Simply Politics? A Look into Trade Linkage's Influence on the Impact of Economic Sanctions

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Abstract

Despite their debatable success, countries and organizations have continued to use sanctions as a tool for international politics. The goal of most sanctions is to bring about change in the targeted country; however, historically we see that many of these goals are not realized, leading some to believe that sanctions are mainly imposed for political reasons rather than for economic ones. This study aims to determine how the trade disruption, enhanced through trade linkage and economic complexity, produced by sanctions impacts the GDP trend of the country. It appears that trade linkages and economic complexity have opposite impacts on GDP. As trade linkages rise, the impact of economic sanctions on the targeted country's GDP is greater; however, as economic complexity rises, sanctions have less of an impact on GDP.

Introduction

Over the past century, economic sanctions have become one of the most utilized political and economic tools used in international politics (Neuenkirch and Neumeier 2015). In theory, sanctions will put pressure on the economy of the targeted country to invoke political or economic change through internal and external pressure. As Woodrow Wilson explained, "a nation boycotted is a nation that is in sight of surrender. Apply this economic, peaceful, silent, deadly remedy and there will be no need for force." (Neuenkirch and Neumeier 2015). For sanctions to be as successful as Wilson portrays them to be, it must impact the targeted nation in a significant capacity. Most economists measure this in terms of GDP impact. It is believed that the more GDP impact that a sanction has, the more likely the sanction is to achieve its political goals, ranging from regime change to reduction in arms. However, there is still much debate how effective sanctions are at achieving political goals. Some sanctions that have had a seemingly large impact on GDP have not produced the desired change wanted by the sender country. In these cases, the sender nation could be more concerned with making a political statement rather than achieving these goals. Even though the success rate of sanctions is widely debated, sanctions are continually being used today as a major political tool and thus warrant the many studies that have been conducted on the topic.

This study adds to the literature by addressing the question "to what degree does the pre-sanction trade linkage between the targeted and sending nations affect the GDP trend within a sanctioned country?" Change in GDP over the course of the sanction is the best measure to determine the economic pressure that is imposed on the targeted nation because it incorporates not only the effect on trade, but also the multiplier effect throughout the economy, as GDP is a measurement of the total economy. There have been multiple studies conducted to explain how

the impact on trade can determine the cost of a sanction. For example, Kaempfer and Lowenberg's (1999) study compares multilateral and unilateral sanctions based on their political cost to leaders. This study determines that the more trade is impacted by economic sanctions, the greater the political impact will be on leaders of targeted nations. Others, like Neuenkirch and Neumeier (2015), focus on sanctions' impact on GDP growth depending on the size of the sender country relative to the target. These papers are similar to this study in that they measure to what degree the universality of a sanction matters. However, this is the first study to analyze how the trade linkage, a measure of bilateral trade between two countries, impacts the degree in which sanctions impact GDP.

Judging from past literature, we expected the outcome of this study to follow intuition: the larger the trade linkage between sender and target nations, the larger the impact of the sanction on GDP growth. This is a reasonable assumption because losing a large trading partner increases the overall loss to GDP. However, if the sender is only a small trading partner, the targeted country will be able to either find substitutes for the trade lost or the sanction will have a negligible impact and thus be ineffective. Neuenkirch and Neumeier (2015) confirm this theory in their study on the comparison of UN and US sanctions. Because UN sanctions are more inclusive, and thus have a large trade linkage with most countries, they have a larger long-term effect on the targeted country's GDP growth, than U.S. sanctions.

This study also explores whether there is a correlation between the effect on the GDP trend and the economic complexity of the targeted nation during sanctions. Economic complexity is measured by the variety of exports that a country produces within a given year. A country like Japan has a very high economic complexity because its exports are diverse, ranging from fish to electronics. On the other hand, Saudi Arabia, a country that is highly dependent on

its oil production, has a very low economic complexity. Complexity could impact the effectiveness of economic sanctions in one of two ways, or possibly a combination of both. First, if a sanction is implemented on a country for a specific output, the impact depends on the economic complexity. If a targeted country has a high degree of economic complexity, a variety of exports can still be traded, and therefore the impact will not be as great. If a targeted country has a low economic complexity and its major export is targeted, there would likely be an extensive impact on its economy. Another way economic complexity could determine the effectiveness of sanctions is through the introduction of new trading partners. If a country is targeted by sanctions, but has a high economic complexity, it may be easier for it to find new trading partners because it has a wide variety of goods to offer. Both trade linkage and complexity are different approaches at getting at the same underlying case: how trade impacts the GDP trend within a country, and what happens when that trade is disturbed.

As mentioned previously, understanding the effects of economic sanctions on the GDP growth of a nation are important because of the popularity of sanctions as a political tool in international politics. The results of this study could have some policy implications for both senders and targets of trade sanctions. The incentive of imposing a sanction decreases if the potential outcome looks unsuccessful. Countries often use sanctions to take a political stand, such as when the U.S. imposed sanctions on Cuba and Vietnam during the Cold War to discourage communism. This study helps unveil how countries make sanction policy choices and whether they are driven by effectiveness or the simply the desire to make a political statement, as some sanctions may suggest.

Literature Review

While there is much literature available on the impacts of economic sanctions, it often does not consider the direct economic implications on the GDP trend. There are many papers considering the effects on healthcare, social welfare of the targeted country, and the economic impacts on countries neighboring the target. There are also troves of literature on the goals and successes of economic sanctions using empirical and case study analysis. This study diverges from the rest in its approach for determining the GDP impact of sanctions. Instead of using the Solow Growth model or the gravity model like many past studies, here we analyze how sanctions cause a divergence from the GDP trend of a country. The literature on this subject not only provided rationale for imposing sanctions, but also models for determining GDP trend of a country and forecasting how sanctions disrupts this trend, which have all contributed to this study. However, this study adds to this extensive literature through the inclusion of trade linkage and economic complexity.

One of the most essential pieces of literature to my study has been *Economic Sanctions Reconsidered* by Hufbauer, Schott, Elliott and Oegg (2007). This widely read book has made Hufbauer one of the most respected economists within sanctions literature. While Hufbauer offers quite a few conclusions in his study, the one that has perhaps gathered the most attention is his regression on the success of economic sanctions and their impact on GNP. The success of economic sanctions is the dependent variable, and it is measured as a qualitative or "categorical" variable. We modify the "success" measure by using GDP as our dependent variable as it allows there to be a monetary cost associated with sanctions based on the loss of trade. This could have policy implications, whether it is a country imposing sanctions or receiving them, it is important to understand the quantitative costs associated with a political policy such as this.

To understand sanctions, it is important to understand the rationale behind sanctions. Hufbauer, Schott, Elliott and Oegg (2007) offer five categories of objectives according to historical analysis; creating modest change in the targeted government's policy, destabilizing the targeted government, disrupting a minor military adventure, impairing military potential, and creating a major change in the targeted country's policy. More broadly, most countries use sanctions either for influence or deterrence. Large countries often impose most sanctions as a way to gain influence in other countries' politics. Others, such as the US in the Cold War Era, use sanctions as a way to assert their dominance and ability to take action. Sanctions are used to deter countries from breaking international law or committing atrocities against their people or others. This has been seen recently in the cases of Iran and North Korea as they have begun to establish their nuclear programs. In these cases the sanctions have the goals of discouraging future objectives, and thus are more difficult to measure in terms of success. Hufbauer has developed a scale to measure the success of a sanction based on the goals of the sender nation. This scale ranges for 1-16, with 1 being completely unsuccessful and 16 being completely successful. The scale is calculated by "multiplying the policy result index by the sanctions contribution index" used in Hufbauer's studies. Hufbauer marks any sanction that receives a score above 9 as a successful sanction. According to this measure, only 34% of sanctions in Hufbauer's study were successful.

The literature not only explained the rationale behind sanctions, but also a framework for how GDP should be determined in regression models. GDP is dependent on a wide variety of economic and political and factors. The main model that has been used to show economic growth in a nation is the Solow-Cass-Koopman model, which predicts that GDP growth is dependent on capital, labor and technology (Ben-David and Loewy, 2003). However, this model

is incomplete because it assumes that the country is a closed economy. Trade has the potential to compose an important part of an economy and therefore should not be underestimated when calculating GDP growth. In a 2003 study, David and Loewy (2003) agreed that the growth model should incorporate trade as an integral part of economic growth. The incorporation of trade within GDP growth models has become increasingly critical with increased international trade. In macroeconomic trade models, GDP is defined as C+I+G+NX, where NX is net exports of a country. Therefore, unless a country is closed, trade will have an impact on GDP and GDP per capita.

Sanctions have a potential effect on GDP because they affect the trade of participating parties. Caruso (2003) offers a basic graphical model of economic sanctions that shows how a targeted country is affected by sanctions. The demand curve, D, represents the target country's demand for traded commodities. It is assumed that this country is open and a price taker, therefore the supply curve is horizontal. The vertical line represents the quantity of imported goods while the sanction is in place. As the quantity of goods supplied moves from q1 to q* the price of the goods increases from pw, world price, to p*. As this shift occurs, a deadweight loss is created, represented by the wedge between pw and p*.

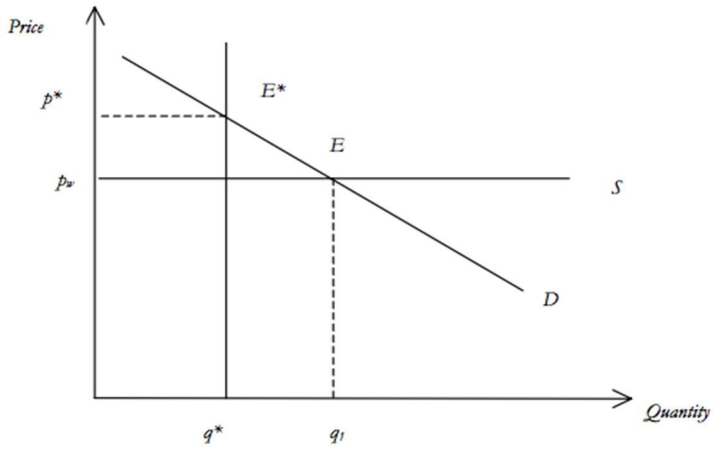

Figure 1. The Impact on trade

Figure 1

As sanctions are imposed, the quantity of goods traded should decrease and price should increase within the country causing its trade to suffer, which should affect GDP.

Neuenkirch and Neumeier's (2015) comprehensive study of U.S. and UN sanctions tests the economic impacts of multilateral versus unilateral sanctions. In this paper, the authors find that UN sanctions have a longer and more significant impact than U.S. sanctions on targeted countries or groups. Comparatively, UN sanctions decrease the targeted countries' GDP growth rates per capita by 2% over 10 years, while the U.S. sanctions decrease the growth by 0.75-1% over 7 years. While both sanctions have a large impact on the targeted country, it is clear the more comprehensive UN sanctions are economically more significant. Instead of providing a comparison of two discrete types of sanctions as this study does, we will use trade linkage and economic complexity as continuous independent variables to track the GDP impact of sanctions. It is informative to look at sanctions in the presence of different trade linkages to determine the degree of impact. Neuenkirch and Neumeier define the strength of a sanction between the two countries as mild, moderate, or severe. Each category is defined based on the kind of sanctions in place. For example, military restrictions are mild, while restrictions on primary exports are moderate. Trade linkage and complexity offer another way to measure the severity in a more continuous quantitative manner. The percentage of trade between two countries and the variety of exports of a targeted country offer continuous measurements of the universality of sanctions that will make the study less reliant on somewhat arbitrary definitions.

Neuenkirch and Neumeier's study has proven useful in several different ways. Perhaps the most important contribution the paper makes to this study is the introduction of a model to measure GDP growth. Nuenkirch and Neumeier's study relies on different variations of the following regression:

GDP Growth= B1log(Real GDP/Capita)+B2(Population)+B3(Openness)+B4(inv/GDP) +B5(Political Terror)+B6(Polity Score)+B7(Interstate Conflict)+B8(Interstate Conflict w/int.)+B9(UN Sanctions(yes/no))+B10(US Sanctions (yes/no))

This regression incorporates various aspects of the Solow growth model, such as population and political climate. Although this model is calculating how sanctions impact GDP, Neuenkirch and Neumeier are missing the interaction between trade and sanctions throughout their regression. Sanctions directly impact trade, and therefore it is important to include them in some capacity in regressions measuring GDP. We altered this model to focus directly on how GDP is impacted by sanctions through trade linkage and economic complexity.

Neuenkirch and Neumeier's model is very similar to the gravity model, one of the most commonly used models in trade literature. Hufbauer and Oegg (2003) modify the gravity equation for sanctions in their study "The Impact of Economic Sanctions on U.S. Trade: Andrew Rose's Gravity Model." This model measures the amount of trade that will occur between two different countries based on the size of each country's economy and the distance between them. While this model predicts trade, it does not predict how GDP will change from trade. And while the Solow-Cass-Koopman model predicts GDP growth, it does not account for trade. Therefore, some aspects of the gravity model can be incorporated in the GDP growth model to more accurately depict what is happening as a result of sanctions in terms of trade. Andrew Rose's gravity model is presented as the following:

Log(Tradeij)=C+B1log(GDPi*GDPj)+B2log(GDPPCi*GDPPCj)+B3log(DIST)+ B4log(AREAP)+B5(Regional)+B6log(Comlang)+B7log(Border)+B8log(Custrict)+B9(LandL)+ B10(Island)+B11(ComCol)+B12(CurCol)+B13(Colony)+B14(ComCtry)+B15(Lim)+B16(Mod) +B17(Ext)+B18(Lim*)+B19(Mod*)+B20(Ext*)

Although this model only predicts trade between two countries, the theory behind the gravity model could prove to be essential in determining how sanctions affect the GDP trend. While the gravity model has been used for decades as a way to determine trade between two countries, over time it has become less relevant because of globalization. Shipping has become more efficient and thus less expensive, and language barriers are not as high as they once were. Another reason to retreat from this theory is because of the problem of multiple senders or targets per sanction, such as in the case of UN sanctions and Arab League sanctions. Distance and common language cannot be measured in this case and therefore the gravity model cannot be used in these cases.

While these papers have all provided useful insight on the impacts that sanctions make on a country's economy, this study will fill in some gaps we saw in the analyses. Instead of using a gravity or Solow model, we instead use initial GDP to show how the GDP trend changes due to sanctions. Also trade linkage and economic complexity are not used in previous analyses.

Data

To test our hypothesis that trade linkage will have a positive correlation with the impact of sanctions on GDP, we examine Hufbauer's sanctions data set. This extensive data set covers 204 sanctions or threat of sanctions episodes from 1918 to 2000. Each case provides information on the type of sanction (export, import or financial), the goal of the sender, the length, and the outcome. The variable that is most important for this study, however, is trade linkage. Trade linkage is defined as the "average of pre-sanction target country exports to the sender country as

a percentage of total target country exports and imports from the sender country as a percentage of total target country imports." This variable is essential to this study as we determine how sanctions impact trade and, as a result, GDP. Trade linkage of the targeted nation is the percentage of exports and imports of the targeted nation that are with all of the sender nations combined if there are more than one senders.

Because we are concerned with trade impacts, we have decided to focus on export and import sanctions as opposed to financial sanctions. Financial sanctions restrict credits or grants to the targeted country. This study focuses on the current account rather than capital; therefore, these sanctions must be treated differently. In our data set 100 out of the 204 sanction cases utilize financial sanctions in some capacity. Therefore, we have decided to include sanctions that primarily focus on export and import restrictions, but may have some financial restrictions imposed as well. For example, the U.S. imposed sanctions on Chile in 1975 over human rights violations. The U.S. utilized both export and financial sanctions in the form of reduced economic and military aid to Chile. Cases such as this one are included because, although they include financial sanctions, the main restrictions involve trade.

GDP data are collected from the World Bank. Although Hufbauer's sanctions data start in 1939, the World Bank only offers GDP data since 1960. Due to difficulties in locating reliable international data on real GDP prior to 1960, this study focuses on sanctions starting after 1960. Even still, some gaps exist in the World Bank's data, such as for the USSR or North Korea. Maddison's World Dataset (2016) is used for these missing country years by comparing data points in which both data sets have entries and developing a ratio between the GDPs. Given these restrictions, 61 case studies from Hufbauer's data set are analyzed here, summarized in figure 2.

Variable	Obs	Mean	Std. Dev.	Min	Max
Sender	0				
Target	0				
Firstyearh	61	1983.328	10.93271	1960	2000
Lastyeari	61	1988.197	10.68148	1962	2006
Years	61	1988.328	10.93271	1965	2005
Linkage	61	30.76721	29.40406	.5	100
GDPStart	61	1.37e+11	3.35e+11	1.01e+08	1.61e+12
GDPEnd	61	1.60e+11	3.57e+11	1.01e+08	1.61e+12
GDP5	61	1.84e+11	4.23e+11	1.85e+08	2.36e+12
Length	61	4.868852	5.330652	0	32

Figure 2

As for the second question, how economic complexity will impact the effect of sanctions on the GDP trend, the data were collected from MIT's *Observatory of Economic Complexity*. This database reports the disaggregated exports of most countries around the world and determines the percentage of total exports for each product. The creators of this Atlas use data from the UN's COMTRADE database to determine their results. This dataset, along with data from the World Bank, is used to conduct regressions concerning economic complexity. However, some countries, like the USSR and other countries in the Soviet Bloc, do not have historical economic complexity data. Therefore, for economic complexity there are 44 case studies available to run regressions. The summary statistics are shown below for economic complexity:

Variable	Obs	Mean	Std. Dev.	Min	Max
Sender	0				
Target	0				
Firstyearh	44	1983.727	9.418842	1965	2000
Lastyeari	44	1988.091	9.863765	1971	2006
Years	44	1988.727	9.418842	1970	2005
Linkage	44	25.13864	26.78807	.5	100
GDPStart	44	1.87e+11	3.84e+11	2.24e+08	1.61e+12
GDPEnd	44	2.15e+11	4.08e+11	3.60e+08	1.61e+12
GDP5	44	2.51e+11	4.83e+11	2.96e+08	2.36e+12
Length	44	4.363636	4.069689	0	18
Complexity	44	.2156581	.9239761	-1.61024	2.02292

Figure 3

Theory

International trade theory can be used to show how sanctions are supposed to impact GDP growth. As shown in figure 4, sanctions create a price increase by decreasing the total quantity in the targeted country. *e1* is the supply and demand equilibrium for the country before the sanctions are put in place and P1 is the world price. This graph assumes that there are export sanctions on the targeted country and that the sanctions will eliminate all trade. Export sanctions decrease total quantity by reducing the amount of imports to the country by y on the supply and demand graph below. As this occurs, the quantity supplied shifts to the left from S1 to S2 to compensate for this loss, with S2 representing the autarky supply curve. This causes prices to rise above world price and a loss in welfare for the targeted country.

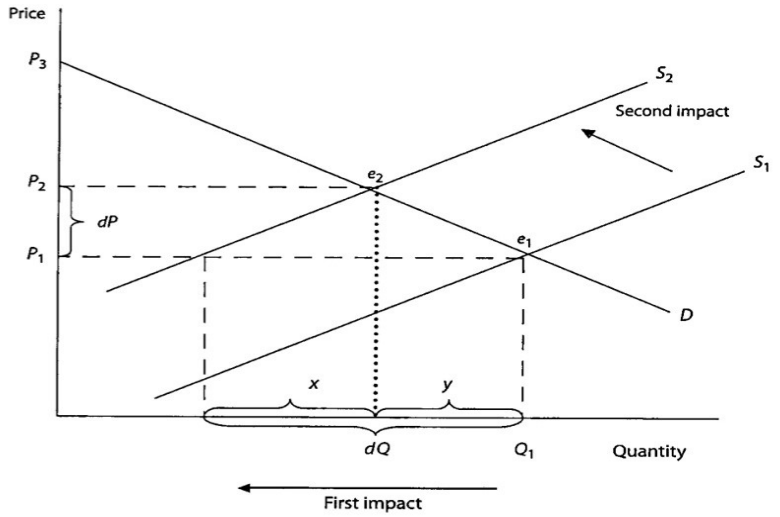

Figure 4

This price effect is similar to a price change in the tariff model. Sanctions, like tariffs and quotas, are barriers to free trade and therefore follow the same patterns as these other restrictions. If sanctions restrict trade as intended, the policy should have a similar impact to tariffs and quotas. If the target is operating efficiently, they should be purchasing and selling goods at the world price levels. However, prices rise as the quantity of imports is restricted causing a deadweight loss, as seen in Caruso's graph previously. The general equilibrium model

also shows this impact as the targeted country is reverting back to autarky as sanctions restrict trade. As the terms of trade change due to the movement in production, prices deviate from world prices, creating both a consumption and production distortion. Although the country is still operating along the production possibilities frontier, it is not specializing in the good in which it has a comparative advantage and thus lies on a lower indifference curve. The country is using its resources to produce goods and services that it could more efficiently import, and thus it is removing resources away from its comparative advantage. This would lower total GDP of the country because the goods that the country is now producing are less valued in the world market compared to the comparative advantage goods. Thus the country would have a lower value of exports as they put more resources into producing import-competing goods.

Because sanctions move the targeted country back towards autarky, we hypothesize that as the trade linkage gets larger between the target and sender countries, the closer the country will move towards autarky during sanctions. This impact should cause welfare to decrease and GDP to be negatively impacted. To test this prediction, we use GDP as the dependent variable and trade linkage and pre-sanction GDP as independent variables. The first regression conducting is the following:

$$\text{GDP post sanction} = \beta_0 + \beta_1(\text{GDP pre-sanction}) + \beta_2(\text{Trade Linkage}) + \beta_3(\text{GDP pre-sanction x Trade Linkage})$$

This regression shows how trade linkage will impact the outcome of economic sanctions based on GDP. Pre-sanction GDP is GDP at the start year of the sanction and is used to show how the

sanctions cause GDP to deviate from its trend. The interactive term is used to show how both GDP and trade linkage will affect post sanction GDP.

Another question we look to investigate is economic complexity's impact on sanctions. We expect as economic complexity gets larger for the target country, the less impact the sanction will have on trade. This is expected because the economy will be able to sustain lack of trade in one sector with trade in other sectors. Whereas in a country like Saudi Arabia that depends on oil, if that commodity was targeted by sanctions, it would have a large impact on its GDP, and its economy would not be able to sustain the loss of trade for oil. This regression will be similar to the one conducted with trade linkage, with pre-sanctioned GDP as an independent variable and an interactive variable between pre-sanction GDP and economic complexity.

Results

Signs from initial regressions confirm these hypotheses with varying significance. In the first regression GDP five years after the sanction was the dependent variable and initial GDP and trade linkage were the independent variables:

$$\text{GDP after Five Years} = \beta_{0+} \beta_1 (\text{GDP pre-sanction}) + \beta_2 (\text{Trade Linkage})$$

Regression 1

In a robust regression, both the GDP at the start of the sanction and linkage were statistically significant at the 95% level. GDP at the start of the sanction generates a positive coefficient, meaning the larger the pre-sanctioned GDP of the targeted country; the larger GDP will be five years after sanctions begin. We also find a negative correlation between GDP five years after the start of the sanction and trade linkage. This means as trade linkage gets larger between the target and sender, the more negative the impact on GDP. As trade linkage increases by one unit, GDP decreases by over half a billion dollars, seen in figure 5. Each unit is defined as 1% increase in

the targeted country's total trade that is conducted with the sender country. A one standard deviation increase in trade linkage before the sanction is put in place is associated with a drop of 161 billion dollars five years after the sanctions begin.

Linear regression

Number of obs	= 61
F(2, 58)	= 51.95
Prob > F	= 0.0000
R-squared	= 0.9078
Root MSE	= 1.3e+11

GDP5	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPStart	1.187875	.1923996	6.17	0.000	.8027457	1.573005
Linkage	-5.49e+08	2.56e+08	-2.14	0.036	-1.06e+09	-3.58e+07
_cons	3.78e+10	1.97e+10	1.92	0.060	-1.63e+09	7.72e+10

Figure 5

Regression 2 included an interactive variable between initial GDP and trade linkage. The interaction term allows the effect of trade linkage on post sanction GDP to differ depending on the initial GDP of the target. This regression shows how trade linkage will impact the GDP five years after the sanctions begin, depending on the starting GDP of the targeted country:

GDP after Five Years= $\beta_0 + \beta_1$ (GDP pre-sanction)+ β_2 (Trade Linkage)+ β_3 (GDP pre-sanction x Trade Linkage) Regression 2

The equation above captures the joint impact on GDP of the initial GDP and trade linkage rather than how they independently impact GDP. Initial GDP was again statistically significant; trade linkage was not, and thus these results are not conclusive. Even so, trade linkage does have a large negative coefficient as we were expecting, as seen in figure 6.

Linear regression

Number of obs	= 61
F(3, 57)	= 53.44
Prob > F	= 0.0000
R-squared	= 0.9080
Root MSE	= 1.3e+11

GDP5	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPStart	1.177785	.2232886	5.27	0.000	.7306577	1.624913
Linkage	-6.00e+08	3.84e+08	-1.56	0.123	-1.37e+09	1.68e+08
GDPStart_Li~e	.0039838	.0160259	0.25	0.805	-.0281074	.0360751
_cons	3.63e+10	1.74e+10	2.09	0.041	1.49e+09	7.12e+10

Figure 6

The interactive variable had a coefficient that was also not statistically significant. In this specification, dGDP/dLinkage=beta Linkage +beta Interaction*GDP. While the estimated coefficient on the interaction variable is small in magnitude, once is it scaled by pre-sanctioned GDP it becomes a large number. To determine what this would mean for the two extreme start values, we computed how the GDP after five years would be affected for both the max start GDP and min start GDP. For a small economy, linkage would have a negative 577 million dollar GDP impact after 5 years. For the large economy there would be positive 598 million dollar impact GDP after 5 years. Although these are the two extremes there is a clear difference between small and large countries as illustrated in figure 7 below:

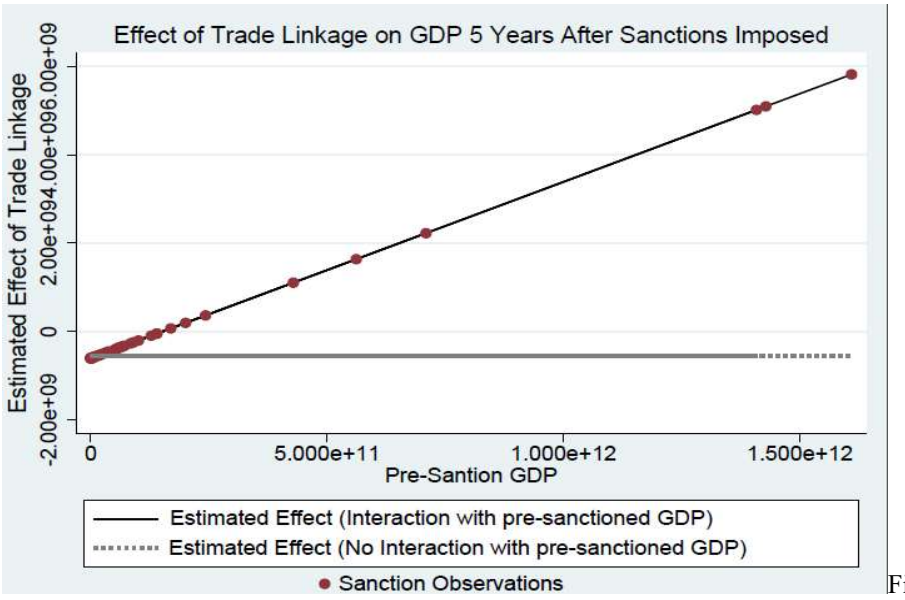

Figure 7

Figure 7 represents how the impact of trade linkage on GDP is impacted by initial GDP. The horizontal line shows the estimated effect of sanctions without the interaction between initial GDP and trade linkage. The upward sloping line shows the estimated effect with the presence of the interaction variable. As the pre-sanctioned GDP gets larger, trade linkage causes a smaller change in GDP trends. For most observations, trade linkage shows a negative correlation to GDP after a sanction has taken place, as shown by the abundance of observations below zero, however there are some outliers in this dataset that reverse this trend. There could be several reasons as to why countries with a relatively large pre-sanction GDP would be less impacted by trade linkage. First, the countries could have a higher economic complexity. If this is the case those countries will more easily be able to attain new trading partners because of their diverse outputs. Another reason for this trend is that their GDP was strong so this growth was hard to break from the trend.

It is also interesting to note that most of our observation had targeted nations with relatively similar initial GDPs. One explanation for this is that sanctions often are imposed in a time of conflict. Often conflicts begin from economic discontent, which could explain the similar small GDPs. The theory of dysfunctionalism states that conflict impacts the economy of a country and thus breeds discontent, which in turn leads to more conflict. It is difficult for a country to break out of this cycle and thus this theory could be causing this trend. However, we must reiterate that the interactive variable was not significant in the 95% interval. There are several reasons why the independent variables in this regression are not significant. The first is that the sample size is small. There are only 61 sanctions episodes within the data set, which could be too small to determine the impact of trade linkage in models that include an interaction term. This makes the confidence variables very large and thus the estimates fairly imprecise.

To determine how the length of a sanction impacts the GDP effects of that sanction we ran the following regression both with, figure 9, and without, figure 8, the interaction variable:

GDP End of Sanction= β_0 + β_1 (GDP pre-sanction)+ β_2 (Trade Linkage)+ β_3 (GDP pre-sanction x Trade Linkage)+ β_4 (Length of Sanction) Regression 3

Unlike the regressions without length, both the equations that included length with and without the interaction variable had statistically significant independent variables. Without the interaction variable, the impact on GDP was negative 336 million dollars per 1% increase in trade linkage. The regression with the interactive variable also has a statistically significant negative impact on GDP.

Linear regression

				Number of obs	=	61
				F(3, 57)	=	254.47
				Prob > F	=	0.0000
				R-squared	=	0.9834
				Root MSE	=	4.7e+10

GDPEnd	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPStart	1.057182	.0383001	27.60	0.000	.9804879	1.133877
Linkage	-3.36e+08	1.24e+08	-2.72	0.009	-5.84e+08	-8.85e+07
Length	2.81e+09	1.02e+09	2.75	0.008	7.61e+08	4.85e+09
_cons	1.22e+10	8.55e+09	1.43	0.159	-4.92e+09	2.93e+10

Figure 8

Linear regression

Number of obs	= 61
F(4, 56)	= 220.44
Prob > F	= 0.0000
R-squared	= 0.9834
Root MSE	= 4.8e+10

GDPEnd	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPStart	1.05761	.0441387	23.96	0.000	.9691892	1.14603
Linkage	-3.34e+08	1.14e+08	-2.94	0.005	-5.62e+08	-1.06e+08
GDPStart_Li~e	-.0001738	.0046611	-0.04	0.970	-.0095111	.0091634
Length	2.80e+09	1.06e+09	2.66	0.010	6.88e+08	4.92e+09
_cons	1.23e+10	9.58e+09	1.28	0.205	-6.90e+09	3.15e+10

Figure 9

While these numbers are large, they are much smaller than the previous regressions. The change in size of this variable can be explained by the addition of length. These results indicate that the longer the length of the sanctions, the less impact it will have on GDP. As sanctions increase in length, the more time the targeted country has to find new trading partners or develop new sectors. The significance of length also is evidence that countries may impose sanctions even if they are having little impact. It is also interesting to see the correlation between these two independent variables. As the length of sanctions increases, the larger the trade linkage tends to be. We ran a smaller sample size in which we only included sanctions 10 years and under in length to eliminate the extreme sanction cases that could be distorting the data. This regression did not prove to have drastically different results and therefore there must be another force behind this correlation between length and trade linkage. One explanation could be the introduction of "black knights" that reverse the impact of the sanctions or the introduction of new trading partners. Black knights are outside actors that help the target of sanctions through trade or aid, for political reasons. In these instances even though there was a large trade linkage between the sender and target before the sanction started, this measurement should change with the introduction of trading partners.

To test how trade linkage impacted GDP based on pre-sanctioned GDP for a dependent variable of GDP at the end of a sanction episode, we graphed a similar analysis to the one show in figure 7.

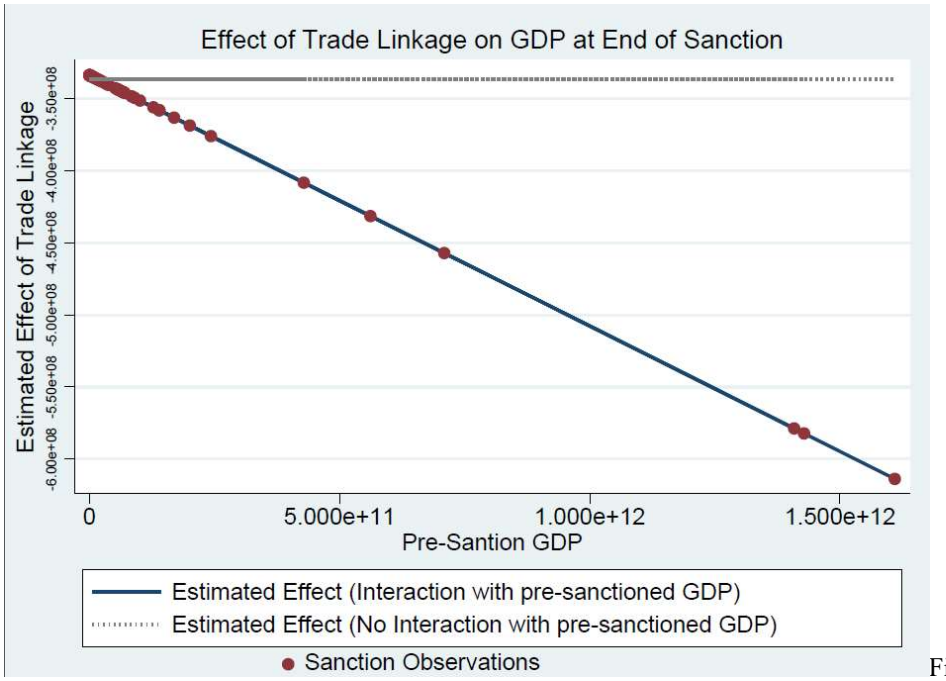

Figure 10

The data show a different trend than the regressions without length. As initial GDP gets larger, the estimated effect of trade linkages becomes increasingly negative, meaning the larger the economy that is being targeted by sanctions the larger the negative impact of trade sanctions. This is the opposite impact than expected, and the opposite impact than what is seen in regressions that do not include length. As noted before the interactive coefficient is not significant and therefore these results should be taken with hesitation. While the impact of trade linkage based on pre-sanctioned GDP is unclear, there is evidence that there is a difference outcome for targeted nations that have different initial GDPs.

In addition to examining how trade linkage impact the GDP trend of a sanctioned country, we also examined how economic complexity affects the GDP trend. As noted previously, economic complexity is a measurement of the diversity of exports in a country. All

of the regressions for linkage were also run with economic complexity as a dependent variable. There were only 44 sanction episodes included in our second stage of analysis of trade sanctions because of the constraints of economic complexity data. The first regression was GDP five years after the start of the sanction, and the dependent variables as the GDP and the economic complexity at the start of the sanction. As expected, economic complexity generated a positive coefficient. This means as the economic complexity gets larger, the effect on GDP during the sanctions is smaller, the opposite case compared to trade linkage. The coefficient number was very large, 3.24e+10. This indicates that for every increase in economic complexity by one, there is a 32 billion dollar increase in the GDP five years after the sanction episode. While this number seems excessively large, every increase in one unit of economic complexity equates to a vast difference in diverse countries and non-diverse countries. The matrix of diversity and ubiquity calculate this spectrum, which ranges from -2.5 to about 2.5. However, in this first regression complexity was not statistically significant within the 95 % confidence interval.

```
Linear regression                               Number of obs =      44
                                                F(  2,    41) =   37.29
                                                Prob > F      =  0.0000
                                                R-squared     =  0.9030
                                                Root MSE      =  1.5e+11
```

GDP5	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPStart	1.145538	.2151046	5.33	0.000	.7111257	1.579951
Complexity	3.24e+10	2.45e+10	1.32	0.193	-1.70e+10	8.19e+10
_cons	3.00e+10	1.78e+10	1.68	0.100	-6.00e+09	6.60e+10

Figure 11

We next analyzed how economic complexity impacts GDP five years after an imposed sanction for different initial GDPs. As we saw in the first regression, economic complexity has a positive coefficient; however, the interactive variable has a negative coefficient. This means that the economic complexity impact of GDP after the sanction is negatively dependent on the

starting GDP of the sanctioned country. Therefore, as the starting GDP of a sanctioned country gets larger, the economic complexity will have a negative on GDP five years after the sanction is imposed on the targeted country. This outcome however, is not significant. The reasons why these results might not be statistically significant could be the possible reasons why trade linkage was not significant such as the sample size or the introduction of new trading partners.

Linear regression

Number of obs	44
F(3, 40)	27.24
Prob > F	0.0000
R-squared	0.9059
Root MSE	1.5e+11

GDP5	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDPStart	1.485484	.2983457	4.98	0.000	.882505	2.088463
Complexity	3.98e+10	2.44e+10	1.63	0.111	-9.56e+09	8.92e+10
GDPStart_Co~x	-.1885323	.1026319	-1.84	0.074	-.3959592	.0188945
_cons	1.32e+10	2.05e+10	0.64	0.526	-2.84e+10	5.47e+10

Figure 12

As with trade linkage, we calculated how these coefficients would impact the maximum start GDP and the minimum starting GDP. For the smallest country in terms of GDP, the partial determined that 40 billion dollar GDP increase after five years and the largest country in this study would have a 264 billion dollar decrease on GDP after five years. In graphing the effectiveness of all sanctions episodes based on economic complexity the following is generated:

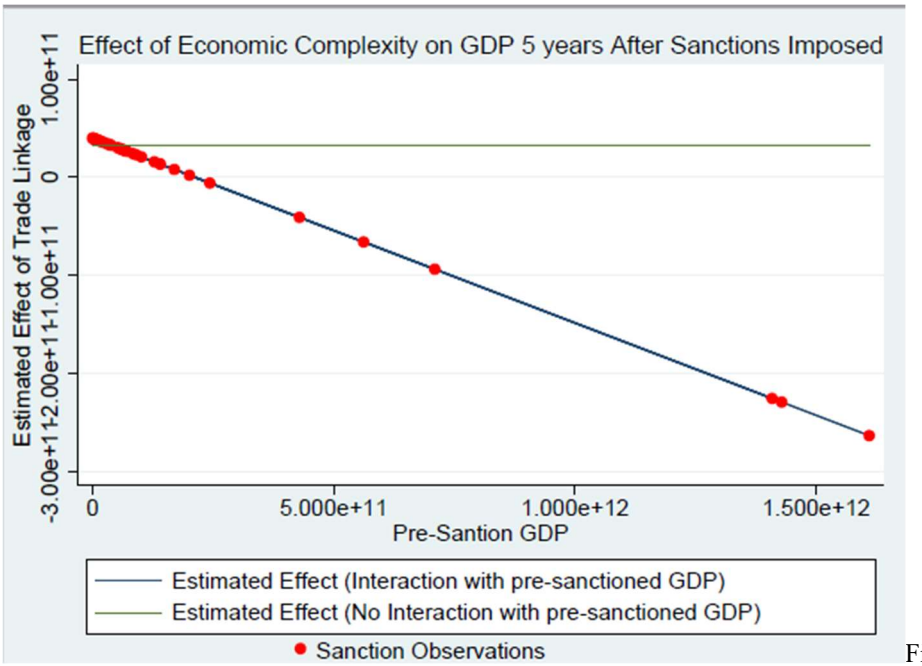

Figure 13

The straight line represents no interaction with initial GDP and the sloped line represents the interaction between initial GDP and economic complexity. Unlike the in figure 5, there is a negative slope for the economic complexity and pre-sanctioned GDP interaction, meaning economic complexity enables countries with smaller initial GDPs to combat the decrease in trade due to sanctions more than it helps those with larger GDPs. Theoretically, this makes economic sense because a smaller country would benefit more from increased economic complexity than economically larger countries would. If a country has a higher economic complexity, it would be able to more easily able to find replacement for lost trading partners. This is essential and more important for a country with a smaller economy because may not be able to recover as quickly as large economies. This same relationship can be seen with length included in the regression as seen in figure 14:

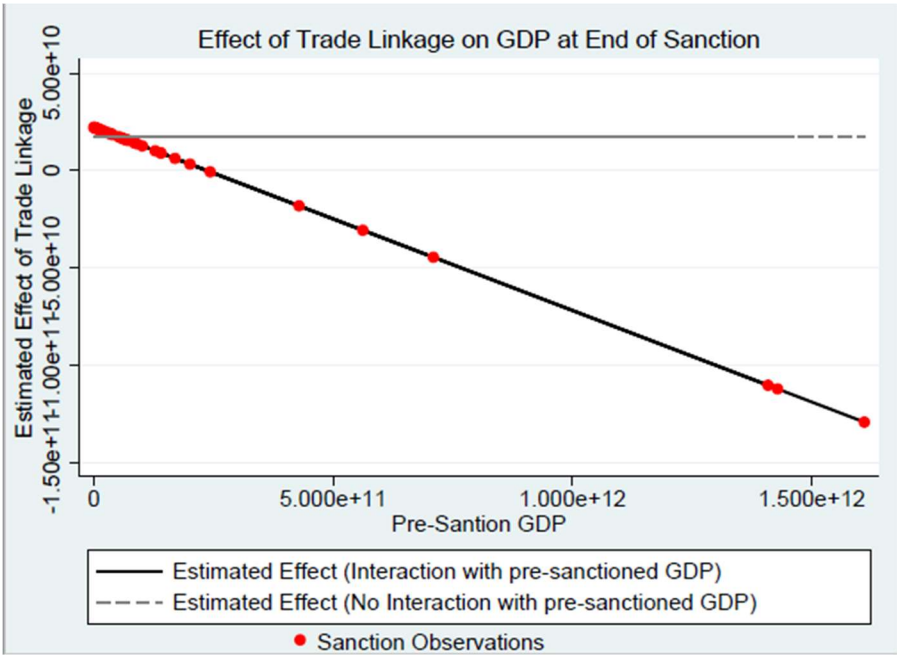

Figure 14

Economic complexity has a larger positive impact on countries with smaller initial GDP compared to those with a large initial GDP. Although interaction coefficients are not significant, they are interesting to analyze how trends have the potential to change depending on the pre-sanctioned GDP.

Conclusion

While some of the results presented in this study proved to be inconclusive, there are several interesting findings that are worth noting. Trade linkage was significant when we factored in length, but was not when we limited the measurement of GDP to five years after a sanction was imposed. This indicates that length is significant in determining the success and impact of sanctions. If the sanction is not initially effective impacting GDP, there are more trade partners and opportunities available to the sanctioned country. Economic complexity on the other hand, was not statistically significant in this study. There are several possible explanations for this insignificance, including the multi-dimensional nature of the variable. Unlike trade linkage, which is only a two-dimensional variable between countries, economic complexity is

much broader and impacts the country on a global scale. Economic complexity represents all exports that a country has, not just with one country. Another interesting conclusion from this study is the correlation between the initial size of a sanctioned country's economy and the effect of sanctions. Those countries with a larger initial GDP show that sanctions do not have as large of an impact as those countries that have a relatively smaller GDP.

These results have several policy implications for both sender and targeted nations of sanctions. For the sending countries, it is important to note that sanctions must have an initially impact to be successful impacting GDP. If the sanction does not have a strong initial impact, it will be easier for the targeted nation to find replacement trading partners. Senders also must take notice of trade linkage between them and the targeted countries. If there is a higher trade linkage, there is a higher chance that the sanction will be successful. Targeted nations should also be aware of these findings. If targeted countries are able to find substitute trade partners quickly, they will be able to offset the negative consequences of the sanction easier.

There are still many questions to be answered within economic sanctions literature. One interesting aspect of sanctions that has not been looked at is the impact of sanctions in the age of the Internet. Because of our ever-increasing globalized economy, trading has become cheaper and more efficient. As trade becomes easier, this could have implications for sanctions as it may become easier to find substitute trading partners.

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