2011)



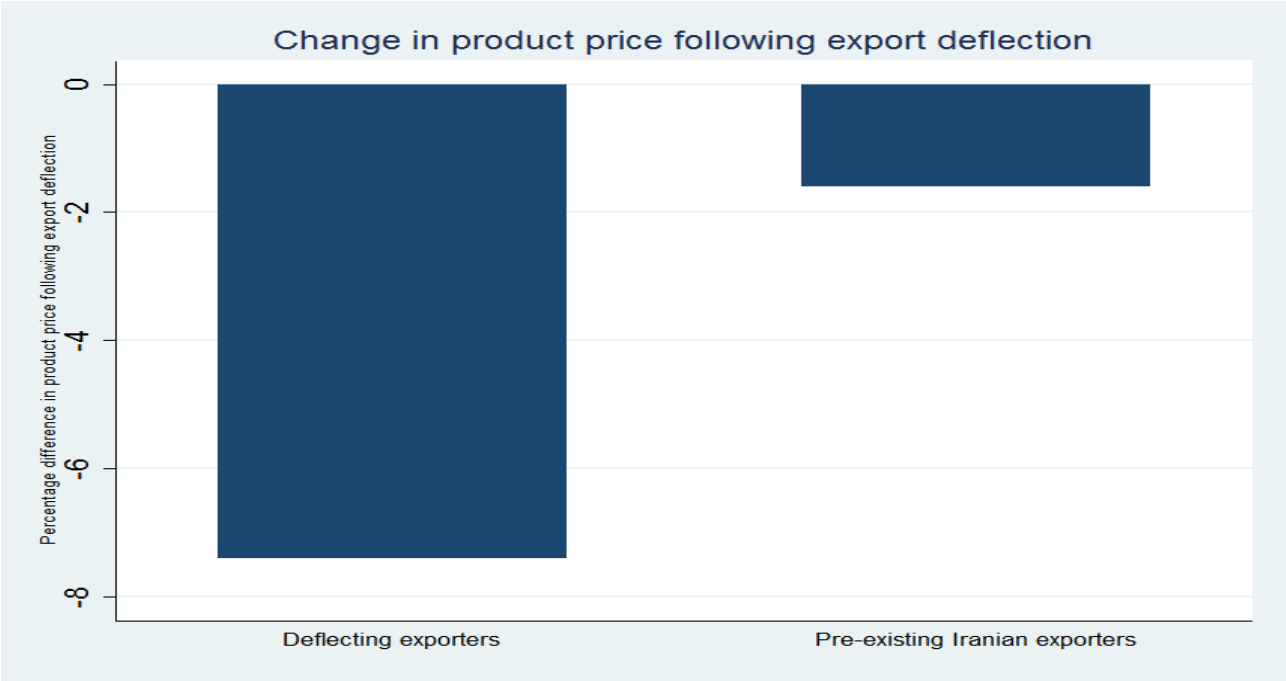
Note: This figure shows the sum of exports to sanctioning countries (SCs) and to non-sanctioning countries (NSCs) by (i) exporters who exported only to SCs and (ii) exporters who exported to both SCs and to NSCs between January 2006 and June 2011. Sanctions against Iranian exporters were imposed in March 2008. The blue line represents the sum of Iranian monthly exports to SCs by the above-mentioned exporters. The red (dashed) line represents the sum of Iranian monthly exports to NSCs by the exporters who exported to both SCs and to NSCs between January 2006 and June 2011. Source: Author's calculations using Iranian Customs data.

Figure 8: Recession or sanctions?



Note: Author's calculations using Iranian Customs data.

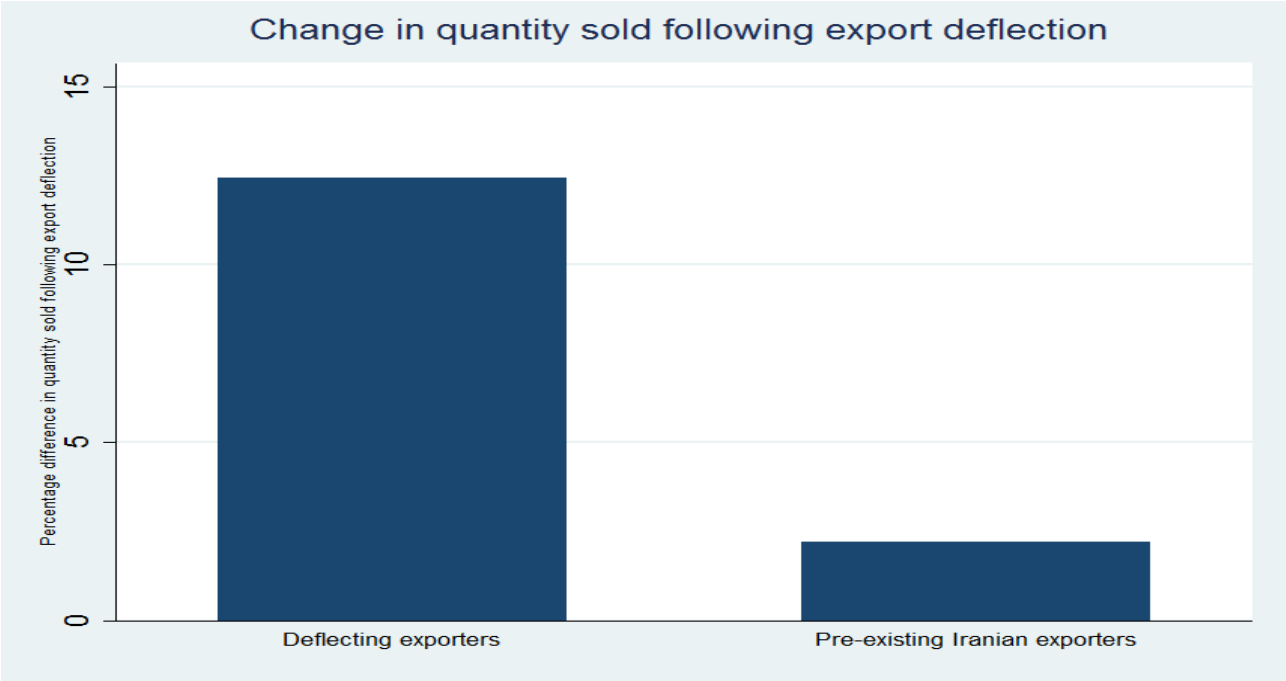
Figure 9: Change in product price following export deflection



Note: This figure shows the percentage difference in product prices after export deflection. Sanctions against Iranian exporters were imposed in March 2008. The left-hand side bar shows the average price drop in the first product shipment of deflecting exporters to non-sanctioning countries following export deflection relative to the price of same product by same exporters in their last shipment to sanctioning countries before export deflection. The right-hand side bar shows the average price drop in the same products sold by other Iranian exporters that were already existing in the new destination at the time of first shipment by deflecting exporters, after export deflection took place.

Source: Author's calculations using Iranian Customs data.

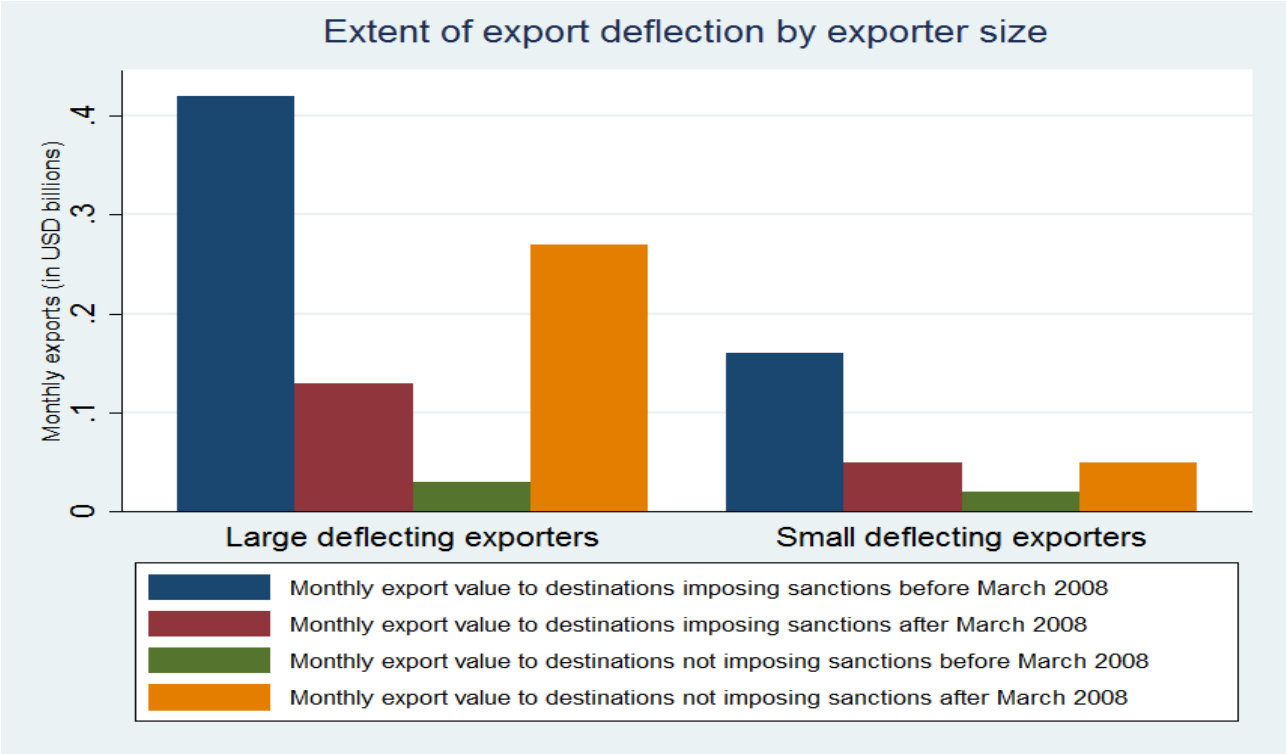
Figure 10: Change in quantity sold following export deflection



Note: This figure shows the percentage difference in product quantity sold after export deflection. Sanctions against Iranian exporters were imposed in March 2008. The left-hand side bar shows the average percentage annual change in product quantity exported by deflecting exporters between the first year of exporting to a NSC after March 2008 and the last year of exporting to a SC before March 2008. The right-hand side bar shows the average percentage annual change in product quantity exported by other Iranian exporters that were already existing in the new destination at the time of first shipment by deflecting exporters.

Source: Author's calculations using Iranian Customs data.

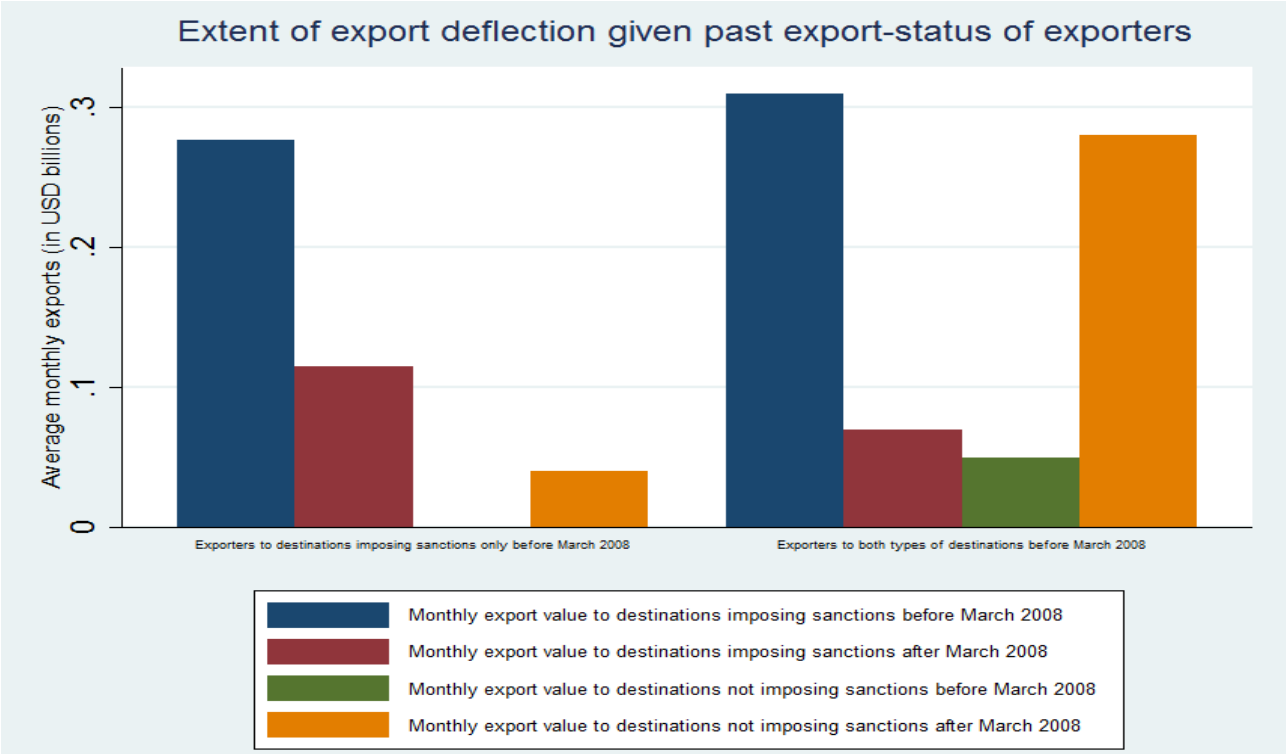
Figure 11: Extent of export deflection, by exporter size



Note: This figure shows the extent of export deflection by exporter size. Sanctions against Iranian exporters were imposed in March 2008. The figure looks at exporters who exported to both sanctioning countries and to non-sanctioning countries between January 2006 and June 2011. It differentiates between large exporters (whose monthly export value was above the export value per average exporter before March 2008 at sanctioning countries) and small exporters (whose monthly export value was below the export value per average exporter before March 2008 at sanctioning countries). Large deflecting exporters achieved higher level of export deflection than small deflecting exporters.

Source: Author's calculations using Iranian Customs data.

Figure 12: Extent of export deflection, by past export status



Note: This figure shows the extent to which Iranian exporters were able to deflect exports following the imposition of export sanctions against them in March 2008. It differentiates between (i) exporters who exported only to sanctioning countries before March 2008 and (ii) exporters who exported to both sanctioning countries and to non-sanctioning countries before March 2008. The average monthly export value by both types of exporters to sanctioning countries decreased from 0.58 (blue bars) before March 2008 to 0.11 (red bars) after March 2008. The average monthly export value by both types of exporters to non-sanctioning countries increased from 0.05 (green bars) before March 2008 to 0.32 (orange bars) after March 2008.

Source: Author's calculations using Iranian Customs data.

Table 1: Export destruction and deflection

		α_1	β_1	α_2	β_2	Statistics
(1)	$t \leq 27$	0.0570 (0.018)	1.0024 (0.217)			$N_{t \leq 27}=110820$ $N_{t > 27}=150305$
	$t > 27$			0.0691 (0.024)	1.0148 (0.340)	$F(2, 262121)=35.67$ Prob > F=0.000
(2)	$t \leq 27$	0.0213 (0.009)	1.0071 (0.311)			$N_{t \leq 27}=67851$ $N_{t > 27}=92867$
	$t > 27$			0.0106 (0.032)	1.0264 (0.285)	$F(2, 160714)=48.37$ Prob > F=0.000
(3)	$t \leq 27$	0.0215 (0.006)	1.0054 (0.253)			$N_{t \leq 27}=19700$ $N_{t > 27}=22958$
	$t > 27$			0.0122 (0.004)	0.9481 (0.165)	$F(2, 42654)=82.7$ Prob > F=0.000
(3-a)	$t \leq 27$	0.0102 (0.003)	0.9916 (0.327)			$N_{t \leq 27}=17527$ $N_{t > 27}=19903$
	$t > 27$			0.0071 (0.002)	0.5431 (0.183)	$F(2, 37426)=73.4$ Prob > F=0.000
(3-b)	$t \leq 27$	0.0326 (0.008)	1.1718 (0.308)			$N_{t \leq 27}=2173$ $N_{t > 27}=3055$
	$t > 27$			0.0247 (0.006)	0.9632 (0.247)	$F(2, 5224)=45.7$ Prob > F=0.000
(4)	$t \leq 27$	0.0289 (0.010)	0.9023 (0.219)			$N_{t \leq 27}=32152$ $N_{t > 27}=46164$
	$t > 27$			0.0594 (0.154)	1.0311 (0.326)	$F(2, 78312)=27.75$ Prob > F=0.000
(4-a)	$t \leq 27$	0.0205 (0.008)	0.8712 (0.307)			$N_{t \leq 27}=28740$ $N_{t > 27}=41858$
	$t > 27$			0.0411 (0.150)	1.0141 (0.283)	$F(2, 70594)=29.24$ Prob > F=0.000
(4-b)	$t \leq 27$	0.0317 (0.137)	1.0121 (0.350)			$N_{t \leq 27}=3412$ $N_{t > 27}=4306$
	$t > 27$			0.0628 (0.204)	1.2408 (0.326)	$F(2, 7714)=31.48$ Prob > F=0.000

Note: In (1) X_{et} refers to total exports at time t . In (2) X_{et} refers to total exports by exporters who exported only to non-sanctioning countries (NSCs). In (3) X_{et} refers to total exports to sanctioning countries (SCs) by (i) exporters who exported only to SCs and (ii) exporters who exported to both SCs and NSCs between January 2006 and June 2011.

Estimations (3a) and (3b) repeat estimation (3) for small and large exporters, respectively. I define small exporters as those whose monthly export value was below the export value per average exporter before March 2008 at SCs. And, I define large exporters as those whose monthly export value was above the export value per average exporter before March 2008 at SCs. In (4) X_{et} refers to total exports to NSCs by exporters who exported to both SCs and to NSCs between January 2006 and June 2011. Estimations (4a) and (4b) repeat estimation (4) for small and large exporters, respectively. Standard errors are in parantheses. All coefficients are statistically significant at the 1% level. Sanctions were imposed in March 2008.

Source: Author's estimations using Iranian Customs data.

Table 2: Sanctions and exporter entry and exit at the destination level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$Entry_{dt}$		$Exit_{dt}$		Add_{dt}		$Drop_{dt}$	
$S_d.PS_t$	-0.241 ^b (0.122)	-0.262 ^b (0.130)	0.077 ^b (0.045)	0.082 ^b (0.040)	-0.149 ^b (0.082)	-0.164 ^b (0.086)	0.241 ^c (0.132)	0.220 ^a (0.081)
S_d dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PS_t dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination Controls		Yes		Yes		Yes		Yes
Observations	8421	8421	8421	8421	8421	8421	8421	8421

Note: $Entry_{dt}$ and $Exit_{dt}$ are logs of entry and exit rates of exporters at the destination-quarter level. Add_{dt} is the log of share of exporters that added a new product to their product-mix at destination d at time t . $Drop_{dt}$ is the log of share of exporters that dropped an existing product from their product-mix at destination d at time t . Standard errors in parantheses. ^a, ^b and ^c denote statistical significance at the 1%, 5% and 10% levels, respectively. S_d is a dummy variable that equals to 1 for sanctioning countries, and zero otherwise. PS_t is a dummy variable for the post-sanctions period, starting in March 2008. Destination controls include logs of GDP, distance, number of immigrants, number of exporters, as well as inflation rate, ease of imports, FDI (net flows), tariff rate, and import growth at the destination level.

Source: Author's estimations using Iranian Customs data.

Table 3: Product prices after export deflection

	α_3	β_3	α_4	β_4	Statistics
$t \leq 27$	0.0124 (0.152)	0.0041 (0.019)			$N_{t \leq 27} = 52726$ $N_{t > 27} = 83401$
$t > 27$			0.0214 (0.011)	-0.0813 ^a (0.023)	$F(2, 136123) = 37.18$ $Prob > F = 0.002$

Note: This table focuses on exporters who cut their product exports to sanctioning countries and existed in non-sanctioning countries after March 2008. The dependent variable, P_{ept} , is the price of product p exported by exporter e at time t . The independent variable, P_{ept-1} , is the price of product p exported by exporter e at time $t - 1$. Standard errors are in parantheses. ^a denotes statistical significance at the 1% level. Sanctions were imposed in March 2008, at $t = 27$.

Source: Author's estimations using Iranian Customs data.

Table 4: Product quantity sold after export deflection

	α_5	β_5	α_6	β_6	Statistics
$t \leq 27$	0.0112 (0.231)	0.0056 (0.263)			$N_{t \leq 27} = 4729$ $N_{t > 27} = 7622$
$t > 27$			0.0228 (0.113)	0.1160 ^a (0.019)	$F(2, 12347) = 41.73$ $Prob > F = 0.000$

Note: This table focuses on exporters who cut their product exports to sanctioning countries and existed in non-sanctioning countries after March 2008. The dependent variable, Q_{ept} , is the quantity of p exported by exporter e at time t . The independent variable, Q_{ept-1} , is the quantity of product p exported by exporter e at time $t - 1$. Standard errors are in parantheses. ^a denotes statistical significance at the 1% level. Sanctions were imposed in March 2008, at $t = 27$.

Source: Author's estimations using Iranian Customs data.

Table 5: Which exporters deflected?

	$Deflect_{e t>27}$		
	(1)	(2)	(3)
$\ln X_{e \leq 27}$	0.171 ^b (0.082)	0.304 ^a (0.103)	
$\ln Experience_{e \leq 27}$	0.125 ^b (0.061)		0.148 ^c (0.084)
Exporter FEs	Yes	Yes	Yes
Month FEs	Yes	Yes	Yes
Observations	237182	237182	237182

Note: The dependent variable, $Deflect_{e|t>27}$, equal to 1 if the exporter exited a sanctioning country and, afterward, entered a non-sanctioning country after March 2008, and zero otherwise. And, $\ln X_{e|\leq 27}$ and $Experience_{e|\leq 27}$ represent the size and experience of the exporter before March 2008. I measure the size and experience of the exporter by, respectively, the log of export value and log of number of months of presence in export market between entry and March 2008. Standard errors in parentheses are clustered at the destination level. ^a, ^b, and ^c denote statistical significance at the 1, 5, and 10 % levels, respectively.

Source: Author's estimations using Iranian Customs data.

Table 6: Did past export status matter?

	Intensive margin	Extensive margin
	$\ln X_{epNSCt}$	$P(EXP)_{epNSC PostS}$
	(1)	(2)
$S_d.PS_t$	0.048 ^b (0.021)	0.037 ^c (0.021)
$S_d.PS_t$ *ExporterA		0.053 ^b (0.024)
$S_d.PS_t$ *ExporterB		0.092 ^a (0.031)
$S_d.PS_t$ *ExporterC	0.501 ^a (0.125)	
ExporterA		0.017 (0.121)
ExporterB		0.092 ^c (0.053)
ExporterC	0.016 ^a (0.042)	
$\ln X_{e PreS}$	0.051 ^a (0.019)	0.045 ^a (0.013)
Exporter FEs	Yes	Yes
R-squared	0.27	0.39
Observations	211341	211341

Note: Standard errors in parentheses are clustered at the destination level. ^a, ^b, and ^c denote statistical significance at the 1, 5, and 10 % levels, respectively. All specifications include a constant term. S_d is a dummy variable that equals to 1 if the destination imposed export sanctions against Iran in and after March 2008, and zero otherwise. PS_t is a dummy variable for the period t=27-66, starting in March 2008. $ExporterA$ is a dummy variable that equals to 1 if the exporter had exported product p to a sanctioning country but had not exported at all to a NSC before March 2008. $ExporterB$ is a dummy variable that equals to 1 if the exporter had exported product p to a SC but exported another product to a NSC before March 2008. $ExporterC$ is a dummy variable that equals to 1 if the exporter had exported a product to a SC as well as to a NSC before March 2008. $\ln X_{e|PreS}$ denote exporter-size. $P(EXP)_{epNSC|PostS}$ is a binary variable that equals to 1 if the exporter had exported product p to destination d after sanctions were imposed, and zero otherwise.

Source: Author's estimations using Iranian Customs data.

Table 7: Which products did deflecting exporters deflect?

	$Deflect_{ep t>27}$	
	(1)	(2)
X_{epPreS}	0.743 ^b (0.320)	0.411 ^b (0.209)
$X_{share_{epPreS}}$	0.482 ^b (0.228)	0.517 ^a (0.139)
$Diff$	-0.514 ^a (0.208)	-0.633 ^a (0.214)
Exporter FEs	Yes	
Destination FEs	Yes	
Observations	237182	237182

Note: $Deflect_{ep|t>27}$ equals to one if the exporter dropped a given product from a sanctioning country and, then, introduced it in a non-sanctioning country after March 2008, and zero otherwise. X_{epPreS} is the log of exporter-level export value of a product to a SC before sanctions. $X_{share_{epPreS}}$ represent is weight of the product in the exporter-level exports to a SC before sanctions. $Diff$ is a dummy variable which equals to 1 if the product is differentiated, and zero otherwise. ^a and ^b denote statistical significance at the 1% and 5% levels, respectively. Standard errors are in parentheses.

Source: Author's estimations using Iranian Customs data.

Table 8: Characteristics of destinations that Iranian exporters targeted after sanctions

	N_{dt}		$XGrowth_{dt}$	
	(1)	(2)	(3)	(4)
UN vote correlation		0.814 ^a (0.075)		0.952 ^a (0.041)
Diplomatic visit		0.434 ^a (0.153)		0.108 ^a (0.031)
GDP	0.079 ^c (0.041)	0.060 ^c (0.033)	0.062 ^c (0.035)	0.053 ^c (0.031)
Distance	-0.056 ^c (0.032)		-0.048 ^b (0.022)	
Inflation		0.034 ^c (0.020)		0.029 ^c (0.018)
Ease of importing		0.007 (0.038)		0.011 (0.013)
FDI (net inflows)		0.145 ^b (0.059)		0.129 ^b (0.064)
Tariff rate		-1.140 ^b (0.455)		-1.111 ^b (0.472)
Import growth		0.066 ^c (0.036)		0.042 ^c (0.023)
Number of Iranian Immigrants		0.318 ^c (0.177)		0.418 ^b (0.182)
Number of Iranian exporters		0.547 ^a (0.218)		0.464 ^a (0.147)
Month FEs	Yes	Yes	Yes	Yes
Destination FEs		Yes		Yes
Observations	984	984	984	984

Note: The dependent variables in columns 1-2 are the logs of total number of defecting exporters to a given destination at a given month. The dependent variables in columns 3-4 are the logs of monthly growth rate of exports by exporters who exported only to non-sanctioning countries. The UN vote correlation denotes the log of correlation between positions of countries during UN General Assembly votes. Diplomatic visit is a dummy variable equal to 1 if the destination received an Iranian diplomatic visit by a high official (mainly President or Minister) and discussed bilateral-trade after sanctions. The remaining independent variables are in log terms and are related to the non-sanctioning countries. Standard errors are in parentheses. ^a, ^b, and ^c denote statistical significance at the 1, 5, and 10% levels, respectively.

Source: Author's estimations using Iranian Customs data.

Appendix

Table A.I: Descriptive statistics of Iranian exporters

Quarter	Number of exporters	Export value per exporter (USD millions)	Number of products per exporter	Number of destinations per exporter
2006-Q1	7599	0.44	3.77	1.93
2006-Q2	7487	0.46	3.94	1.99
2006-Q3	9234	0.46	4.10	1.98
2006-Q4	7575	0.47	4.13	1.95
2007-Q1	6848	0.45	3.84	1.99
2007-Q2	6753	0.51	4.22	2.04
2007-Q3	6943	0.56	4.35	2.08
2007-Q4	7280	0.65	4.33	2.08
2008-Q1	6513	0.60	4.20	2.10
2008-Q2	6403	0.81	4.38	2.14
2008-Q3	6463	0.84	4.27	2.13
2008-Q4	6154	0.69	4.42	2.11
2009-Q1	5929	0.72	4.21	2.06
2009-Q2	5870	0.77	4.21	2.08
2009-Q3	5809	0.83	4.40	2.07
2009-Q4	6440	0.93	4.35	2.05
2010-Q1	6008	1.07	4.32	2.10
2010-Q2	5877	1.06	4.27	2.08
2010-Q3	5968	1.09	4.11	2.11
2010-Q4	6216	1.16	4.44	2.07
2011-Q1	5614	1.24	4.00	2.09
2011-Q2	5273	1.48	4.06	2.10
Pre-Sanctions	7359	0.48	4.08	2.028
Post Sanctions	6001	0.93	4.26	2.087

Note: Author's calculations based on Iranian exporter daily-level data after aggregating it at the quarter-level. A product is defined as a HS 6-digit category. Sanctions hit in March 2008. Pre-sanctions period covers 2006-Q1 to 2008Q-1. Post-sanctions period covers 2008-Q2 to 2011-Q2.

Table A.II.: Additional descriptive statistics of Iranian exporters

	2006	2007	2008	2009	2010
Number of Exporters	15050	13538	12721	11373	10929
Number of Entrants		6341	6051	5186	4581
Number of Exiters		7853	6868	6534	5025
Export Value per Exporter	744583	896995	1178605	1412918	1918004
Export Value per Entrant		329768	391489	434135	514745
Export Value per Exiter		207088	215958	395504	223334
Export Value per Survivor		532114	674982	822935	1138257
Share of top 1% Exporters in Total Exports	0.504	0.518	0.576	0.508	0.529
Share of top 5% Exporters in Total Exports	0.707	0.717	0.747	0.719	0.725
Share of top 25% Exporters in Total Exports	0.927	0.932	0.938	0.937	0.939

Table A.III: Iranian exporters and products, before and after sanctions

Quarter	Number of exporters to		Number of products to	
	SCs	NSCs	SCs	NSCs
2006-Q1	1641	4937	637	2141
2006-Q2	1567	5256	655	2156
2006-Q3	1624	5332	713	2216
2006-Q4	1846	5393	776	2133
2007-Q1	1687	5385	736	2109
2007-Q2	1484	5452	646	2189
2007-Q3	1564	5578	657	2171
2007-Q4	1658	5524	746	2116
2008-Q1	1452	5781	642	2132
2008-Q2	1379	5812	643	2222
2008-Q3	1405	6010	641	2185
2008-Q4	1289	5558	681	2160
2009-Q1	1102	6116	579	2181
2009-Q2	1080	6666	574	2199
2009-Q3	1127	6419	630	2159
2009-Q4	1191	6628	629	2232
2010-Q1	1063	6725	603	2306
2010-Q2	1059	6487	631	2251
2010-Q3	1051	5824	602	2317
2010-Q4	1029	5822	587	2421
2011-Q1	904	5959	577	2447
2011-Q2	870	5942	552	2298
Pre-Sanctions	1613.67	5417.43	689.78	2151.44
Post Sanctions	1119.15	6084.86	609.92	2259.84
% change	-30.65	12.73	-11.58	5.04

Note: Author's calculations based on Iranian exporter daily-level data after aggregating it at the quarter level. A product is defined as a HS-6 digit category. The exporters who exported to sanctioning countries (SCs) as well as to non-sanctioning countries (NSCs) are included in both groups in this table. Sanctions hit in March 2008. Pre-sanctions period covers 2006-Q1 to 2008-Q1. Post-sanctions period covers 2008-Q2 to 2011-Q2.

Table A.IV: Export transshipment

Product	% Δ in Iranian exports to				% Δ in Iranian exports to United Arab Emirates	% Δ in UAE re-exports to			
	US	Canada	UK	France		US	Canada	UK	France
Plants Seeds	-51	-97	-81	-29	+154	+20	+90	+70	+18
Sugars	-49	-137	-15	-98	+69	+29	+83	+14	+53
Plastics	-73	-95	-92	-70	+146	+29	+62	+51	+21
Carpets	-99	-12	-34	-23	+151	+40	+15	+28	+19
Ceramics	-51	-74	-73	-22	+20	+29	+72	+29	+21
Copper	-91	-58	-81	-37	+184	+84	+21	+70	+90
Furniture	-87	-95	-89	-98	+60	+34	+29	+37	+44

Note: Author's calculations based on Iranian Customs transactions and UN-Comtrade data. All figures represent % changes between pre- and post- sanctions periods. A product is defined at the HS-6-digit level.