

Examine Sanctions Efficiency against Iran's Non-oil Trade (Gravity Model)

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Abstract:

The United States first imposed economic sanctions against Iran in 1979, and they have been more or less in effect in various ways until now. During this period while Iran has claimed that embargoes have been in vain, Washington has insisted on using this foreign policy tool to force Tehran to change its attitude.

This paper examines the direct impact of economic sanctions on Iran's non-oil trade for the purpose of demonstrating whether or not these sanctions have been effective. A modified "gravity model" of bilateral trade flows is utilized which adjusted specific variables to more precisely portray Iran's unique economic situation. The panel analysis incorporates available data, covering the period from 1977 to 2006, drawn from sampling of 42 trading partners of Iran.(A1)

In order to test the effect of sanctions, this study uses both the extensive and moderate sanctions as two dummy variables influencing the slope coefficient. The result shows that the extensive and moderate embargoes have had significant impacts on Iran's non-oil trade so far; however, this is not the case for the limited blockades.

In conclusion despite being statistically significant, real evidence indicates that the trade sanctions have had little meaningful impact on the direction of the Iranian government's foreign policy. Therefore, politically, it could be concluded that sanctions have been in vain; but, economically, this article categorizes the multilateral boycotts, holding all other factors constant, as an ultimately successful initiative.

Introduction:

Economic sanctions play an important role in the foreign policy of the United States and Washington has increasingly used this tool in recent years to promote its objectives.

Regarding Iran, as a response to the hostage crisis followed by Islamic revolution, economic sanctions have been used as an alternative to war or as a political weapon against Iran by the States. In fact, Washington has been using embargoes to force Tehran to change its foreign policy attitude.

Since 1979, the Islamic Republic of Iran has challenged the US hegemony of the Persian Gulf area by Islamic revolutionary thought, anti United-States and Israel thought, supporting or sponsoring terroristic activities, supporting anti Middle East peace process' groups, struggling to access nuclear knowledge, and doing some examinations on nuclear bombs secretly; and, almost the only response from the world due to limit or change Iran's behavior has been sanctions. In first place, the trade and financial blockades on Iran were imposed by President Jimmy Carter in 1979; and it has been more or less in effect in various forms and coverage up until now. Economic sanctions were used during President Clinton's administration; indeed, he announced the comprehensive sanctions against Tehran in April 1995. President Bush, also, used these weapons against Iran.

In an increasingly integrated global economy, it is important to have a clear understanding of the costs of U.S financial and trade embargos for Iran; moreover, Iran's situation can be a good example of evaluate the effectiveness of this foreign policy that is challenged by politicians and economists.

Most of the previous analyses about the effectiveness of unilateral or multilateral sanctions that have been imposed against Iran have suggested that they have had limited ability to change the attitude of government of Iran. For instance, Jahangir Amuzegar argues that the US sanctions have not been successful to achieve its goal of transforming the Islamic regime. Patrick Clawson indicates that the sanctions have not persuaded Iran's government to change its behavior. Kamran Dadkhah and Hamid Zangeneh point out the US should use more appropriate means like going through some sort of dialogue with Iran. Ernest Preeg claims that US should unilaterally lift the sanctions because it has not had a positive result for Washington. Hossein Alikhani's overall evaluation is that the sanctions have failed politically to influence Iran. In fact, he believes

that Iran's policies have not changed, and therefore the US should be more careful in using of economic sanctions.

The problem is that all of this research has simply political perspective; therefore, much less is known about the real economic costs of sanctions for the Iran. For that reason, this paper tries to have an economic view to analyze the impact of trade sanctions on Iranian economy to find out what really happened.

This article assesses the effectiveness of trade sanctions on Iran's economy by a somewhat different approach compared to the prior studies. Applying the econometric approach is the most obvious diversity between this paper and the former. The other difference is using panel analysis in order to evaluate the impact of multilateral sanctions on Iran rather than assessing the U.S. unilateral embargoes.

The article begins with an explanation of the economic model that is used, and the changes were made to adopt this model with Iran's situation. Then, there are some explications of the variables. The econometric results are then. Finally, the estimated results compares with the reality to gain an overall success or failure of the sanctions against Iran.

The Gravity Model:

As the initial, direct aim of imposing trade sanctions is reducing the target's exports or imports or both; the common, useful method of analyzing trade flows in economics, the gravity model, is used in this present study.

Although, Issac Newton's Gravity Model has been used to explain gravitational force in the universe, it's not easy to discover who is the first user of it in economics. It's because the notion is too natural that seems to have been always used as a useful tool for trade flows' analysis. However, the early trade's application of it was by Linnemann(1966).

Originally, in physics sciences, Newton's theory points out that the gravitational pull between two bodies is positively related to their masses' product and inversely to the distance between them. From the law of universal gravitation, the force on a body acted upon by Earth's gravity is given by:

$$F = [G m_1 m_2] r^{-2}$$

Where r is the distance between the center of the Earth and the body, and here we take m1 to

be mass of the Earth and m2 to be the mass of the body.

In economics, in the simplest form, the similar concept applies; therefore, the economic gravity model indicates that the amount of trade between two countries is positively related to their outputs and negatively to the distance between them. In fact the gravity model of trade in international economics, similar to other gravity models in the social science, predicts bilateral trade flows based on the economic sizes of (often using GDP measurements) and the distance between two units.

The basic theoretical model for trade between two countries (i and j) takes the form of:

$$F_{ij} = [G M_i M_j] D_{ij}^{-1}$$

Where F is the trade flow, M is the economic mass of each country, D is the distance and G is a constant.

The foundation of this model is based on the relative advantage of decreasing transportation costs that follows by geographical proximity; however, most applications of the gravity model include other variables besides size and distance that might be expected to influence trade flows. They have also been used in international relations to evaluate the impact of treaties and alliances on trade, and it has been used to test the effectiveness of trade agreements and organizations such as the North American Free Trade Agreement (NAFTA) and World Trade Organization (WTO).

Econometric Estimation of Gravity Model:

Since the gravity model for trade does not hold exactly, in econometric applications, it is customary to specify:

$$F_{ij} = G M_i M_j D_{ij}^{-1} \eta_{ij}$$

Where Fij represents trade or exports between two countries, Mi and Mj typically represent the GDPs, Dij denote the distance between them, and η_{ij} represents an error term with expectation equal to 1.

The traditional approach to estimate this equation consists in taking logs of both sides; leading to log-linear model of the form (note: constant G becomes β_0):

$$\ln(F_{ij}) = \beta_0 + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) + \beta_3 \ln(D_{ij}) + \ln(\eta_{ij})$$

In applied work, the model is often extended by including variables to account for, language relationship, tariffs, contiguity, access to sea, colonial history, and so forth.

Gravity Model and Sanctions:

The most important usage of the gravity model for analyzing effectiveness of sanctions is the work of Gary Clyde Hufbauer et al which is the underlying main idea of this paper.

At the beginning, the exact additional explanatory variables of Hufbauer's working paper include Common Language, Common Border, Landlocked, Product Land Area, Common Colonizer, and Colony, with respect of Iran situation, were used. But, there was a big problem; the adjusted R-square was very low, meaning that these explanatory dummy variables, besides the core gravity variables were not, appropriately, able to explain our dependent variable, bilateral trade. Indeed, having only the high percentage of R-square, because of its inherent, is not enough for a good econometric model; what we needed was an appropriate adjusted R-square for our model to prove that our variables can expound trade flows.

Moreover, as Iran's trade policy, probably because of the lack of knowledge or long-term sanctions, doesn't go by the gravity model, this paper tried to adapt the Hufbauer's suggested model with the Iranian economy's specific situation. Therefore, some proper variables were entered into the model.

The model used in this study claims that the sum of exports and imports, the same as Hufbauer's, would increase as the size variable increase, and the distance variable decrease. In addition, in order to capture the effect of sanctions, two dummy variables are added.

The following section will define the dependent and independent variables and briefly will describe their hypothesized effect on trade flows.

Variables:

Dependent Variable:

The dependent variable in this model is bilateral merchandise non-oil Iran's trade (as Iran economy relies on its oil resources, in order to prevent the impact of oil revenue on this analysis, the data of non-oil trade was used in the present study) which is defined as exports

plus imports in current dollars, covering the period from 1977 to 2007. Our data set includes 42 trading partners of Iran, based on data availability; therefore, the total pooled (unbalanced) observations are 1092. The source for trade information is the International Monetary Fund's Direction of Trade statistics.

Independent Variables:

Core gravity model variables:

The classic gravity model depends on the Gross Domestic or National Product, and Distance between countries:

GDP: A combination of Iran's and its trading partners' gross domestic product, measured in current U.S. dollars. GNP figures are taken from the International Monetary Fund's International Financial Statistics. The more amount of GDP would mean the more amount of exports and imports; therefore the positive sign is expected.

Dist: The distance between Iran and its trading partners, measured as the number of kilometers between Tehran and the trading partners' capital. As transport costs decrease by geographical proximity, the greater distance tends to decrease the trade; therefore the expected sign in the model would be negative. Distance calculations are based on the CIA World Fact Book, the "great-circle" method was used.

Other independent variables:

As the classic gravity model should be modified with Iran's conditions, there are two types of variables that could be added to the basic model. Firstly, some variables which follow the initial rules and definition of the gravity model; secondly, dummy variables.

As Iran's sanctions has been one of the reasons of United Arab Emirates' rapid growth through foreign direct and indirect investments, tourism industry, re-export, and so forth, UAE's GDP is added as a variable. Figures 1 and 2 show especially after Iran's revolution and Tehran's comprehensive sanctions, there are noticeable increase in UAE's GDP and GDP per capita. But, this idea was reputed by our model.(A2)

Figure 1: Iran and UAE's GDP(World Bank)

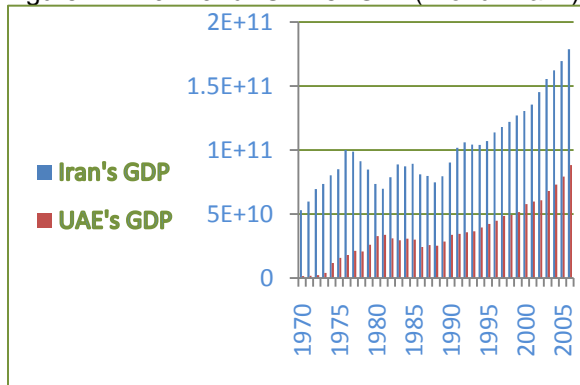
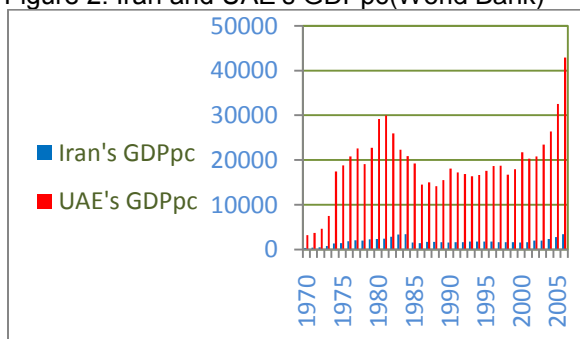


Figure 2: Iran and UAE's GDPpc(World Bank)



The other addition is terms of trade that has gravity's features and we also are able to consider the exchange rate. As result shows, this variable was accepted by our model. In addition, Iran experienced the huge war that would have affected economical indexes. Therefore these following variables are added to the model.

ToT: In order to the statement of the income terms of trade that capacity of a country's imports is assessed by exports' revenue, ToT in this study is the value of the exports(to each partner) to the price index of imports(from each partner). An improvement in a nation's terms of trade happens when the ratio of the exports' price increases more than the ratio of the imports' price. The price of imports is increased by sanctions; therefore, a target has to give up more exports for the imports it receives. Moreover, the foreign exchange rate is included in the analysis. ToT's data is from the central Bank of the Islamic Republic of Iran.

WAR: A dummy variable that shows the war between Iran and Iraq during the period of 1980-88.

Finally, in order to test the impact of economic sanctions on Iran's non-oil trade, the following two dummy variables according to the intensity or coverage of the embargo were developed to indicate economic sanctions against Iran.

MOD, EXT: indicate whether sanctions were in place during the year in question, and whether their coverage was moderate or extensive. This study considered sanctions before 1995 as moderate and after 1995 (according to the chronology of sanctions against Iran and the comprehensive sanctions have been imposed against Iran started in 1995 by the States) as extensive sanctions. As it is expected that the sanctions are able to decrease the ratio or the speed of the trade flows, therefore, it supposed that these two variables influence the slope coefficient of the model. Apparently these two variables would have negative signs.

Logarithm-Linear form:

The regression equation form is log-linear based on the data's shape of the diagram; it means that the equation is linear when all variables are expressed either as a logarithm or as dummy variables. The continues variables(GNP, DIST, TOT) are expressed in logarithmic form. And, the dummy variables discussed before take the value 1 for the presence of sanctions and war; and, take the value 0 vice versa.

Regression equation:

A pooled least squares regression method is used for this study. The main advantage of using PLS is the possibility of evaluating the impact of multilateral sanctions on Iran rather than the influence of the Washington's unilateral blockades; furthermore, by holding constant the effect of the other variables, this analysis provides estimating the independent effect of each factor. In the following regression equation, the dependent variable is the logarithm of non-oil trade between Iran $\{i\}$ and country $\{j\}$, C represents the constant of the equation, and β 's signifies the coefficients for the independent variables.

$$\begin{aligned} \text{Log(Trade}_{ij}) = & \\ & C + \beta_1 \text{Log(GDP}_i * \text{GDP}_j) \\ & + \beta_2 \text{Log(DIST)} + \beta_3 \text{Log(ToT)} \\ & + \beta_4 (\text{WAR}) + \\ & \beta_5 (\text{MOD} * \text{Log(GDP}_i * \text{GDP}_j)) \\ & + \beta_6 (\text{EXT} * \text{Log(GDP}_i * \text{GDP}_j)) \end{aligned}$$

Econometric Result:

By the means of E-views 5.0 software, panel data analysis, the pooled least square method for the thirty years started from 1977, and forty two Iran's trading partners meaning 1092 total pool, unbalanced observations, the estimated model is:

$$\begin{aligned} \text{Log(Trade}_{ij}) = & \\ & -8.250255 + \\ & 0.373749 \text{Log(GDP}_i * \text{GDP}_j) \\ & -0.133752 \text{Log(DIST)} \\ & +0.533398 \text{Log(ToT)} \\ & -0.195783 (\text{WAR}) \\ & -0.001675 (\text{MOD} * \text{Log(GDP}_i * \text{GDP}_j)) \\ & -0.003907 (\text{EXT} * \text{Log(GDP}_i * \text{GDP}_j)) \\ & +0.119474 @ \text{TREND} \end{aligned}$$

The variables--GDP, DIST, ToT, WAR, MOD, EXT-- all have the expected signs; and the core gravity's variables are highly significant. Result shows the Durbin-Watson statistic is very low. Using Period Seemingly Unrelated Regression as a remedial treatment for Heteroscedasticity and Autocorrelation the estimated model is:

$$\begin{aligned} \text{Log(Trade}_{ij}) = & \\ & -8.019011 + \\ & 0.380836 \text{Log(GDP}_i * \text{GDP}_j) \\ & -0.079396 \text{Log(DIST)} \\ & +0.508936 \text{Log(ToT)} \\ & -0.165030 (\text{WAR}) \\ & -0.002349 (\text{MOD} * \text{Log(GDP}_i * \text{GDP}_j)) \\ & -0.003990 (\text{EXT} * \text{Log(GDP}_i * \text{GDP}_j)) \\ & +0.112330 @ \text{TREND} \end{aligned}$$

GDP: As it was expected, this coefficient has a positive sign which means by increasing the amount of product, trade between countries would increase. Because of the logarithmic form of the equation, this coefficient for the GDP continues variable can be interpreted as elasticity. Therefore, a ten percent increase in the combination of the GDP increases the dependent variable by 3.8 percent. Moreover, GDP coefficient is highly significant.

DIST: Although the negative sign, that was expected that means the greater distance decrease trade. The 0.07 and the insignificance coefficient suggests Iran does not follow the decreasing transportation costs' idea behind the gravity model. It would be true, according to the sanctions, Iran has found some markets for its product any way.

ToT: Shows that a unit increase in this variable or in other words an increase in the exports' price index, or a decrease in the price index of imports, or a combination of these two that leads to a unit increase in the Term of Trade ,holding constant the other factors, means 0.5 unit increase in the trade. Under sanctions imports costs would increase, therefore, the trade increases following by an increase in the ToT.

WAR: It is obvious that a war decreases the exports and imports. As the dependent variable is expressed in logarithmic form, the exponent of the coefficient must take before interpreting it. Then, the coefficient on a dummy variable can be interpreted as a percentage shift in the dependent variable when the dummy takes the value 1. So, $e^{0.165}$ equals 1.17.

@TREND: The possible effects of time are justified by adding this variable.

The primary interest of this paper is the impact of economic sanctions on trade flows. Therefore, the following lines will explain that what would happen when the sanctions are in place.

EXT: The negative sign of this variable demonstrates that Iran's exports and imports has been negatively affected by sanctions; in addition, this dummy variable is highly significant statistically.

MOD: A decreasing in Iranian has been determined by the expected sign of this variable, as well. Therefore, if moderate sanctions are in place, it would decrease the slope. Moreover, it is highly significant.

Therefore, from the result above, significant trade sanctions' dummy variables, it is obvious that embargoes, have influenced Iranian non-oil aggregate exports and imports.

General Result:

According to the results, the basic gravity model-Size and Income-all have the expected sign. In other words, an increase in Iran and its trading partners' GDP and a decrease in Distance between Iran and its participants would rise Iranian trade amount.

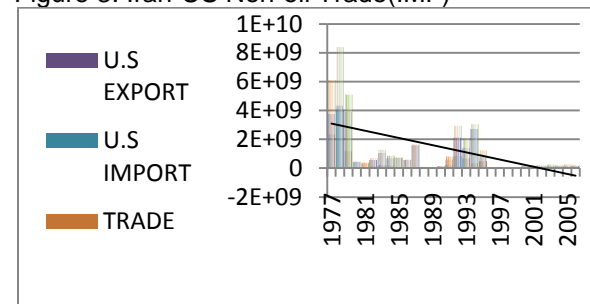
Although the GDP variable is highly significant, the DIST is not statistically significant at the usual levels. It means the relative advantage of the gravity theory about the transportation costs has not been followed by Iranian policy makers. It would be an indirect impact of trade sanctions. It is obvious that a country which has been under sanctions just strive to find some markets to sale its products in order to purchase the necessity goods and services.

Based on the results drawn from evaluating the sanctions' impact on Iran's non-oil trade, the moderate and extensive embargoes have had statistically significant influence on the Iran's imports and exports' bargains with its trading partners. The negative signs of these dummy variables, as well, indicate an increase in Iranian trade by sanctions. But numerically this amount is low.

In following paragraphs we will take a look at some real evidence that would prove our econometric results plus the reasons that would reduce the effect of sanctions. Therefore, there are some points that we should make them clear:

First, Washington has always been the first country and very often the only one that has signed sanctions acts against Iran. Figure 3 shows the historical trade's pattern between Iran and the United States.

Figure 3: Iran-US Non-oil Trade(IMF)



As is shown before 1979 there was a meaningful amount of trade between these two countries; in fact the United States used to be one of the major trade partner of Iran; and right before the Islamic revolution, Washington was the second largest exporter to Tehran. After the hostage crisis, U.S trade with Iran reduced remarkably due to the embargoes. Although there are some ups and downs, the overall pattern shows a diminished trend.

The point is disregarding the sanctions acts by American exporters or removing the embargoes on food and medicine and some other items, accessing to American's products through a third countries or dealers would be the reasons of lower impact of sanctions than the expectation.

Secondly, overall, the U.S exported items to Iran were essential and price inelastic; in the short-run, loosing U.S trade and finding substituted partners mean reducing the amount of export and import. However, in the long-term they gradually become elastic, because Iran has been able to find new partners. This would be another reason for scanty impact of the sanctions.

Thirdly, the insignificant amount of Iran's imports to the world market, plus these items is usually luxury goods, highly price elastic and labor intensive. Decrease in demand for these products due to sanctions has made their prices lower; and the lower prices means decreasing in productions and exports.

The other reason is the most of the sanctions against Iran have been unilateral. Embargoes almost always have not been supported by china and Russia and sometimes by France, Italy, Germany and so forth. For instance, as figure 4 and figure 5 show the trade between Russia and china with Iran is increasing.

Figure 4: Iran-China Non-oil Trade (IMF)

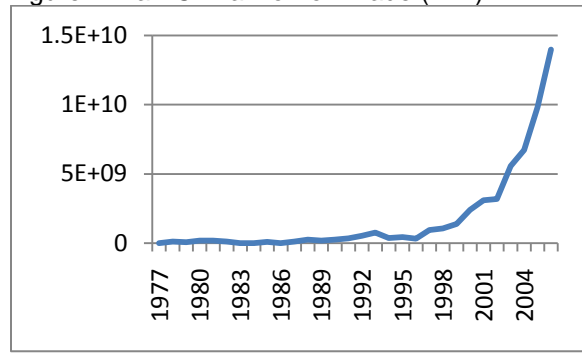


Figure 7: Iran-Russia Exports & Imports (IMF)

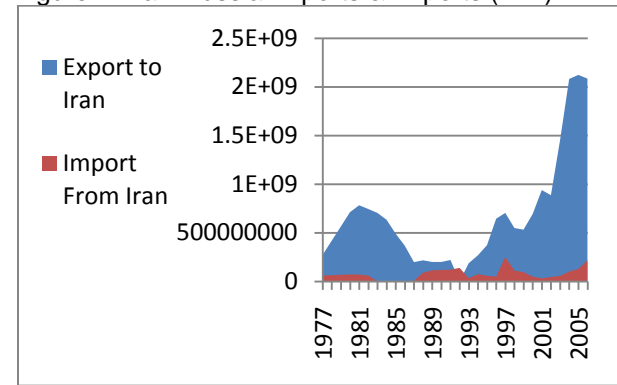
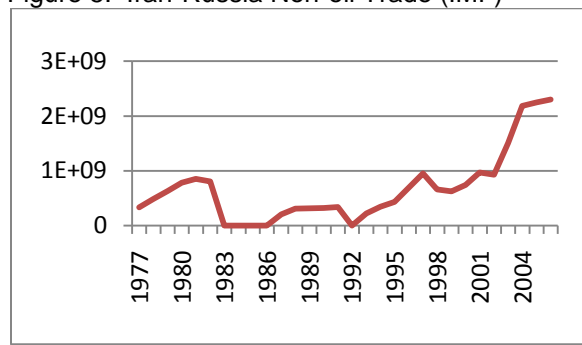


Figure 5: Iran-Russia Non-oil Trade (IMF)

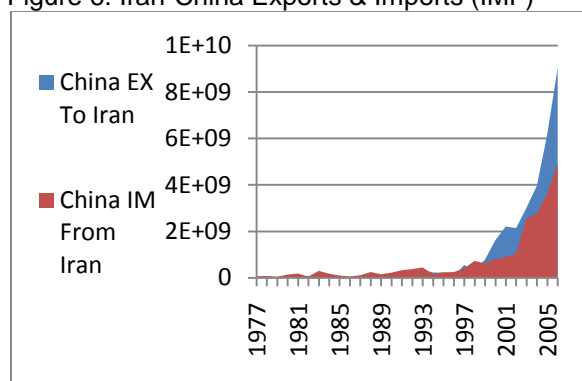


Finally, After 9,11 and the wars that is going on in the Middle East, and as Iraq, Afghanistan and Pakistan have become U.S allies, also with Iran political attitude there is little hope in near future for Tehran to have any markets in these potential (the common language, border, religion) neighbors economic climates.

In conclusion regardless to the amount of influence, the trade sanctions have some costs for Iran by forcing Tehran to import the products of lower quality and at higher prices from other countries, not having access to the high-qualified products or equipments to produce the items that leading Iran to lose its market as an exporter. These are the evidences that prove our results that drawn from the suggested gravity model.

As figure 6 and 7 show that although there is some lost in Iran's import but Iran has always been the major market for these two partners. Moreover, American products are immediately substituted by German, Italian, French, Russia and China ones.

Figure 6: Iran-China Exports & Imports (IMF)



As an academic suggestion, regarding the numerical result of Dist, it would be better if we find a better way, instead of gravity model, to evaluate the cost of trade sanctions on Iran.

APENDIX:

A1) Iran's Partners

Austria	Belgium	Canada	Denmark	France
Germany	Greece	Italy	Japan	Portugal
Netherlands	Spain	Sweden	Switzerland	U.K
U.S	Kenya	China	India	Malaysia
Bangladesh	Pakistan	Poland	Thailand	Srilanka
Hongkong	Hungary	Turkey	Bahrain	Jordan
Philippines	Romania	Kuwait	Lebanon	Qatar
Singapore	Saudi	Syrian	UAE	Argentina
Brazil	Russia			

A2) UAE's GDP in The Model

Dependent Variable: TRADE					
Method: Least Squares					
Date: 03/04/08 Time: 20:51					
Sample: 1977 2006					
Included observations: 28					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	
C	-108.6609	44.28817	-2.453497	0.0240	
GDP	6.534747	2.269778	2.879025	0.0096	
GDPPC	-1.377715	1.301186	-1.058815	0.3030	
DIST	-2.506507	1.045791	-2.396758	0.0270	
UAE	-0.617769	1.359505	-0.454407	0.6547	
LOG(EX)	-1.786178	0.821120	-2.175294	0.0424	
WAR	-0.051285	0.290764	-0.176380	0.8619	
MOD	0.228281	0.517990	0.440706	0.6644	
EXT	-0.486239	0.665583	-0.730546	0.4740	
R-squared	0.687872	Mean dependent var	8.739583		
Adjusted R-squared	0.556449	S.D. dependent var	0.612621		
S.E. of regression	0.408003	Akaike info criterion	1.300009		
Sum squared resid	3.162869	Schwarz criterion	1.728218		
Log likelihood	-9.200128	F-statistic	5.234049		
Durbin-Watson stat	1.175306	Prob(F-statistic)	0.001467		

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