The impact of the United States sanctions on Iran's trade flows

– A gravity model approach

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Abstract

The Iranian economy has over 30-years been under several of US sanctions due to differences in their political objectives, affecting primarily their economic lifeblood, the oil business. Therefore during this period the Iranian economy has experienced setbacks in their development of national prosperity. This paper investigates the effect of the economic sanctions, during the time period 1975-2006, on Iran's trade flows by incorporating the gravity model. Also, including geographical proximity and cultural ties further extends the model, which has been shown to strongly influence trade. The findings suggest that sanctions have negative impact on trade flows and are consistent with previous findings. Further estimation methods such as the Heckman- and PPML method are applied accounting for zero trade flows. The empirical results indicate that sanctions have had a large negative effect on trade flows as expected. When further dividing the sanctions into five different time periods the results conclude the previous ones, however the five time periods have been influenced by sanctions in different varieties. Hence sanctions hamper trade and prevent the Iranian economy to thrive to its fullest potential.

Keywords: Trade flows, Sanctions, Gravity model, Iran and the United States

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1. Introduction

Trade has played a vital role in the path to economic development for many nations. The past decades have seen rapid growth in international trade due to the improvement of free trade, transportation, technology and the removal of artificial barriers. Nations and regions have become more involved in the world economy and constantly seek new ways to achieve development of exports and imports in terms of goods and services. While the growth of trade helps to build new markets it can also create uncertainty in the previous ones because of competition. For that numerous of governments impose trade barriers to protect their industries and nations. Additionally the senders' governments may also restrict exports and imports for political reasons due to disagreements in different countries policy objectives. This form of policy tool is called a sanction and is a significant instrument of international diplomacy as well as a frequent feature in political interactions among nations.

The rationale behind the imposition of economic sanctions is primarily to provoke a behavioral change in a target nations government behavior and for that sanctions have emerged as a tool policy for many international actors, among others the United States. The country has devoted its influence over the international financial system to create some of the most comprehensive sanctions in history.[1] The policy instrument has therefore been one of the United States primary tools toward Iran for several years, highlighting grave violations in human rights, nuclear objectives and alleged support of international terrorism. Due to the differences between the countries over a span of three decades, the United States has restricted Iran's export and imports, primary exports of lucrative oil and gas as well as Iran's financial sector. The United States sanctions against Iran were initiated during the 1979 hostage crisis and ended in 1981, consequently leading to difficulties in its effort to reach the pre-revolution level of national prosperity.[2]

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[1] Hufbauer, G, K Elliott, B Oegg, and J Schott. (2007) and Haidar, J. (2015)

[2] Amuzegar, J. (1997), *"Iran's economy and the US sanctions"* Middle East Institute. Vol 51 No.2 Page 185-199 [2015-03-09]

Although the hostage crisis ended in 1981, the sanctions have been irregularly added and subtracted since the end of the 70's until present time, affecting both the Iranian imports and exports, and therefore leading to a number of articles studying the effects of sanctions on bilateral trade. An empirical analysis on Iran's trade flow by Hadinejad, Mohammadi and Shearkani's (2010) investigates the impact of sanctions on Iran throughout a 30-year period. Their findings establish that the sanctions have in fact had a negative effect on Iran's non-oil trade volume. However they additionally conclude that trade sanctions have yet had impact on the Iranian governments foreign policy.[3]

It was not long after the revolution in 1984 until the sanctions were re-imposed by the US due to alleged support in international terrorism, although it was eased the same year it had consequences on their oil export. In 1987 the economy was yet again subject to various sanctions for not taking actions in controlling for narcotic production as well as their adverse approach against a peaceful settlement in the Iran-Iraq War. The consequences of total embargo on Iranian oil as well as banning export of goods to Iran that could be used for military purposes showed significant shortfalls in their economy. Even though the sanctions were diminished the following year they were re-imposed in 1995 until 2000 prohibiting all bilateral trade between the countries, the official reason being Iran continuing on supporting international terrorism. The expectation was that their allies would support the sanctions by prohibiting purchase of Iranian oil. The anticipation of joining the sanctions did however not have impacts on their allies, as they believed that it would not have much political impact on Iran.

Furthermore it wasn't until the Iranian nuclear argument broke out into open in the end of 2002 and the beginning of 2003 that the desire of harder sanctions was considered and deliberated. The argument concerned Iran managing underground operations with nuclear resources and was demanded to suspend all enrichment

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[3] Hadinejad, M, Mohammad, T, Shearkhani, S. (2010) *"Examine the Sanctions' Efficiency on Iran's Non-Oil Trade (Gravity Model)"* Social Science Electronic Publishing, Inc.

related and reprocessing activities. The Iranian government did however not respond to the demand, therefore the European Union and United Nations have since 2006 taken actions concerning the alleged nuclear program and implemented international economic sanctions toward Iran. The restrictions by the EU and United nations have also constrained the sale and supply of goods and technology for usage in nuclear activities with Iran. The sanctions against Iran have subsequently since 2006 been tightened for each year that passes. Hence, the destructive impact of sanctions on Iran's economy is well recognized from lost revenue in exports.[4]

The objective of this paper is to conduct an empirical analysis of the numerous economic sanctions imposed on Iran by the US and hence measures the impact on Iran's trade flows during 1975-2006.

When exploring trade volumes the gravity model is intensively used in empirical investigations as it offers a useful method of predicting trade flows. The model has long been acknowledged for its consistent empirical achievement in clarifying many different types of flows, such as migration, commuting, tourism, and commodity shipping. This paper will investigate the impact of sanctions on Iran's bilateral trade with its trading partners through the help of the gravity model.

The results from this paper indicate US sanctions, represented by an average of all sanctions, strongly influence Iran's trade flows and have reduced trade by displaying negative coefficients. Additionally when applying region, exporter and importer dummies to control for certain changes over time the coefficient maintains its negative effects. When further distributing the sanctions into the five different time periods, demonstrating when the sanctions were implemented, the effect confirms that the different time periods have affected trade flows negatively, however in different varieties. Indicating that the five time periods have had different effects on the Iranian trade flows.

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[4] Ataev, N. (2013) *"Economic Sanctions and Nuclear Proliferation: The case of Iran"*
Central European University Department of Economics. Page 1-68 [2015-04-10]

The thesis is organized as follows. The next section, reviews the theoretical foundation of the gravity model and the different estimation methods obtainable. Section 3 presents an extensive history of the sanctions imposed on Iran chronically. Section 4 presents earlier studies concerning the gravity model by taking various estimates into consideration. Section 5 provides descriptive data and specifies the variables and econometric models that will be used in the regression. Results are presented in section 6 and section 7 offers an analysis followed by a conclusion of the findings in section 8.

2.Theoretical Framework

2.1 The Gravity Model

The gravity model is a tool used in a wide range of empirical fields and it has dominated the literature on trade policy evaluation the past few decades and can trace and assess trade patterns. It was at first applied to international trade by Tinbergen (1962) and Pöynöhen (1963) as an empirical specification. They based the model on Newtonian physics and the "Law of Universal gravitation", introduced in 1687. The law described that as distance increases all other things being equal, the interaction between the two objects decreases. Conversely as the mass increases so does the interaction between the two objects.[5]

In the following version introduced by Tinbergen the gravity model is applied to predict bilateral trade flows using different inputs. The basic model demonstrates imports being a function of the size of the economies as well as the distance between them. The trade flows has a correlation with economic size and the inverse relationship with the distance between them and hence has the following form;

$$T_{ij} = A \frac{Y_i Y_j}{D_{ij}} \qquad (2.2)$$

Where

T_{ij} = The total trade flows from the origin country *i* to destination country *j*

$Y_i Y_i$ = The economic sizes of the two countries *i* and *j*. This usually is Gross Domestic Product (GDP)

D_{ij} = The distance between the two countries *i* and *j*

A= The gravitational constant term.

In addition to size and distance, the gravity trade model features socio-cultural estimate as well as geographical proximity that can affect trade flows, containing common language and common border. These variables will be described and implemented further on in the thesis.

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[5] Head, K. (2003)

2.2 Logarithmic Transformation

The first part of the section presented the gravity model equation in its basic form given to the theory. According to provided theoretical and empirical studies from diverse scholars and Silva and Tenreyro (2006), the gravity model can be interpreted into stochastic versions to account for deviations from the theory, however, the majority of empirical literature uses the logarithmic transformation of gravity equation for its estimation. The estimations of natural logs further simplify the gravity function and it is possible to obtain a linear relationship between log trade flows and the logged economy sizes and distances;[6]

$$LnT_{ij} = \alpha_0 + \alpha_1 lnY_i + \alpha_2 lnY_j - \alpha_3 lnD_{ij} + \varepsilon_{ij} \quad (2.3)$$

Where

α_0 is the intercept

α_1 , α_2 and α_3 are the coefficients to be estimated

According to this equation the size of bilateral trade is an increasing function of economic size (Y_i and Y_j) and a decreasing function of nation distance (D_{ij}). Almost all studies take national income and distance into account; hence these parameters maintain their position as essential and basic estimates. [7]

2.3 Econometric considerations

The basic ordinary least square (OLS) regression of a gravity model can provide a good fit of the data with a high R^2 value; it can however yield severe omitted variable bias affecting the results. Andersson and Van Wincoop (2003) demonstrated in their paper that the bias is due to disregarding the effect of relative prices on trade flows. By including the multilateral resistance term (exporter and importer dummies), which characterizes a reflection of the average trade resistance between two trading nations

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[6] Santos Silva, J.M.C and Tenreyro, S. (2006), *"The log of Gravity"*. Review of economics and statistics 88 (4) Page 642-658 [2015-03-19]

[7] Batra, A. (2004), *"India's Global Trade Potential: The gravity model approach"*. Indian's council for research on international economic relations, Working paper, No 151. Page 1-38 [2015-03-19]

as well as all other possible trading partners, would exclude the bias and generate greater reliable regressions. This is due to the bilateral relationship between two nations trading with each other do not determine trade flows any further. Also by including region dummies it make it simpler to estimate the impact of time invariant variables.[8]

Another way to deal with potential biases in parameter estimates is to incorporate time dummies in the model. Including time dummies for each year in the regression model permits the model to characterize some of the variation in the data to unobserved events that took place during each year. In order words it captures factors that affects all countries trade simultaneously. Hence changes over time that may affect the dependent variable trade flows can be captured. An example could be global changes in commodity prices.

Glick and Rose (2002) article demonstrates what occurs when the time dummies are not included and when they are included in their model. When they include the time dummies, the condition changes and the estimated coefficient for their variable of interest is becomes smaller, therefore they predict that the time dummy plays an important role in estimating bilateral trade flows since it yields different estimate results.[9]

Benedicts and Vicarellis (2009) paper studies the presence of fixed effect in order to account for the biases in OLS estimation. Accordingly when implementing fixed effect the regression can avoid misspecification problems in the estimates by controlling for the time invariant unobservable factors that may disturb bilateral trade

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[8] Anderson, J.E. And Wincoop, E. Van. (2001) *"Gravity with gravitas: A solution to the border puzzle",* National Bureau of Economic Research, Working paper 8079, January. Page 1-37 [2015-03-31]

[9] Glick, R. and Rose, A.K. (2002) *"Does a currency union affect trade? The time series evidence"*, European economic review 46-6 Page 1125-1151 [2015-03-17]

flows.[10] Earlier papers demonstrating the issue of fixed effect is by Rose from (2000, 2001). The model in his paper establishes that the original estimate of the currency union trade effect very large, +200%, however when correcting for fixed effects, the results in his paper from (2001) displays a remarkable reduction in currency union. Hence including pair dummies has a significant effect on the estimates and the regression.[11]

However a prior setback concerning the fixed effect, according to the scholars, considers the issues of not being capable to identify the impact of time invariant estimates as for instance, geographical distance and common language and hence excluding the estimates from the regression. Additional disadvantage when applying region fixed effect corresponds to removing significant amount of variation in the regression when there is small variation over time, which might lead to biased results, involving large standard errors.[12]

A second recognized problem in the OLS regression is that trade data set frequently contains of zeros, as the matrix of bilateral trade might not constantly be full. The use of logarithm transformation for the dependent variable generates an instant difficulty when trade is zero, since the log of zero is undefined. While various countries trade in large volumes and have strong economic ties with other countries, certain countries have no trade at all, generating zero trade flows. Missing values may also be the case, creating zero observations that are implemented in the data as zero trade flows. This may generate difficulties when estimating the model by OLS and potentially leads to the issue of sample selection bias. There are different methods that can be applied to the data in order to solve the problem.

[10] Benedicts, L.D and Vicarelli, C. (2009),*"Dummies for Gravity and Gravity for Policies: Mission Impossible".* Mimeo, Presented at the European Trade Study Group (ETSG) conference, Rome, Italy, September. Page 1-29 [2015-03-28]

[11] Rose, A.K. (2001), *"Currency unions and trade: the effect is large"* Economic Policy, 33, Page 2-12 [2015-03-17]

[12] Benedicts, L.D and Vicarelli, C. (2009),*"Dummies for Gravity and Gravity for Policies: Mission Impossible".* Mimeo, Presented at the European Trade Study Group (ETSG) conference, Rome, Italy, September. Page 1-29 [2015-03-28]

The first method is to ignore the zeros; this would however only be acceptable if the zeros were the results of an approximation of small trade flows. Another method is to add the number one to all zero trade values; this is nevertheless not a satisfactory solution since it may lead to inconsistent estimators. A third solution to account for the zeros is to apply the Poisson Pseudo likelihood (PPML) or Heckman model estimator and compare the results with the OLS estimates.[13] These alternative estimator methods will be explained further in the next section.

Moreover the paper will accordingly include time dummies, importer and exporter dummies as well as region dummies to control for certain changes over time in trade flows not explained for.

2.4 Alternative Gravity Model estimators

The OLS model has long been a baseline estimator when theorizing and analyzing the gravity model. However different scholars have highlighted certain issues concerning the OLS baseline estimator in recent literatures and on account of criticism being presented, two alternative estimators have been presented for dealing with the OLS difficulties, PPML and Heckman.

Santos Silva and Tenreyro (2006) proposed the alternative method of PPML after evaluating the OLS estimates. The model stipulates reliable estimates of the original nonlinear model by running a form of nonlinear least squares on the basic equation and treats the bilateral trade data like count data. A desirable advantage is that PPML, unlike OLS estimate, is that it includes observations for which the observed trade value is zero. While the OLS excludes the zero that is undefined when converted into

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[13] Benedictis, L. D and Vicarelli, C. (2009). *"Dummies for Gravity and Gravity for Policies: Mission Impossible"*. Mimeo, Presented at the European Trade Study Group (ETSG) conference, Rome, Italy, September. Page 1-29 [2015-04-01]

logarithm estimates, the PPML incorporates the zeros in the model, dealing with the issue of sample selections bias.[14]

Furthermore another desirable property for the model considers the issue of heteroscedasticity generated in OLS estimates. The PPML model, unlike the OLS model is robust against heteroscedasticity[15].

Martin and Pham (2008) exploit the PPML estimate when zero trade flows are frequent and established in their paper that the PPML estimator is robust against heteroscedasticity and solves the heteroscedasticity problem generated in OLS estimates, since the latter model is not efficient.[16] A third advantage concerns the PPML models interpretation of the coefficients, which follows the similar outlines as the OLS. The issue of the dependent variable not being specified in logarithm forms is not a setback as it can be interpreted in elasticity's, as in OLS.[17]

As clarified previous, the OLS regression does not allow for zero trade matrix. Even though the zeros may reflect lack of measurement or a lack of reporting in the dataset, it is essential to incorporate them in the regression since it may contribute to a rise concerning the sample selection bias. A common approach to handle the non-random sample selection is to estimate the Heckman sample selection model. The model is divided into two-step estimation; the first step is the anticipated values of the trade flows restricted on country trading, hence the outcome equation considers the variables from the original gravity model. The second part additionally includes one variable that affects the probability that two countries participate in trade, say

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[14] Shepherd, B. (2013) *"The Gravity Model of International Trade: A User Guide"* United Nations ESCAP, Page 51-56 [2015-03-12]

[15] *The heteroscedasticity is present when the size of the error term differs across values on the independent variable.*

[16] Martin, W and Pham, C. S. (2008) *"Estimating the Gravity Equation when Zero Trade Flows Are Frequent"* MPRA Paper, 9453. Page 2-46 [2015-04-07]

[17] Santos Silva, J.M.C and Tenreyro, S. (2006) *"The log of Gravity"*. Review of economics and statistics 88 (4) Page 641-658 [2015-04-07]

common border. With this variable, countries are said to engage in trade more than non-common border countries.[18]

Martin and Pham (2008) also investigate the application of the Heckman selection estimator and suggest that the Heckman method performs better if true recognizing restrictions are obtainable contrary to the PPML.[19]

There are however technical disadvantages concerning the model. One of these drawbacks considers that the Heckman model presents bias, which may be a concern as the approach is not robust to heteroscedasticity.

With that being said, it is difficult to select which model to be desired in the applied papers. The two models have both their advantages and disadvantages. Therefore the paper will present both the PPML and the Heckman models in the results since the two alternative estimates demonstrate robust results to the use of diverse estimators.

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[18] Shepherd, B. (2013) *"The Gravity Model of International Trade: A User Guide"* United Nations ESCAP, Page 51-56 [2015-03-13]

[19] Martin, W and Pham, C. S. (2008)*"Estimating the Gravity Equation when Zero Trade Flows Are Frequent"* MPRA Paper, 9453. Page 2-46 [2015-04-07]

3. Historical overview of economic sanctions against Iran

First round of sanctions

Prior to the revolution in Iran 1979, during Shah Mohammad Reza Pahlavi's era, the United States was one of Iran's prime trade partners with a 16 percent share of Iran's imports, making them the second largest exporter to Iran, after Germany with its 19 percent shares. However following the revolution in 1979, the relationship between Iran and the United States was altered on the 4 of November 1979 when a unit of Iranian students captured Americans in the US embassy in Tehran and created a hostage crisis. The hostage taking was prolonged 444 days (1979-1981) and during that period the two countries experienced a collapse in their diplomatic and economic relations. The collapse primary lead to the United States imposing economic sanctions throughout the period the Americans were held prisoners in the US embassy.

The sanctions included the US embargoing oil imports from Iran as well as embargoing exports to Iran, prohibiting Aid and military assistance to Iran (expect for food and medicine), hence affecting both the Iranian exports and imports. Moreover the US froze 12 billion dollars of Iran's deposits in the US banks. Trade that had been growing significantly during a long period with the US ended abruptly. By the middle of 1981 the sanctions were lifted by President Ronald Reagan and the sanctions imposed on both trade and financial sanctions had an important influence in achieving the release of the hostages. The following year the business between the countries was taken up again but would not last for long.[20]

Second round of sanctions

In 1984 Iran was accused of being involved in supporting international terrorism as it was said that they were involved in the bombing of the US Marine Barracks in Lebanon the previous year. Hence leading the US restricting the exports including transfer of weapons, ammunition as well as prohibiting foreign aid and also the use of credit or financial assistance to Iran. They further prohibited exports of aircraft and related parts, excluding authorized licenses. These sanctions were implemented twice during 1984 but were however eased the same year. Also during this period Iran was

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[20] Sanctions against Iran: http://www.state.gov/e/eb/tfs/spi/iran/index.htm [2015-03-04]

on an ongoing war with Iraq (1980-1988) and were said to have an adverse approach against a peaceful settlement.[21]

Third round of sanctions

During 1987 President Ronald Reagan invoked section 481 of *"The Foreign Assistance act of 1961"* and section 505 of *"The international security and development cooperation act of 1985"* therefore enhancing the sanction strategy. The official reasons being Iran not taking satisfactory actions in controlling illegal movements such as narcotics production, trafficking and money laundering. Due to these events, the US took actions in order to prevent imports of Iranian goods and services, mainly crude oil, however exceptions concerning petroleum product refined from Iranian crude oil. Also US exports of technological products were forbidden to Iran. The sanctions were eased to some extent the same year and completely in the beginning of the following year. [22]

Fourth round of sanctions

The years following up until 1995 involved US taking measures to prevent their allies to trade with Iran. By imposing Iran as a threat to the rest of the world, and after having imposed sanctions in 1995 on all bilateral trade and investment in Iran, including the Iranian oil, the US expected their allies to reduce trade with Iran. However regardless of US expectations their request did not have an excessive impact on the other countries. Consequently the objections to discontinue trading with Iran led President Bill Clinton to take actions and thus prevented investments in the Iranian oil and gas. This in turn led to the new sanctions enhancing the formerly executed ones from 1984, resulting in the amount of trade that was existed between the countries, was forbidden. The anticipation of enhancing the sanctions was that the allies would this time unite with the US and create setbacks for the Iranian economy.

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[21] Amuzegar, J. (1997) *"Iran's economy and the US sanctions"* Middle East Institute. Vol 51 Page 186-199 No.2 [2015-03-09]

[22] Torbat ,A.E. (2005) *"Impacts of the US trade and financial sanctions on Iran"* Blackwell Publishing Ltd 2005 Page 409-434 [2015-03-04]

Yet the end result was minimal since they did not believe that imposing sanctions could have considerable political influence on Iran's behavior by the comprehensive sanctions on all bilateral trade and investment in Iran. This further gave rise to the Iran Libya Sanctions ACT (ILSA) that was invoked by the Clinton administration in 1996. The act concerned penalizing foreign companies that exported petroleum products, natural gas or related technology to Iran. Hence penalizing any foreign company that invests more than $20 million in the Iranian oil region.[23] The consequences of the banning of Iran's oil directed the Iranians towards other buyers and the replacement of imports from the US had consequences in form of higher costs or with substitutes that were less desired in the third party markets.[24]

In spite of President Clinton actions to diminish trade with Iran the economic, sanctions were reduced five years later in the end of 2000 on account of a new leader in Iran by the name of Mohammad Khatami. The new president of the Islamic republic of Iran had assured there to be new economic and political reforms in Iran. As he gained more support in the parliament, the US continued to ease the sanctions the fact being that food and medicine did not contribute to a nation's military tool to support terrorism. Up until President Clinton's completion as president the sanctions were further lifted on non-oil goods and the prospect of a more soften relation curled, but there was no major breakthrough.

Fifth round of sanctions
Nonetheless the settlement between the two countries ended and the US policies against Iran went from bad to worse as entering "The Bush Era". In September 2001 there was a terrorist attack against United States that consequently made Iran a target of terrorism and the country was called "axes of evil" and being accused of supporting terrorism. By 2003 it was discovered by the International Atomic Energy Agency (IAEA) that Iran was conducting secret operations with nuclear resources and was demanded to suspend all enrichment related and reprocessing activities.

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[23]ILSA act: http://en.wikipedia.org/wiki/Iran_and_Libya_Sanctions_Act [2015-03-05]

[24] Amuzegar, J. (1997) *"Iran's economy and the US sanctions"* Middle East Institute page Vol. 51 No.2. 185-199 [2015-03-09]

Regardless of the requests to suspend uranium by the EU and the support of leading countries Russia, The United States and China, Iran failed to respond to the demands of the EU and IAEA. The restrictions in 2006 included the US banning the Iranian bank "Saderat" to access to the US financial system. Up until 2006 the economic sanctions of the US were challenged by lack of cooperation however after 2006 this changed remarkably. [25]

During 2007 the United Nations took actions toward preventing trade with Iran regarding uranium enrichment and restricted possession of nuclear materials as well as freezing Iranian assets, imposing the toughest sanctions since roughly 30 years. Also the same year the extension of ISA (former ILSA) was permitted, excluding Libya in the act. Furthermore the UN expanded the freezing of Iranian assets by the first quarter of 2008 including monitoring the activities of Iranian banks and inspecting Iranian ships and aircrafts.[26] An additional reason for the relationship worsening between Iran and the west was because of the provocative president in Iran, Mahmoud Ahmadinejad (2005-2013), controversial statements about the United States and Israel. He called the nuclear issue a civil right and defended it, causing reactions from the west.

During mid-2010 there was no improvement, which then resulted in committing the toughest sanctions imposed on the country, the reason being Iran failing to stop enriching the nuclear fuel and the purchases of military being carried out by the Islamic Revolutionary Guards. This prompted several countries to reduce their oil imports from Iran the following year, including Japan, India, China, South Korea, Turkey, South Africa and Singapore. And by 2012 Canada, joined the sanction train together with the other countries and banned all bilateral trade with Iran.[27]

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[25] Ataev, N. (2013) *"Economic Sanctions and Nuclear Proliferation: The case of Iran"* Central European University Department of Economics. Page 1-68 |2015-03-17]

[26] United nations: http://www.un.org/press/en/2008/sc9268.doc.htm [2015-03-09]

[27] Ataev, N. (2013) *"Economic Sanctions and Nuclear Proliferation: The case of Iran"* Central European University Department of Economics. Page 1-68 |2015-02-12]

Since 2012 the US and the EU had imposed additional sanctions on Iran's oil exports and banks. The 27 EU member states had until then accounted for about 20 % of Iran's oil exports was now banned. Along with EU: s instructions, the Brussels- based body that handles global banking transactions took actions on prohibiting money to flow in and out of Iran via authorized channels. In 2013 a new president was elected in Iran by the name of Hassan Rouhani and by the end of 2013 he made some modest achievements with Iran, approving on a temporary agreement with the EU and the P5+1 (The US, UK, France, China, Russia and Germany). The agreement stated that Iran would constrain its uranium enrichment activities. In return the EU along with the P5+1 would stipulate sanction relief on Iran's petrochemical exports along with its imports of goods and services. The arrangements also agreed on partially facilitate Iran's access restricted funds, and there were an anticipated progress made after a long period of disagreements. The settlements however remained insignificant up until this year.[28]

The issue concerning Iran's illicit nuclear program was believed to be a remaining topic until last month in April 2015. Nevertheless Iran agreed to a detailed nuclear outline, taking one step toward a wider deal. The agreement attained by the P5+1 accounted Iran would keep it's nuclear facilities open and under strict production limits thus easing the sanctions that have been in effect in different scope and intensity the past few decades.[29]

However a notion that should be stated is that even though the US have implemented sanctions during different periods of time to prohibit trade with Iran, they have not been in place 100 %. Therefore export of medical and agricultural equipment, humanitarian assistance and trade in informational material such as film had not been prohibited intended to benefit the Iranian people.[30]

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[28] BBC Sanctions against Iran: http://www.bbc.com/news/world-middle-east-15983302 [2015-03-12]

[29] NY Times, Sanctions lifted: http://www.nytimes.com/2015/04/03/world/middleeast/iran-nuclear-talks.html?_r=1 [2015-04-20]

[30] BBC Sanctions against Iran: http://www.bbc.com/news/world-middle-east-15983302 [2015-05-09]

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3.1 Graphical overview concerning the sanctions

The graph below considers Iran's' trade flow throughout a thirty year period (1975-2006). The total import curve demonstrates Iran obtaining imports thus corresponding to United States exporting to Iran. The total export curve demonstrates United States obtaining imports thus corresponding to Iran exporting to the United States. Furthermore the imports and exports are expressed in US dollars.

Graph 3.1 Total import and export during period of 1975-2006
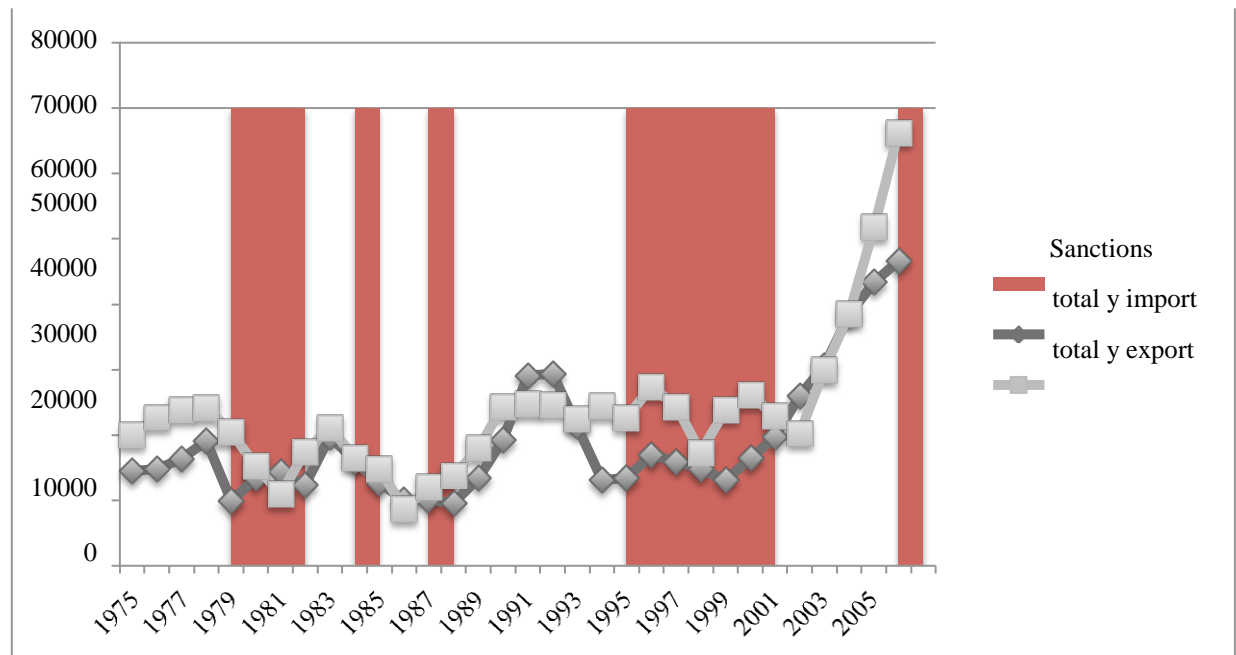
By demonstrating the graph it can be concluded that the Iranian imports follows a slightly sharp decline when implementing the sanctions during the first three time periods 1979-1981 (sanctions 1), 1984 (sanctions 2) and 1987 (sanctions 3). Imposing the first sanctions in 1979-1981 did have a negative impact on Iran's imports as the first year demonstrates a decline in imports, however there is an increase in imports the following year, hence the impact was reduced the remaining years.

The decrease in imports after sanctions 2 supports the idea that sanctions suppress trade after they have been removed, as the economy may have a hard time to recover. The time period 1995-200 establishes the fourth round of sanctions and the graph shows that the comprehensive sanctions on all bilateral trade and investment between

the countries decreased trade, however the import curve demonstrates a decrease even before in 1994. Moreover there are large upward spirals after lifting the sanctions in 1981, 1987 and 2000, indicating increase in imports.

When observing the exports curve it demonstrates that the Iranian export had a substantial decline during 1979 and 1984, corresponding when the first and the second round of sanctions were implemented. The decline in 1984 continued surprisingly after the sanctions have been removed, supporting the similar idea as stated above concerning sanctions suppressing trade (exports) even after they have been removed.

Exports increased after 1987 and became rather stable up until 1996, one year after the sanctions 4 were implemented. Hence during the period of 1995-2000 when the fourth round of sanctions was implemented exports increase the first year but follow a sharp decline up until 1998. The export curve overall dominates, indicating the Iranian economy exports in larger volumes than it imports.

4. Previous Studies

The gravity model has been used in the analysis of a range of international trade issues. Certain results have become necessary to encounter with as they have contributed to essential benchmarks, and other papers have become highpoints for additional studies. The model has long been acknowledged for its consistent empirical achievement in clarifying many different types of flows, such as migration, commuting, tourism, and commodity shipping. These various specifications of gravity model have been applied to determine the impact of different estimates on the volume of trade.

Nitsch (2000) analyzed the influence of national borders on international trade within the European Union (EU) through the gravity model for the time period 1979 to 1999. His findings suggested that domestic trade within the average EU country in fact was approximately ten times bigger than trade with alternative EU country (same size and distance). The paper estimated a home counting bias[31] of 11,3 for the EU member countries, after controlling for language, common border, distance and remoteness. The conclusion being made in the paper suggested that even within the EU, national borders were in fact a crucial influence when trading with other nations.[32]

Dilanchiev (2012) used the gravity approach to examine the trade pattern of Georgia by incorporating data from 2001 until 2011.The paper included the basic gravity estimates and the control variables such as EU member, common history and foreign direct investment (FDI). As expected Georgia's trade was affected positively by the GDP and negatively by distance in the basic gravity model. The paper concluded that foreign direct investment affects Georgia's the trade volume positively and found that common history was a significant factor influencing Georgia's trade pattern.[33]

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[31] *The term home bias refers to the tendency of individuals to make investments in their home countries rather than in the foreign countries markets.*

[32] Nitsch, V. (2000). *"National Borders and International Trade: Evidence from the European Union"* Canadian Journal of Economics 33, Page 1091-1105. [2015-03-27]

[33] Dilanchiev, A. (2012), "*Empirical Analysis of Georgian Trade Pattern: Gravity Model*", Journal of Social Sciences, 1(1) Page 75-78 [2015-04-15]

Khiyavi, Moghaddasi and Yazdani (2013) explored the essential factors affecting trade in agriculture in the case of developing countries with the help of gravity model. The data considered 14 developing countries, including India, Brazil, Iran and Kenya and more, with a time period of 1991-2009. The results of the study revealed growth of the market size of exporting and importing nations tend to influence trade in agricultural commodities. Moreover agricultural trade volume of the importing nation was positively and significantly influenced by its per capita income and inversely in the circumstance for the exporting country.[34]

The study by Soori and Tashkini (2012) introduced the gravity model towards explaining bilateral trade between Iran and different regional blocks across the globe during 1995-2009. Their empirical results indicated that as expected, geographical distance has a negative sign and is significant in the model. Hence, trade grows if the transportation costs decreases and vice versa as one could expect, strengthening assumptions advocated by different economists. They further extended the model by adding economic dimension (average of GDP) and income per capita to their model. The extended model confirmed the estimates had positive outcome on bilateral trade. Finally they implemented the variable FDI and confirmed their hypothesis denoting that the variable had a positive correlation to trade.[35]

A work that observed Iran's bilateral trade was Nasiri and Hassani Asl (2013) concerning the assessment of Iran's international trade potential. The outline regarded Iran's 161 trading partners in 2011 and by implementing the gravity model they examined the gaps regarding potential and actual trade among member nations. Their results established that the standard gravity model with the basic estimates GDP per capita and distance were significant. Furthermore they included control variables common border, common cultural issues, membership in ECO, membership of

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[34] Khiyavi, P.K. Moghaddasi, R, and Yazdani, S. (2013), *"Investigation of Factors Affecting the International Trade of Agricultural Products in Developing Countries"*, Life Science Journal, 10(3s), Page 409-414. [2015-04-15]

[35] Soori, A.R and Tashkini, A. (2012), *"Gravity Model: An application to trade between Iran and Regional Blocs"*, Iranian Economic Review, Vol 16, No 31. Page 1-10 [2015-03-20]

business partner in ASEAN, membership of business partner in EU and EAEC (East Asia economic consideration), in their gravity model and created an augmented gravity model that considered the characteristics of Iran's individual partners. Their results indicate that population, membership of business partner in EU and EAEC control variables were significant and had a substantial effect on Iran's bilateral trade flows. In order to determine Iran's trade potential the estimated coefficients from the regression model were used to analyze Iran's trade pattern. Hence they compared the actual values of trade flows with all of their business partners and the numbers indicated whether trade potential were possible or not with Iran's trading partners. Their results denoted that Iran possessed potential to increase trade with 94 nations and had maximized the trade level with 67 nations.[36]

A paper that examined the sanctions efficiency on Iran's Non-oil trade by applying the gravity model was Hadinejad, Mohammadi and Shearkani's paper from 2010. Their object was to distinguish whether the sanctions had been effective or not throughout 1977-2006 with a sample of 42 trading partners of Iran. The effect of sanctions was essentially estimated using dummy variables; moderate or extensive, which demonstrated the coverage of the sanctions. They demonstrated that the moderate sanctions were implemented before 1995 and the extensive after 1995 due to the history of sanctions on Iran. The economic findings in this paper indicated that the dummy variable EXT (extensive) had a negative effect on Iran's trade flows since the estimate had a negative sign and was statistically significant. The other dummy variable MOD (moderate) was also statistically significant, indicating that the extensive embargoes had influenced Iran's exports and imports negatively. The distance measure surprisingly demonstrated a positive sign but the estimate was interestingly insignificant. An explanation according to them could be that Iran

[36] Nasiri, N and Hassani A.S.H. (2013) *"Assessment of IRAN's International Trade Potential (A Gravity Model Analysis)",* Reef Resources Assessment and Management Technical Paper Vol. 38 (5) Page 398-409 [2015-03-26]

doesn't follow the declining transportation costs idea from the basic gravity model and has discovered other marketplaces for its goods and services.[37]

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[37] Hadinejad, M, Mohammad, T, Shearkhani, S. (2010) *"Examine the Sanctions' Efficiency on Iran's Non-Oil Trade (Gravity Model)"* Social Science Electronic Publishing, Inc. Page 1-6 [2015-03-26]

5. Data and description

The panel data set used in this thesis includes bilateral trade data for a span of 31 years, with a time period of 1975-2006, yielding 9701 observations for the data set. The time period is interesting in the point of view that it covers bilateral trade flows four years prior the revolution in 1979 and ends in 2006, covering the whole period where only the United States implemented the sanctions. Additional reason for choosing the following years is to measure the effect before the financial crisis took place, which left an enormous impact on the world economy. Also all data that doesn't regard Iran being the exporter and importer is dropped from the data and not included in the observation. The data applied for this empirical analysis were collected from different databases and can be regarded in the appendix. Moreover the data set incorporates 177 trading partners of Iran and can be regarded in the appendix.

5.1 Variables

5.1.1 Dependent variable
The dependent variable in the equation corresponds to bilateral trade flows and is the export and import of good and services between nations. However in this paper the dependent variable denotes the value of bilateral trade denoted in exports from country *i* to *j* represented in current US dollars, covering the period 1975 to 2006.[38]

5.1.2 Independent variables
The classic gravity model in particular include economic sizes of the countries as explanatory factors, also denoted GDP (*i,j*). The variable GDP_i and GDP_j indicate the gross domestic product measured in US dollars for the origin and destination countries and acquire constant prices as well as common currencies. Where constant prices are captured by the price level of GDP expressed relative to the United States.[39] When two countries GDP's increases it will generate more amounts of exports and

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[38] Feneestra, R.C. And Taylor, A.M. (2014) "International Economics" 3 ed. Worth publishers New York Page 189-193 [2015-03-25]

[39] Head, K., T, Mayer and J. Ries. (2010), *"The erosion of colonial trade linkages after independence"* Journal of International Economics, 81(1): Page 2-28 [2015-04-24]

imports; therefore a correlation exists between economic size and trade flows and vice versa. Thus the estimated coefficients are expected to have a positive sign.[40]

The classic gravity model additionally depicts distance as the other explanatory factor affecting the total value of goods traded. However unlike GDP coefficients, the distance measure affects trade adversely since increasing geographic distance decreases the trade between nations. Usually the time invariant distance measure affects trade flows adversely because increasing distance due to economic, cultural and political differences will diminish request for reciprocal trade. According to Huang (2007) larger distance between nations tend reduce trade due to the transactions costs becoming more expensive as well as other obstacles to trade such as informational and physiological disagreements. Therefore the expected sign in the model would be negative.[41] It should be noted that the distance measure consists of the distance between the two nations capital measured in kilometers from great circle distance, in this case between Tehran and the trading partners capital.[42]

The population variables for origin and destination nations are added with the purpose of estimating the market size. Accordingly, the estimates should acquire positive signs since the bigger the market, the more it is said to trade indicating a positive effect on trade flows.[43] It may however also have a contrary impact on trade flows as nations with larger economies may be less open to trade due to the nations finding more within their own borders. Dell' Ariccia (1999) [44] and Martínez-Zarzoso (2003)

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[40] Krugman, P.R and Obstfeld, M. (2012) *"International Economics Theory and Policy"*. 9th ed. Pearson Education Limited. Page 43-44[2015-03-26]

[41] Huang, R.R. (2007) *"Distance and trade: disentangling unfamiliarity effects and transport cost effects."* European Economic Review 51 Page 161–181 [2015-03-24]

[42] Head, K. (2003) *" Gravity for beginners"* Paper prepared for UBC econ 590a students, January, Faculty of commerce, University of British Colombia Page 2-11 [2015-03-24]

[43] Matyas, L. (1997) *"Proper econometric specification of the gravity model"* World Econ 20(3) Page 363–368 [2015-03-24]

[44] Dell'Ariccia, G. (1999) *"Exchange rate fluctuations and trade flows: evidence from the European union."* IMF Staff Pap 46(3) Page 315–334 [2015-03-24]

acquired negative signs in their paper indicating that larger countries have more capable resources and are efficient in supporting themselves in larger extent.[45]

5.1.4 Dummy variables

The following dummy variables, common language and common border refer to time invariant variables and are applied to measure the joint cultural factors and geographical proximity. If nations share common language it's considered that the barriers of communication are smaller and that trade will be higher between the nations, than two nations that do not share the same language. This may be partly related to historically established trade ties. Language is hence predicted to acquire a positive relation to trade. Serrano and Pinilla (2012) strengthen this assumption in their paper by obtaining a positive relationship between language and trade flows.[46]

Common borders are a significant factor in determining trade values because of transaction costs. Nations that share borders have lower transportation costs due to distance being small; hence common border is expected to have a bearing on bilateral trade. Following Charoensukmongkol and Sexton (2011), a positive sign is expected resulting in a positive effect on trade flows that tends to expand bilateral commerce.[47] The estimates takes the value of 1 countries *i* and *j* shares the common language or common border otherwise a 0 if they do not.

5.1.5 Sanctions dummy

To capture the effect of sanctions, the regression model will include the time variant dummy variable intended to control for economic sanctions that might affect trade, conclusively creating an extended model. When evaluating sanctions some

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[45] Martínez-Zarzoso, I. (2003) *"Gravity Model: An application to trade between regional blocs."* American Economic Review, 31(2) Page 174-187 [2015-05-08]

[46] Serrano, R. and Pinilla, V. (2012) *"The long-run decline in the share of agricultural and food products in international trade: a gravity equation approach to its causes",* Applied Economics 44(32), Page 4199-4210 [2015-04-15]

[47] Charoensukmongkol, P and Sexton, S. (2011), *"The effect of corruption on exports and imports in Latin America and the Caribbean"*, Latin American Business Review 12(2), Page 83-98 [2015-04-15]

distinctions should be made. Sanctions imply trade restrictions to reduce exports or imports or both. However there may be financial sanctions as well restricting trade by denying investment, credit or foreign exchange. In this paper financial sanctions are included in the same dummy and it considers restrictions in both exports and imports. Furthermore sanctions in the importing country tend to have a significant negative effect on bilateral imports. The presence of sanctions reduces the volume of trade, hence there exists a negative relationship between sanctions and the dependent variable bilateral trade flows. The abbreviation i corresponds to origin country, and j corresponds to the destination country.

The sanctions implemented on Iran during the time period was only performed by the United States, hence the sanctions regard bilateral sanctions between the countries and is an average measure of sanctions during the 30-year period. The dummy variable indicates whether the destination nations have imposed sanctions on the origin country or not and value of the dummy variable is binary. The dummy variable is coded with either a 1 or 0. 1 if the destination country has imposed sanctions during some period of time or otherwise 0.

Further, In order to test the impact of sanctions on bilateral trade during the time period they were executed, the sanctions will be divided into five different time periods. The first sanctions implemented on Iran took place in 1979-1981, displaying sanctions 1, The second and third occurred in 1984 and 1987, representing sanctions 2 and sanctions 3, The fourth and fifth wave happened in 1995-2000 and 2006, representing sanctions 4 and sanctions 5. Similar to the average sanction measure these dummy variables are coded 1 if the destination country has imposed sanctions, otherwise 0.

5.2 Econometric modeling

In order to explore the impact of sanctions on Iran's trade flows the model is set up as a logarithm form in order to obtain a linear relationship, similar to *equation 2.3*. The model is also extended with a number of dummy variables intended to control for geographic relations and cultural influences that might affect trade. All variables are in logarithms except the binary variables sanctions, language and common border. This is due to not being able to take natural log of a dummy variable, as the logarithm of zero is undefined. The time-invariant controls are distance, common border and common language. Below follows the standard gravity model equation.

The baseline-estimated equation is:

$$LnT_{ijt} = \beta_1 + \beta_2 lnY_{it} + \alpha_1 lnY_{jt} + \alpha_1 lnDis_{ijt} + \varepsilon_{ijt} \qquad (5.1)$$

Where T_{ijt} is total trade flows from the origin country i to destination country j in year t, Y_{it} and Y_{jt} corresponds to country i and j 's economic sizes measured in GDP in year t, Dis_{ijt} is the distance between country i and j in year t and ε_{ijt} is the error term.

The first modified gravity model includes the dummy variable sanctions in the regression in order to measure political conflict. The estimated equation is:

$$LnT_{ijt} = \beta_1 + \beta_2 lnY_{it} + \alpha_1 lnY_{jt}$$

$$+\alpha_1 lnDis_{ijt} + \alpha_1 \sum_{i}^{!} Dsanct_{ijt} + \varepsilon \qquad (5.2)$$

Where T_{ijt} is total trade flows from the origin country i to destination country j in year t, Y_{it} and Y_{jt} corresponds to country i and j 's economic sizes measured in GDP in year t, Dis_{ijt} is the distance between country i and j in year t. $Dsanct_{ijt}$ is an average measure corresponding sanctions implemented on Iran by country j in year t taking the value of 1 if sanctions have been implemented and 0 otherwise. ε_{ijt} is the error term.

The second modified model is incorporated with a number of extra controls; population is added in order to measure to what extent population affects trade. Sets of dummy variables are also included. Common language is added controlling for cultural ties and the geographical dummy variable common border is included to control to what extent it may significantly affect international trade transportation.

The estimated equation is:

$$LnT_{ijt} = \ln\alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln Y_{jt} + \alpha_3 \ln Dist_{ijt}$$

$$\sum + \propto_4 \quad Dsanct_{jt} + \alpha_5 \ln Population_{it} + \alpha_6 \ln Population_{jt}$$

$$+ \alpha_7 Dlanguage_{ijt} + \alpha_8 Dborder_{ijt} + \varepsilon_{ijt} \qquad (5.3)$$

Where T_{ijt} is total trade flows from the origin country i to destination country j in year t, Y_{it} and Y_{jt} corresponds to country i and j 's economic sizes measured in GDP in year t, $Dist_{ijt}$ is the distance between country i and j in year t. $Dsanct_{ijt}$ is an average measure corresponding sanctions implemented on Iran by country j in year t taking the value of 1 if sanctions have been implemented and 0 otherwise. Population i and population j are the size of the population in the consistent countries in year t. $Dlanguage_{ijt}$ and $Dborder_{ijt}$ are dummies taking the values 1 if nations i and j share common language or common border in year t, otherwise 0. ε_{ijt} is the error term.

In addition, when the sanctions are divided into five different time periods to measure the effect during a specific year the estimated equation is the following:

$$LnT_{ijt} = \ln\alpha_0 + \alpha_2 \ln Y_{it} + \alpha_3 \ln Y_{jt} + \alpha_4 \ln Dist_{ijt}$$

$$+ \alpha_5 Dsanct1_{ijt} + + \alpha_6 Dsanct2_{ijt} + + \alpha_7 Dsanct3_{ijt} + + \alpha_8 Dsanct4_{ijt}$$

$$+ \alpha_9 Dsanct5_{ijt} + \alpha_{10} \ln Population_{it} + \varepsilon_{11} \ln Population_{jt}$$

$$+ \alpha_{12} Dlanguage_{ijt} + \varepsilon_{13} Dborder_{ijt} + \varepsilon_{ijt} \qquad (5.4)$$

Where T_{ijt} is total trade flows from the origin country *i* to destination country *j* in year *t*, Y_{it} and Y_{jt} corresponds to country *i* and *j* 's economic sizes measured in GDP in year *t*, D_{ijt} is the distance between country *i* and *j* in year *t*. $Dsanct1_{ijt}$ corresponds to sanctions implemented during time period 1979-1981, $Dsanct2_{ijt}$ measures sanctions implemented in year 1984, $Dsanct3_{ijt}$ corresponds to sanctions implemented in year 1987, $Dsanct4_{ijt}$ measures the sanctions implemented in time period 1995-2000 and $Dsanct5_{ijt}$ for year 2006. Population *i* and population *j* are the size of the population in the consistent countries in year *t*. $Dlanguage_{ijt}$ and $Dborder_{ijt}$ are dummies taking the values 1 if nations *i* and *j* share common language or common border in year *t*, otherwise 0. ε_{ijt} is the error term.

5.3 Choosing between random effect and fixed effect model

When analyzing the panel data there is a choice between the estimation techniques of random effect (REM) and fixed effect (FEM). The FEM allows the individual *Xi's* to be fixed for each subject, hence making it time invariant while the REM considers the intercept values to be random drawings from a much larger population. In order to distinguish which model to choose, the Hausman specification test can be applied comparing the two estimation techniques. The test suggests that if the p-value is less than 0.05 we can reject the null hypothesis indicating that the random effect is efficient. Thus the alternative hypothesis is appropriate and the fixed effect is preferred.[48]

The results of the Hausman test carried out in this analysis strongly rejects the REM as the p-value of the estimated chi-square is very low, **Prob>chi2 = 0.00.** Thus in this paper the fixed effect will be carried out. An advocate for the fixed effect estimation is the scholar Matyas (1997) who denotes that the model is more efficient in gravity model analyzes.[49]

[48] Gujarati, D. (2011), *"Econometrics By Examples"* Palgrave Macmillan Publishers. Page 279-295 [2015-05-10]

[49] Matyas, L. (1997) *"Proper econometric specification of the gravity model"* World Econ 20(3) Page 363–368 [2015-04-20]

6. Results

Table 6.1 reports the estimation outcomes resulting from the different variables employed. Five different regressions are retained in the study, including a set of time dummies variables in all regressions to account for the changing nature over time that affects all trade flows. The first column lists the coefficients of a basic gravity model. The second column includes the average sanctions dummy in the regression model to evaluate the effects of embargoes on the volume of trade. The third column represents a gravity model including all control variables as well as region dummies incorporated in order to make it simpler to estimate the impact of time invariant variables. The fourth column lists all the variables including exporter and importer dummies. The last column lists the coefficients of fixed effect regression.

Table 6.1 Regression estimation results for trade flows

Independent Variables	OLS (1.1)	OLS (1.2)	OLS (1.3)	OLS (1.4)	FE (1.5)
Ln (GDP i)	1.216	1.231	1.216	0.475	0.475
	(.022)***	(.022)***	(.044)***	(.088)***	(.186)***
Ln (GDP j)	1.305	1.317	1.299	1.157	1.157
	(.020)***	(.020)***	(.046)***	(.101)***	(.210)***
Ln (Distance)	-1.497	-1.483	-0.125	-3.401	Omitted
	(.047)***	(.046)***	(.149)	(.542)***	
Dummy: Sanctions	-	-2.608	-2.159	-1.001	-1.001
		(.445)***	(.471)***	(.501)***	(.263)***
Ln (Population i)	-	-	-.1412	1.111	1.111
			(.052)***	(.213)***	(.475)***
Ln (Population j)	-	-	-0.059	3.014	3.014
			(.050)	(.282)***	(.605)***
Dummy: Common Language	-	-	-1.298	-9.358	Omitted
			(.243)***	(1.43)***	
Dummy: Common Border	-	-	1.222	-12.440	Omitted
			(.141)***	(1.117)***	
Time dummy	Yes	Yes	Yes	Yes	Yes

Exporter dummy	No	No	No	Yes	Yes
Importer dummy	No	No	No	Yes	Yes
Region dummy	No	No	Yes	No	No
Observations	5830	5830	5818	5818	5818
R^2 value	0.561	0.563	0.647	0.820	0.010*

[Notes: Standard error within parenthesis. *** Indicate significance of P-value at 5 percent level p<0.00. * Indicate within R^2 obtained in fixed effect models]

The first column (1.1) estimates data in a simple linear regression with gravity model coefficients. The independent variables economic sizes and distance have the expected signs and are statistically significant and thus consistent with theory expectations. An increase in Iran and its trade partners GDP and a decrease in distance between Iran and its members will raise Iran's trade flows. The importing country's GDP, the US, influence the pattern of trade more than the exporting (Iran's) country GDP. Also for every one percent increase in the distance between a Iran and a trading country, trade flows tends to fall by around 1,50 percent. The R^2 demonstrates that the explanatory variables account for 56 percent of the observed variation in trade flows in the data.

The results listed in column (1.2), particularly the advent of the dummy variable sanctions demonstrates a negative coefficient, coherent with existing theories. Trade is specified in logarithmic form, to interpret the coefficient on the sanction dummy exponent must be used. The impact of an increase in sanctions of will decrease Iran's trade flows by around 93 percent *[(e $^{-2.608}$-1)*100%]*. Thus indicating that the embargoes executed by the US has a large negative impact on the Iranian trade.

The remaining variables are also significant, thus for the distance measure, Iran follows the decreasing transportation costs' idea as the gravity model predicts. The R^2 indicate a value of 56 percent, implying that the sample regression line fits the data as well as the previous column (1.1).

In column (1.3) all of the coefficients have negative signs except for economic sizes (as expected) and the dummy variable common border. There is therefore a positive

relationship between common border and trade flows, demonstrating that as trade flows increases so does the common border between nations, thus supporting Charoensukmongkol and Sexton (2011) hypothesis regarding positive relationship between Iran's trade flows and common border. The cultural proximity, language follows a negative sign denoting negative impact on trade flows, contrary to the empirical findings by Serrano and Pinilla (2012).

Also the coefficients are statistically significant except for population for country *j*, the US, and the distance measure, the insignificance indicates decreases in distance between partners do not explain the increased trade flows. However the significance of the dummy variables indicates individual features of Iran's trade partners could have had significant impact on mutual trade flows. The sanctions dummy results resemble previous results however with a slightly smaller negative value of -2.159, indicating that an influence of increase in sanctions will decrease trade flows by 88 percent *[(e $^{-2.159}$-1)*100%]*. The result indicates that the embargoes have a negative effect on trade flows. Therefore when including the region dummies to account for the time invariant variables the coefficients for sanctions are reduced. Furthermore 12 observations are reduced once region, exporter and importer dummies are included.

Contrary to previous columns, column (1.4) regression acquires positive signs for population estimates and a negative effect on common border estimate, contradicting previous scholars' theoretical predictions. Furthermore all variables are significant at the five percent level. The indications suggest economic sizes have a positive impact with elasticity's of 0.47 and 1.16. Thus denoting, an increase in GDP of 10 percent for the origin country Iran increases trade by 4.7 percent and an increase in GDP of 10 percent for the destination country, the United States, increases trade by 11.6 percent. The sanctions estimate is reduced by half, near -1.00, hence the established interpretation is that sanctions reduce trade flows by 63 percent. *[(e $^{-1.001}$-1)*100%]*. When including exporter and importer dummies the sanctions dummies are reduced indicating that the exporter and importer dummies have a significant effect.

The R^2 value corresponds to 82 percent, corresponding the highest value in the table. Hence concluding that all variables incorporated in the model explain 82 percent of changes related to Iran's bilateral trade flows.

The final column, (1.5) demonstrates as anticipated, that the time invariant estimates distance, common language and common border to be omitted due to the fixed effect. As mentioned earlier the model does not include variables that are not changing over time, therefore this also contributes to the exporter and importer dummies to be omitted from the regression. Contrary to OLS estimation (1.3) the population variable for destination country is positive and significant, indicating population having a positive effect on trade flows in the fixed effect model. As expected, the sanction dummy is negative followed by an estimate value of -1.00, a value that is considerably less than the previous regression models. Thus one can conclude that the fixed effect contributes with more reliable estimates than OLS, based among others on the significance and signs of the estimates in the FE column.

Incorporating five sanction dummies acquires a modification of the regressions presented in table 6.2. The dummy variables have distributed the sanctions into five different time periods: sanctions 1: 1979-1981, sanctions 2: 1984, sanctions 3: 1987, sanctions 4: 1995-2000 and sanctions 5: 2006. Similar to the previous table, all models include time dummies. The first column (1.6) demonstrates the gravity model with all five sanctions dummies. The second column (1.7) includes region dummies; the third column incorporates exporter and importer dummies. The last column lists the coefficients of fixed effect regression.

Table 6.2 Regression results for trade flows when allocating sanctions into five various time periods

Independent Variables	OLS (1.6)	OLS (1.7)	OLS (1.8)	FE (1.9)
Ln (GDP i)	1.231	1.218	0.478	0.478
	(.022)***	(.044)***	(.088)***	(.186)***
Ln (GDP j)	1.318	1.301	1.159	1.159
	(.047)***	(.046)***	(.101)***	(.210)***
Ln (Distance)	-1.483	-.1256	-3.391	Omitted
	(.568)***	(.150)	(.550)***	
Dummy: Sanct1	-1.187	-0.757	0.232	0.232
	(.471)***	(.594)	(.602)	(.115)***
Dummy: Sanct2	-1.357	-0.942	0.244	0.244
	(1.114)***	(.559)	(.504)	(.348)
Dummy: Sanct3	-1.355	-0.884	0.366	0.366
	(0.224)	(1.201)	(1.126)	(.973)
Dummy: Sanct4	-4.064	-3.601	-2.319	-2.319
	(.640)***	(.646)***	(.721)***	(.896)***
Dummy: Sanct5	-3.513	-3.043	-1.922	-1.922
	(.189)***	(.267)***	(.260)***	(.143)***
Ln (Population i)	-	-0.143	1.095	1.095
		(.052)***	(.213)***	(.473)***
Ln (Population j)	-	-0.061	2.996	2.996

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		(.050)	(.281)***	(.603)***
Dummy: Common Language	-	-1.297 (.243)***	-9.295 (1.432)***	Omitted
Dummy: Common Border		1.222 (.141)***	-12.363 (1.117)***	Omitted
Time dummy	Yes	Yes	Yes	Yes
Exporter dummy	No	No	Yes	Yes
Importer dummy	No	No	Yes	Yes
Region dummy	No	Yes	No	No
Observations	5830	5818	5818	5818
R^2 value	0.563	0.647	0.821	0.102*

[Notes: Standard error within parenthesis. *** Indicate significance of P-value at 5 percent level p<0.00. * Indicate within R^2 obtained in fixed effect models]

In column 1.6, the underlying classical gravity model for international trade following GDP and distance acquire the expected signs and remains highly significant. Therefore, the further away a trading nation is, the lower will the trade intensity be. However the values indicate trade increasing less than proportionately with the GDP of the importing country Iran, and more than proportionately with the GDP of the exporting country the United States. The results illustrates that all of sanctions coefficients have negative signs, sanctions 1 and 2 around -1, while sanctions 4 and 5 around -4. They are consistent with expectations that sanctions decrease trade, following statistically significant values. The lower value for sanctions 1, a decrease of around 70 percent on trade flows, might be on the account of the United States "only" restricted oil exports, aid and military assistance imports during 1979-1981. Also during sanctions 2 the United States restricted weapon, aid, credit and finance assistance, resulting in a decrease in trade flows by 74 percent. Whilst during sanctions 4 all bilateral trade was restricted between the countries, thus resulting in larger negative trade flows effects of 98 percent.

Furthermore the only sanction coefficient not significant is sanctions 3. Thus in this year, 1987, Iran's trading has been carried out without being influenced by the

embargoes transmitted out by the United States. A claim for this reason might be discovering further trading partners and hence utilizing unused relationships accompanied by the new nations.

Column 1.7 illustrates performance of including dyadic control variables. The geographical and cultural proximity dummies do not alter the signs of the former coefficients and they follow their expected signs. However distance, sanctions 1, sanctions 2, sanctions 3 and population j are not statistically significant. Hence it seems that the importance of geographical neighborhood does not apply and there is an economic motivation to increase trade with geographically distant countries. The insignificance values of sanctions 1, and sanctions 3 denote Iran's trade sanctions implemented by the United States did not induce a disruption of trade during 1979-1981, 1984 and 1987. Under these periods of time Iranian trade has been executed without interference from sanctions. The remaining significant sanctions 4 and 5 present decreases in trade flows by nearly 97 and 95 percent. As expected when they are in place they have a large negative impact on trade flows.

The following column, 1.8 demonstrates the inclusion of importer and exporter dummies in the presence of all monadic and dyadic variables. The results listed in the following column show that increases in the economic sizes promote bilateral trade with elasticity's that vary between 0.47 and 1.16. When comparing column 1.7 and 1.8 the common border coefficient has transformed from a positive sign to a negative sign similar to the comparison of column 1.3 and 1.4. Hence when including exporter and importer dummies the geographical proximity dummy is altered, indicating that exporter and importer dummies controlling overall for different properties of the business cycle or different chocks for each country has an effect in the regression.

Moreover the first three sanction dummies present positive coefficient signs, that would indicate a positive correlation between the embargoes and trade flows however with highly insignificant p-values. The insignificant values suggest that the following sanctions do not explain the changes in Iran's trade flows. Another possible explanation that could exist considers that trade was during these periods were limited between the countries and therefore the effect is not captured.

The last two sanctions executed, sanction 4 and 5, corresponds to the years 1995-2000 and 2006. These values are both negative and significant. Thus during 1995-2000 restrictions against all bilateral trade investment between the US and Iran did in fact have a great impact on trade flows, decreasing trade flows by around 90 percent, whilst an increase in sanctions implemented in 2006 decreased trade flows by 85 percent. Moreover, imports were affected more than exports between 1995 until 2000, as can be regarded in graph 3.1 with a sharp decline in imports one year before the sanctions, 1994, and an even greater increase after the sanctions were lifted in 2000. The R^2 denotes all variables included in the model explain 82 percent of changes related to Iran's bilateral trade flows.

Finally the fixed effect is applied and determined in column 1.9 diminishing time invariant variables, including exporter and importer dummies. Estimation results confirm that trade is positively correlated with countries economic sizes and both the coefficients are significant. The following sanction variables results indicate positive coefficients on the first three sanctions and negative signs on the last two. However it follows that sanctions 2 and sanctions 3 are not significant while the remaining sanctions, 4 and 5, are highly significant. Thus the similar interpretations can be made here as in column (1.8) concerning the United States restricting all bilateral trade flows throughout 1995-2000, therefore affecting trade flows to large extent. Moreover, an interesting remark concerning sanctions 4 is that this dummy is the only variable that follows the expected negative relationship throughout the different regressions and is significant in every column.

Additionally sanctions 1 indicate a positive relationship between trade flows and sanctions as well as demonstrating a significant value; hence there is no evident explanation to why the results indicate inconsistent values.

Table 6.3 reports the estimation outcomes resulting from the two different estimation methods. The first four columns denote Heckman using the two-step procedure. Column (2.1) and (2.3) denotes the Heckman regression estimates of the trade flows; column (2.2) and (2.4) denotes the selection equation. The last column represents PPML. All columns include year dummies, the third and fourth include exporter and importer dummies and the last column includes region dummies.

Table 6.3 Empirical results for trade flows from alternative estimation methods

	Heckman				PPML
Independent Variables	**(2.1)** Regression	**(2.2)** Selection	**(2.3)** Regression	**(2.4)** Selection	**(2.5)**
Ln (GDP i)	1.229	0.510	0.475	0.021	0.811
	(.029)***	(.012)***	(.080)***	(.079)	(.035)***
Ln (GDP j)	1.316	0.355	1.157	0.027	0.763
	(.0223)***	(.0102)***	(.084)***	(.074)	(.033)***
Ln (Distance)	-1.481	-0.477	-3.355	0.008	-0.176
	(.047)***	(.025)***	(.216)***	(.215)	(.119)
Dummy: Sanctions	-2.605	-1.231	-0.980	-2.288	-0.876
	(.495)***	(.371)***	(.398)***	(3.664)	(.431)***
Dummy: Common Border	-	-0.280	-	1.781	0.643
		(.098)***		(1.218)	(.122)***
Ln (Population i)	-	-	1.111	0.082	-0.053
			(.246)***	(.326)	(.038)
Ln (Population j)	-	-	3.014	0.033	-0.033
			(.247)***	(.340)	(.036)
Dummy: Language	-	-	-5.574	-1.761	-1.495
			(.595)***	(1.003)	(.169)***
Time dummy	Yes		Yes		Yes
Exporter dummy	No		Yes		No
Importer dummy	No		Yes		No
Region dummy	No		No		Yes
Observations	9155		9138		9138

Rho	-0.004***	-0.080***	-
Lambda	-0.009***	-0.122	-
R²	-	-	0.679

[Notes: Standard error within parenthesis. *** Indicate significance of P-value at 5 percent level p<0.00]

Disregarding zero trade flows introduces obvious problems in the log-linear form of the gravity equation. To solve this problem, various panel data estimation techniques are applied in the table above. Both the Heckman model and the OLS regression are estimated in log linear specification form. As the sample selection is used, it corrects the issue of zero trade flows by considers them to be unobserved, the observations are therefore increased by 1/3, from 5830 to 9138.

The first part of the output (2.1) is the usual gravity model, and the coefficients are quite close to their OLS counterparts in table 6.1 OLS regression column (1.2). Further the results indicate negative relationship between sanctions and trade flows for both methods, consistent with theories. One percent increase in the bilateral distance results in a decrease of 1.48 percent in bilateral trade flows as predicted by the OLS model as well as 1.48 percent as predicted by the Heckman model. The second part (2.2) presents the results for the selection equation and the variable common border is reporting for factors affecting the probability of positive trade. The variable applied, as exclusion restriction is significant but acquires a negative sign, suggesting evidently, sharing common border with Iran is relatively less advantageous for trade flows. Also the sanction coefficient corresponding to the average of all sanctions is lower in the selection part, with a value of -1,21. Furthermore the parameter rho is low and statistically significant, indicating that the sample selection is consistent in the dataset.

The first part of output (2.3) demonstrates the inclusion of all independent variables and similar to the previous comparison the OLS counterparts in column (1.3) the coefficients are similar to larger extent. However the dummy variable language differs when comparing the models and the distance measure is significant at the five

percent level in Heckman regression while it is insignificant in the OLS regression. The sanctions coefficient is significant and negative in column (2.3) but not in column (2.4). Also the second part (2.4) includes common border explaining for the zero values. The common border estimate is positive in the Heckman selection, it is however not significant as for all of the other estimates. Thus reasonable predictions concerning common border cannot be made here. Also the parameter rho is low and statistically significant, indicating that the sample selection should be consistent in the dataset.

The last column corresponds the results for the Poisson Pseudo Maximum Likelihood estimation (PPML). The dependent variable is not presented in logarithm unlike the Heckman model and OLS, but in levels. The estimated signs follow the gravity model prediction and is quite similar to OLS and Heckman estimation, however PPML reduces the magnitude of the coefficients as well as the standard errors. The model similar to Heckman model includes more observations than OLS, 9318 correspondingly. Exporter and importer dummies were not included here as it was not possible in Stata to estimate together with the dummies.

Although the sign and significance are quite similar to column (1,3) PPML has reduced the magnitude of the coefficients as well as the standard errors. The sanctions coefficient displays a negative sign and is highly significant. The PPML measure provides the following results regarding the sanctions dummy; the impact of an increase in sanctions of will decrease Iran's trade flows by around 59 percent $[(e^{-0.87})$ - $1*100\%]$. Further the measures distance, origin population and destination population are not significant, as established in the OLS regression column (1.3). Hence these measures do not explain the changes in trade flows. Moreover R^2 denotes all variables included in the model explain about 68 percent of changes related to Iran's bilateral trade flows.

The first four columns in table 6.4 denote as previously explained the Heckman model using the two-step procedure. Column (2.6) and (2.8) denotes the Heckman regression estimates of the trade flows; column (2.7) and (2.9) denotes the selection equation. The last column (3.0) represents PPML. All columns include year dummies, the third and fourth include exporter and importer dummies and the last column includes region dummies.

Table 6.4 Empirical Results for trade flows from alternative estimation methods

Independent Variables	Heckman				PPML
	(2.6) Regression	**(2.7)** Selection	**(2.8)** Regression	**(2.9)** Selection	**(3.0)**
Ln (GDP i)	1.229	0.510	0.478	0.020	0.812
	(.029)***	(.012)***	(.0803)***	(.079)	(.034)***
Ln (GDP j)	1.317	0.355	1.159	0.026	0.765
	(.022)***	(.010)***	(.083)***	(.074)	(.032)***
Ln (Distance)	-1.482	-0.477	-3.351	0.006	-0.180
	(.047)***	(.025)***	(.215)***	(.215)	(.118)
Dummy: Sanct1	-1.186	4.440	0.226	5.307	0.143
	(.846)	(11328.2)	(.593)	(1.29e+08)	(.522)
Dummy: Sanct2	-1.357	4.465	0.233	5.358	-0.858
	(1.687)	(21968.1)	(1.107)	(2.13e+08)	(.345)***
Dummy: Sanct3	-1.355	4.545	0.353	5.520	0.429
	(1.688)	(21349.9)	(1.107)	(1.77e+08)	(.552)
Dummy: Sanct4	-4.059	-2.012	-2.282	-3.457	-2.009
	(.760)***	(.450)***	(.541)***	(6.330)	(.524)***
Dummy: Sanct5	-3.510	3.657	-1.910	4.310	-3.149
	(1.684)***	(22041.8)	(1.104)***	(4.00e+08)	(.196)***
Dummy: Common Border	-	-0.280			0.642
		(.098)***			(.122)***
Ln (Population i)	-	-	1.094	0.0806	-0.052
			(.245)***	(.327)	(.038)

Ln (Population j)	-	-	2.996	0.0329	-0.003
			(.246)***	(.340)	(.036)
Dummy: Language	-	-	-5.552	-1.644	-1.491
			(.594)***	(.941)	(.168)***
Time dummy	Yes		Yes		Yes
Exporter dummy	No		Yes		No
Importer dummy	No		Yes		No
Region dummy	No		No		Yes
Observations	9155		9155		9138
Rho	-0.003***		-0.073***		-
Lambda	-0.008		-0.111		-
R^2	-		-		0.682

[Notes: Standard error within parenthesis. *** Indicate significance of P-value at 5 percent level p<0.00]

Similar to the previous table, 6.3, the observations are increased by 1/3 compared to table 6.2. Comparing the results from Heckman regression (2.6) with OLS regression (1.6) the methods display similar coefficient signs and the same significance levels on all independent variables as expected. It follows that the first three sanction dummies are not significant in the Heckman model or the OLS model, indicating the sanctions during this time period does indeed not describe the fluctuations in trade flows, however the remaining coefficients are highly significant.

Column (2.7) considers Heckman selection part when including common border to the regression. The variable is expected to affect the probability of exporting, however not the size of exports. The variable is highly significant and remains negative, contrary to what is expected. Thus suggesting as previously stated that sharing a common border with Iran is relatively less advantageous for trade flows. Moreover all of the sanctions are acquire positive values and are insignificant, except for sanctions 4. As previously stated, the constraints on all bilateral trade flows did have a substantial effect on trade flows and can be even observed in this model.

Additionally the rho estimate is small and significant, thus is not a major problem in the given dataset.

The first part of output (2.8) demonstrates the inclusion of all independent variables and is similar with column (1.8). Illustrating that the estimates follow the same pattern, except for the dummy variable language where the variable is smaller in column (1.8) than (2.8). The first three round of sanctions are insignificant and positive while the last two obtain negative values and are significant.

The second part (2.9) includes common border and is acquires a positive sign, but is however not significant. Also the parameter rho is low and statistically significant, indicating that the sample selection should be consistent in the dataset. Contrary to (2.7) this column acquires positive and insignificant signs on all five sanctions. However in this table the common border estimate is not significant and has a positive sign. Making explanation of these estimates hard to interpret or consider reliable.

The remaining column PPML (3.0) illustrates insignificant values for two out of five sanctions dummies. The remaining sanctions (2, 4 and 5) are highly significant and thus explain the trade flows during the specific time periods. Hence the impact of sanctions during 1984, 1995-2000 and 2996 decrease Iran's trade flows by around 58, 87 and 96 percent.

An interesting notion as mentioned before, reflects the significance of sanctions 4 almost throughout different estimate methods (except column 2.9). The coefficient has been significant as well as negative in every regression. Concluding what has been revealed before, the time period of 1995 up until 2000 had a substantial negative influence on Iran's trade flows. This assumption is reasonable considering the United States blocking all bilateral trade flows between the United States and Iran. Also an R^2 value of 0.62 denotes all variables included in the model explain 62 percent of changes related to Iran's bilateral trade flows.

7. Analysis

The main focus of this thesis has been determining the consequence of sanctions implemented on Iran and the effect it has had on their international trade. Iran is unique in the sense that it possesses massive oil and gas, hence making it a major source of export revenue. A main reason exports have declined is due to fact that they lost one of their favorable trading relations, the United States. As would be expected, results demonstrated economic sanctions have had a large depressing effect on bilateral trade flows since first implemented in 1979. According to the estimated sanctions coefficient derived in the first regression model in column (1.2), the value corresponded a negative sign and was highly significant, hence when the US sanctions are in place they reduce trade flows by 93 percent, a result of restricting trade between the countries.

The following columns demonstrated that bilateral trade of Iran has significant sensitivity to independent variables such as common language, common border, population and that these variables could explain about 82 % of the changes of the dependent variable bilateral trade. Contrary to what is expected, common language indicates negative signs throughout table 6.1, following significant values. Although it is said that countries sharing common language may trade in larger extent with each other the results contradict the principle. A reason might be the newfound trading partners of Iran over the past decades such as Russia and the Asian countries China, India and South Korea, where the majority of Iranian exports go. Also Germany, located in Europe, have had a large trade relationship with Iran since the beginning of 70's, indicating the impression that countries sharing common language trade more with each other is not substantial in the analysis.

The outcome of column (1.3) indicates a positive relationship between common border and trade flows, as expected theoretically. Iran sharing borders with 13 neighbors improves their trade flows by retaining a strong relationship with the following countries. However in column (1.4) there is a shift in the coefficient sign of common border, from positive to negative. Thus indicating that sharing a common border will decrease trade flows with Iran, thus for neighboring countries, trade is not

intensive. A reason for this could be that crude oil, which has been the main export of Iran, has declined due to other Middle Eastern countries exporting oil and not dealing with embargoes by the United States. Also as the US bans crude oil, many oil companies withdraw from Iran in fear of loosing access to the markets in West. The claim is discussed by Amuzegar (1997) who demonstrates how the United States during 1995 and 1996, influenced several countries and companies to reduce their trade with Iran. An example considers China, which suspended an agreement to provide Iran with two nuclear reactors as well as cancelling uranium conversion facility sale to Iran, however claiming that they acted for "reason of its own".[50] Another drawback is that the sanctions may create economic problems such as inflation and currency depreciation making it difficult to conduct business in Iran. Hence due to the increased rising of costs of imports, the import problem makes it difficult for companies to export their products.

The lowest results for the effects of sanctions can be demonstrated in the two last columns in table 6.1, with decrease of 63 percent in trade flows. There is hence no doubt that the negative impact of embargoes is a fact on Iran's trade flows, however when considering fixed effect the values are reduced compared to previous results in the table. An overall assumption reasonable to assume is that in the absence of embargoes implemented, Iran's GDP would be higher due to the unlimited sales of petroleum products. Another interesting result is that the sanctions coefficient follows negative signs and is significant throughout the different columns in table 6.1, indicating the sanctions have influenced trade flows negatively. It can be discussed if the high values of the sanctions dummy in the first columns provide the most reasonable results. The models including importer and exporter dummies are said to provide the most reasonable results as they give consistent parameter estimates. To discuss this, table 6.2 divided the sanctions into different time periods.

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[50] Amuzegar, J, (1997) *"Iran's economy and the US sanctions"* Middle East Institute. Vol 51 No.2 Page185-199 [2015-05-26]

As mentioned above, the sanctions were also distributed into five different time periods in table 6.2 to clarify the effect the sanctions had under different parts of the 30-year time interval. The following columns in this table provide diverse results for the five sanctions. The first column (1.6) confirms what the theories expect regarding the positive signs of GDP and the negative signs of distance and sanctions. The following estimates are also significant expect for the dummy sanction 3. Hence during 1987, where the United States banned oil exports as well as imports to Iran for technological products, the sanctions did not explain the changes in trade flows in Iran. The sanctions executed due to the alleged intentions of not taking satisfactory actions in controlling illegal movements did overall not affect Iran's economy. Graph 3.1 demonstrates an increase in the Iranian exports during 1987 as well before (1986) and after (1988). Thus further strengthening the results indicating sanctions did in fact not affect Iranian trade flows since exports were enlarged before and after 1987. The graph also establishes the Iranian imports being constant during 1986-1988. This would indicate that the ban on the Iranian oil exports did overall not affect the country's trade, further supporting the insignificant notion of sanctions 3.

Column (1.7) denotes negative signs on all sanctions, however sanctions 1,2 and 3 are not significant. Hence during the time periods of 1979-1981, 1984 and 1987, the embargoes do not explain the changes in trade flows. Observing graph 3.1 yet again Iran's exports had a decrease between 1978 and 1979 following an increase during 1980-1981. The embargoes during this period covered restrictions on oil exports and restrictions on aid and military assistance. Even though the first round of sanctions were not significant, a reasonable assumption could be due to the sanctions being eased in some goods and services. Although the outcome in (1.7) demonstrates insignificant values for sanctions 2, the graph illustrates negative changes in both imports and exports. According to the graph restricting imports of weapon, foreign aid, aircraft and related parts did affect trade flows negatively, however the insignificant value would indicate that the sanctions do not describe the fluctuations in trade flows.

The last column in table 6.2 surprisingly denote positive values for the first three sanctions, however they are not significant indicating that they do not describe the

changes of trade flows during those periods. Another interesting remark is the population measures, which has moved from a negative effect to a positive effect in column (1.8). As previously explained the populations measures can have acquire a negative sign as well as a positive sign. Trade may therefor increase towards larger countries as well as smaller countries. Hence as Iran's size of population increases so does trade flows. The reason could be the fact that Iran has increased trade with richer economies such as Russia, Germany and China.

Similar to the previous comparison between common borders in table 6.1, the estimates acquire a negative sign in column (1.7) but a negative in column (1.8). A possible explanation could be due to political differences that Iran has encountered with neighboring countries making other countries reluctant to trade with them. Arabic Islamists countries may influence other Arabic countries and have alliances with them, taking Saudi Arabia as an example. Therefor instead of trading crude oil with Iran the following countries may engage in trade with Saudi Arabia, a nation that has improved its economy the past decades, essentially due to the crude oil production.

The estimate standing out in the last column when applying the fixed effect is the sanction 1 dummy coefficient. The value is both positive and significant, indicating that implementing sanctions in 1979 and until 1981 the trade flows had a positive effect. This result can however not be explained.

Further the results for table 6.2 indicate that sanctions 4 are both negative and highly significant throughout the different methods. Even when applying fixed effect in the last column the dummy variable withstands its negative value and significance. This could thus imply that the embargoes that concerned reduction on all bilateral trade flows during 1995-200 did have a negative effect on Iran's trade flows corresponding to a plunge in the value of the Iranian economy resulting in a devaluation of the Iranian currency, rial. The graph for total export import demonstrates a higher level of Iranian export than imports during that time period than any other comparison between the two lines. Hence although the sanctions had a significant effect during that time period the Iranian economy still grew to some extent thanks to the exports.

Further the outcomes of the Heckman and PPML methods demonstrate distinctive results comparing to the OLS methods applied. For the average sanctions variable the values are negative throughout the whole table, however the results standing out is sanctions for the PPML method. The estimation indicates a value of -0.87, a value indicating a decrease in trade flows by 59 percent, hence sanctions overall depress trade flows. Denoting the values from the second PPML estimation concerning the five different sanctions two out of five are not significant and acquire positive values. Sanctions 2 are the coefficient demonstrating a reduction in trade flows by around 57 percent during this period of time. Comparing this value to the graph for total import and export the sanctions have a negative affect even after it has been lifted, denoted previously.

8. Conclusion

More than 30 years have passed since the first US sanctions were implemented on Iran. Since then the economy has been struck with decline in their economic and political ties around the world. The various scenarios with the gravity model have been incorporated in order to determine if the sanctions had an effect on the Iranian trade flows. The general results indicate that sanctions have had an overall effect on their economy affecting their main asset, crude oil the greatly. Further when dividing the sanctions into five different time periods the results still indicate a negative effect on trade flows.

Hence the Iranian economy has overall been held back in its effort to develop the country's prosperity. However the sanctions have not always lasted for long, one assumption might be that it has hurt the US companies and their credibility, thus making it worse for all parties. There is an adjustment being made in this moment considering the nuclear program issue, which will hence decrease the amount of sanctions implemented on the country. What the future holds for the Iranian economy is yet to be seen.

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Appendix

Dataset

GDP: *The data on the economic sizes of different nations comes from the world banks World development indicators (WDI).*

Distance: *The bilateral distances and common come from the CEPII distance database: (http://www.cepii.fr/anglaisgraph/bdd/distances.htm). A population-weighted great circle distance is used between large cities of the two countries.*

Population: *The data for population also originates from the World Bank's World Development Indicators (WDI).*

Common Language: *Official language is also comprehended from: (http://www.cepii.fr/anglaisgraph/bdd/distances.htm).*

Population: *The data for population also originates from the World Bank's World Development Indicators (WDI).*

Sanctions: *The sanctions dummy variables are collected and provided by: http://www.cfr.org/iran/lengthening-list-iran-sanctions/p20258 and http://www.treasury.gov/resource-center/sanctions/Programs/Pages/iran.aspx. The sanctions have been applied to the dataset in Stata manually.*

Common border: *Data for common border is collected from: (*http://econ.sciences-po.fr/thierry-mayer/data)

Country list of Iran's trading partners

Countries			
1.Aruba	29.Switzerland	57. United Kingdom	85. Kyrgyz Republic
2.Afghanistan	30.Chile	58. Georgia	86. Cambodia
3.Angola	31.China	59. Ghana	87. Saint Kitts & Nevis
4.Albania	32.Ivory Coast	60. Guinea	88. Korea, Rep.
5.Netherlands Antilles	33. Cameroon	61. Guadeloupe	89. Kuwait
6.U.A.E	34. Congo, Rep. Dem.	62. Gambia	90. Laos
7.Argentina	35. Colombia	63. Greece	91. Lebanon
8.Armenia	36. Comoros	64. Grenada	92. Liberia
9.Australia	37. Cape Verde	65. Greenland	93. Libya
10.Austria	38. Costa Rica	66. Guatemala	94. Saint Lucia
11.Azerbaijan	39. Cuba	67. French Guiana	95. Sri Lanka
12.Burundi	40. Cyprus	68. Guyana	96. Lithuania
13.Belgium	41. Czech Rep.	69. Hong Kong, China	97. Latvia
14.Benin	42. Germany	70. Honduras	98. Macao
15.Burkina Faso	43. Djibouti	71. Croatia	99. Morocco
16.Bangladesh	44. Dominica	72. Hungary	100. Moldova
17.Bulgaria	45. Denmark	73. Indonesia	101. Madagascar
18.Bahrain	46. Dominican Rep.	74. India	102. Maldives
19.Bahamas, The	47. Ecuador	75. Ireland	103. Mexico
20.Belarus	48. Egypt, Arab Rep.	76. Iraq	104. Macedonia, FYR
21.Belize	49. Spain	77. Israel	105. Mali
22.Bermuda	50. Estonia	78. Iceland	106. Malta
23.Bolivia	51. Ethiopia	79. Italy	107. Myanmar
24.Brazil	52. Finland	80. Jamaica	108. Mozambique

25.Barbados	53. Fiji	81. Jordan	109. Mauritania
26.Brunei	54. France	82. Japan	110. Martinique
27.Cen.Afr. Rep.	55. Faroe Islands	83. Kazakhstan	111. Mauritius
28.Canada	56. Gabon	84. Kenya	112. Malawi

113. Malaysia	130. Portugal	147. Slovenia	164. Uruguay
114. New Caledonia	131. Paraguay	148. Sweden	165. The United States
115. Niger	132. French Polynesia	149. Seychelles	166. Uzbekistan
116. Nigeria	133. Qatar	150. Syrian Arab Rep.	167. St Vincent & Gren.
117. Nicaragua	134. Réunion	151. Chad	168. Venezuela, RB
118. Netherlands	135. Romania	152. Togo	179. Vietnam
119. Norway	136. Russian Fed.	153. Thailand	170. Vanuatu
120. Nepal	137. Rwanda	154. Tajikistan	171. Samoa
121. New Zeeland	138. Saudi Arabia	155. Turkmenistan	172. Yemen, Rep.
122. Oman	139. Sudan	156. Tonga	173. Serbia & Montenegro
123. Pakistan	140. Senegal	157. Trinidad and Tobago	174. South Africa
124. Panama	141. Singapore	158. Tunisia	175. Zambia
125. Peru	142. Sierra Leone	159. Turkey	176. Zimbabwe
126. Philippines	143. Somalia	160. Taiwan	177. Algeria
127. Papua New Guinea	144. Sao Tome & Principe	161. Tanzania	
128. Poland	145. Suriname	162. Uganda	
129. Korea, Dem. Rep.	146. Slovak Rep.	163. Ukraine	