Econometric Analysis:
Effect of Barriers on Trade

Alexander Goerzen, Brandon Schussler, Niccolo Suriano

Abstract:

In this analysis we seek to investigate the impact of various import tariffs on trade as a percentage of GDP. Members of the World Trade Organization (WTO) set up defined tariffs to help facilitate trade with one another. There are specific guidelines for joining, namely the equitable tariff limits that disallow discrimination among countries. These universal rates allow for a firm investigation into how tariffs affect trade as percent of GDP, because it assists in diminishing the impact of substitutes among countries that are not apart of WTO. After regressing the countries' average weighted tariff to their trade percentage of GDP it was concluded that there is a negative correlation between a country's import tariff and the amount of total trade as percent of GDP.

Introduction:

International trade is defined as the exchange of capital, goods, and services across international borders or territories. Such trade makes up a large share of gross domestic product (GDP) for most nations. In theory, countries engage in trade with other countries when one does not have the resources or capacity to meet their own needs and wants. As nations develop domestic scarce resources, they can produce a surplus of goods and trade this surplus of goods for the resources they need with another nation. The World Trade Organization (WTO) is the only global international organization dealing with the rules of trade between nations. WTO agreements are negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. For socioeconomic reasons many nations choose to impose tariffs on imported goods. A tariff is simply a tax or duty placed on an imported good by a domestic government. Tariffs are usually levied as a percentage of the declared value of the good, similar to a sales tax. Unlike a sales tax, tariff rates are often different for every good and tariffs do not apply to domestically produced goods. The benefits and drawbacks of tariffs are usually distributed unevenly, since a tariff is a tax, for which the government will see increased revenue as imports enter the domestic market. Domestic industries also benefit from a reduction in competition, since import prices are artificially inflated. The main objective of tariffs is to decrease demand for imports while increasing demand for domestic products. On the other hand, a disadvantage of tariffs is that they raise the price of imports, leading to a decrease in consumer surplus. Tariffs discourage international competition, leading to decreases in domestic product variation or availability.

The analysis motivates the economic rationale that there is a limit to the effectiveness of an imposed tariff. As the tariff on imported goods increases, so does the cost of doing business, meaning the profitable margins faced by a trading nation diminish. The paper illustrates, how tariffs affect trade as a percentage of GDP. The expectation is countries that impose higher weighted average tariffs will have a lower trade percentage of GDP.

Literature Review:

Imbruno (2016) explores the effectiveness of trade policy applications on Chinese imports for time period of 2000-2006. The decline in tariffs also includes gradual removal of non-tariff barriers (NTBs) as agreed within the WTO's accession protocol in 2001. While manufacturing imports increase because of tariff cuts, agricultural imports grow due to the elimination of import licenses in China. The official entrance to the WTO of China was in December 2001 which was an important factor to the decrease of tariffs. In 1985, for instance, China's average duty rate was 43 percent and in 2001 it changed to an average of approximately 15 percent. Imbruno supports the hypothesis, that a reduction of tariffs would suggest an increase in the trade, which is also a direct effect of the benefit to join the WTO. By 2005 China set its most-favorable-nation (MFN) tariff at 9.7 percent, a further decrease. In the agreements, this MFN percentage is applied to all WTO nations. Although agricultural imports increased because of the removal of import licenses, tariffs reduction had a different result than the hypothesis of our paper as well, which in this case meant that the statistical effect was not significant.

Non-tariff barriers are composed of a few different categories they are licenses, border taxes and anti-dumping, customs, Technical barriers such as health safety and welfare, and subsidies and aids. These barriers are also attempted to be regulated by the WTO to help facilitate trade and allow trade to be uniform regardless of whomever is importing. Over the years countries have started limiting these barriers, but the Technical trade barriers still persist. There are also, at least related to wine, unique requirements per country, Mariani et al (2014). As in wine can only be called wine if it adheres to a distinct process and science of manufacturing. With the large amount of growth the wine industry has seen over the past decade there are now more imports of wine from new producers than the Originals (France, Italy, Spain). These exchanges and new markets are not unlike many of the agricultural products that are currently on the market. These barriers if removed would help ease trade, but the cost as Mariani et al (2014) points out is getting uniformity. The FDA in the USA has different regulations for its citizens than the other national regulators for food and pharmaceuticals. This pertains to wine in that there are now a diverse range of wines with grapes grown differently than regions are used to. It is further complicated in WWTG an independant wine organization looking to standardize wine to allow for seamless trade isn't recognized by the WTO as being a standard. All WTO members have to conform to the WTO standards. This complication is causing rising prices and for a slow dispersion of wine throughout the world. Demand is still being met, but at the expense of welfare to the consumers of each participating country as well as all countries looking to export. In investigating the non-tariff barriers on trade as percentage of GDP, there is hope to determine the effect that these regulations and differing standards have on a free exchange of goods.

In the international trading system, countries are at constant odds to develop a trading scheme in which they will each reach a Pareto optimum. The trouble lies within maintaining and upholding agreements while simultaneously ensuring that your country is able to receive all the necessary benefits or gains that trade allows, Graaff (2000). From this game of trade comes a many theories that conclude a tariff war will result in a Nash Equilibrium and a pair of tariff trading strategies. In the paper written by Kemp, Long, and Shimomura a dynamic model of international trade is explored and results in again a set of tariff and trade strategies that will result in a Nash equilibrium. The regression analysis that we wish to perform will add to how the countries grow with trade agreements and tariffs. It should be seen or expected to be seen that all countries gain from trade regardless of the tariffs, because a Nash equilibrium will be reached as seen at the dynamic level.

A dynamic Nash analysis performed by Kemp et al (2001) defines a set of state variables that refer to the temporal change in price of a tradeable good in the domestic market. That means that a good that is produced domestically is price compared to a good that is imported. The same good, but unique in where it came from. These goods are mapped to the tariff factors that vary with time. Under these mechanisms the price of the domestic good is mapped to a scaling factor that is based upon the end result i.e. “playing” one round. The key idea to ensure that the experiment doesn’t map to a series of infinite repeated games is to state that the history of the tariff factors is limited to a statistical history Kemp et al (2001). This in essence models a world where trade isn’t free, thus a realistic approach. The end result of dynamic Nash experiment, which compares the free trade dynamic outcome to an optimized “feedback-tariff” game shows that there are welfare gains to be had when countries tariff at an optimum level, Kemp at al (2001) and Graaff (2000). The only issue that arises is the time sensitivity. Since this is a dynamic model the assumption is that countries can trade and exchange in a meaningful amount of time. This means that goods are paid for and enter into the market place without too much delay of receipt. This will become very important in analysis of growth in the regression model. If gains are not realized, then it is foreseeable that the tariff factors are sub-optimal or that the countries time preferences are violated.

Our first linear regression includes 121 nations (counting the European Union as one because it is also a custom union) which approaches a broader analysis compared to just one single country, analised in Imbruno(2016). Our multiple regression model aims to examine the relationship between the average tariff and Trade, but we added several independent countries that we believe are relevant to this model, in particular we added other barriers to trade in order to seek if not only tariffs but also the other barriers are negatively related to Trade.

Data:

Simple Linear Regression

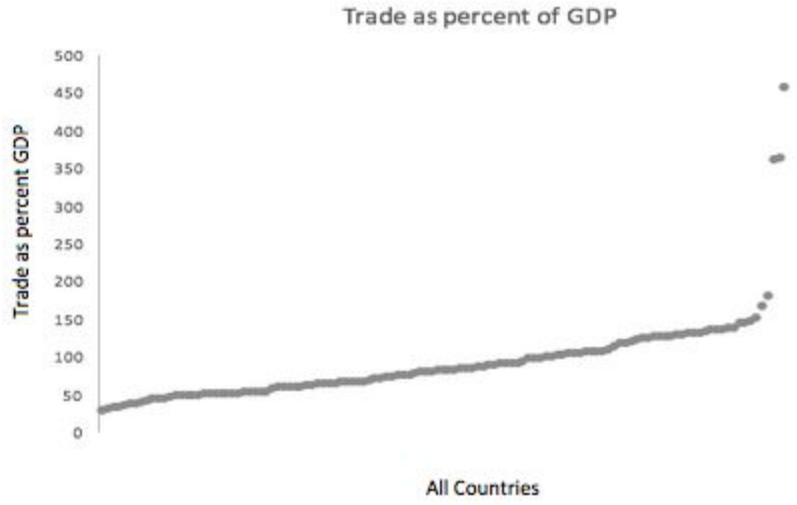
This is the summary for our variables of the Linear regression Model.

Variable	Obs	Mean	Std. Dev.	Min	Max
TradeasGDP	121	89.73087	59.36845	25.63479	455.2767
WAT	129	7.787597	3.991436	0	20.9

I. Trade as Percent of GDP

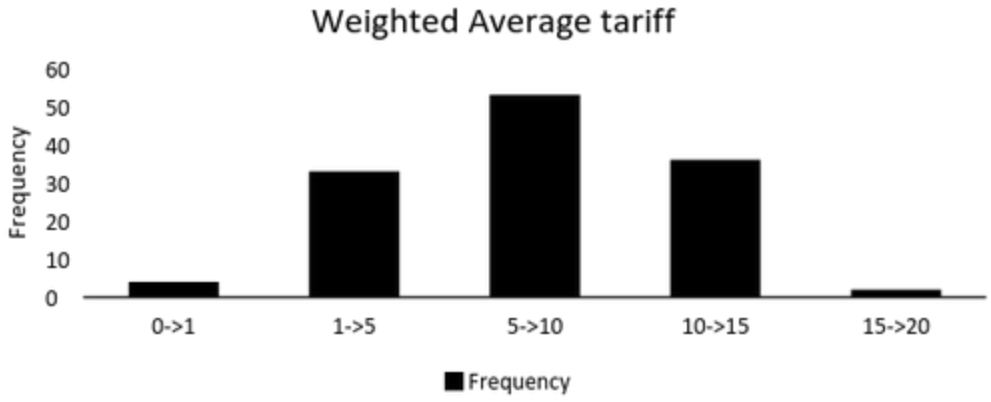
To conduct our analysis we decided to choose "Trade as percent of GDP" as our dependent variable (our "Y").

Trade as percent of GDP is a variable that has grown since the foundation of WTO in 1994, the worldwide trade growth was and still is a goal of the WTO. In the following chart is show all the possibilities of trade as percent of GDP, the data goes from a minimum of 25% to a maximum of 455%. Almost all the possibilities are taken from 25% to 150% then there are 3 outliers which are Macao, Singapore, and Hong Kong. Trade as Percent of GDP can be higher that 100% since it is (Import+Exports)/GDP and GDP is a sum of Consumption, Income, Government Spending, Exports Less Imports. What happens in small countries with high productivity like Hong Kong and Singapore is that due to their small size, instead of trying to be self-sufficient and produce all the products their population needs, they specialize in a few highly-profitable industries. These industries may produce more money from exports than the entire domestic economy. All that money from exports allows them to purchase imports far into excess of what their domestic economy could otherwise support. All the data referring to Trade as percent of GDP is taken from World Bank Database and are related to 2014.



II. Weighted Average Tariff

Trade weighted average tariff (WAT) is our first independent variable for the Simple Linear Regression Model. Trade Weighted Average tariff is "HS 6-digit MFN applied tariff"averages weighted by HS 6-digit import flows for traded products (or "tariff lines") — in calculating the average tariffs, more weight is given to products with larger import flows. Where HS 6-digit stands for "The World Customs Organization's Harmonized System" (HS) and they use code numbers to define products. A code with a low number of digits defines broad categories of products; additional digits indicate sub-divisions into more detailed definitions. Six-digit codes are the most detailed definitions that are used as standard. Countries can add more digits for their own coding to subdivide the definitions further according to their own needs. Products defined at the most detailed level are "tariff lines". In a worldwide perspective the Average tariffs are going down. The WAT is almost normal distributed as is shown in the next graph. All the data related to WAT are taken from WTO database and refer to 2014.



Multiple Linear Regression

This is the summary for our variables of the Multiple regression Model.

Variable	Obs	Mean	Std. Dev.	Min	Max
TradeasGDP	121	89.73087	59.36845	25.63479	455.2767
WAT	129	7.787597	3.991436	0	20.9
NTB	109	342.5872	627.1439	1	4808
PRI	108	69.2037	11.35638	43	93
FDI	116	5623.549	13930.4	-675.55	96894.98
PPP	93	138094.8	206410.6	558.0545	944503.1

III. Non-tariff barriers

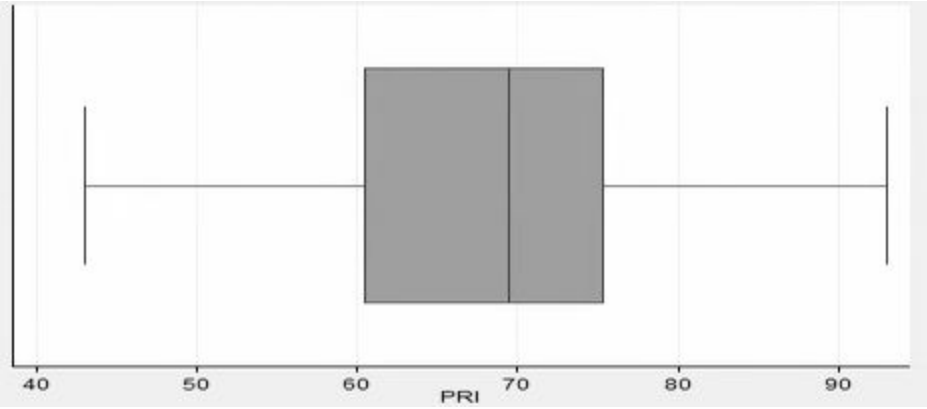
For our second model we added the amount of Non-tariff barriers as another independent variable. The total amount of NTB for country is a sum of Anti dumping, Countervailing, Quantitative Restrictions, Safeguards, Sanitary and Phytosanitary, Special Safeguards, Technical Barriers to Trade, Tariff-rate quotas and Export Subsidies.

NTB is another very important barrier because they tend to diminish trade in a less evident way.

All our data referring to NTB are taken from WTO database and refer to 2014.

IV. Political Risk Index

For our third model we added the Political Risk Index as an independent variable. The PRI is the overall measure of risk for a given country, calculated by using all 17 risk components from the Political Risk Services Methodology including turmoil, financial transfer, direct investment, and export markets. The Index provides a basic, convenient way to compare countries directly, it ranges from a minimum of 43 to a maximum of 93, the country with a higher index have a stronger political stability, on the contrary countries with a lower PRI are more unstable (african countries). The box-plot below how the data are distributed. All the data referring to PRI are taken from Political Risk Services Database and refer to 2014.



V. Foreign Direct Investment

Foreign direct investment is an investment made by a company or individual in one country in business interests in another country, in the form of either establishing business operations or acquiring business assets in the other country, such as ownership or controlling interest in a foreign company. FDI

data are taken from WorldBank database, refer to 2014 and all data are in million. We believed that this variable has a positive relationship with Trade, because more FDI should increase Trade.

VI. Purchasing Power

PPP GNI (formerly PPP GNP) is gross national income (GNI) converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GNI as a U.S. dollar has in the United States. Gross national income is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. Data are in current international dollars. Data are taken from Worldbank and refers to year 2014 and are in million.
We believed that this variable has a positive relationship with Trade, because PPP should increase Trade.

Our data meet Gauss Markov Assumptions for the Multiple regressions:

-Linear in parameter: population slope and intercept are linear
-Random sample: we have a random sample of 121(1' model), 103 (2' model), 93 (3' model), 68 (4' model)
-No perfect collinearity: As the table shows, there is no perfect collinearity between our independent variables. We chose variables that we thought were not highly correlated.

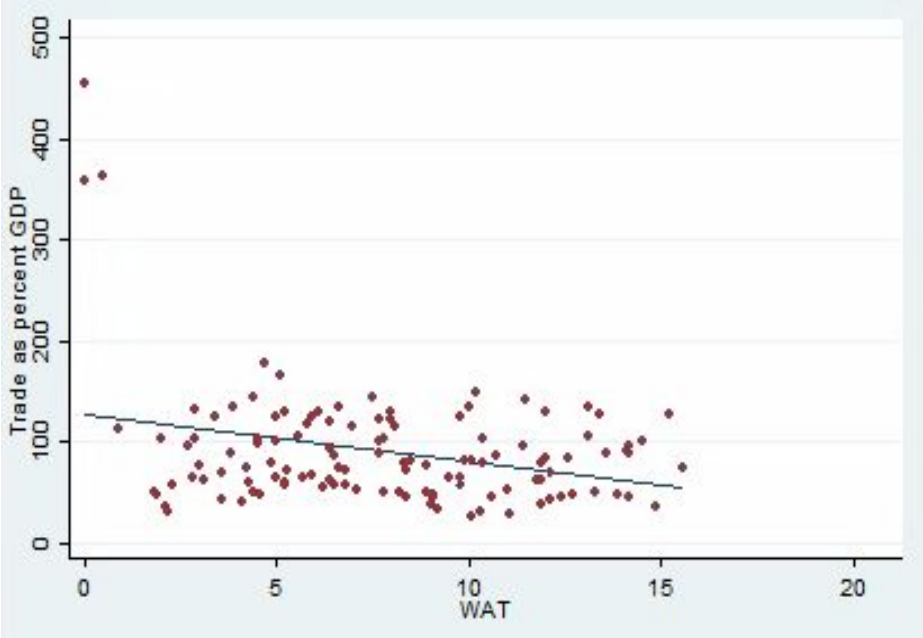
	Tradea~P	WAT	NTB	PRI	FDI	PPP
TradeasGDP	1.0000					
WAT	-0.4116	1.0000				
NTB	-0.1324	-0.3868	1.0000			
PRI	0.4854	-0.5004	0.3570	1.0000		
FDI	-0.0529	-0.0927	0.1837	0.3202	1.0000	
PPP	-0.0152	-0.1059	0.0783	0.2546	0.6293	1.0000

-Zero conditional mean: There is no direct method to test for this assumption, so we just impose it on our model. We assume that the expected value of the error term given any
values of the independent variable is 0.
-Homoskedasticity: There is also no direct method to test for this assumption, so we impose it on our data. Thus, we assume that the variance of the error term due to any values of the independent variables is zero.

Results:

Simple Linear Regression

Our simple linear regression model illustrate what we expected: there is, even if not very strong, a negative correlation between the Weighted Average Tariff and the total Trade in one country. One main problem is related to R-squared that in this model is extremely low (0.09), but we think that this value in our multi regression model will be higher. As is shown in the below chart the data is not tightly packed, which also reflects the R-squared value. Stata Output in the Appendix.



Multiple linear Regressions

Models

1. Trade = +125.77 -4.25 (WAT)
2. Trade = +152.54 -7.00 (WAT) -0.03(NTB)
3. Trade = +4.63 -4.20 (WAT) -0.04(NTB) +1.86 (PRI)
4. Trade = -74.30 -6.26(WAT) -0.08(NTB) +3.53 (PRI) -0.002 (FDI) -0.00002(PPP)

Dependent Variable: Trade as Percent of GDP				
Independent Variables	Model (1)	Model (2)	Model (3)	Model (4)
Weighted Average Tariff	-4.63 (-3.42)***	-7.00 (-4.46)***	-4.20 (-2.17)**	-6.26 (-2.90)***
Non-Tariff barriers		-0.03 (-3.54)***	-0.04 (-4.03)***	-0.08 (-4.00)***
Political Risk index			1.86 (2.94)***	3.53 (4.58)***
Foreign Direct Investment				-0.002 (-1.07)
PPP GNI				-0.00002 (-0.56)
Intercept	125.76 (10.72)***	152.54 (10.66)***	4.63 (0.09)	-74.30 (1.21)
No. of obs.	121	103	93	68
R-square	0.089	0.20	0.27	0.46

*Significant at 10%, **5%, ***1% T-statistic in parenthesis.

By looking at the table above one can the coefficient and t-statistic values for all the variables across our 4 models.

The first thing we noticed is that our R-squared value has increased thourgh our models, going up to 0.30 in the last model.

In the first model the first coefficient is significant at 1% and it remains strongly significant also in the second and third model. Stata Output in the Appendix.

Our second model is probably the best one. It shows how both WAT and NTB are negatively

correlated to Trade and both the two coefficients and the intercept are significant at 1% and the R-squared is at 0.2. Stata Output in the Appendix.

Our third model is also great it keeps showing the same results of the previous model and it adds that the more a political system is solid so higher PSI the more the country will have a higher value of Trade as percent of GDP. All the coefficients in this model are strongly significant, but the intercept is not. The value of R-squared has increased to 0.27. Stata Output in the Appendix.

Our fourth model is the one with more variables, our first 3 explanatory variables are all significant at 1% but since FDI and PPP are insignificant alone, we are going to check if they are jointly significant. Since as you will see in the next section the two variables are jointly significant we keep them in our model. Our R-squared in our last model is 0.46, it has increased from the previous model. Below in the Appendix the STATA result for our final (4') Model.

Robustness Test:

The F-test is 15.04 and the F-critical value at 5% is 3.15, so the 2 variables are jointly significant and we will keep them in our model. Below the calculations.

F-test = [(SSRr-SSRur)/2]/(SSRur/62) = [(288278-194085)/2]/(194085/62) = 15.04

F(2,60)=3.15

F-test > F-cv so Jointly significant

Conclusion:

Our final Model is consistent with our initial expectations: Barriers have a negative impact on trade. Direct barriers such as Import Tariffs have a strong negative impact on trade, indirect barriers such as Non-tariff barriers and Political Instability have also a negative relationship but they are weaker. Both direct and indirect barriers are significant at 1% in our final model. Other factors that we thought were important such as Foreign Direct Investments and the Purchase Power Parity of the country came out not to have a strong correlation with Trade but to be jointly significant to the model.

In order to have a more integrated world with free flow of goods the most important thing underlined by our project are low import tariffs, the lower import tariffs, the more a country is going to import and export. Non-tariff barriers resulted in being less important than we expect, in fact they have only a weak relationship with trade, but still the lower they are the higher will be the amount of trade for the country. The Political Stability of the country turns out to be an important variable of Trade, the

higher it is the higher will be the amount of trade in the country, we forecasted this outcome but we didn't think it was that correlated.

On the other hand Foreign direct investment and Purchasing Power didn't prove to be very important, if a country invests a lot in other countries this doesn't boost trade. We expected a strong positive relationship of these two variables with Trade but our final model shows that we were wrong: FDI and PPP are not important independent variables, but are jointly significant.

Furthermore, these results lend themselves to supporting Mariani et al (2014), Graaf(2000), and Kemp (2001) in that establishment of tariffs in a non-optimal price dictated by an organizational agreement yields a loss in welfare as realized by trade as a percent of GDP. Even still, with non-uniformity of all counties trading and exporting different goods the implementation of a barrier be it tariff or nontariff has a negative impact on a country highlighted by Mariani et al (2014) and our regression analysis. On a larger scale, as the regression hoped to prove, that trade isn't a zero sum game as Kemp et al (2001) stated, there is a noticeable impact in world trade with slight adjustments in the tariff rates. The regression shows that this previously niche observation takes on a broader macro scale that barriers have a negative impact on trade.

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Sdf

Appendix:

List of countries for the final Model

Afghanistan	*Guatemala*	*Nicaragua*
Albania	*Guyana*	*Nigeria*
Armenia	*Haiti*	*Norway*
Australia	*Honduras*	*Oman*
Bahrain	*Iceland*	*Pakistan*
Belize	*India*	*Panama*
Bolivia	*Indonesia*	*Paraguay*
Botswana	*Israel*	*Peru*
Brazil	*Jamaica*	*Philippines*
Burkina Faso	*Japan*	*Qatar*
Burundi	*Jordan*	*Russian Federation*
Cameroon	*Kazakhstan*	*Rwanda*
Canada	*Kenya*	*Senegal*
Central african Republic	*Kuwait*	*Singapore*
Chile	*Kyrgyz Republic*	*South Africa*
Colombia	*Macao*	*Switzerland*
Costa rica	*Madagascar*	*Tanzania*
Dominican Republic	*Malaysia*	*Thailand*
Ecuador	*Mauritius*	*Tunisia*
*European Union***	*Mexico*	*Turkey*

Ghana	*Morocco*	*United States*
Grenada	*New Zealand*	*United Arab Emirates*
**it includes 28 States	*Vietnam*	*Uruguay*

Stata Outputs

Model 1

```
. regress TradeasGDP WAT
```

Source	SS	df	MS	Number of obs	=	121
				F(1, 119)	=	11.70
Model	37876.6524	1	37876.6524	Prob > F	=	0.0009
Residual	385076.918	119	3235.94048	R-squared	=	0.0896
				Adj R-squared	=	0.0819
Total	422953.57	120	3524.61308	Root MSE	=	56.885

TradeasGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
WAT	-4.625236	1.351912	-3.42	0.001	-7.302157	-1.948316
_cons	125.7695	11.73469	10.72	0.000	102.5336	149.0054

Model2

```
. regress TradeasGDP WAT NTB
```

Source	SS	df	MS	Number of obs	=	103
				F(2, 100)	=	12.27
Model	79260.2845	2	39630.1423	Prob > F	=	0.0000
Residual	322900.081	100	3229.00081	R-squared	=	0.1971
				Adj R-squared	=	0.1810
Total	402160.365	102	3942.74868	Root MSE	=	56.824

TradeasGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
WAT	-7.006791	1.571232	-4.46	0.000	-10.12407	-3.889511
NTB	-.0332144	.0093895	-3.54	0.001	-.051843	-.0145859
_cons	152.546	14.30455	10.66	0.000	124.1662	180.9258

Model3

```
regress TradeasGDP WAT NTB PRI
```

Source	SS	df	MS	Number of obs	=	93
				F(3, 89)	=	10.99
Model	106820.336	3	35606.7785	Prob > F	=	0.0000
Residual	288278.97	89	3239.08955	R-squared	=	0.2704
				Adj R-squared	=	0.2458
Total	395099.305	92	4294.55766	Root MSE	=	56.913

TradeasGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
WAT	-4.201355	1.935169	-2.17	0.033	-8.046495	-.3562162
NTB	-.0388022	.0096335	-4.03	0.000	-.0579438	-.0196605
PRI	1.862062	.6341694	2.94	0.004	.6019808	3.122143
_cons	4.637712	53.16651	0.09	0.931	-101.003	110.2784

Model 4

```
regress TradeasGDP WAT NTB PRI FDI PPP
```

Source	SS	df	MS	Number of obs	=	68
				F(5, 62)	=	10.40
Model	162802.924	5	32560.5847	Prob > F	=	0.0000
Residual	194085.794	62	3130.41603	R-squared	=	0.4562
				Adj R-squared	=	0.4123
Total	356888.718	67	5326.69728	Root MSE	=	55.95

TradeasGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
WAT	-6.260794	2.155481	-2.90	0.005	-10.56954	-1.952049
NTB	-.0826871	.0206749	-4.00	0.000	-.1240157	-.0413586
PRI	3.527238	.7693795	4.58	0.000	1.98927	5.065205
FDI	-.002242	.0020987	-1.07	0.290	-.0064372	.0019532
PPP	-.0000235	.0000417	-0.56	0.575	-.0001067	.0000598
_cons	-74.30663	61.19044	-1.21	0.229	-196.6246	48.01132

F-test

Unrestricted Model

```
. regress TradeasGDP WAT NTB PRI FDI PPP
```

Source	SS	df	MS	Number of obs	=	68
				F(5, 62)	=	10.40
Model	162802.924	5	32560.5847	Prob > F	=	0.0000
Residual	194085.794	62	3130.41603	R-squared	=	0.4562
				Adj R-squared	=	0.4123
Total	356888.718	67	5326.69728	Root MSE	=	55.95

Restricted Model

```
regress TradeasGDP WAT NTB PRI
```

Source	SS	df	MS	Number of obs	=	93
				F(3, 89)	=	10.99
Model	106820.336	3	35606.7785	Prob > F	=	0.0000
Residual	288278.97	89	3239.08955	R-squared	=	0.2704
				Adj R-squared	=	0.2458
Total	395099.305	92	4294.55766	Root MSE	=	56.913