The Impact of Economic Sanctions on Iran's Export Composition: Evidence from a Gravity Model, 1995–2019

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Abstract

This study investigates the impact of economic sanctions on Iran's export composition, using a traditional gravity model with a particular focus on sectoral heterogeneous effects of the sanctions between 1995 and 2019. Utilizing disaggregated country-product level trade data from the BACI dataset, along with a continuous sanctions intensity index developed by Laudati and Pesaran (2023), the analysis assesses contemporaneous and lagged effects of sanctions using fixed and random effects panel regression models. The findings show that while the immediate impact of sanctions is limited, lagged effects—especially in the second and third years—are both significant and substantial, suggesting a delayed but powerful disruption to Iran's export. Notably, the manufacturing sector exhibits more rapid recovery relative to total exports and non-oil exports, indicating greater resilience. The results also point to a broader diversification trend in Iran's export composition, potentially driven by sanctions-induced structural adjustment. Through their heterogeneous effects on different sectors of Iran's economy over time, sanctions have contributed to a shift away from oil dependence and toward a more diversified export structure. This research contributes to the growing literature on sanctions by demonstrating how economies under prolonged sanctions can develop adaptive capacities. Moving beyond previous studies that focus primarily on trade volumes, it shows that sanctions can fundamentally reshape the structure of trade itself.

Acknowledgement

I would like to express my deepest gratitude to my advisors, Professor Saleh Tabrizy and Professor Attila Ratfai, for their invaluable guidance and support throughout this project. What I learned in my meetings with Professor Tabrizy went far beyond the scope of this thesis and had a lasting impact on my academic development. I am also grateful to Professor Marc Kauffman and Dr. Sajedeh Goudarzi for their thoughtful feedback and encouragement.

I sincerely thank my parents and my brother, Bahram, for their unwavering support and belief in me. I am also truly thankful to my friends—Sema, Balim, and Parisa—for their constant support and companionship throughout this journey.

In memory of Shahla—an inspiring teacher and cherished neighbor—whose life, like those of many other beloved Iranian souls, was tragically lost to cancer after being deprived of critical medicines due to sanctions. As Weisbrot and Sachs (2019) remind us, sanctions function as a tool of collective punishment with devastating humanitarian consequences and should be regarded as a violation of international law, particularly due to their indiscriminate harm to civilians.

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List of Abbreviations

BACI	Base Analytique du Commerce International
CEPII	Centre d’Études Prospectives et d’Informations Internationales
FE	Fixed Effects Estimator
GSDB	Global Sanctions Data Base
GDP	Gross Domestic Product
HI	Herfindahl Index
JCPOA	Joint Comprehensive Plan of Action
OLS	Ordinary Least Squares
P5+1	China, France, Russia, United Kingdom, United States, and Germany
PPML	Pseudo Poisson Maximum Likelihood
RE	Random Effects Estimator
RTA	Regional Trade Agreement
SWIFT	Society for Worldwide Interbank Financial Telecommunication
TIES	Threat and Imposition of Economic Sanctions Database
VIF	Variance Inflation Factor
WDI	World Bank’s World Development Indicators

1 Introduction

The use of sanctions as an instrument of coercive statecraft has surged in recent years. Between 2021 and 2023, the world experienced the most significant year-on-year increase in active sanctions. In 2021 alone, active sanctions rose by 31.2% compared to 2020. This upward trend persisted, with further increases of 25% in 2022 and 23% in 2023 (Yalcin et al., 2024). The growing use of sanctions as a foreign policy tool has raised important policy questions about their effects on target countries and their broader implications for international trade. These inquiries have sparked renewed academic interest in understanding the impact of sanctions on various aspects of the international economy.

While numerous studies have explored the macroeconomic impacts of sanctions—particularly on aggregate trade flows—relatively few have examined their effects on the composition of trade. This thesis contributes to the literature by analyzing how long-term sanctions have reshaped Iran's export structure, employing a gravity model utilizing fixed and random effects estimators. A key innovation of this study lies in its use of highly disaggregated panel data at the country-product level from BACI database, which helps address issues of trade misreporting and missing trade values that have limited previous research. Moreover, unlike earlier studies that rely on simple sanction counts, this thesis employs a continuous measure of sanctions intensity adopted from Laudati and Pesaran (2023), offering a more nuanced understanding of the impact of sanctions. This study focuses on the period between 1995 to 2019, capturing major episodes of international sanctions against Iran, during which consistent and comparable data are available for bilateral trade, sanctions intensity, and trade cost control variables. The timeframe also deliberately excludes the post-2019 period to avoid distortions caused by the COVID-19 pandemic.

Several characteristics make Iran a compelling case study for renewed attention in studying the effects of economic sanctions on target countries. First, over the past four decades, Iran has been subjected to a very wide range of economic and financial sanctions, varying in scope and intensity—from asset freezes and oil embargoes to investment restrictions and disconnection from international banking and payment systems—beginning in November 1979. Since the adoption of UN Security Council Resolution 1803 in 2008, Iran has endured an increasingly severe sanctions regime, culminating in what is widely regarded as one of the most stringent economic coercive measures in contemporary history—the 'Maximum Pressure' campaign (Laudati and Pesaran, 2023). As Djavad Salehi-Isfahani notes, Iran has effectively been under the harshest sanctions in modern history for several decades. Second, as Felbermayr et al. (2025) point out, nearly every country in the world has, at some point, imposed sanctions on Iran, making it a uniquely comprehensive case study. Third, as Haidar (2017) highlights, Iran's export data is available at a high level of disaggregation, providing a valuable empirical foundation for analyzing the impact of sanctions.

The analysis focuses on the differential impact of sanctions on key export categories—total exports, non-oil exports, and manufactured goods—over a 25-year period. The findings reveal that sanctions do not have a uniform or immediate effect. While short-term impacts are limited, lagged effects—especially in the second and third years following sanction escalation—are substantial and statistically significant. These delayed disruptions suggest a more complex and prolonged adjustment process. Importantly, the manufacturing sector exhibits relatively faster recovery, hinting at potential structural shifts and sectoral resilience in Iran's export portfolio. The evidence also indicates the heterogenous effects of the sanctions on different sub-sections of Iran's economy, contributing to a broader trend of export diversification—away from crude oil dependence.

These results have important implications for both theory and policy. This analysis moves beyond the prevailing focus in existing literature on the trade-suppressing effects of sanctions, demonstrating that sustained sanctions can also catalyze structural transformation in the targeted economy. They also suggest that certain sectors—such as manufacturing—may develop adaptive capabilities more effectively than others like crude oil, raising questions about the unintended long-run consequences of sanctions as a policy tool.

The contribution of this thesis is fourfold. First, it moves beyond aggregate trade flows to analyze the compositional effects of sanctions using detailed, disaggregated data. Second, it employs a novel, continuous measure of sanctions intensity, offering more granular insights than traditional binary indicators. Third, by incorporating both immediate and lagged responses to sanctions, the study uncovers a temporal dimension of trade adjustment that has been largely overlooked. Fourth, it addresses a significant gap in the literature by examining whether sanctions have contributed to the diversification of Iran's exports—an aspect that, despite its policy relevance, has received little attention in existing research. Together, these elements provide a more comprehensive understanding of how sustained external constraints reshape the economic behavior of targeted states.

The structure of this research is as follows. Section 2 provides a brief timeline of the most significant sanctions imposed on Iran, along with descriptive evidence on the potential link between sanctions and changes in the composition of Iran's exports. Section 3 reviews the most relevant literature. Section 4 outlines the data sources, control variables, and gravity model framework employed in the analysis, and details the estimation strategy. To investigate whether the structural transformation in Iran's export composition can be primarily attributed to the heterogeneous effects of economic sanctions, a regression analysis is conducted to examine the impact of sanctions across different export subsectors. Section 5 presents and discusses the results. Finally, Sections 6 and 7 provide concluding remarks and suggestions for future research.

2 Background and Descriptive Evidence

This section provides a brief background and presents the key observations that motivate the current research. First, a brief timeline of the most important sanctions against Iran's economy is provided in the upcoming second sub-section of this chapter. Afterwards, descriptive evidence on the impacts of economic sanctions on Iran's export is provided. The visualizations included are intended to set the stage for the subsequent regression analysis by illustrating the underlying patterns of structural transformation in Iran's exports. These visuals help clarify the main research questions analyzed throughout this work. First, snapshots of Iran's export composition at the beginning, middle, and end of the study period are presented, followed by the control countries. This is followed by time-series trends showing the evolution of total exports, along with separate data on crude oil and non-oil exports. Finally, the section presents the correlation between sanctions intensity and the diversification of Iran's exports, highlighting a potential link between sanction pressure and structural change in Iran's export.

2.1 Timeline of the Key Sanctions on Iran

In this section, a narrative overview of the most significant events related to sanctions on Iran is provided. Figure 1 summarizes the key episodes that likely had the strongest impact on Iran's export performance. As illustrated, a sustained upward trend in Iran's exports was disrupted in 2008, marking the onset of one of the most severe phases of economic warfare against the country. Notably, Iran's export trajectory appears to respond swiftly and distinctly to major developments in the sanctions regime, with each new episode shifting the export trend onto a different path. For instance, after four consecutive years of export decline, a notable recovery is observed in 2015, coinciding with the sanctions relief brought about by JCPOA. This rebound continues until 2018, when the reimposition of sanctions by the United States—supported by its allies in the European Union—leads to a sharp decline in exports once again.

A more detailed assessment of how these sanctions have contributed to the observed shifts in export performance will be undertaken in the subsequent regression analysis.

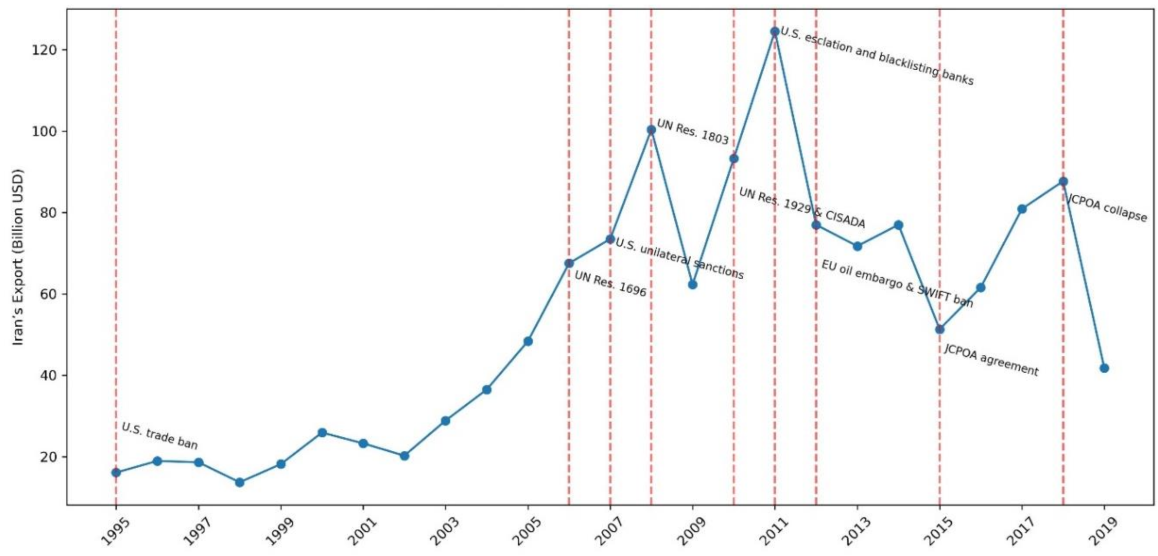

Figure 1 Timeline of Key Sanctions Episodes and Changes in Iran's Export Trajectory

Source: Produced by the Author Based on BACI Data

2.1.1 1979–1995: Foundational U.S. Sanctions

Following the 1979 Iranian Revolution, with the justification of the U.S. Embassy hostage crisis, the United States began to impose sanctions on Iran. Diplomatic relations were severed, Iranian assets in the U.S. were frozen, and a comprehensive embargo on Iranian oil and trade was implemented (Kahalzadeh, 2023). Over the next decade, sanctions evolved in response to geopolitical tensions. In 1984, the U.S. accused Iran of support for terrorism to intensify these measures. A pivotal moment came in 1995, when the Clinton administration enacted an executive order banning all bilateral trade between the U.S. and Iran (Felbermayr et al., 2025).

2.1.2 2006–2008: Sanctions Targeting the Nuclear Program

In July 2006, the UN Security Council adopted Resolution 1696, urging Iran to halt its uranium enrichment activities. Failure of the negotiations to stop Iran's uranium enrichment program led to the Security Council's December 2006 vote to restrict Iran's access to nuclear-related materials and technologies and to freeze the assets of key Iranian individuals (Haidar, 2017). The United States followed this with its toughest sanctions since the 1979 embargo, targeting Iran unilaterally in October 2007. European Union also imposed unilateral sanctions on Iran (Felbermayr et al., 2025).

In March 2008, through Resolution 1803, the Security Council intensified restrictions on Iran's non-oil exports. Countries like the U.S., EU member states, Canada, and Australia followed with their own versions of export bans. These included requirements for U.S. firms to gain federal authorization before importing from Iran and prohibitions on public financial support for Iranian imports in the EU (Haidar, 2017). Canada also restricted services related to Iranian maritime shipping, and Australia blocked the transit of Iranian goods. The common objective of these coordinated sanctions was to increase pressure on Iranian exporters (Haidar, 2017).

2.1.3 2010–2012: Comprehensive Economic Sanctions and Isolation

By June 2010, after negotiations between Iran and the P5+1 (China, France, Russia, United Kingdom, United States, and Germany) failed, the Security Council passed Resolution 1929, escalating sanctions by expanding the arms embargo and introducing broader financial restrictions (Haidar, 2017). Concurrently, the U.S. Congress passed the Comprehensive Iran Sanctions, Accountability, and Divestment Act (CISADA), penalizing companies providing Iran with refined petroleum and enhancing pressure on its financial institutions (Kahalzadeh, 2023).

In 2011, US President significantly escalated economic pressure by implementing new sanctions that severely disrupted Iran's oil exports and blocked access to global financial markets (Salehi-Isfahani, 2023). This marked a sharp turn in the impact of sanctions: Iran's foreign currency reserves were frozen, new forex inflows dwindled, and firms—both public and private—were increasingly excluded from international markets (Salehi-Isfahani, 2023). That same year, the U.S. blacklisted two major Iranian banks for engaging with previously sanctioned entities (Haidar, 2017).

The European Union joined these efforts by imposing an oil embargo in January 2012 and freezing the assets of the Iranian Central Bank (Felbermayr et al., 2025). EU-based insurance firms were barred from underwriting Iranian shipments, compounding the sanctions' reach. By March 2012, the global financial isolation of Iran was further solidified when all Iranian banks were disconnected from the Society for Worldwide Interbank Financial Telecommunication (SWIFT), the secure international platform for banking transactions (Haidar, 2017; Kahalzadeh, 2023). The US went further to stop financial and insurance services to be delivered to Iran (Felbermayr et al., 2025).

2.1.4 2013–2015: A Period of Negotiations

In response to the increasing economic pressure, Iran engaged in negotiations with the P5+1 countries, leading to the Joint Comprehensive Plan of Action (JCPOA), finalized in July 2015. The JCPOA aimed to restrict Iran's nuclear program in return for sanctions relief. While the sanctions remained largely intact during this period, the anticipation of a resolution created positive expectations. However, many international businesses hesitated to resume operations until the deal was officially implemented (Kahalzadeh, 2023).

On January 16, 2016, the JCPOA officially came into effect. This led to the lifting of many nuclear-related sanctions and marked Iran's partial reintegration into the global economy. Trade volumes surged, and a wave of investment interest followed, particularly in energy, finance, and transportation sectors (Ghodsi & Karamelikli, 2022). However, this resurgence was fragile, as lingering U.S. sanctions remained in place, limiting the scale of financial transactions with Western institutions (Salehi-Isfahani, 2023).

2.1.5 2018: U.S. Withdrawal and "Maximum Pressure"

This brief respite ended on May 8, 2018, when President Donald Trump announced the U.S. withdrawal from the JCPOA. This marked the beginning of the third major episode of sanctions against Iran (Kahalzadeh, 2023). The U.S. reimposed all previously suspended sanctions and added a new wave of measures and more stringently punishing the entities outside the US jurisdiction who traded with Iranian companies. These actions also targeted the investment projects pledges founded based on JCPOA agreement (Ghodsi & Karamelikli, 2022).

One defining feature of the sanctions from 2010 onwards was the expansion of secondary sanctions—penalties on foreign firms and governments doing business with Iran. This tactic effectively discouraged global actors from engaging with Iran, even if they were not U.S.-based (Kahalzadeh, 2023). The economic consequences were swift: foreign direct investment plummeted, trade deals were canceled, and previously optimistic growth forecasts gave way to stagnation (Salehi-Isfahani, 2023).

This complex and overlapping sanctions landscape—marked by financial isolation, trade restrictions, and evolving enforcement mechanisms—highlights the need for a more nuanced approach to assessing their economic impact. The next subsection provides descriptive evidence on the evolution of Iran's export under the shadow of sanctions.

2.2 Evolution of Iran's Export

Figures 2 to 4 illustrate the initial motivation behind this research by visualizing the composition of Iran's exports at three key points in time between 1995 and 2019. The first snapshot, from 1995, marks the beginning of the study period; the second, from 2009, corresponds to the onset of the most stringent sanctions; and the third, from 2019, represents the end of the period under analysis. A notable observation is that during the first 14 years, there was little change in the share of crude oil in Iran's total exports, which declined only slightly from 84% to 81%. However, in the subsequent decade, this share dropped significantly—from 81% to 37%—indicating a substantial shift in the composition of Iran's exports and a growing role for non-oil sectors in the country's external trade. In 2019, following crude oil, the largest shares of Iran's exports were accounted for by alcohols, ethylene polymers, and iron or non-alloy steel.

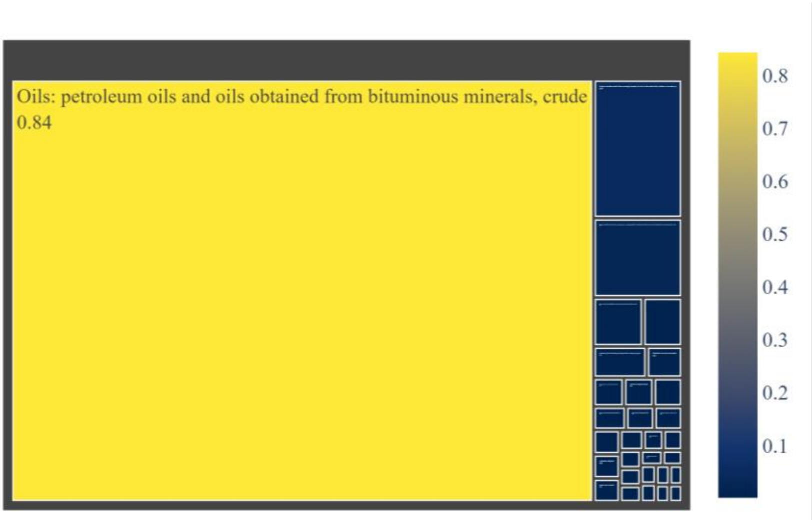

Figure 2 Composition of Iran's Exports in 1995 (Crude Oil Share: 84%)

Source: Produced by the Author Based on BACI Data

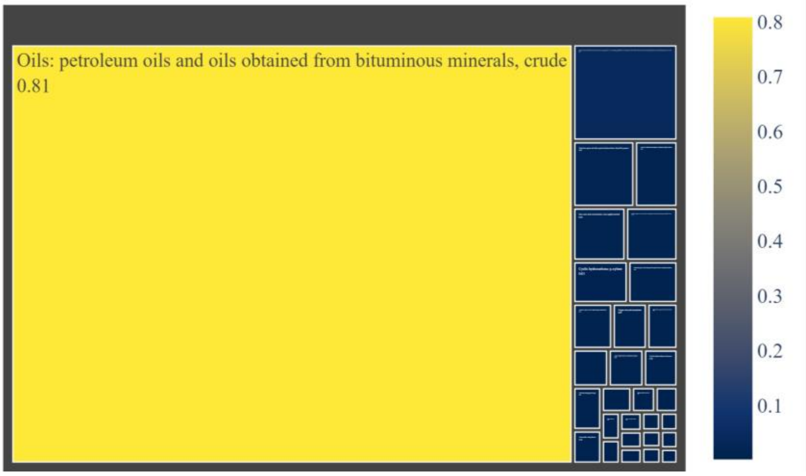

Figure 3 Composition of Iran's Exports in 2009 (Crude Oil Share: 81%)

Source: Produced by the Author Based on BACI Data

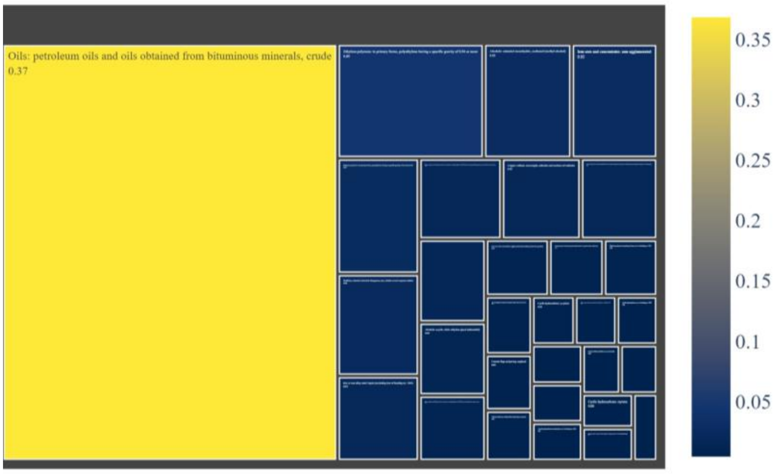

Figure 4 Composition of Iran's Exports in 2019 (Crude Oil Share: 37%)

Source: Produced by the Author Based on BACI Data

This raises the question of whether the observed trend in Iran can be attributed to exogenous shocks other than sanctions. If global or regional shocks beyond sanctions were responsible for the structural changes in Iran's economy, we would expect to see similar patterns in other oil-rich Middle Eastern countries that did not suffer sanctions in this period. As an initial step to test this hypothesis, treemaps illustrating the composition of trade in two comparable countries—Saudi Arabia and Kuwait—have been produced. Figures 5 and 6 present these visuals, and no comparable trends are evident. The share of oil in Saudi Arabia's exports declined only slightly, from 69% in 1995 to 66% in 2019. In Kuwait, the share actually increased from 65% to 68% over the same period.

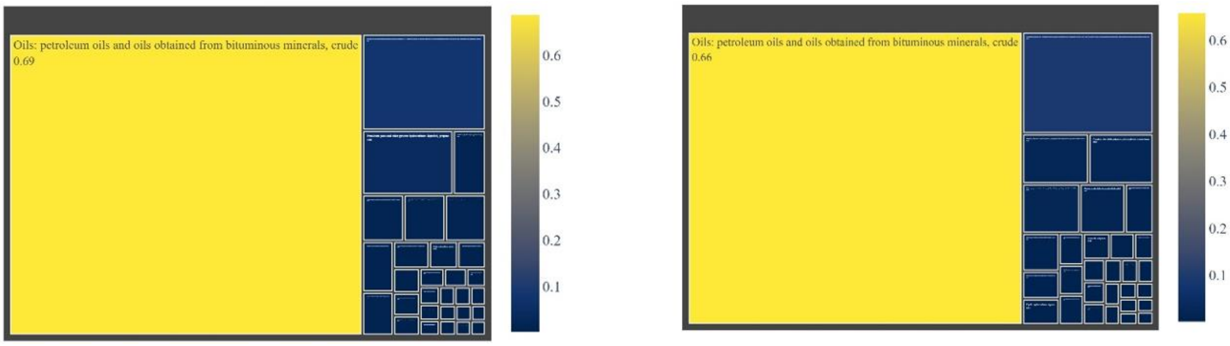

Figure 5 Composition of Saudi Arabia's Exports in 1995 (Left) and 2019 (Right): Persistent Dominance of Oil

Source: Produced by the Author Based on BACI Data

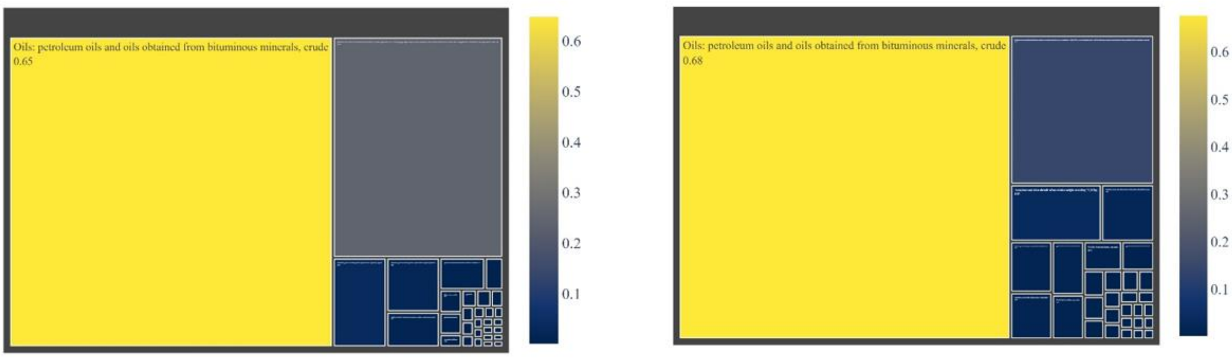

Figure 6 Composition of Kuwait's Exports in 1995 (Left) and 2019 (Right): Continued Reliance on Oil Exports

Source: Produced by the Author Based on BACI Data

Before moving forward an important question remains to be answered: Is the observed shift in the composition of Iran's trade merely a consequence of declining oil revenues, or does it also reflect a genuine expansion of the country's non-oil export sectors? Figures 7 and 8 illustrate the evolution of Iran's oil and non-oil exports respectively, challenging the notion that the increasing share of non-oil exports is solely due to reduced oil income. A more nuanced analysis is needed to explain the underlying dynamics. It is plausible that a decade of "maximum pressure" sanctions functioned similarly to protective tariff barriers, inadvertently fostering domestic production and enabling the emergence of previously underperforming sectors such as manufacturing—a hypothesis supported by Salehi-Isfahani (2021).

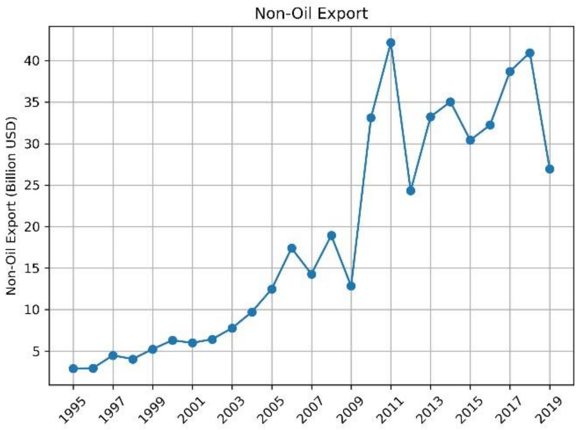

Figure 7 Trend in Iran's Non-Oil Exports (1995–2019)

Produced by the Author Based on BACI Data

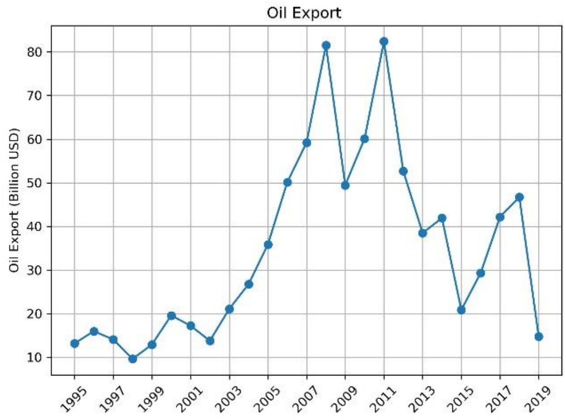

Figure 8 Trend in Iran's Crude Oil Exports (1995–2019)

Source: Produced by the Author Based on BACI Data

Another notable trend in the evolution of Iran's exports is illustrated in Figure 9. Prior to the tightening of sanctions in 2008, following the adoption of UN Security Council Resolution 1803, Iran experienced robust export growth. Between 1995 and 2008, the country's total exports grew by 524.16%, corresponding to an average annual growth rate of 17.56%. Specifically, in 2007–2008, Iran's exports increased by 36.64%. However, following the imposition of UNSC sanctions, exports declined sharply by 37.95%, marking a significant reversal in the previous growth trajectory. This sharp inflection underscores the potential disruptive impact of sanctions and raises important questions about the long-term structural shifts they may have triggered in Iran's export composition.

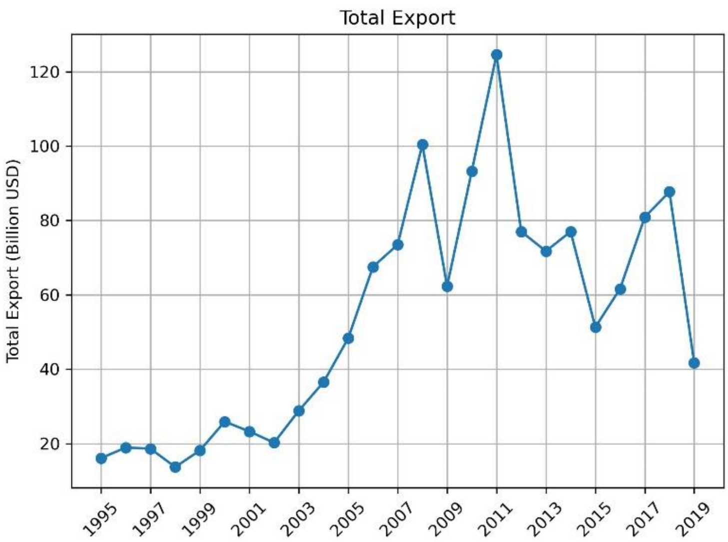

Figure 9 Iran's Total Exports (1995–2019): Sharp Growth Followed by a Significant Shift in Trajectory After the 2008 UNSC Sanctions

Source: Produced by the Author Based on BACI Data

This continuous growth occurred under successive governments—Hashemi Rafsanjani (1989–1997), Seyyed Mohammad Khatami (1997–2005), and Mahmoud Ahmadinejad (2005–2013)—each with fundamentally different ideological and economic policy orientations. It also persisted despite various internal and external shocks, including oil price fluctuations, political unrests, and changes in global demand, to which the Iranian economy appeared to adapt successfully. This raises a critical question: did the external shock of economic sanctions play a decisive role in disrupting this robust growth trajectory?

To further explore the relationship between economic sanctions and Iran's export performance, this study examines the diversification of Iran's exports. Following Bacchetta et al. (2012), the Herfindahl Index (HI) of export diversification is calculated for each year. The index is calculated as follows:

(1) $$\mathrm{HI} = \sum_k (s_k)^2$$

where S_k denotes the share of sector k in country's exports. Furthermore, the Pearson correlation coefficient between the Herfindahl Index and the Sanctions Intensity measure is calculated to be 0.63, which is statistically significant at the 1% level ($p<0.01$). For a visual depiction of this relationship, Figure 10 presents the evolution of sanctions intensity (left axis) alongside the Herfindahl Index (right axis). It should be emphasized that this evidence is purely correlational and does not provide information about causality. In line with the findings of Laudati and Pesaran (2023), this suggests that the escalation of economic sanctions after 2008 is correlated with a structural transformation of the Iranian economy. This interpretation aligns with Batmanghelidj (2024), who argues that Iran's "resistance economy" strategy was an adaptive response to sanctions, involving strategic product selection decisions aimed at enhancing economic resilience.

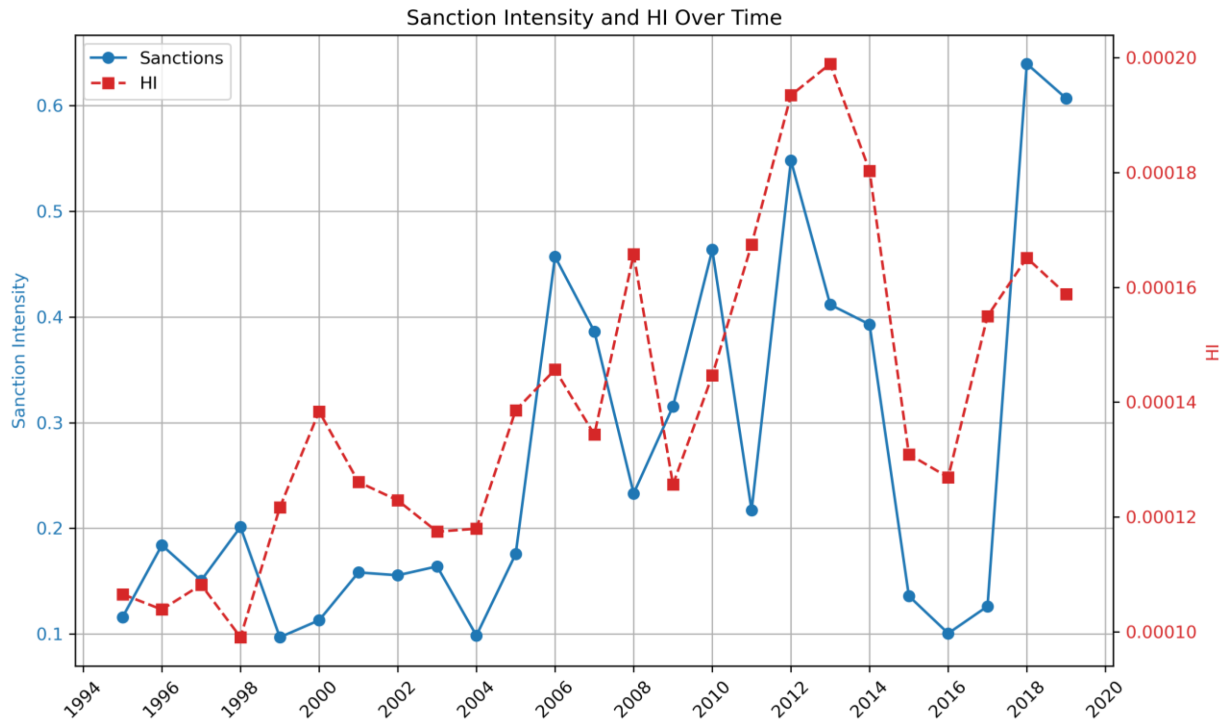

Figure 10 Sanctions Intensity and Export Diversification in Iran (1995–2019): A Positive Correlation

Source: HI Produced by the Author Based on BACI Data and Sanctions Intensity Based on Laudati and Pesaran (2023)

Note: This figure plots the evolution of Iran's Herfindahl Index of export diversification (right axis) alongside a sanctions intensity measure (left axis). The visual shows a marked rise in both series after 2008, indicating a correlation between increasing sanctions pressure and changes in export structure.

The observations outlined above underscore the need for a more rigorous analysis of the effects of sanctions on Iran's exports. While the initial descriptive evidence is suggestive, it does not offer a conclusive explanation of the potential relationship. This line of query is pursued with an in-depth regression analysis in section 4 of this thesis. The results of the regression analysis provide additional evidence that sanctions, through their heterogeneous impact on different sectors of the Iranian economy over time, contributed to a shift away from oil dependence and fostered greater export diversification. The following section presents a concise review of the most relevant literature that informs the research questions explored in this study.

3 Literature Review

Understanding the economic consequences of sanctions, particularly in the context of international trade, has become increasingly important in both academic and policy circles. A growing body of empirical literature explores how sanctions—whether imposed, threatened, targeted, or comprehensive—affect trade flows, macroeconomic stability, and economic adaptation across a range of contexts. Iran has emerged as a particularly salient case study due to the frequency, intensity, and duration of sanctions imposed on it. This literature review synthesizes key contributions in this field, with a focus on studies that analyze the general trade effects of economic sanctions using gravity models and cross-country data, examine Iran-specific responses to sanctions, including export deflection and structural adjustments, and evaluate the effectiveness and heterogeneity of sanctions based on their design, scope, and political context. Together, these studies provide critical insight into the mechanisms through which sanctions reshape trade dynamics and highlight important methodological innovations that inform the present research.

The most popular tool to measure the impacts of the economic sanctions on the trade flows between the countries has been gravity model. For more than 50 years, the gravity model has been a work-horse of the research conducted on the international trade (Bacchetta et al., 2012). The traditional gravity model of international trade, drawing inspiration from Newton's law of gravitation, accounts for bilateral trade flows by considering both the economic size of countries and the geographic distance between them (Dinçer, 2013; Leitão, 2024). According to this theory, trade between two nations tends to increase with their economic magnitude and decrease with trade barriers or frictions such as distance (Baier, Kerr, and Yotov, 2018). First introduced by Tinbergen in 1962, the model has since become a staple in trade research (Metin and Tepe, 2021). Beyond economic factors, it incorporates non-economic determinants of trade such as shared language, population size, and cultural ties (Metin and Tepe, 2021). The framework is also used to evaluate the influence of trade agreements, regional blocs, and socio-cultural linkages on trade volumes (Dinçer, 2013). Recent developments have strengthened its theoretical underpinnings, enhancing its ability to assess spatial economic interactions more accurately (Ghosh, 2011). Today, the applications of gravity model of trade span several domains of the global economy, including foreign direct investment and tourism demand (Leitão, 2024). As will be reviewed below, the gravity model is the most commonly used framework in research on the effects of sanctions on trade.

Yang, et al. (2004) conduct one of the earliest comprehensive empirical analyses of the impact of U.S. economic sanctions, employing a gravity model as their primary empirical framework. Using a cross-country dataset covering U.S. sanctions imposed between 1980 and 1998, the authors evaluate whether these measures achieved their intended policy goals. Their findings indicate that comprehensive U.S. economic sanctions significantly reduce bilateral trade with targeted countries. Notably, Iran and Cuba are identified as among the most severely affected. In particular, the study finds that in the years 1988, 1989, and 1993, U.S. sanctions reduced trade with sanctioned countries by over 90%.

Haidar (2017) provides one of the most detailed empirical studies of how Iran's export responds to targeted sanctions by analyzing over 1.81 million Iranian non-oil export transactions from Iran's customs records between 2006 and 2011. The study focuses on the export sanctions imposed in March 2008 by the United States, European Union, Canada, and Australia. He argues that these sanctions selectively increased export costs for Iranian firms based on the fact that the destination country is among the sanctioning countries, or non-sanctioning countries, making the case of Iran a valuable natural experiment to study sanctions regimes. The highly disaggregated nature of Haidar's dataset allows him to precisely identify instances of export deflection. Haidar (2017) finds that Approximately two-thirds of the export value lost due to sanctions was redirected to non-sanctioning countries. Moreover, a critical finding of Haidar (2017) aligning with the current study is that exporters not only shifted destinations but also adjusted their pricing and output strategies—lowering prices and increasing quantities—implying welfare losses and efficiency distortions caused by sanctions. Haidar's analysis demonstrates that targeted export sanctions can lead to large-scale trade rerouting, but the consequences are uneven across firms and products. This finding also motivated the current research to study the sector specific heterogeneity of the effects of sanctions. Haidar (2017) demonstrates that while some exporters successfully deflect trade and survive, others—particularly smaller and more specialized firms—suffer long-lasting damage. His findings also imply that export deflection, while mitigating some direct losses, does not fully neutralize the negative welfare and efficiency impacts of sanctions.

Dadpay and Tabrizy (2021) empirically assess the impact of a period of sanctions relief following the Joint Comprehensive Plan of Action (JCPOA) on Iran's export performance, focusing on non-oil sectors. Using quarterly trade data from 2011 to 2018 across 28 industrial sectors, they estimate that industry-level non-oil exports grew by an average of 9.9% in the post-JCPOA period compared to a similar window before the agreement. Their analysis highlights the growing importance of non-oil exports in Iran's trade structure during a time of intensified sanctions after 2011. Consistent with Haidar (2017), they argue that the relative stability of non-oil exports amid sanctions reflects the ability of larger firms to deflect trade toward non-sanctioning countries. As such, these firms were less reliant on temporary political openings like the JCPOA. Overall, their findings underscore the heterogeneous effects of sanctions, emphasizing the need for sector-specific analysis, which is an area of focus of the current research. They also support the idea that non-oil exports, particularly from smaller or less dominant industries, can serve as vital channels of resilience and adaptation in sanction-hit economies.

Beyond trade data, Laudati and Pesaran take a broader macroeconomic approach, incorporating sanctions as a structural shock to the Iranian economy. Laudati and Pesaran (2023) offer a novel contribution to the literature by developing a continuous measure of sanctions intensity and evaluating its macroeconomic effects on the Iranian economy over the period 1989–2019. Unlike most studies that define arbitrary "sanctions on/off" periods or use binary treatment variables, their approach captures the gradual and nuanced variation in sanctions pressure over time. Their empirical framework is built around an augmented structural vector autoregressive (SVAR) model of the Iranian macroeconomy, which includes the sanctions intensity variable as a key external shock. This model is used to identify both short-run and long-run effects of sanctions on key economic indicators such as the rial–USD exchange rate, inflation, money supply growth, and output growth. Laudati and Pesaran's results show that sanctions have statistically significant negative effects on oil exports, the rial's exchange rate, inflation, and Gross Domestic Production (GDP) growth. Their impulse response analysis shows that a positive sanctions shock (i.e., intensified sanctions) causes: a sharp decline in oil export revenues; an overreaction of the Iranian rial in foreign exchange markets; a subsequent increase in inflation; and a decline in real output within two quarters. Most importantly, they find that quantitatively, the estimated loss in output growth is approximately 0.9 percentage points per quarter (3.6% annually), and Iran's output growth under sanctions averaged 3%, whereas in the absence of sanctions, it could have reached 4–5% annually. Interestingly, the paper also highlights that due to restrictions on oil exports, Iran has undergone significant structural transformation, with notable growth in non-oil sectors, including petrochemicals, light manufacturing, and agriculture. These findings contribute to the broader debate on sanctions' long-term impact: while harmful in the short run, sanctions may induce adaptation and diversification in heavily targeted economies. This insight is particularly relevant for the current research that seeks to analyze sectoral responses to the sanctions, including shifts in export combination.

Felbermayr et al. (2025) emphases on the heterogeneous nature of sanctions' effects on international trade. Their comprehensive analysis using the Global Sanctions Data Base (GSDB) distinguishes between trade sanctions and financial sanctions, revealing that while trade sanctions show no statistically significant effect on trade overall, financial sanctions consistently produce negative and significant impacts. However, when the authors disaggregate trade sanctions into *complete* and *partial* forms, a clearer pattern emerges: complete trade sanctions sharply reduce trade flows—by over 70% on average—between the sanctioning and sanctioned countries, whereas partial trade sanctions have no statistically significant effect. From a sectoral perspective, the study identifies agriculture as the sector most affected by comprehensive sanctions, followed by mining and energy, manufacturing, and finally services. The findings of Felbermayr et al. (2025) emphasis on the asymmetric impact of sanctions on exports and imports, and the importance of intensity of sanction types, directly inform the current analysis of Iran's export flows under sanctions.

Adding to the discussion on heterogeneity, Dizaji and Farzanegan (2024) explore how political institutions moderate sanctions' effects. They investigate the impact of U.S.-imposed trade sanctions on global trade patterns, with the innovation to use quality of political institutions in target countries as a control variable. Their work also distinguishes between sanctions with different levels of intensity. Their results show that a one-unit increase in the intensity of complete trade sanctions reduces U.S. bilateral trade with sanctioned partners by approximately 76%, while a similar increase in partial sanctions leads to a 16% decrease. When examining the direction of trade, complete sanctions on exports and imports reduce U.S.

bilateral trade by 90% and 39%, respectively, all else being equal. Methodologically, the authors employ a gravity model of international trade, using panel data on bilateral trade flows between the United States and 79 trading partners over the period 1980–2020. The sanctions intensity index is developed from detailed U.S. sanctions records, distinguishing between complete and partial measures. Their bilateral trade data are sourced from the International Monetary Fund's Direction of Trade Statistics database.

Complementing these insights, Afesorgbor (2019) distinguishes between imposed and threatened sanctions, highlighting anticipatory behavior of the economic agents. He examines the differential effects of threatened versus imposed economic sanctions on international trade using a panel dataset of bilateral trade flows from 1960 to 2009. Applying a gravity model framework, the study finds that imposed sanctions significantly reduce trade between sender and target countries, whereas threatened sanctions may actually increase trade, potentially due to stockpiling behavior by economic agents anticipating future restrictions. This anticipatory behavior was a valuable insight informing the current study. More importantly, Afesorgbor (2019) also conducts a sector specific analysis. At the sectoral level, the analysis reveals that even essential goods, such as food and medical supplies, experience declines in trade under sanctions—contradicting the humanitarian exemptions outlined in the Geneva Convention. The study utilizes the Threat and Imposition of Economic Sanctions data base (TIES) dataset by Morgan et al. (2014) to construct dyadic, sender-target, and year-specific observations on the sanctions. Aggregate trade flow data are sourced from the IMF's Direction of Trade Statistics, while disaggregated trade flows are drawn from the UN Comtrade database.

Frank (2018) investigates the impact of economic sanctions on bilateral trade using a panel of data from 1987 to 2005 from the TIES, the Direction of Trade Statistics data base and CEPII database to implement a gravity model with multiple estimation strategies, including

OLS, pseudo Poisson maximum likelihood (PPML), fixed effects, and first differences. The study finds that sanctions reduce bilateral trade by approximately 9%, a result that is robust under OLS and PPML but not statistically significant when using first-differencing. Contrary to the former research, he finds that moderate sanctions, rather than extensive or limited ones, appear to be the primary drivers of this trade reduction. Frank also critiques earlier studies, such as Haidar (2016), for not adequately addressing multilateral resistance terms with fixed effects, which might lead to endogeneity bias.

A major shortcoming of prior research on sanctions and trade is their reliance on datasets like TIES (e.g. Afesorgbor, 2019) or GSDB (e.g. Felbermayr et al., 2025). While these datasets distinguish between complete and partial sanctions, they fail to quantify the intensity of sanctions in force. Moreover, they often assume a clear-cut point of imposition and lifting sanctions, which rarely exists in practice. As Laudati and Pesaran (2023) emphasize, Iran's sanctions regime is characterized by persistent and overlapping measures, making binary treatment models inadequate. This also makes using standard difference-in-differences (DiD) designs less effective, as there are no well-defined pre-sanctions periods to serve as a clean counterfactual. This comes in contrast to the approach adopted by important contributors to the discussion on Iran's sanctions like Dadpay & Tabrizy (2021) and Haidar (2017). Building on their innovation, this study adopts their sanctions intensity measure to better capture the evolving nature of the Iranian sanctions regime.

Another limitation of earlier works lies in the trade data used. Studies drawing on the IMF's Direction of Trade Statistics (e.g. Afesorgbor, 2019; Frank, 2018; Dizaji & Farzanegan, 2024), the UN Comtrade database (e.g. Dadpay & Tabrizy, 2021), or Iranian customs records (e.g. Haidar, 2017) are potentially affected by misreporting due to sanctions circumvention strategies. This thesis addresses this issue by using BACI trade data, which applies a reliability assessment technique and mirrors import and export records to mitigate reporting inconsistencies.

As outlined above, the existing literature highlights the varied effects of sanctions on trade, including export deflection, sectoral disparities, and structural change. While existing studies have advanced our understanding of how sanctions affect trade volumes, less attention has been paid to their impact on the composition of exports. Moreover, gaps remain in capturing sanctions intensity over time and in addressing data reliability issues. The next section outlines the data and empirical strategy used to address these complexities and explains how incorporating social, geographical, and economic controls contributes to a more precise analysis.

4 Empirical Analysis

4.1 Model

Following the approaches of Yang et al. (2004), Dizaji and Farzanegan (2024), Afesorgbor (2019), and Frank (2018), this study employs a gravity model of trade to estimate the impact of sanctions on the value of Iran's exports across different subsectors. The baseline specification models the logarithm of Iran's exports to all destination countries as the dependent variable. The key explanatory variable is the logarithm of a sanctions intensity measure, along with its first, second, and third one-year lags. Two key control variables included are the logarithms of Iran's GDP and the logarithms of GDP of the importing country.

(2)
$$\log(\text{export}_{ijt}) = \beta_0 + \beta_1 \log(\text{sanct}_t) + \beta_2 \log(\text{sanct}_{t-1}) + \beta_3 \log(\text{sanct}_{t-2}) + \beta_4 \log(\text{sanct}_{t-3}) + \beta_5 \log(\text{GDP}_{it}) + \beta_6 \log(\text{GDP}_{jt}) + a_{ij} + u_{ijt}$$

where, i indexes the exporting country (Iran), j indexes the importing (destination) country, and t denotes the year. In this model, $\log(\text{export}_{ijt})$ denotes the logarithm of Iran's exports to destination countries. $\log(\text{sanct}_t)$ represents logarithm of the sanctions intensity measure along with its lagged values $\log(\text{sanct}_{t-1})$, $\log(\text{sanct}_{t-2})$, $\log(\text{sanct}_{t-3})$. $\log(\text{GDP}_{it})$ and $\log(\text{GDP}_{jt})$ refer to the logarithms of Iran's GDP and the GDP of the destination country, respectively. As will be discussed in detail in Section 4.3, *Estimation Method*, the term a_{ij} represents the unobserved, time-invariant fixed effects that are specific to each country pair. These fixed effects capture all stable characteristics of a given bilateral trade relationship that do not vary over time but may influence the trade flows between countries. The model also includes the idiosyncratic error term u_{ijt} .

The use of three one-year lagged effects to measure the impact of sanctions is well-justified in the literature and is further validated through empirical testing with alternative model specifications. Yotov, Piermartini, and Larch (2016), in their Advanced Guide to Trade Policy Analysis, provide methodological recommendations for analyzing global trade based on best practices in the literature. When working with panel data and alternative interval specifications to measure the effects of policy change, they advise experimenting with different lag structures while maintaining estimation efficiency. For example, to account for the possibility that the effects of Regional Trade Agreements (RTAs) evolve over time, they employ up to three lagged RTA variables.

A large body of literature on the economic impact of sanctions supports the use of multiple lags to reflect delayed responses in trade. In the case of Iran, this is particularly relevant due to the long-term nature of oil export contracts, which comprise the bulk of the country's trade during the study period. Jena, Akash, and Gupta (2024), using a structural gravity model across a global panel from 1990 to 2019 to study the effect of sanctions on trade volumes and diversion, include up to three lags and find that the contemporaneous effect of sanctions is strongest, with gradually diminishing impacts over time. Similarly, Falk and Ljungqvist (2020), in their study of the effect of sanctions on Russian trade between 2009 and 2018, include up to four lags, though only the first-year lag is statistically significant.

Other studies, while not explicitly specifying lag structures, still capture delayed effects through alternative modeling approaches. For example, Ghodsi and Karamelikli (2022) apply a nonlinear autoregressive distributed lag (NARDL) model to assess the impact of sanctions on Iran's trade flows.

In this study, incorporating lagged effects is crucial to capture the heterogeneous and time-distributed impact of sanctions, particularly across different segments of Iranian trade such as manufacturing and non-oil exports. Accounting for these dynamics helps explain observed shifts in the composition of Iran's exports over the study period. The sector-specific variation in the timing and magnitude of sanctions' effects might be partly due to differences in production structures, contract durations, and adjustment costs.

Various variables are commonly used in gravity models to represent trade costs. While bilateral distance and GDP of the trading countries are the most common control variables in gravity models, additional indicators such as contiguity are often included. To account for information-related trade costs, researchers also include dummies for shared language, geographic proximity, and cultural ties like common religion. These factors suggest that countries with similar business environments—due to language, proximity, or shared history—face lower search and transaction costs (Bacchetta et al., 2012). Firms in such contexts are more familiar with each other's business practices, which increases the likelihood of forming trade relationships. Additionally, trade barriers are typically captured through dummy variables representing the presence of regional trade agreements (Bacchetta et al., 2012).

To more accurately capture trade costs, barriers, and facilitation factors, this research posits that trade flow between Iran and destination countries is driven by the intensity of the sanctions on Iran, Iran's supply potential (GDP), the importer's market demand potential (GDP), and the cost of trade (such as transportation measured by the distance between the capital of the two countries)_ following Afesorgbor (2019). A full model specification including a comprehensive set of control variables is implemented to better account for trade frictions:

$$
\begin{aligned}
\log(\text{export}_{ijt}) = \; & \beta_0 + \beta_1 \log(\text{sanct}_t) + \beta_2 \log(\text{sanct}_{t-1}) + \beta_3 \log(\text{sanct}_{t-2}) + \beta_4 \log(\text{sanct}_{t-3}) \\
& + \beta_5 \log(\text{GDP}_{it}) + \beta_6 \log(\text{GDP}_{jt}) + \beta_7 \log(\text{distcap}_{ijt}) + \beta_8 \text{contig}_{ijt} \\
& + \beta_9 \log(\text{pop}_{it}) + \beta_{10} \log(\text{pop}_{jt}) + \beta_{11} \text{fta\_wto}_{ijt} + \beta_{12} \text{comrelig}_{ijt} \\
& + \beta_{13} \text{eu}_{jt} + a_{ij} + u_{ijt}
\end{aligned} \tag{3}
$$

where, log(export_{ijt}) denotes the logarithm of Iran's exports to destination countries. Log(sanct_{t}) represents logarithm of the sanctions intensity measure along with its lagged values log(sanct_{t-1}), log(sanct_{t-2}), log(sanct_{t-3}). Log(distcap_{ijt}) denotes the logarithm of the distance between the capital of the destination country and Tehran, capital of Iran. Contig_{ijt} is a binary variable equal to 1 if the destination country shares a border with Iran. Log(GDP_{it}) and log(GDP_{jt}) represent the logarithms of Iran's GDP and that of the destination country, respectively, while log(pop_{it}) and log(pop_{jt}) refer to the logarithms of the populations of Iran and the destination country. fta_wto_{ijt} is a binary indicator equal to 1 if the destination country has a regional trade agreement with Iran. Comrelig_{ijt} is a religious proximity index, and eu_j_{t} is a binary variable indicating whether the destination country is a member of the European Union.

4.2 Data

This research uses the Base Analytique du Commerce International (BACI) dataset to measure trade flows between Iran and its destination countries. Compiled by the Centre d'Études Prospectives et d'Informations Internationales (CEPII), BACI provides bilateral trade data for over 200 countries, disaggregated into approximately 5,000 product categories, covering the period from 1995 to 2023 (Gaulier & Zignago, 2010). The dataset is constructed by reconciling export and import data reported to the United Nations COMTRADE database—the most comprehensive source of global trade statistics, capturing over 95% of world trade.

To improve accuracy, BACI employs a reliability index for each reporting country and uses a mirroring technique to correct for discrepancies between reported imports and exports (Gaulier & Zignago, 2010). This makes it particularly suitable for analyzing the effects of international sanctions, where incentives to misreport trade may exist. Moreover, the reconciled trade values in BACI contain significantly fewer missing entries, as observations are only excluded if both the exporting and importing countries fail to report a given trade flow. In addition, BACI data are cleaned to exclude re-exports, ensuring a more accurate representation of actual bilateral trade (Yotov, Piermartini, and Larch, 2016).

These features of the BACI dataset allow this research to leverage a large volume of highly disaggregated trade data with greater reliability and precision. The reconciliation of import and export reports, the reduction of missing values, and the exclusion of re-exports enhance the dataset's suitability for studying the effects of international sanctions. Compared to alternative sources such as the IMF trade statistics or the raw UN COMTRADE data commonly used in former research on the effects of sanctions on the international trade, BACI offers more consistent and accurate trade flow estimates.

The effects of sanctions are assessed using the sanctions intensity index, developed by Laudati and Pesaran (2023) that is particularly well-suited to the Iranian context, where the economy has been subject to a wide range of overlapping and evolving sanctions with varying types and degrees of intensity since the 1979 Islamic Revolution—without clear-cut imposition or removal dates. To capture the variation in sanctions pressure over four decades, Laudati and Pesaran employ a news-based approach, counting the number of articles referencing sanctions on Iran in six major international newspapers. This method serves as a proxy for a latent sanctions intensity process, under the assumption that daily news coverage partially reflects the true, unobserved severity of sanctions. The resulting quarterly index, scaled between 0 and 1, is converted into an annual measure using the median, rather than the mean or maximum, to mitigate the influence of extreme values observed in specific years (e.g., 2017).

The use of the sanctions intensity index developed by Laudati and Pesaran (2023) is particularly justified in the Iranian context, where sanctions have not only been extensive and overlapping but also persistent in their economic effects. Traditional binary indicators like TIES and GSDB that simply code for the presence or absence of sanctions fail to capture the lingering and cumulative impact that long-term sanctions regimes can exert on trade. As Yang et al. (2004) demonstrate in their empirical study, the adverse effects of U.S. sanctions on formerly planned economies and comprehensively sanctioned states persisted with a long lag after they are formally announced removed, with trade levels remaining suppressed. This evidence underscores the importance of adopting a more nuanced, continuous measure of sanctions pressure—such as the news-based index by Laudati and Pesaran—that can reflect the enduring nature and intensity of economic sanctions over time.

In this research, for the control variables the Gravity database was used comprising of geographic, cultural, trade facilitation and macroeconomic features of the importing and exporting pairs of 252 countries over the period of 1948 to 2019 (Conte, Cotterlaz, & Mayer, 2022). This database provides annual data on the above-mentioned variables for each country pair that constitutes a potential trade relationship in the analysis. These include unilateral variables, such as the GDP and population of both the exporting and importing countries at time t, as well as bilateral variables, such as geographic distance and contiguity (shared borders).

The time period under study spans from 1995 to 2019. This timeframe was chosen to capture key episodes of international sanctions against Iran, including their imposition, intensification, and periods of partial relief. It also reflects the availability of consistent and comparable data for bilateral trade, control variables, and the sanctions intensity index across a broad set of country pairs. Moreover, restricting the analysis to the pre-2020 period helps avoid the confounding effects of the COVID-19 pandemic, which could distort trade flows due to factors unrelated to sanctions or economic fundamentals.

The control variable Log(distcapijt) used in this research is calculated as the natural logarithm of the distcap variable, a bilateral variable indicating the distance between the capital city of country pairs in Kilometers, rounded to the nearest km, from Conte, Cotterlaz, & Mayer (2022), which is derived from the GeoDist Database (Mayer & Zignago, 2011). It should be noted that this dataset takes the changes in capital cities into accounted, allowing the distcap variable to vary over time.

The control variable contig is a binary variable indicating the contiguity (1 where the country pair share borders and otherwise 0) from Conte, Cotterlaz, & Mayer (2022), which is constructed based on ARCGIS's World Countries (Generalized) dataset, supplemented manually using Wikipedia as a source to fill the missing values.

The control variable comrelig is religious proximity index, drawn from Conte, Cotterlaz, & Mayer (2022). This index is calculated based on Disdier & Mayer (2007) by summing the products of the population shares of Catholics, Protestants, and Muslims in the origin and destination countries. The index ranges from 0 to 1 and increases as countries share a dominant common religion.

The control variables $\log(GDP_{it})$ and $\log(GDP_{jt})$ are the natural logarithm of the Gross Domestic Production of Iran and the destination country of the Iran's export, respectively. Similarly, $\log(pop_{it})$ and $\log(pop_{jt})$ are natural logarithm of the population in thousands of the Iran and population of the destination country of the Iranian export, respectively. GDP, calculated in current thousands of US$, and population are derived from Conte, Cotterlaz, & Mayer (2022). The primary source for GDP and population data is the World Bank's World Development Indicators (WDI). However, the WDI does not report data for countries that does not exist anymore, as its geographic classifications reflect the world as of 2021. Therefore, Conte, Cotterlaz, & Mayer (2022) employ two alternative sources to supplement missing observations from the WDI dataset. For GDP, Katherine Barbieri's International Trade Dataset is used, providing figures for 1948–1992—for example, separate data for East and West Germany (Barbieri, 2005). For population, Angus Maddison's *Statistics on World Population, GDP and Per Capita GDP* are used, as available on the website of the Groningen Growth and Development Centre.

The control variable fta_wto is a binary variable equal to 1 if the country is engaged in a regional trade agreement with Iran, drawn from Conte, Cotterlaz, & Mayer (2022) which is constructed based on the data from WTO's Regional Trade Agreements Information System.

The control variable eu_j is a binary variable that indicates if the country of the destination of the Iran's trade is a member of the European Union, drawn from Conte, Cotterlaz, & Mayer (2022) compiled using information available on the European Union's website.

4.3 Estimation Method

In this study, both Fixed Effects (FE) and Random Effects (RE) estimators are employed to analyze the impact of sanctions on bilateral trade flows using panel data. These estimators are well-suited to address unobserved heterogeneity across country pairs and over time. The main difference between the two lies in how they treat the unobserved individual-specific effects. The FE estimator allows for correlation between these unobserved effects and the explanatory variables by removing time-invariant characteristics through a within transformation (Wooldridge, 2016). Therefore, some of the control variables like contiguity and common religion are absorbed by the FE estimator. In contrast, the RE estimator assumes that the unobserved effects are uncorrelated with the explanatory variables and treats them as part of the composite error term. While the FE approach is more robust when this correlation exists, it cannot estimate the impact of time-invariant variables (Wooldridge, 2016). The RE estimator, on the other hand, is more efficient under the assumption of no correlation and permits the inclusion of time-invariant regressors. This section provides a detailed discussion of each method, including their assumptions, implementation, and suitability in the context of this analysis.

The FE estimator is a widely used panel data technique that can be implemented via Ordinary Least Squares (OLS) on time-demeaned variables and effectively removes unobserved time-invariant effects (Wooldridge, 2016). This feature allows for correlation between the unobserved effects and the explanatory variables, making FE particularly suitable when such correlation is expected. Provided that the strict exogeneity condition holds, the FE estimator yields unbiased and consistent estimates. However, valid inference under this method also requires additional assumptions, such as homoskedasticity and no serial correlation in the error terms (Wooldridge, 2016). It is worth noting, as Angrist and Pischke (2009) emphasize, that although Fixed Effects (FE) estimates control for certain types of omitted variables, they are particularly vulnerable to attenuation bias caused by measurement error. This underscores the importance of using consistent and reliable data in the analysis.In this study, fixed effects models are estimated using heteroskedasticity-robust standard errors. According to (Wooldridge, 2016) this estimator works as follows:

(4) $$y_{it} = \beta x_{it} + a_i + u_{it}, \quad t = 1, 2, \ldots, T.$$

where a_i denotes the fixed effect, and y_{it} and x_{it} are varying across units and through time t with error term u_{it}. Then an average for each unit through time yields:

(5) $$\bar{y}_i = \beta\bar{x}_i + a_i + \bar{u}_i$$

As shown in equation (6), subtracting equation (5) from equation (4) yields the within-transformed (demeaned) version of the fixed effects model (7), in which the unobserved effect, a_i is absorbed by the estimator:

(6) $$y_{it} - \bar{y}_i = \beta_1(x_{it} - \bar{x}_i) + u_{it} - \bar{u}_i, \qquad t = 1, 2, \ldots, T,$$

(7) $$\ddot{y}_{it} = \beta\ddot{x}_{it} + \ddot{u}_{it}, \qquad t = 1, 2, \ldots, T,$$

where double-dot notation denotes the demeaned (within-transformed) version of the variable and the fixed effects a_i are eliminated via this transformation.

A limitation of standard fixed effects estimation is that it does not allow for estimating the coefficients of time-invariant variables, such as distance and contiguity, as these are automatically absorbed by the fixed effects (Dizaji and Farzanegan, 2024). Inclusion of these variables can potentially improve the model. According to Serlenga and Shin (2004), this approach also overlooks the possible correlation between time-invariant variables and unobserved country-pair-specific effects, potentially leading to biased estimates. An additional drawback of fixed effects estimation, as noted by Angrist and Pischke (2009), is that the transformations used to eliminate fixed effects tend to remove both “bad” variation associated with omitted variable bias and “good” variation that carries useful information about the variable of interest. This trade-off can attenuate the estimated effects and reduce efficiency. To address this, a random effects model can be used, which allows for estimating the coefficients of time-invariant variables under the assumption that the explanatory variables are uncorrelated with the random effects (Bussière and Schnatz, 2009).

Another important shortcoming of FE estimation is that, as Cunningham (2021) points out, FE models cannot address reverse causality or simultaneity bias. That is, while FE controls for time-invariant unobserved heterogeneity, it does not solve the problem of endogenous regressors that may be jointly determined with the outcome variable. Therefore, in situations where the explanatory variable and the dependent variable influence each other, FE estimates may still be biased. However, in the context of this study, reverse causality is not a serious concern. It is highly unlikely, for example, that Iran's manufacturing export levels are causally responsible for triggering the imposition of international sanctions, making simultaneity bias improbable in this case. Sanctions are exogenous to Iran's short-term trade patterns, as their imposition reflects geopolitical decisions rather than export performance.

The second estimator used in this research is random effects (RE) estimator. In cases where we believe unobserved effect is uncorrelated *with explanatory variable*, it is recommended to adopt the RE estimator. RE includes an explicit intercept, allowing us—without loss of generality—to assume that the unobserved effect has a zero mean. In FE models, the aim is to eliminate unobserved effect, since it is assumed to be correlated with one or more of the explanatory variables. However, if unobserved effect is actually uncorrelated with all explanatory variables across time, removing it through transformation (as in FE) leads to inefficient estimates. One key advantage of RE over FE is its ability to estimate the effects of time-invariant variables, since RE assumes unobserved effect is uncorrelated with all explanatory variables (Wooldridge, 2016). Take the following equation with unobserved effect, a_i, and explanatory variables x_{itj}. Here, a critical consideration to use RE is the assumption that $cov(x_{itj}, a_i)=0$, for each t across the time period under the study, a_i is uncorrelated with each explanatory variable.

(8) $$y_{it} = \beta_0 + \beta_1 x_{it1} + \cdots + \beta_k x_{itk} + a_i + u_{it}$$

The transformation used in RE estimator is as follows:

(9)
$$y_{it} - \theta\bar{y}_i = \beta_0(1-\theta) + \beta_1(x_{it1} - \theta\bar{x}_{i1}) + \cdots + \beta_k(x_{itk} - \theta\bar{x}_{ik}) + (v_{it} - \theta\bar{v}_i),$$

where θ is a transformation parameter to perform quasi-demeaning of the variables. It helps eliminate serial correlation in the composite error term ($v_{it}=a_i+u_{it}$) and allows efficient estimation via Generalized Least Squares.

(10)
$$\theta = 1 - [\sigma_u^2/(\sigma_u^2 + T\sigma_a^2)]^{1/2}$$

In equation (10) σ^2_a is the variance of a_i, and σ^2_u is the variance of u_{it}.

As the empirical results are presented in the next section, the baseline model with short set of control variables is first estimated using both FE and RE estimators. Subsequently, the same approach is applied to the model that includes the full set of controls. Then the results are compared across the estimations. Incorporating the RE estimator alongside the FE estimator enables the inclusion of time-invariant variables—such as contiguity and religious proximity—which would otherwise be eliminated under the FE framework.

To examine the heterogeneous effects of sanctions across different sectors of the Iran's export, calculations are conducted on three distinct datasets. The first dataset includes the total value of Iran's exports to all destination countries. The second excludes "Oils: petroleum oils and oils obtained from bituminous minerals, crude" from the total export value. The third focuses specifically on export flows from the manufacturing sector. For each dataset, both FE and RE regressions are estimated—first using only the logarithm of GDP for both the origin country (Iran) and the destination countries as control variables, and then with an expanded set of controls. The subsequent section presents and discusses the results.

Finally, it should be mentioned that while the fixed effects estimator is commonly used as a tool for causal inference in panel data analysis, establishing a definitive causal relationship between sanctions and trade outcomes remains challenging due to potential time-varying confounders and other endogeneity concerns that are unaccounted for due to complex international trade environment. For this reason, the term 'association' is intentionally used when discussing the results, rather than asserting direct causality.

5 Results and Discussion

This section presents and interprets the empirical findings on the impact of international sanctions on Iran's export composition between 1995 and 2019, utilizing the gravity model described in the previous section. The analysis focuses on identifying how sanctions have affected different subsectors of Iran's export basket and whether these effects suggest deeper structural transformations. The results are organized as follows: First, baseline regressions using FE and RE estimators are reported with a limited set of controls. Second, the models are extended to include a full set of economic, socio-political, and geopolitical control variables. To explore heterogeneity in the impact of sanctions, each level of analysis is disaggregated into three segments of Iran's trade: total exports, non-oil exports, and manufacturing exports. Throughout the discussion, findings are interpreted in relation to the existing literature and the study's central hypotheses.

First, Table 1 presents the regression results using a limited set of control variables—specifically, the logarithm of GDP for Iran and the respective destination country. To assess the impact of sanctions on Iran's exports, the model includes both a contemporaneous sanctions variable and three lagged terms, each capturing the effect of sanctions with a one-year delay. The final column reports the number of observations. Statistical significance is indicated by asterisks, with corresponding p-values detailed below the table.

Table 1 Regression Analysis, Short Set of Controls

Variable	FE, total	RE, total	FE, Non-oil	RE, Non-oil	FE, Manufacturing	RE, Manufacturing
contemporaneous	-0.355	-0.525**	-0.284	-0.412**	-0.172	-0.339
first lag	-1.430***	-1.682***	-0.926***	-1.114***	-1.201***	-1.421***
second lag	-1.000***	-1.050***	-0.772***	-0.813***	-0.931***	-0.948***
third lag	-0.967***	-0.850***	-0.662**	-0.582**	-0.124	-0.023
log GDP Ir	0.484***	0.264**	0.487***	0.327***	0.493***	0.274***
log GDP Destination	0.523***	0.844***	0.542***	0.777***	0.436***	0.749***
N Observations	3005.000	3005.000	3005.000	3005.000	2925.000	2925.000

**** p<0.01 , ** p<0.05, * p<0.10*

As shown in Table 1, the coefficient on the contemporaneous effect of sanctions is not statistically significant in most regressions, except in the RE models where the dependent variable is total exports and non-oil exports. In these two cases, the coefficients are statistically significant at the 5% level, whereas most other significant coefficients in the table reach the 1% level. Since both the sanctions intensity measure and the export values are expressed in logarithmic form, the coefficients can be interpreted as elasticities. In the RE regressions, the elasticity estimates are –0.525 for total exports and –0.412 for non-oil exports, indicating that a 1% increase in sanctions intensity is associated with an immediate reduction in exports of approximately 0.5% and 0.4%, respectively. However, as shown in Table 2, when the extended set of control variables is included, these coefficients decline to –0.097 and –0.110, and their p-values rise above 0.10, suggesting a loss of statistical significance.

Two possible explanations account for the lack of significance in the contemporaneous effect of sanctions. First, policy changes—such as sanctions—often take time to be implemented and to affect trade flows, resulting in delayed responses. Second, the finding aligns with Afesorgbor (2019), who argues that the early stages of sanctions may temporarily boost trade flows. Upon the announcement of new sanctions, economic agents may increase exports in anticipation of future restrictions, engaging in stockpiling behavior to mitigate potential losses. This anticipatory response can partially offset the immediate negative impact of sanctions in their first year.

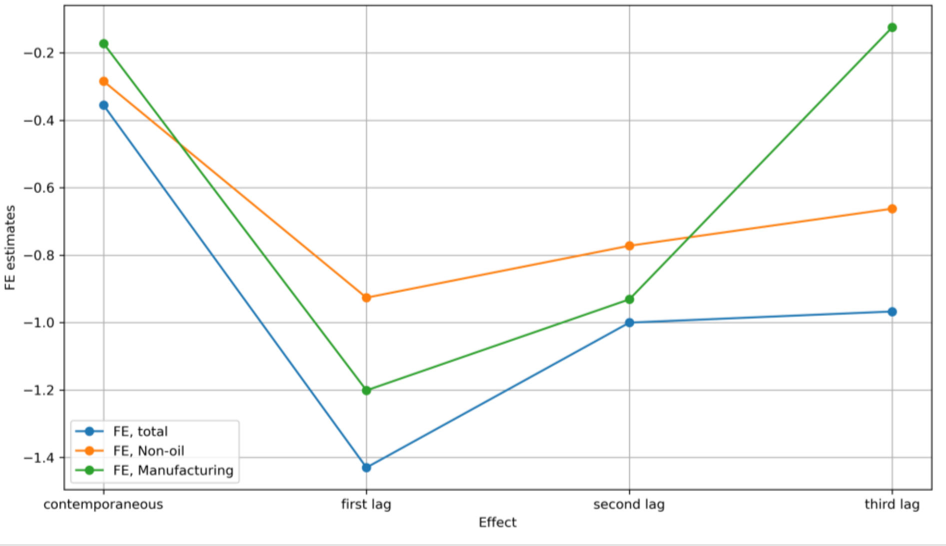

Figure 11 Fixed effect regression coefficients with short controls

Source: Based on the calculations reported in table 1

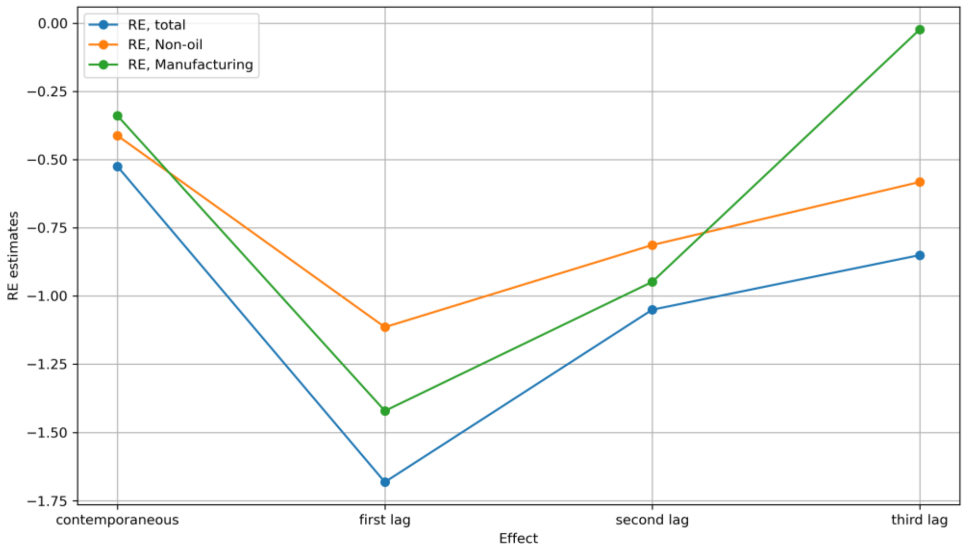

Figure 12 Random effect regression coefficients with short controls

Source: Based on the calculations reported in table 1

To interpret the magnitude of the sanctions coefficients, it is important to consider the range of variation in the sanctions intensity measure. Between 2011 and 2012, this measure increased by 34 units, rising from 0.22 to 0.55. The most significant decrease occurred between 2014 and 2015, when the sanctions intensity dropped from 0.39 to 0.13— 26 units reduction—

reflecting the impact of sanctions relief under the JCPOA. Conversely, the largest increase was observed between 2017 and 2018, when the sanctions intensity rose by 51 units, from 0.13 to 0.63. This surge happened as the P5+1 countries, following the lead of U.S. president Donald Trump, defaulted on their commitments based on JCPOA sanctions relief.

Two observations about the coefficients of the regressions in table 1 are worth extra attention. First, the coefficients on effects of the log sanctions and its lagged effects for the non-oil export follow the same trend as the total export with a smaller magnitude, suggesting that the effects of sanctions and their lagged effects have larger impacts on the crude oil sector. Second, the coefficient for the third lag of the sanctions for manufacturing section is small and statistically insignificant, reflecting a more rapid recovery of the manufacturing sector. These observations provide some evidence in support of the hypothesis that the heterogenous effects of the sanctions contributed in reshaping the composition of the Iran's export.

Table 2 Regression Analysis, Long Set of Controls

Variable	FE, total	RE, total	FE, Non-oil	RE, Non-oil	FE, Manufacturing	RE, Manufacturing
contemporaneous	-0.127	-0.097	-0.129	-0.110	-0.026	-0.037
first lag	-0.888***	-0.865***	-0.565***	-0.551***	-0.896***	-0.906***
second lag	-0.972***	-0.973***	-0.761***	-0.764***	-0.997***	-0.989***
third lag	-1.115***	-1.136***	-0.745***	-0.765***	-0.143	-0.145
log distcap	-38.312***	-1.597***	-34.493***	-1.647***	-37.354***	-1.680***
contiguity	0.000	0.978	0.000	1.020	0.000	1.223**
log GDP IR	0.725***	0.777***	0.651***	0.692***	0.655***	0.654***
log GDP Destination	1.092***	0.941***	0.945***	0.823***	0.879***	0.848***
log population Dest	0.139	0.370***	-0.132	0.345***	-0.512	0.246***
log population IR	-7.215***	-6.862***	-4.629***	-4.687***	-4.420***	-5.113***
Free Trade Agreement	1.716***	1.754***	1.355***	1.424***	1.111***	1.204***
common religion	0.000	1.449***	0.000	1.522***	0.000	1.466***
EU membership	0.123	0.138	-0.153	-0.099	-0.066	0.077
N Observations	2949.000	2949.000	2949.000	2949.000	2869.000	2869.000

****** p<0.01 , ** p<0.05, * p<0.10*

As shown in table 2, in regression with longer set of control variables, all the lagged effects of the sanctions are statistically significant at 1% level expect for the third lag effect on the manufacturing data in both FE and RE regressions that are statistically insignificant.

Moreover, the third lag effect for the data on non-oil export that was statistically significant merely at the 5% level with the shorter set of control variables is also significant in 1% level with the longer set of control variables and also are larger in absolute magnitude.

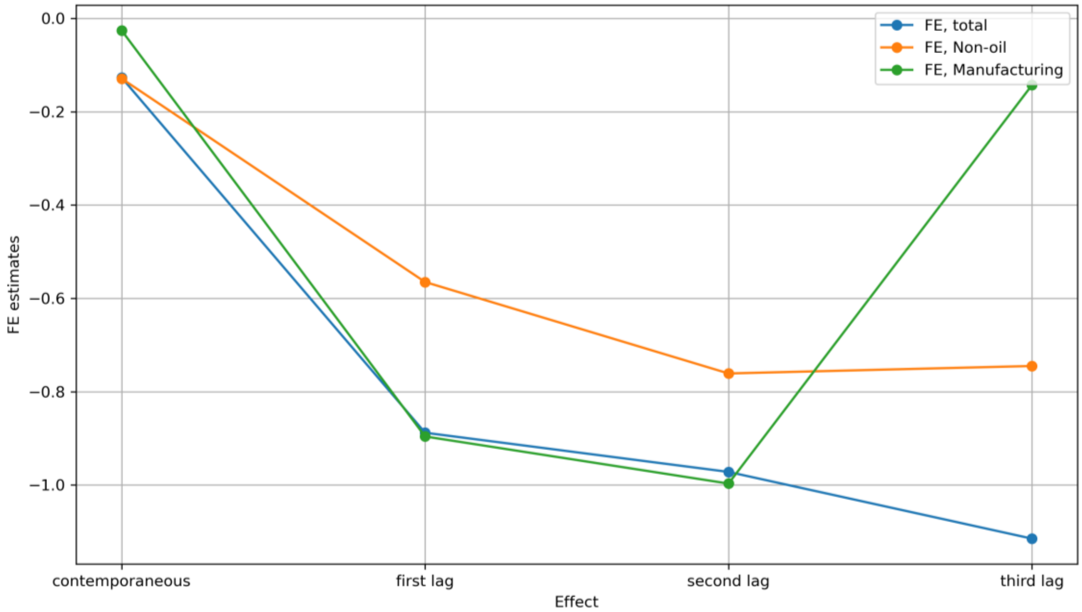

Figure 13 Fixed effect regression coefficients with full controls

Source: Based on the calculations reported in table 2

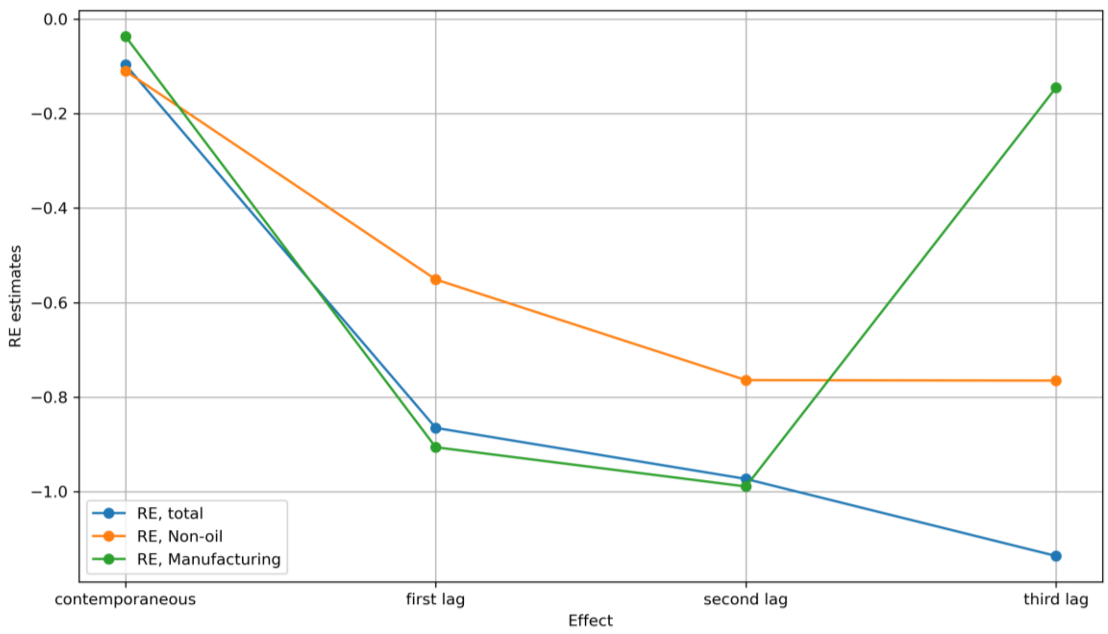

Figure 14 Random effect regression coefficients with full controls

Source: Based on the calculations reported in table 2

Based on Table 2, several noteworthy observations can be made regarding the coefficients on the effects of sanctions. First, similar to table 1, the absolute value of the third lagged effect of sanctions on manufacturing exports declines more sharply compared to that of total trade and non-oil trade. This pattern holds consistently across regressions with both the shorter and longer sets of control variables. This suggests that, while the manufacturing sector is initially affected by sanctions to a similar extent as other sectors, it tends to recover more quickly. Such resilience could help explain the increasing share of manufacturing in Iran's export composition.

Second, as shown in Figures 11 to 14, across all regressions—whether using the shorter or longer set of control variables—the coefficients of the sanction effects over time for non-oil exports closely follow the same trend as those for total exports, albeit with consistently smaller absolute values. This suggests that the non-oil export sector is less severely affected in each time lag following a sanctions shock.

Third, the coefficients on the effects of sanctions are consistently smaller in magnitude when the longer set of control variables is included, compared to the regressions with the shorter set. This suggests that the expanded set of controls improves the model specification and likely reduces omitted variable bias. While the FE estimator accounts for time-invariant omitted variables, it does not eliminate bias from time-varying omitted factors, which must be addressed through proper model specification. As illustrated in Figures 11 and 12, under the shorter specification, the absolute value of the first lag coefficient is larger than those of the second and third lags. However, with the longer set of controls illustrated in Figures 13 and 14, the second and third lags become larger than the first (with the exception of the third lag for manufacturing, as discussed earlier). This shift in the trend underscores the importance of including relevant control variables to produce a more accurate and realistic analysis. The stronger effects observed in the second and third years after the imposition of sanctions likely reflect delayed economic responses at both the firm and sectoral levels. Sanctions often take time to translate into real trade disruptions due to existing contractual obligations, shipping lags, and stockpiled inventories.

The pattern of sanction effects over time in Figures 11–14 contrasts with Jena, Akash, and Gupta (2024), who, using a global panel, find the strongest trade impact of the sanctions in the contemporaneous year, with diminishing effects over three lags. Likewise, Falk and Ljungqvist (2020) find only the first-year lag to be statistically significant in their study on the impact of sanctions on Russian trade. These discrepancies may reflect context-specific dynamics.

Consistent with the core assumptions of the gravity theory of international trade, Table 2 shows that the coefficients on the logarithm of GDP for both the country of origin (Iran) and the destination countries, as well as the binary variable indicating the presence of a free trade agreement, are all statistically significant at the 1% level. These results support the gravity model's prediction that trade volumes increase with the economic size of trading partners and the existence of institutional arrangements that reduce trade barriers. The significance and expected signs of these variables reinforce the credibility of the model specification and highlight the importance of including such fundamental determinants in regressions.

EU membership was included as a control variable under the assumption that EU countries might be more likely to comply with U.S. unilateral sanctions, which constitute the majority of sanctions imposed on Iran. However, as shown in Table 2, the coefficients on this variable are not statistically significant in any of the regressions, regardless of the estimator used or the specific subset of Iran's export data analyzed. This result does not align with the findings of Haidar (2017), who documented a diversion of Iran's exports away from EU destinations in response to sanctions.

According to Table 2, the coefficient on the common religion variable is omitted in the FE estimator due to its time-invariant nature, but it remains statistically significant at the 1% level in the RE estimator, with a coefficient magnitude consistently ranging between 1.4 and 1.5 across different model specifications. Similarly, the contiguity variable is absorbed by the FE estimator, while in the RE regressions, its coefficients range from 0.978 for total exports (statistically insignificant) to 1.223 for the manufacturing sector (statistically significant at the 5% level). This suggests that geographic proximity plays a more critical role in the export of manufacturing goods, potentially due to lower transport costs or supply chain integration with neighboring countries. Another possible explanation could be the composition of Iran's exports with a large share of oil and petrochemicals—products that are also major exports of its neighboring countries. This overlap may reduce the relative importance of geographic proximity for total exports, while proximity remains more relevant for sectors like manufacturing, where logistical considerations play a larger role.

One final observation is that the coefficients on the logarithm of Iran's population are relatively large across the regressions. However, this relationship may be misleading and partially driven by a spurious correlation. A plausible explanation is the presence of a confounding time trend. As noted by Khandan and Pritchett (2017), Iran experienced a period of rapid population growth during the early years of the sample. According to the World Bank (2025), Iran's population increased from approximately 62 million in 1995 to 87 million in 2019. Notably, the intensity of sanctions also increased significantly toward the end of the period. Thus, the observed population effect may in part be capturing this shared upward trend, rather than reflecting a genuine relationship.

Finally, There was a concern regarding potential multicollinearity between the variables for common religion and contiguity. To address this, a Variance Inflation Factor (VIF) test was conducted. The resulting low VIF values indicate that multicollinearity is not a significant issue, and the estimates for these variables can be considered reliable.

Table 3 Variance Inflation Factor, common religion and contiguity

Variable	VIF	1/VIF
comrelig	1.12	0.896574
contig	1.12	0.896574
Mean VIF	1.12	

6 Conclusion

This study provides robust empirical evidence on the heterogeneous and dynamic effects of economic sanctions on Iran's exports. The regression results show that while the immediate (contemporaneous) impact of sanctions is often statistically insignificant, the delayed effects—particularly in the second and third years following imposition—are significant and economically meaningful. These effects are more pronounced in total export data that include the crude oil sector, compared to non-oil exports, indicating that crude oil has been the hardest-hit sector under sanctions. This helps explain the gradual shift away from crude oil exports. In contrast, the manufacturing sector shows a quicker recovery, suggesting a higher degree of adaptability and resilience.

The analysis reveals that the observed shift in Iran's export composition—from a heavy reliance on crude oil toward a more diversified export basket—cannot be solely explained by declining oil revenues. This supports the hypothesis that sanctions acted as trade barriers, contributing to the structural transformation of Iran's economy in line with the "resistance economy" framework described in the literature. Moreover, the consistent reduction in the absolute value of the sanctions coefficients when additional control variables are introduced highlights the importance of accounting for socio-economic and geographical factors, as well as potential confounders, to improve model specification. Finally, the inclusion of a RE estimator, which captures both within- and between-unit variation and allows for the retention of time-invariant controls, complements the FE approach. This dual specification offers a more nuanced picture of the impact of sanctions on Iran's export composition and reinforces the robustness of the results.

Overall, these findings contribute to a nuanced understanding of how long-term sanctions reshape not just trade volumes but the very structure of targeted economies. They also provide policy-relevant insights into how countries under prolonged sanctions may develop adaptive capacities, with implications for domestic economic planning.

7 Suggestions for Future Research

Several avenues remain open for future exploration. One promising direction is to investigate how Iran's gradual shift from oil dependency toward greater export diversification—particularly into manufacturing—has influenced domestic labor markets. Unlike the capital-intensive oil sector, manufacturing tends to generate more employment opportunities per unit of output, suggesting potential labor market benefits worth quantifying.

Another critical area for future research is the effect of sanctions on the import of essential goods, such as food and medicine, which are protected under international humanitarian law, including the Geneva Conventions. This line of inquiry is particularly urgent in light of the COVID-19 pandemic, during which sanctions may have hindered Iran's ability to procure vaccines and provide basic livelihood support for its population.

Finally, future studies could examine how the geographic composition of Iran's trade has evolved in response to sanctions. Prolonged sanctions on Iran may have induced a reorientation of trade away from countries that are overcompliant with U.S. secondary sanctions—primarily in Europe—toward partners that are less aligned with U.S. sanction strategies, particularly in Asia. Such a shift could have lasting implications for Iran's network in the global economy and offer broader insights into how persistent external pressure reshapes international trade networks.

8 Appendices

8.1 Appendix A: Analytical Tools, Software Environment and the use of AI

All data cleaning, analysis, and regression models were carried out using Python and Stata. Python was primarily used for data wrangling and visualization, while Stata was employed for panel regression models and fixed/random effects estimation.

The analysis was conducted using:

- Python 3.10 (packages: pandas, matplotlib, NumPy, Seaborn)
- Stata 17 for panel data estimations and regression analysis

During the preparation of this thesis, several AI tools were used to support different stages of the research and writing process. These included ChatGPT for language editing and methodological clarification, as well as Elicit, Semantic Scholar, and Research Rabbit for literature exploration and review. These tools were employed for:

- Improving the clarity and flow of academic writing (e.g., rephrasing and editing drafts)
- Clarifying methodological concepts and econometric terminology
- Generating suggestions for better structure and presentation of results
- Finding and exploring relevant academic literature
- Refining and troubleshooting coding for data analysis
- Identifying appropriate citation formats and editing references

All research design, data analysis, interpretation of results, and final decisions regarding content were carried out independently by the author. AI tools were used as writing and editorial aids, not as sources of substantive content or analysis.

8.2 Appendix B: Detailed Regression Tables on Sanctions and Export Flows

In this section full information of the regression analyses discussed in the former sections are provided. The tables present the estimated effects of sanctions intensity on different subsections of Iran's export flows using both FE and RE panel regression models with short and full set of control variables. The dependent variable is the logarithm of export value. The key explanatory variable is the logarithm of the sanctions intensity measure, including contemporaneous and three lagged values (L, L2, L3). Standard errors are reported in parentheses. Significance levels are indicated as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. It is worth mentioning that FE model has a very slightly higher within R^2 than the RE specification when controlling for time-varying factors, indicating a better fit in capturing within-country-pair variation. However, the RE model yields a higher overall R^2, reflecting its ability to explain both within and between variation, albeit under the assumption that unobserved effects are uncorrelated with the regressors.

Table 4A Estimated coefficients from panel regressions examining the impact of sanctions intensity on Iran's total export, including lagged effects and short set of controls.

	FE	RE
log_sanctions_intensity_measure	-0.355	-0.525**
	(0.224)	(0.214)
L.log_sanctions_intensity_measure	-1.430***	-1.682***
	(0.251)	(0.242)
L2.log_sanctions_intensity_measure	-1.000***	-1.050***
	(0.218)	(0.218)
L3.log_sanctions_intensity_measure	-0.967***	-0.850***
	(0.287)	(0.284)
log_gdp_i	0.484***	0.264**

	(0.146)	(0.111)
log_gdp_j	0.523***	0.844***
	(0.158)	(0.092)
_cons	-9.005***	-10.584***
	(1.723)	(1.674)
Within RÂ²	0.075	0.072
Between RÂ²	0.525	0.522
Overall RÂ²	0.433	0.443
N	3005.000	3005.000
Standard errors in parentheses		
="* p<0.10	** p<0.05	*** p<0.01"

Table 5A Estimated coefficients from panel regressions examining the impact of sanctions intensity on Iran's total export, including lagged effects and full set of controls.

	FE	RE
log_sanctions_intensity_measure	-0.127	-0.097
	(0.222)	(0.214)
L.log_sanctions_intensity_measure	-0.888***	-0.865***
	(0.217)	(0.211)
L2.log_sanctions_intensity_measure	-0.972***	-0.973***
	(0.223)	(0.222)
L3.log_sanctions_intensity_measure	-1.115***	-1.136***
	(0.290)	(0.288)
log_distcap	-38.312***	-1.597***
	(5.590)	(0.262)
contig	0.000	0.978
	(.)	(0.703)
log_gdp_i	0.725***	0.777***
	(0.151)	(0.129)

log_gdp_j	1.092***	0.941***
	(0.190)	(0.095)
log_pop_j	0.139	0.370***
	(0.465)	(0.095)
log_pop_i	-7.215***	-6.862***
	(1.161)	(1.008)
fta_wto	1.716***	1.754***
	(0.272)	(0.262)
comrelig	0.000	1.449***
	(.)	(0.437)
eu_j	0.123	0.138
	(0.238)	(0.219)
_cons	379.365***	64.302***
	(48.388)	(9.795)
Within RÂ²	0.116	0.115
Between RÂ²	0.369	0.777
Overall RÂ²	0.253	0.673
N	2949.000	2949.000
Standard errors in parentheses		
="* p<0.10	** p<0.05	*** p<0.01"

Table 6A Estimated coefficients from panel regressions examining the impact of sanctions intensity on Iran's non-oil export, including lagged effects and short set of controls.

	FE	RE
log_sanctions_intensity_measure	-0.284	-0.412**
	(0.212)	(0.203)
L.log_sanctions_intensity_measure	-0.926***	-1.114***
	(0.212)	(0.208)
L2.log_sanctions_intensity_measure	-0.772***	-0.813***
	(0.209)	(0.209)
L3.log_sanctions_intensity_measure	-0.662**	-0.582**

	(0.268)	(0.266)
log_gdp_i	0.487***	0.327***
	(0.131)	(0.103)
log_gdp_j	0.542***	0.777***
	(0.142)	(0.085)
_cons	-9.919***	-11.131***
	(1.544)	(1.489)
Within RÂ²	0.104	0.102
Between RÂ²	0.479	0.479
Overall RÂ²	0.401	0.408
N	3005.000	3005.000
Standard errors in parentheses		
="* p<0.10	** p<0.05	*** p<0.01"

Table 7A Estimated coefficients from panel regressions examining the impact of sanctions intensity on Iran's non-oil export, including lagged effects and full set of controls.

	FE	RE
log_sanctions_intensity_measure	-0.129	-0.110
	(0.214)	(0.208)
L.log_sanctions_intensity_measure	-0.565***	-0.551***
	(0.192)	(0.188)
L2.log_sanctions_intensity_measure	-0.761***	-0.764***
	(0.215)	(0.215)
L3.log_sanctions_intensity_measure	-0.745***	-0.765***
	(0.267)	(0.265)
log_distcap	-34.493***	-1.647***
	(5.466)	(0.244)
contig	0.000	1.020
	(.)	(0.668)
log_gdp_i	0.651***	0.692***
	(0.136)	(0.117)

log_gdp_j	0.945***	0.823***
	(0.163)	(0.081)
log_pop_j	-0.132	0.345***
	(0.397)	(0.087)
log_pop_i	-4.629***	-4.687***
	(0.934)	(0.869)
fta_wto	1.355***	1.424***
	(0.254)	(0.253)
comrelig	0.000	1.522***
	(.)	(0.404)
eu_j	-0.153	-0.099
	(0.234)	(0.220)
_cons	324.188***	43.844***
	(46.750)	(8.490)
Within RÂ²	0.127	0.125
Between RÂ²	0.398	0.791
Overall RÂ²	0.286	0.693
N	2949.000	2949.000
Standard errors in parentheses		
="* p<0.10	** p<0.05	*** p<0.01"

Table 8A Estimated coefficients from panel regressions examining the impact of sanctions intensity on Iran's manufacturing export, including lagged effects and short set of controls.

	FE	RE
log_sanctions_intensity_measure	-0.172	-0.339
	(0.237)	(0.226)
L.log_sanctions_intensity_measure	-1.201***	-1.421***
	(0.221)	(0.216)
L2.log_sanctions_intensity_measure	-0.931***	-0.948***
	(0.235)	(0.235)

L3.log_sanctions_intensity_measure	-0.124	-0.023
	(0.258)	(0.258)
log_gdp_i	0.493***	0.274***
	(0.134)	(0.105)
log_gdp_j	0.436***	0.749***
	(0.148)	(0.086)
_cons	-8.606***	-10.051***
	(1.699)	(1.597)
Within RÂ²	0.094	0.090
Between RÂ²	0.500	0.499
Overall RÂ²	0.408	0.425
N	2925.000	2925.000
Standard errors in parentheses		
="* p<0.10	** p<0.05	*** p<0.01"

Table 9A Estimated coefficients from panel regressions examining the impact of sanctions intensity on Iran's manufacturing export, including lagged effects and full set of controls.

	FE	RE
log_sanctions_intensity_measure	-0.026	-0.037
	(0.239)	(0.232)
L.log_sanctions_intensity_measure	-0.896***	-0.906***
	(0.201)	(0.198)
L2.log_sanctions_intensity_measure	-0.997***	-0.989***
	(0.240)	(0.240)
L3.log_sanctions_intensity_measure	-0.143	-0.145
	(0.257)	(0.257)
log_distcap	-37.354***	-1.680***
	(4.771)	(0.241)
contig	0.000	1.223**
	(.)	(0.622)
log_gdp_i	0.655***	0.654***

	(0.140)	(0.124)
log_gdp_j	0.879***	0.848***
	(0.182)	(0.086)
log_pop_j	-0.512	0.246***
	(0.427)	(0.088)
log_pop_i	-4.420***	-5.113***
	(1.081)	(0.917)
fta_wto	1.111***	1.204***
	(0.260)	(0.269)
comrelig	0.000	1.466***
	(.)	(0.396)
eu_j	-0.066	0.077
	(0.233)	(0.218)
_cons	350.064***	49.661***
	(40.674)	(8.925)
Within RÂ²	0.117	0.113
Between RÂ²	0.387	0.801
Overall RÂ²	0.279	0.706
N	2869.000	2869.000
Standard errors in parentheses		
="* p<0.10	** p<0.05	*** p<0.01"

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