The Impact of Logistics Performance on the Success of Trade Agreements

The Honors Program
Senior Capstone Project
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ABSTRACT

The purpose of this capstone project is to determine whether or not it is possible to predict the success and effectiveness of new trade agreements by looking at fundamental factors associated with efficient supply chain management. Typically, free trade agreements are analyzed using economic factors such as Gross Domestic Product or labor gains and losses. When this is done to determine whether or not a trade agreement is successful, it is usually backwards looking and too late for a country to opt out without economic repercussions. The aim of this study is to determine whether it is possible to predict the potential success of a free trade agreement. Furthermore, rather than using economic indicators to make predictions, I have decided to use supply chain, specifically logistics, metrics to conduct this study. Using logistics metrics is a better representation than economics, not only because the economics metrics mentioned are lagging indicators, but also because without sound logistics and the capability to move goods from point A to B, a trade agreement would fail. This study is comprised of two different quantitative analyses. First, I look at the Logistics Performance Index (LPI) compared to Net Trade to see if a relationship existed. The next step was to determine what factors drive LPI growth and should be a country's focus for improving. The trade agreement focused on in this study was the Tripartite Free Trade Agreement encompassing 27 countries in Africa.

Figure 1 is a map of the 27 nations in the TFTA (Appendix A)

INTRODUCTION

Since the late 1900's, global trade has risen steadily (Ortiz-Ospina, E. & Roser, M., 2016). As countries began to rely more and more on one another for commodities and goods, they began to create free trade agreements (FTA's). These agreements were aimed at lowering any barriers to trade such as tariffs and customs procedures. As positive as FTA's may seem, critics will argue that many agreements are lopsided, with some nations benefiting at the expense of others (Level, 2016). As such, this study looks to determine how successful an FTA will be before its creation. Currently, there is little research compiled related to how supply chain performance influences a trade agreement. This study is aimed at beginning to fill that knowledge gap. The study differs from others of its kind in that it will be looking at the agreement from a standpoint of supply chain management, more specifically, logistics. In order for a trade agreement to be successful, goods must be moved from country to country. Without strong logistics in place, these goods will be unable to get from point A to point B, and the agreement will fail. It is crucial that a nation has strong logistics.

The focus of this study is centered on the newly created African Tripartite Free Trade Agreement (TFTA) for two main reasons. First, the entire continent has generally been lagging behind the rest of the world as far as growth and development is concerned (Merten, 2015). This study has the potential to help these 27 nations and their citizen's rise out of poverty and improve logistics and standard of life. Furthermore, this is one of the few agreements without a fully developed nation, such as the United States, involved. When a developed nation is involved, the results of a trade agreement are more likely to be skewed. In the case of the North America Free Trade Agreement (NAFTA), the U.S. was much further developed then Mexico and Canada when the agreement was formed. While all the countries have reaped tremendous rewards from the agreement, the United States was able to help its counterparts improve along the way. According to Robert Blecker, "NAFTA did foster greater U.S.-Mexican integration and helped transform Mexico into a major exporter of manufactured goods" (North, 2016). By observing an agreement with only developing nations, a more accurate representation of what nations must do to succeed together should be discovered.

When it comes to trade agreements, a key factor is supply chain performance (Hoekman). After all, if goods cannot be moved from country to country efficiently, a trade agreement is pointless. If this proves to be an accurate way to predict the success of the TFTA, it is possible that the same method can be replicated for future trade agreements around the world. The Logistics Performance Index encompasses many aspects of supply chain and logistics, making it a strong representation of how each country is performing (Arvis, J., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., & Raj, A., 2014).

This is an extensive study comprising of two in depth literature reviews followed by two quantitative analyses. The first literature review is aimed at identifying which variables would be used. As this is a unique study, the second literature review was conducted with the goal of justifying the use of each variable. After completing this step, a linear regression using net trade as the dependent variable and Logistics Performance Index (LPI) as an independent variable assessed whether or not LPI could drive trade growth (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014). Finally, a nonlinear regression was run to determine which specific variables drive LPI. The goal of these studies was to determine where countries should focus investments and improvements to help drive a successful trade agreement.

LITERATURE REVIEW

Introduction

Trade agreements have become the norm in today's world. Being able to conduct business across the globe, forming partnerships with other nations was inevitable. Both intercontinental and regional, many countries hold membership to numerous trade agreements. Recently, these agreements have come under much scrutiny. The debate on free trade agreements makes this research project all the more relevant. By being able to predict the level of success of an agreement, it will be possible to determine the true benefit of entering an agreement before a country actually has to commit.

Being a Global Supply Chain Management major, my focus will lie primarily in how the agreements will impact a countries logistics performance index (LPI). The LPI is a weighted average of six supply chain components – customs, infrastructure, ease of shipping

arrangements, quality of logistics services, tracking and tracing, and timeliness (Arvis, J., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., & Raj, A., 2014). As the underlying theme is regional trade, trade volumes will be analyzed including GDP.

From a manufacturing standpoint, Africa has always been an interesting topic to me. Many anticipated that some of continent's countries would rise in manufacturing as China has, leading to an economic boom. These countries would have lower costs due to largely to low cost labor and little business regulation. To date, and for unknown reasons, this movement has not occurred on the significant scale expected. The obvious question becomes, "Why not?" coupled with the question of, "Is it still possible?" A large-scale trade agreement may be the catalyst needed to propel Africa forward in its development.

It is my hope that this study will succeed in offering predictions on success before countries have to devote resources towards making a trade agreement a reality. If the costs to achieve and implement an agreement are higher than the net benefit of the agreement, it may not be worthwhile for that country to participate.

Background/History

There does not appear to be any studies with the goal of predicting widespread trade agreement success, especially using supply chain metrics. Many of the existing studies focus on one or two countries to determine if they have achieved economic success, but there is no focus on all of the member countries or supply chains. A major development from the ethnic fractionalization standpoint has been the updated studies and formulas used to quantify cultural differences. Ethnic fractionalization deals with the number, sizes, socioeconomic distribution, and geographical location of distinct cultural groups, usually in a state or some otherwise delineated territory (Ethnic Fractionalization). The specific cultural features might refer to language, skin color, religion, ethnicity, customs and tradition, history, or another distinctive criterion, alone or in combination. Frequently these features are used for social exclusion and the monopolization of power (Gale, 2008). One such method developed by Fearon (2003) appears to be considerably more accurate than the previous Ethno-Linguistic Fractionalization (ELF) metric. This advancement will work very well during the quantitative portion of my study.

Ethnic Fractionalization:

Africa represents an interesting situation in terms of global perception. Many "outsiders" view the continent as one location, rather than each of the 53 countries as individual entities. This is very different than any other multi-country continent. Lumping all people under one group portrays a scenario that could not be further from the truth. Africa, in fact, is the most diverse continent on the planet in terms of regional ethnic groups (Fearon, 2003). Tanzania alone has 22 different ethnic groups based on Fearon's classification methods. Not only do the individual countries have multiple ethnicities, the 27 countries I am studying stretch across western Africa from the north to the south. Any region this large will have a diverse population. If these groups are unable to interact with one another without conflict, the trade agreement will be doomed from the start.

When conducting this study, it is crucial to look at these groups individually and give the respect that the culture deserves. It is likely that cultural diversity can play a role in the various levels of development and success each individual country may experience from the trade agreement. So far, there have been a number of studies that have tried to quantify ethnic fractionalization. Fearon (2003), investigated 160 countries in the world in an effort to update the antiquated ELF measure from a study done by Easterly and Levine in the 1990s (Easterly & Levine, 1997). Fearon specifically acknowledges the difficulty in gathering data for much of sub-Saharan Africa, as there are no accurate reports of the various groups at the time of the study. If Ethnic diversity is as large a problem as Fearon suggests, it may also pose challenges to improving trade and inter-country growth. Fearon acknowledges that surveying would be the best method of data collection for this study; however, without the resources available, he relied on secondary sources. With this method, Fearon was able to identify 822 different ethnic groups around the world. For a group to qualify in this study, the group had to make up at least one percent of that nation's population. In order to develop his index, Fearon used a common measure of fractionalization. Basically, the probability that two individuals randomly chosen are from different ethnic groups (Fearon, 2003).

Montalvo and Reynal-Querol (2005) attempted to uncover the same consequences of ethnic heterogeneity. The two hypothesize that an ethnically polarized society may negatively impact the rate of investment. It may also lead to rent-seeking situations that escalate into conflict (Montalvo, & Reynal-Querol, 2005). In this case, the two believe that a polarization

measure can better predict potential conflict than a fractionalization measure. Referring to other reports, the two researchers suggest that ethnic and linguistic fractionalization have a negative effect on the quality of government, but religious fractionalization does not (Montalvo, & Reynal-Querol, 2005). This raises the interesting question of how ethnicities are defined. Montalvo, Reynal-Querol, & Fearon all pose this issue in their studies. Fearon refers to attempts at classification as a slippery slope, while Montalvo & Reynal-Querol highlight six distinct characteristics of classification: race, color, culture, language, ethnic origin, and nationality. As mentioned, the issue of classification is compounded in Africa where information is not always accurate. Montalvo & Reynal-Querol determine it best to look at this issue in two different lights. They argue that polarization can better show the potential for conflict in a country. It was concluded that, in highly heterogenic countries there is no correlation between fractionalization and polarization. The results of this study agree with Fearon that fractionalization does have a negative impact on growth (although not for the reasons they believed) and that polarization also has a negative effect because, "It reduces the rate of investment and increases public consumption and the incidence of civil wars" (Montalvo & Reynal-Querol, 2005, pg. 318).

Posner (2004) measured the ethnic fractionalization in Africa specifically in 2004. Posner argues that the commonly used Ethno-Linguistic Fractionalization (ELF) measure is an inaccurate method for measuring the impact of ethnic diversity on economic growth. This is consistent with the views of Fearon, Montalvo, and Reynal-Querol, as all believe the ELF measure is antiquated and the data used to calculate the values is "suspect" (Posner, 2004). Rather than continue to use this method that aims to show the ethnic layout of a country in one statistic, Posner develops a new method known as the Politically Relevant Ethnic Groups (PREG) measure. Posner specifically acknowledges Fearon as "going the furthest in addressing this problem by creating an index of cultural diversity based on an assessment of the cultural distance between groups…" (Posner, 2004, 862). Posner's method will provide another alternative to ELF, but will require an in depth review to make sure it is accurate. I have not found mention of the PREG model in any other sources I am referencing.

Elbadawi and Sambanis (2000) have done significant research into why there are a number of civil wars raging across Africa. While many believe this is due to rivaling

cultures that cannot coexist, the two believe otherwise. As it turns out, the warring may be due to high levels of poverty, political failure, and the dependence on natural resources (Elbadawi & Sambanis, 2000). Contrary to popular belief, it is argued that having multiple cultures may actually help peace and compromise. With the majority of African nations' economies routed in the export of resources, it comes as no surprise that there would be a war over resources. Add a governing style of dictatorship to the mix, and the perfect storm is created for a conflict (Elbadawi & Sambanis, 2000).

Present-Day African Growth

The nations in Africa have been improving yearly, although this may not be visible to many people from the outside, and there is still a long way to go to catch up with the rest of the world economy. Kimenyi, Lewis, and Routman (2012) acknowledge that developing an intra-African trade agreement is not a fix-all. It is however, a great starting point. The continent as a whole will become more competitive due to economies of scale and the survival of the fittest mentality of markets. As a direct result, the success will spur investment, thus helping to transform the region. Witney Schneidman (2016) also questions whether forming a trade bloc of just African nations is the smartest move. While Schneidman (2016) acknowledges that it is a great step for the nations in Africa internally, it may isolate them from the international stage. As they focus on the development of this agreement, they risk losing trade partners from the developed world. This agreement represents a key point in the future of the region. It has the potential to spur growth in half of the countries in Africa, making it very appealing to do business. At the same time, the nations have to make sure they do not become so focused on intra-African success that they miss out on international opportunities.

Index Reports

In order to test the quantitative portion of this study, numerous indices will be used to run regression models aimed at determining which variables be significant in predicting trade agreement success, specifically focusing on supply chain metrics. The data includes the Logistics Performance Index (LPI), Ease of Doing Business, net trade, and ethnic fractionalization. Additionally, the World Bank compiles development data relevant to this study. The LPI is a study compiled every two years by the World Bank and ranks countries supply chain performance on a scale of 1-5 with 5 being the best. The final score is an average

based on the scores of six supply chain metrics – Customs, Infrastructure, International Shipments, Logistics Competence, Tracking & Tracing, and Timeliness. These metrics are crucial for a country to be able to handle high volumes of trade moving across its borders. This data is compiled by conducting interviews with companies that operated day-to-day within each nation (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014). The Ease of Doing Business report is compiled by ranking economies on their ease of doing business from 1-190 (Economy Rankings). The rankings are determined by sorting the aggregate distance to frontier scores on 10 topics, each consisting of several indicators, giving equal weight to each topic. The distance to frontier score shows the gap existing between a country's actual economic performance and that of the best practice across all indicators. GDP and GDP per capita data was pulled from The World Bank's website along with the trade volumes. The ethnic fractionalization values will come from Fearon's study completed in 2003. Both single regressions as well multi-variable regressions will be conducted to determine the significance of each factor identified in relation to the LPI.

Trade Agreements

With the basis of this entire study surrounding trade agreements and the success that they may have, it is important to take an in-depth look at current agreements in Africa, as well as general information on the formation of blocs and whether trade agreements have been inherently beneficial or harmful. One interesting aspect to this project is that each of the countries forming the Tripartite Free Trade Agreement (TFTA) are already in another trade agreement. Some even hold membership in two. The three other agreements are the South African Development Community (SADC), the East African Community (EAC), and the Common Market for Eastern and Southern Africa (COMESA). As the names suggest, each of these agreements also consists of only African countries.

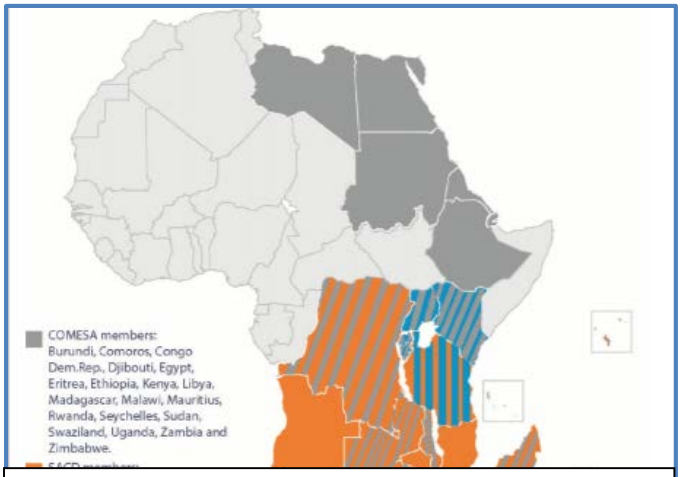


Figure 2: TFTA Nations current FTA memberships
http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/551308/EPRS_BRI(2015)551308_EN.pdf
(Appendix B)

COMESA is by far the largest current agreement, with 20 of the TFTA nations belonging to it. Fourteen nations hold membership in SADC and only six nations are in EAC. Almost half of the countries belong to two of the trade blocs and the rest are exclusively in one.

It will be important to investigate the status of the current agreements, not only to see what the boosts in trade have been, but also to see if they will continue to exist after the TFTA is finalized. Another important aspect to consider is if trade agreements in general, provide common benefits to members. In *Trade Blocs: Relevant for Africa?* Jan Gunning illustrates this issue saying that, "Trade blocs will often result in very unequally divided benefits or, indeed (as we have just seen), in some members of the members gaining while other countries in the bloc lose" (2001 pg.319). The EAC was a perfect example of this. Because Kenya became the manufacturing hub for Tanzania and Uganda, the two countries felt Kenya was gaining more wealth out of the agreement. As a result, the original EAC agreement all but failed, with Tanzania closing its border with Kenya (Gunning, 2001). Alternatively, agreements can help with tariff harmonization and benefit economies. By gaining access to new markets, competition will grow in the market and companies will gain access to economies of scale (Gunning, 2001).

Plant and Taghian (2008), examined success factors in trade blocs. This study has a larger focus on the economic aspect of a trade agreement. A benefit to this study, is that it focuses on regional agreements, much like the TFTA, rather than inter-continental blocs. Based on the model they have proposed, Plant and Taghian believe it is possible to predict the success, although it does not appear they actually applied the model to a specific agreement. Yeats (2004) also attempted to forecast the outcome of Africa Regional Trade Agreements. Rather than use explicitly quantitative data, he focused on qualitative aspects. There are a few issues highlighted in this report that may hinder the ability to build a strong agreement according to Yeats. First, there is very little intra-African trade to begin with. The trade that does occur between countries is very regional, focused around bordering nations, which could help to explain the patterns of the current agreements in place (Yeats, 2004). With little product diversity, it is difficult for the countries to experience benefits from lowering tariffs and trading with one another. With this being a regional agreement, they will still face high tariff levels on the imports from the rest of the world.

Rodriguez and Rodrik (2001) offer a different perspective on trade agreements, arguing that they may not actually be that beneficial. The two caution that eliminating tariffs may not be a fix-all solution. While they are not claiming to be experts in economic policy, they do offer evidence of a greater benefit to having some level of tariffs. In fact, in the late 1800s, many European countries re-imposed tariffs in an effort to protect their own industries from an influx of cheaper American goods (Rodriguez & Rodrik, 2001). In many African nations, the focus must be on stimulating their own economies to improve the status of the country. Keeping some level of tariffs in place may help with this. Not only will it keep the low cost imports from infiltrating and undercutting a country's own manufacturing operations, the revenues can be used on logistics projects to improve infrastructure and quality of life.

Hoekman, Olarreaga, and Zedillo (2007) present the opposite argument to Rodriguez and Rodrik. In their report, *Global Trade and Poor Nations,* the three maintain that the wealthiest nations have all of the influence in any trade agreement formed. Furthermore, if a trade agreement is going to be successful, these top countries must lower tariffs and eliminate subsidies to allow developing nations a chance to compete (Hoekman, Olarreaga, & Zedillo, 2007). This offers a contradicting statement: wealthy nations will begin to suffer from the cheaper goods while developing nations will experience the majority of the benefit.

Justifying the Logistics Performance Index

After settling on using the LPI for both portions of the quantitative analysis – first as the independent variable to determine a relationship with net trade and second as the dependent variable to determine what factors drive LPI – it became apparent that justification was necessary. Because the LPI is based on survey results, some of the responses can be viewed as subjective or inconsistent.

Gray and Slapin (2010) were examining the effectiveness of regional trade agreements. In order to do so, they chose to survey experts in country. Their main justification for using this method is the fact that all trade agreements are structured differently and have different goals for success. Because of this, it can be difficult to develop a standard quantitative value to determine effectiveness. By using a survey method, the authors are able to gain accurate insights into the results of agreements in each region. "Expert surveys offer considerable leverage in environments where hard data for the types of things we want to measure simply do not exist.

By talking directly to the individuals who have worked with these organizations — either as negotiators, consultants, or actual staff members — we are able to get a clear picture of the actual functioning of these agreements on many dimensions" (Gray & Slapin, 2010). Using this logic, I am able to justify using the survey-based LPI. Not only is information difficult to get from Africa, those who are surveyed are in the country operating day in and day out. They are the true experts on the logistics in the regions they operate.

Conclusion

The literature review played a crucial role in determining the hypotheses of this study. Based on the existing research, and the data found, the following hypotheses were developed:

1. If the Logistics Performance Index score of nations in a free trade agreement increase, then Net Trade will rise, leading to FTA success.
2. If nations work to improve a number of the World Bank Country Development Indicators, then their LPI will increase.

These sources will play a critical role in answering the hypotheses. Whether it is background information to have a better understanding, or arguments offering multiple viewpoints, the literature is crucial to presenting a thorough argument for the success of trade agreements.

There were two interesting discoveries found when going through the sources. First is the fact that every single country joining the TFTA is already a member of at least one other regional trade bloc. Each varying in size, it will be interesting to dig deeper to find out why these countries are forming yet another bloc.

The second is the present situation across much of Africa. It seems that the media generally depicts the nations in this region as deep in turmoil and unrest, and with a very low quality of life. While these countries may be less developed than other regions of the world, many are actually in better shape than acknowledged. The region is not governed solely by dictator and tribal conflict as reported, but is, rather, a continuously developing area. Part of this may come from the education influx during the colonial period, and some may be from general advancement and investment. All in all, Africa is much better off than many people believe.

DATA INCONSISTENCIES

One of the largest challenges associated with this study was being able to find complete, accurate data for the 27 nations making up the TFTA. Only 24 of the 27 nations had an LPI report completed with values. The three countries excluded from the study were South Sudan, Swaziland, and Seychelles. Knowing that a regression becomes more accurate with the more data points, it was imperative to find thorough data. When downloading the World Bank data, there were numerous missing values across many countries and many variables. In some instances, relevant variables had to be omitted due to a lack of data. One such example was kilometers of railroad. This was only reported by a handful of countries to begin with. Many of these variables either are not reported consistently, or not even traced in these nations. Before the final sorting of the World Bank data, when there were still about 45 variables, it was necessary to come up with a way to populate as many fields missing data as possible. For each metric missing, I went back to the World Bank site and searched for the specific variable and that country. I then looked to see if that data had been reported at all in either the past 5-10 years or in the two years since the 2014 data I was using. If a value existed, it was included. By doing this I was able to maintain 24 nations for my study. Had nations with only complete 2014 data been used, there would have been 11 nations in the regressions. This would not have been enough data points to gain a true representation of which variables were most important. As this data is tracked and become more complete in the region the model could be rerun to compare results. Other trade agreements should also be easier to analyze from a data availability standpoint.

METHODOLOGY & RESULTS

Quantitative Analysis 1

Before going into the methodology and results associated with this study, it is important to outline the overall aim. By the end of this process supply chain factors that can be directly linked to the overall success of a free trade agreement will be discovered. When entering a trade agreement, each participating nation may develop different goals and desired outcomes for that specific nation. In order to standardize success, a free trade agreement will be considered

successful for each nation if that nation sees an increase in net trade (USD). Net trade is simply total imports + total exports. This represents the best measure for success as it is simple to calculate and the true goal of any trade agreement.

The first quantitative study conducted was using overall LPI as the independent variable and net trade as the dependent variable. Both datasets were from 2014 to ensure consistency and the data went beyond the 27 nations of the TFTA. For this study, it was necessary to use data on as many countries as possible to find the true relationship between net trade and LPI. After combining the data sets, there ended up being 133 countries with data for 2014. Overall LPI for each of the 133 nations can be viewed in appendix C. The analysis software used for regressions was SAS Enterprise Guide. After importing this data, a linear regression on the two variables was conducted (Appendix D). This regression had a p-value <.0001, proving it to be a significant test. The adjusted R-squared value was lower than anticipated at only 0.3081. While a lower R-squared can be expected when only two variables are run, the more error explained, the better.

The net trade data fits a power law distribution. In simpler terms, trade fits the 80/20 rule. This rule states that 80% of an event can be attributed to 20% of the total observations (80-20 Rule). In this case, 80% of global trade can be attributed to 20% of the nations. When looking at the 133 nations, total trade was $44.16 trillion. 80% of this value is $35.32 trillion. The top 25 nations, 19%, made up $35.39 trillion. From here, it became apparent that a non-linear regression would be the proper selection to gain the most accurate results. Using the common Marquardt Regression, the same variables were run again (Gavin 2017). As seen in figure 3, there is a strong best fit line showing a direct relationship between trade and overall LPI. This study showed significance again <.0001 (Appendix E). Having this result, it was possible to further examine the distributions of the top 25 nations versus the remaining 108 used in the study. Plotting this data in Tableau, I

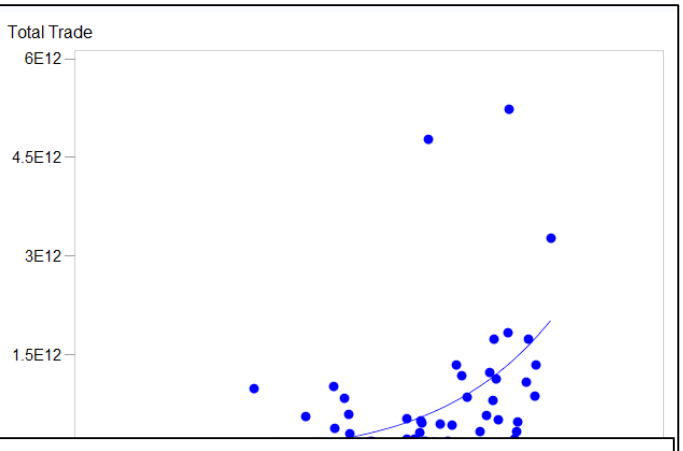


Figure 3: Nonlinear Regression – Net Trade vs. Overall LPI

was able to get a better sense of this trend (Figure 3).

Figure 4 shows the nations broken out into the 80/20 rule. The top 25 nations in red, and the rest in blue. It appears that there is a general threshold at LPI values of 3.25. If a country can reach this point, trade seems to increase signficantly. The majority of the top 25 nations can be found to the right of the 3.25 mark, signifying that they are the strongest logistics performers. There are, however, five exceptions. Russia, Saudi Arabia, Brazil, India, and Mexico, all category 1 nations, fall to the left of the 3.25 LPI threshold. While at first a surprised, it was determined that this most likely occurred due to the countries being heavy commodity exporters. Russia and Saudi Arabia, for example, rely on oil exports for their trade. The major logistics component required to accomplish this is pipelines from the oil refineries to shipping ports. While other infrastructure and measures may be low, pipelines allow them to export high amounts of commodities.

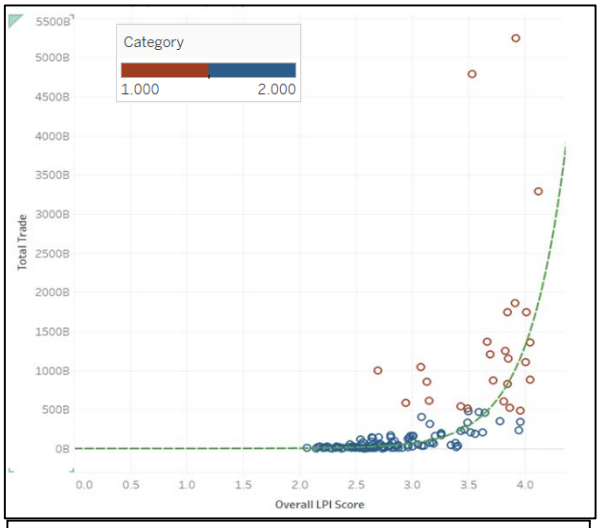


Figure 4: Nonlinear Regression with color-coded nations

In an effort to better determine how LPI impacts trade, the LPI was broken into its six sections: Customs, Infrastructure, International Shipments, Logistics Competence, Tracking & Tracing, and Timeliness. Each of these metrics was run against net trade using the same nonlinear regression as with overall LPI. The goal of this is to identify which of the six may require a higher LPI value (1-5) scale to increase trade. Knowing this may shift a nations focus on investments and improvements to improve overall LPI as efficiently as possible.

Starting with a nonlinear regression for net trade and customs (Appendix F), the results showed a slightly lower score necessary to reach the threshold. The threshold mark is just about 3.1 before the sharp increase in dollars traded. It is anticipated that this level will go up for each of the 27 nations of the TFTA. Since a major goal of trade agreements is lowering barriers to trade, it is anticipated that customs procedures will become less cumbersome for these nations and this metric will increase rapidly. This regression had a significance level <.0001 also. The

lowest score was a 1.50 (Republic of the Congo) and the highest score was a 4.21 (Norway) (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014).

Moving to infrastructure, there were similar results. 3.25 appears to be the threshold to reach. This was a surprisingly low value. Without strong infrastructure, it becomes very difficult to move goods from point A to point B. If this is unable to be done, there is no trade occuring and no trade growth overall. It was initially anticipated that infrastructure would equivalent to the overall LPI threshold. With a p-value <.0001, this nonlinear regression was also proven significant (Appendix G). The lowest ranking for infrastructure was 1.50 (Somalia) and the highest was 4.32 (Germany) (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014).

When observing the same study for international shipments, the regression appears to show that the threshold is close to 3.2 (Appendix H). The same power law distributoin is occuring as with the others. It is expected that this will be one of the easiest metrics for nations to raise as the whole purpose of a trade agreement is to encourage international trade. As trade levels increase, the international shipments will increase, helping to increase scores overall. Again, this regression also proved significant with a p-value <.0001. The lowest ranked nation had a score of 1.70 (Democratic Republic of Congo) and the highest score was 3.82 (Luxembourg) (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014).

Moving into logistics competence, this study shows a threshold at scores of 3.0. This regression shows a specific threshold. Whereas the other components were more gradual increases, logistics competence seems to be very clear as to the line to achieve. All but one of the 25 top trading nations has a score above 3.0 for logistics competence. As can be seen in appendix F, this marquardt regression is significant with a p-value <.0001 (Appendix I). The lowest recorded value is 1.75 (Somalia) and the highest is 4.19 (Norway) (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014).

Moving to the fifth variable that makes up LPI, tracking & tracing, it again appears that the threshold is in the 3.1 – 3.3 range. This is the point where the biggest shift in the best fit line begins. As with each regression, the p-value of this test is <.0001 showing significance (Appendix J). The lowest ranked country for tracking & tracing is a 1.75 (Somalia) with the highest at 4.17 (Germany) (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014).

The final metric going into LPI, Timeliness had one of the highest thresholds. The LPI score at the threshold was approximately 3.45. This was surprising as this metric does not have as much to do with a nations investments and improvements. It seems like this metric would rely more on the companies operating. However it shows, with significance (p-value <.0001), that the higher the score, the better (Appendix K). The low score for this category was 1.88 (Somalia) while the high was 4.71 (Luxembourg) (Arvis, Saslavsky, Ojala, Shepherd, Busch, & Raj, 2014).

Through these regression models, it has been determined that the Logistics Performance Index is a driver of trade. From the further analyses breaking down the LPI into its six segments, it does not appear that any one metric is significantly more important than another. Nations in the TFTA should focus on one area at time to improve a segment, rather than devoting less resources to each segment.

Quantitative Analysis 2

After determining that LPI and Net Trade were directly related, it was possible to take this study a step further and determine what the top factors driving LPI in the TFTA would be. The goal of this portion of the study was to determine where nations should focus their efforts to improve, in order to make the greatest impact. Initially, 950 variables relating to each of the 27 countries were pulled from The World Bank Country Indicators dataset and combined with Fearon's Ethnic Fractionalization data and the Ease of Doing Business data. Running another regression with this many variables having only 27 nations would not have provided accurate results. Possibly unrelated variables could be left in or clustered when they did not actually belong. It was necessary to first cut down the number of variables that would be run against LPI. A ranking system was created to make this process easier. Going through the variables, each variable was assigned a number – one, two, or three. If a variable received a one, it indicated a direct supply chain related variable that would automatically be included in the final regression. Any variables that received a two ranking would be looked at further to determine whether or not they actually belonged in the final regression. Lastly, any three rankings were automatically excluded from the regression. These were variables such as birth rate, % of population with HIV, average length of life, and numerous others that did not directly pertain to supply chain or logistics. Additional variables excluded were those related to trade levels as

trade was already used as the dependent variable in the first quantitative study. After going through this process multiple times, there were 21 variables of the original 952 left to be run against overall LPI (Appendix L).

With these variables another regression was run, again using SAS Enterprise Guide. The overall LPI ranking for the 27 nations became the dependent variable and the 21 variables from the World Bank were used as independent variables. For this regression, a linear backwards regression model was used. Every iteration of this regression removes variables that do not meet the default significance level <.05. The first time this regression was executed, 15 of the 21 variables still remained (Appendix M). While each of these variables was significant, it was determined that the group was too large for a nation to focus on and improve all of them. To narrow in even further, the same regression was run with one change: instead of setting the significance p-value to <.05, it was adjusted to <.02. Five variables remained in the model as significant (Appendix N):

1. Documents to Import (Number)
2. Fixed Telephone Subscriptions
3. Internet Users (per 100 people)
4. Mobile Cellular Subscriptions
5. Secure Internet Servers

These five variables make sense as drivers of LPI performance as they fit into some of the six LPI categories well. The number of documents required to import goods is directly related to customs, international shipments, and even timeliness. The remaining four variables can be related to the ability to track & trace shipments and infrastructure primarily. This regression had an adjusted R-squared value of 0.7362. This means that the majority of possible error has been explained and the regression results are strong. Combined with an overall significance of <.0001 this is a valid regression model.

The results of this study, while significant, had some surprises. The first quantitative analysis aimed at showing a relationship between net trade and LPI was as expected. As Hoekman stated, logistics plays an important role in trade between nations (Hoekman). Without strong logistics performance, efficient trade cannot be conducted. When looking at the second study identifying variables, ethnic fractionalization seemed to be an important factor that was

expected to remain significant. Only one source seemed to question whether EF actually played a role in conflicts and inability for different groups to work with one another. It is possible that the reason for slower growth to this point is unrelated to the cultural group's ability to come to an agreement. The five variables determined as most significant in the second study fit into the six metrics that make up the LPI. Documents required to import (number) is directly related to customs, timeliness, and international shipments. The fewer documents needed with each shipment, the faster and easier goods move through customs. The remaining four variables identified – fixed telephone subscriptions, internet users (per 100 people), mobile cellular subscriptions, and secure internet servers – fit directly into tracking & tracing, and infrastructure. In order to follow shipments, a business must be connected to the region. In order to get connected, telephone and internet infrastructure must be improved. While the first study conducted did not show any of the six LPI metrics being much more important than another, these variables seem clustered into some of the metrics. This study provides strong results for nations looking to improve their potential for success in trade agreements.

CONCLUSION

As the data has shown, this study has proven that there are certain logistics factors that drive an increase in net trade. As trade agreements are centered on improving trade between two or more nations, the ability to determine how successful an agreement could be is crucial. When looking at the Tripartite Free Trade Agreement in Africa, it becomes clear that many of the nations need to make significant improvement in logistics performance in order to have a successful agreement. From the first quantitative analysis completed, the data shows that the Logistics Performance Index does directly impact overall trade. The LPI threshold for a nation to reach in order to see a true increase in trade appears to be about 3.25. When breaking the LPI into its six parts, similar results are seen. For the most part, all six metrics have similar thresholds that would lead to trade increases. Proving that LPI can drive trade established a solid foundation for the remainder of this study.

After identifying 21 variables related to supply chain management, the second portion of this study was run to determine what the top factors driving LPI in the TFTA nations were. In the case of these 27 nations, five variables remained in the backwards regression with

significance. If the nations focus on these five variables, they should see a rise in overall LPI and, in turn, a rise in net trade levels. If this occurs, the TFTA will be deemed a successful trade agreement and can be expanded. In order for this to work each nation must invest in these five areas. If some nations decide not to make the investment, it could hinder the overall success of its surrounding nations. This study was successful in proving that logistics metrics are a direct driver of trade agreement success.

There are some limitations associated with this project. As it is a unique study, the only way to see if the results are accurate is by waiting and following the TFTA. It can be difficult to find data and information on Africa due to how underdeveloped the continent currently is. If there is data available, there is a chance that it will not be as accurate as information coming the European countries or the U.S. Another thing to consider when looking at data on Africa is that it could change quickly. With so many groups all vying for power, it is not uncommon to have multiple coups occur over a short period of time.

Additionally, the TFTA represents an interesting agreement. To start, it is only comprised of African nations. What is more, all the participants already belong to at least one of three existing agreements. This could skew the results when trying to predict a model that works for any agreement. In many agreements, there is at least one developed nation that can help the others significantly. South Africa is the closest African Nation to being fully developed. Also, some of these countries may have already experienced the success of being a trade partner. This could impact how successful they will be going into the future.

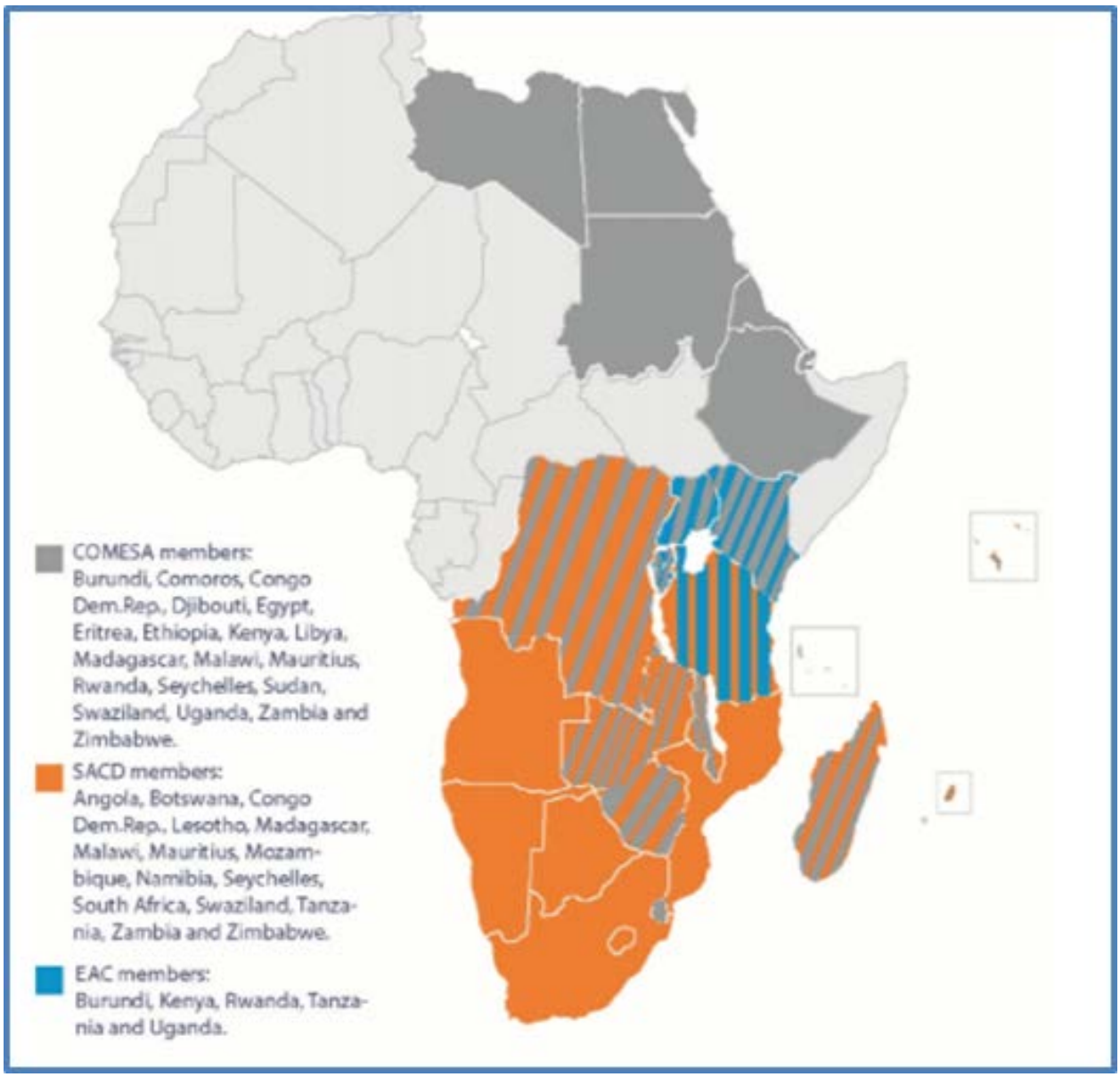
Going forward, there are additional steps that can be taken to better enhance this study. For starters, the TFTA has not existed long enough, it was signed on July 10, 2015, to have concrete data on the results of the agreement. I would like to continue monitoring this agreement to determine if the model develop is accurate. Additionally, in the future I expect the data reported from Africa to become more accurate and more readily available. As this happens, there may be more supply chain variables to add into the second quantitative analysis and expand on what a nation should focus on. As there are numerous different free trade agreements around the world, it could be beneficial to run this model on other agreements to see if the results hold true. Whether it is the same five variables that every trade agreement should focus

on, or if it changes base on agreement, this would be an important advancement to the overall study.

APPENDICES

Appendix A – Nations of the Tripartite Free Trade Agreement

Appendix B – Countries by Existing Trade Agreement



Appendix C – LPI Rankings by Country

LPI ranking and scores, 2014

	2014 LPI				2014 LPI				2014 LPI		
Economy	Rank	Score	% of highest performer	Economy	Rank	Score	% of highest performer	Economy	Rank	Score	% of highest performer
Germany	1	4.12	100.0	Croatia	55	3.05	65.8	Benin	109	2.56	50.0
Netherlands	2	4.05	97.6	Kuwait	56	3.01	64.4	Tunisia	110	2.55	49.7
Belgium	3	4.04	97.5	Philippines	57	3.00	64.2	Fiji	111	2.55	49.5
United Kingdom	4	4.01	96.6	Cyprus	58	3.00	64.1	Angola	112	2.54	49.4
Singapore	5	4.00	96.2	Oman	59	3.00	63.9	Chad	113	2.53	49.0
Sweden	6	3.96	94.9	Argentina	60	2.99	63.6	Tajikistan	114	2.53	48.9
Norway	7	3.96	94.8	Ukraine	61	2.98	63.3	Mauritius	115	2.51	48.5
Luxembourg	8	3.95	94.4	Egypt, Arab Rep.	62	2.97	63.0	Georgia	116	2.51	48.3
United States	9	3.92	93.5	Serbia	63	2.96	62.9	Macedonia, FYR	117	2.50	48.0
Japan	10	3.91	93.4	El Salvador	64	2.96	62.8	Libya	118	2.50	47.9
Ireland	11	3.87	91.9	Brazil	65	2.94	62.3	Mali	119	2.50	47.9
Canada	12	3.86	91.5	Bahamas, The	66	2.91	61.2	Botswana	120	2.49	47.8
France	13	3.85	91.2	Montenegro	67	2.88	60.1	Bolivia	121	2.48	47.4
Switzerland	14	3.84	91.1	Jordan	68	2.87	60.0	Guinea	122	2.46	46.9
Hong Kong SAR, China	15	3.83	90.5	Dominican Republic	69	2.86	59.6	Zambia	123	2.46	46.9
Australia	16	3.81	90.0	Jamaica	70	2.84	59.0	Guyana	124	2.46	46.7
Denmark	17	3.78	89.1	Peru	71	2.84	59.0	Azerbaijan	125	2.45	46.4
Spain	18	3.72	87.1	Pakistan	72	2.83	58.5	Papua New Guinea	126	2.43	45.8
Taiwan, China	19	3.72	87.0	Malawi	73	2.81	58.1	Guinea-Bissau	127	2.43	45.7
Italy	20	3.69	86.2	Kenya	74	2.81	58.0	Comoros	128	2.40	44.9
Korea, Rep.	21	3.67	85.4	Nigeria	75	2.81	57.9	Uzbekistan	129	2.39	44.7
Austria	22	3.65	84.8	Venezuela, RB	76	2.81	57.9	Niger	130	2.39	44.6
New Zealand	23	3.64	84.7	Guatemala	77	2.80	57.6	Lao PDR	131	2.39	44.5
Finland	24	3.62	84.0	Paraguay	78	2.78	57.0	Madagascar	132	2.38	44.3
Malaysia	25	3.59	83.0	Côte d'Ivoire	79	2.76	56.4	Lesotho	133	2.37	44.0
Portugal	26	3.56	82.0	Rwanda	80	2.76	56.3	Central African Republic	134	2.36	43.8
United Arab Emirates	27	3.54	81.3	Bosnia and Herzegovina	81	2.75	56.0	Mongolia	135	2.36	43.4
China	28	3.53	81.1	Maldives	82	2.75	56.0	Equatorial Guinea	136	2.35	43.4
Qatar	29	3.52	80.6	Cambodia	83	2.74	55.8	Zimbabwe	137	2.34	42.9
Turkey	30	3.50	80.1	São Tomé and Príncipe	84	2.73	55.5	Tanzania	138	2.33	42.6
Poland	31	3.49	79.9	Lebanon	85	2.73	55.3	Togo	139	2.32	42.2
Czech Republic	32	3.49	79.8	Ecuador	86	2.71	54.8	Turkmenistan	140	2.30	41.8
Hungary	33	3.46	78.9	Costa Rica	87	2.70	54.5	Iraq	141	2.30	41.8
South Africa	34	3.43	77.9	Kazakhstan	88	2.70	54.4	Cameroon	142	2.30	41.5
Thailand	35	3.43	77.8	Sri Lanka	89	2.70	54.3	Bhutan	143	2.29	41.3
Latvia	36	3.40	77.0	Russian Federation	90	2.69	54.3	Haiti	144	2.27	40.7
Iceland	37	3.39	76.6	Uruguay	91	2.68	53.8	Myanmar	145	2.25	40.0
Slovenia	38	3.38	76.3	Armenia	92	2.67	53.6	Gambia, The	146	2.25	40.0
Estonia	39	3.35	75.1	Namibia	93	2.66	53.1	Mozambique	147	2.23	39.4
Romania	40	3.26	72.4	Moldova	94	2.65	53.0	Mauritania	148	2.23	39.4
Israel	41	3.26	72.4	Nicaragua	95	2.65	53.0	Kyrgyz Republic	149	2.21	38.7
Chile	42	3.26	72.3	Algeria	96	2.65	52.8	Gabon	150	2.20	38.5
Slovak Republic	43	3.25	72.2	Colombia	97	2.64	52.5	Yemen, Rep.	151	2.18	37.9
Greece	44	3.20	70.5	Burkina Faso	98	2.64	52.5	Cuba	152	2.18	37.8
Panama	45	3.19	70.3	Belarus	99	2.64	52.5	Sudan	153	2.16	37.2
Lithuania	46	3.18	69.8	Ghana	100	2.63	52.1	Djibouti	154	2.15	36.8
Bulgaria	47	3.16	69.1	Senegal	101	2.62	52.0	Syrian Arab Republic	155	2.09	34.9
Vietnam	48	3.15	69.0	Liberia	102	2.62	51.9	Eritrea	156	2.08	34.7
Saudi Arabia	49	3.15	68.8	Honduras	103	2.61	51.5	Congo, Rep.	157	2.08	34.5
Mexico	50	3.13	68.2	Ethiopia	104	2.59	51.0	Afghanistan	158	2.07	34.3
Malta	51	3.11	67.5	Nepal	105	2.59	50.9	Congo, Dem. Rep.	159	1.88	28.2
Bahrain	52	3.08	66.7	Solomon Islands	106	2.59	50.8	Somalia	160	1.77	24.8
Indonesia	53	3.08	66.7	Burundi	107	2.57	50.2				
India	54	3.08	66.6	Bangladesh	108	2.56	50.1				

Appendix D – Net Trade vs. LPI Linear Regression

Linear Regression Results

Model: Linear_Regression_Model
Dependent Variable: Total Trade

Number of Observations Read	133
Number of Observations Used	133

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.332556E25	2.332556E25	59.79	<.0001
Error	131	5.110526E25	3.901165E23		
Corrected Total	132	7.443081E25			

Root MSE	6.24593E11	R-Square	0.3134
Dependent Mean	3.31998E11	Adj R-Sq	0.3081
Coeff Var	188.13156		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type I SS	Type II SS	Standardized Estimate
Intercept	1	-2.03924E12	3.114052E11	-6.55	<.0001	1.465962E25	1.672936E25	0
overall LPI score	1	7.96549E11	1.030134E11	7.73	<.0001	2.332556E25	2.332556E25	0.55981

Collinearity Diagnostics

Number	Eigenvalue	Condition Index	Proportion of Variation	
			Intercept	overall LPI score
1	1.98476	1.00000	0.00762	0.00762
2	0.01524	11.41202	0.99238	0.99238

Appendix E – Net Trade vs. LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

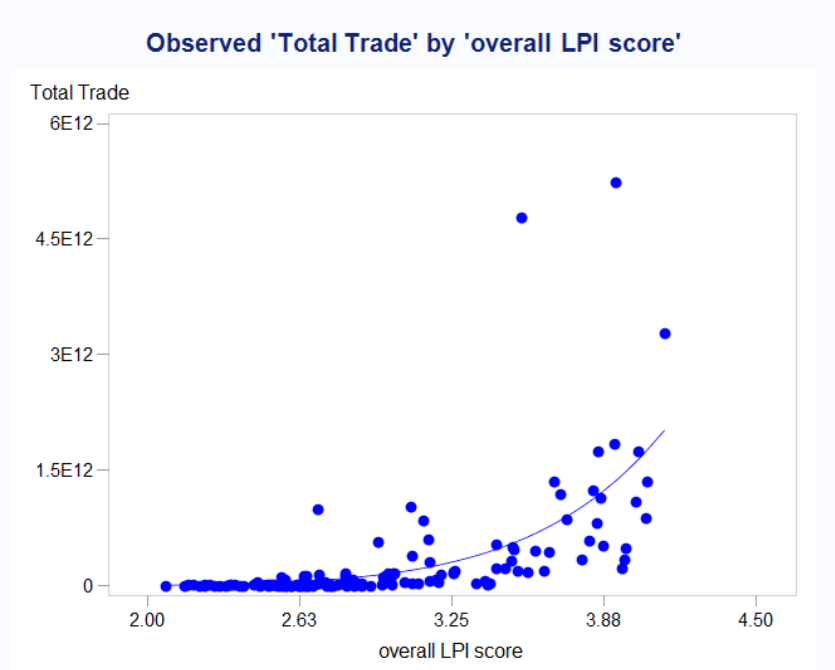
Estimation Summary	
Method	Marquardt
Iterations	84
Subiterations	116
Average Subiterations	1.380952
R	6.789E-9
PPC(a)	5.538E-8
RPC(a)	0.00015
Object	9.014E-9
Objective	4.584E25
Observations Read	133
Observations Used	133
Observations Missing	0

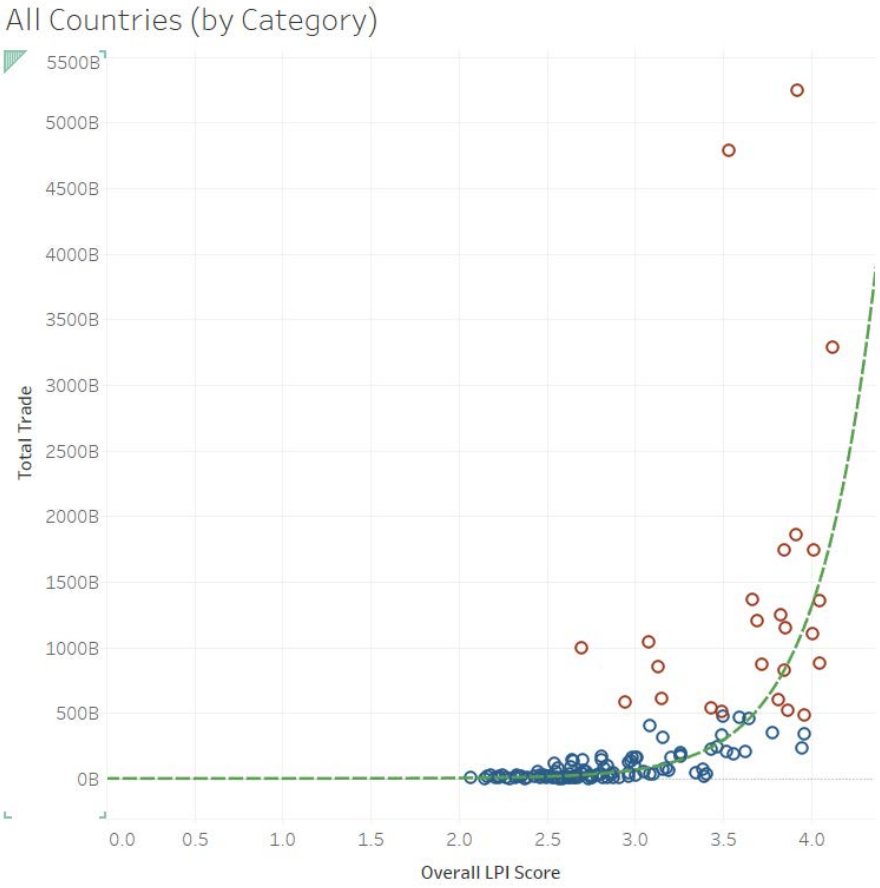
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	4.325E25	2.162E25	61.80	<.0001
Error	131	4.584E25	3.499E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	28318206	52980198	-7.649E7	1.3313E8
b	7.8898	1.3836	5.1527	10.6268

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9988436
b	-0.9988436	1.0000000


Observed 'Total Trade' by 'overall LPI score'
Total Trade
6E12
4.5E12
3E12
1.5E12
0
2.00
2.63
3.25
3.88
4.50
overall LPI score


All Countries (by Category)
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
Total Trade
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Overall LPI Score

Appendix F – Net Trade vs. Customs LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

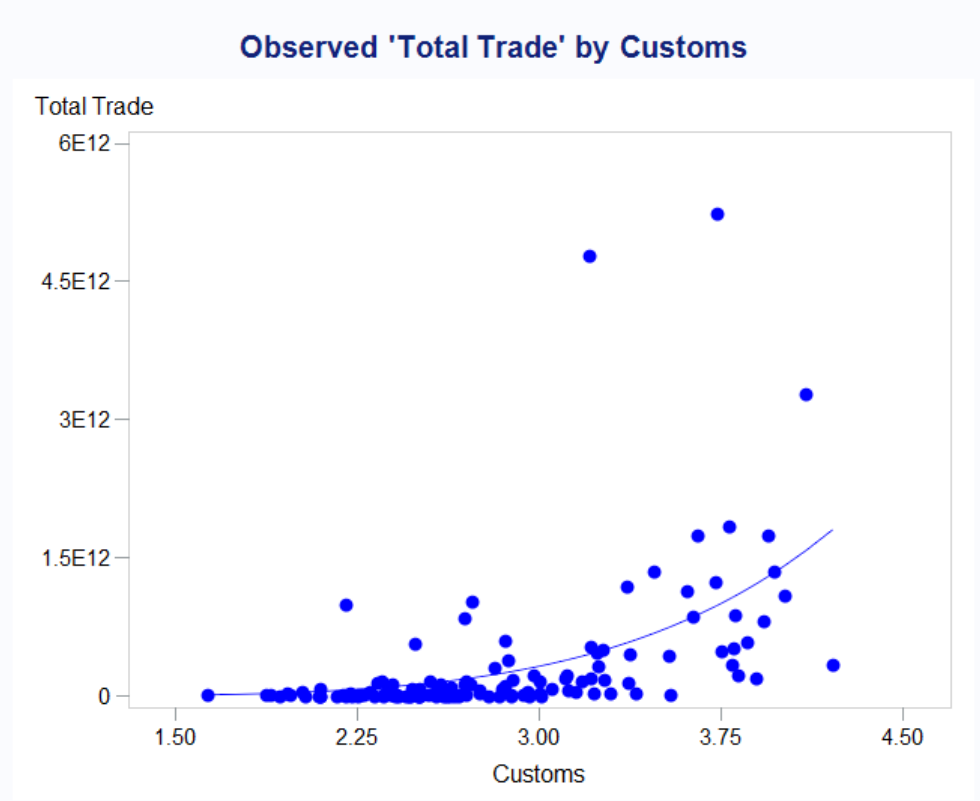
Estimation Summary	
Method	Marquardt
Iterations	71
Subiterations	99
Average Subiterations	1.394366
R	3.301E-6
PPC(a)	0.000048
RPC(a)	0.000217
Object	1.78E-10
Objective	5.399E25
Observations Read	133
Observations Used	133
Observations Missing	0

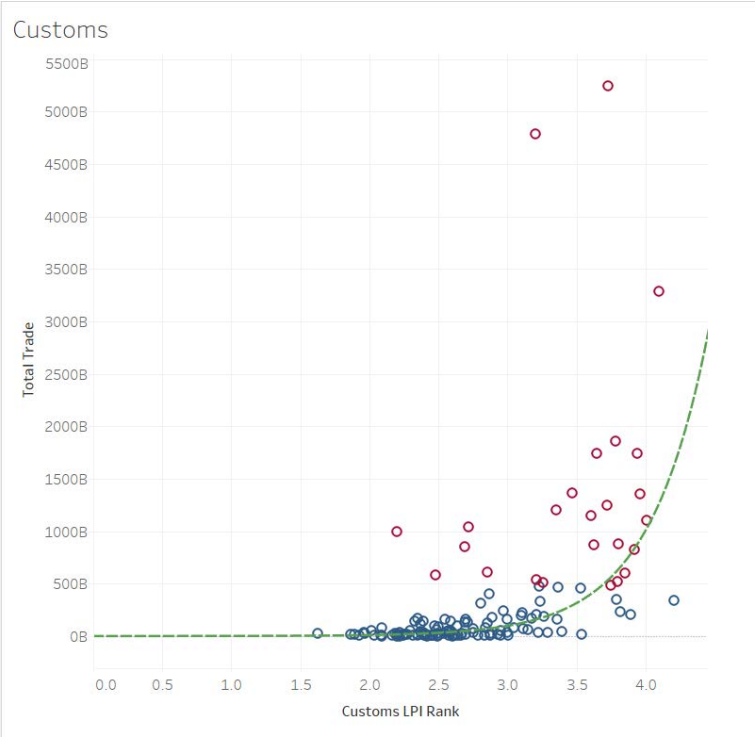
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	3.51E25	1.755E25	42.58	<.0001
Error	131	5.399E25	4.121E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	1.2866E9	1.6261E9	-1.93E9	4.5035E9
b	5.0438	0.9618	3.1412	6.9465

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9963177
b	-0.9963177	1.0000000


Observed 'Total Trade' by Customs
Total Trade
6E12
4.5E12
3E12
1.5E12
0
1.50
2.25
3.00
3.75
4.50
Customs


Customs
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
Total Trade
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Customs LPI Rank

Appendix G – Net Trade vs. Infrastructure LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

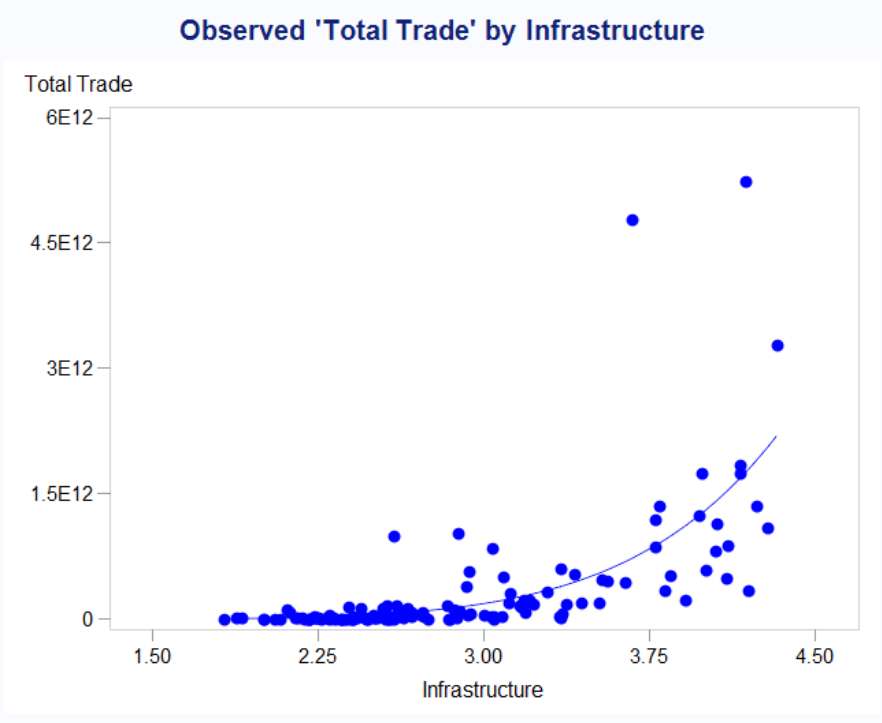
Estimation Summary	
Method	Marquardt
Iterations	102
Subiterations	135
Average Subiterations	1.323529
R	4.454E-6
PPC(a)	0.000072
RPC(a)	0.001846
Object	5.51E-7
Objective	4.095E25
Observations Read	133
Observations Used	133
Observations Missing	0

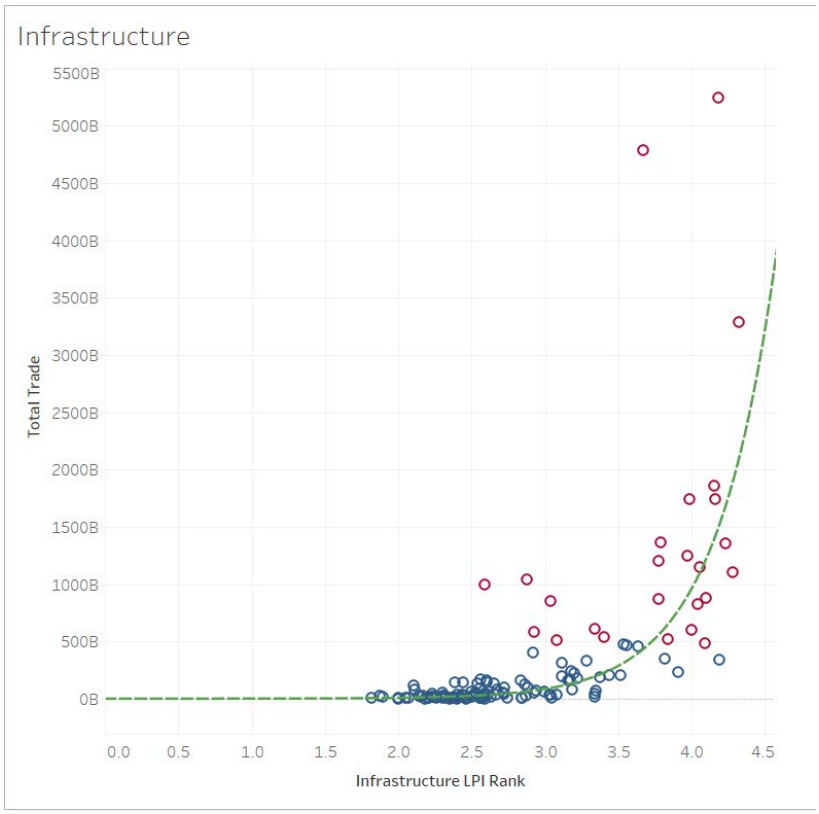
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	4.814E25	2.407E25	77.00	<.0001
Error	131	4.095E25	3.126E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	1.1795E8	1.7455E8	-2.273E8	4.6325E8
b	6.7142	1.0593	4.6187	8.8097

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9985163
b	-0.9985163	1.0000000


Observed 'Total Trade' by Infrastructure
Total Trade
6E12
4.5E12
3E12
1.5E12
0
1.50
2.25
3.00
3.75
4.50
Infrastructure


Infrastructure
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
Total Trade
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Infrastructure LPI Rank

Appendix H – Net Trade vs. International Shipments LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

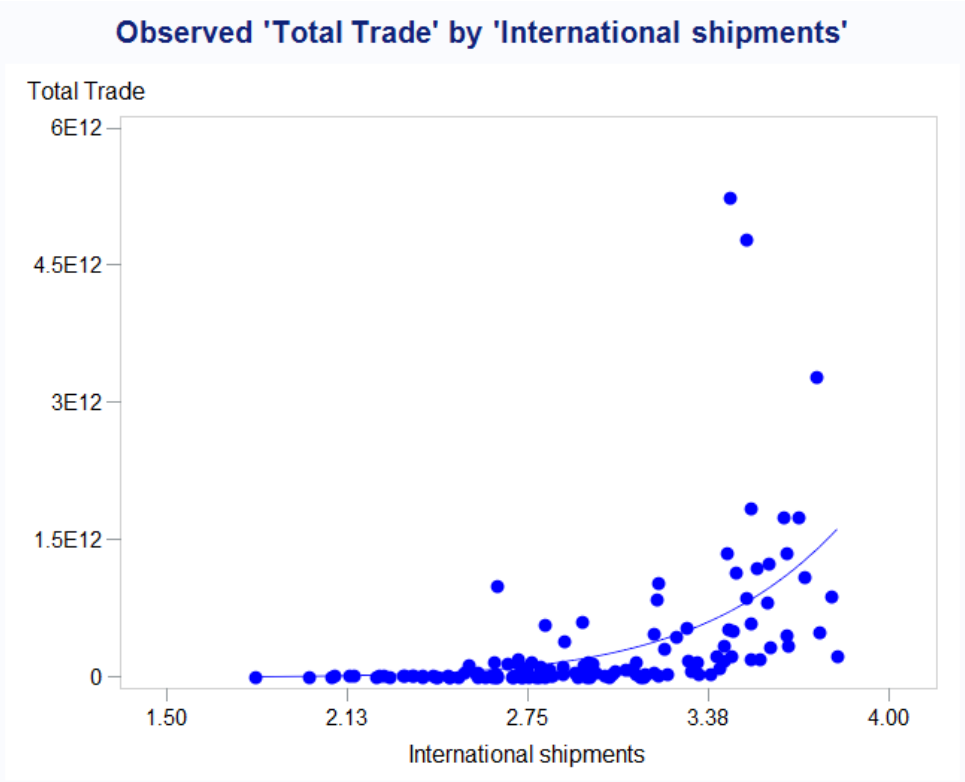
Estimation Summary	
Method	Marquardt
Iterations	66
Subiterations	93
Average Subiterations	1.409091
R	6.629E-6
PPC(a)	0.00016
RPC(a)	0.000482
Object	2.69E-10
Objective	5.405E25
Observations Read	133
Observations Used	133
Observations Missing	0

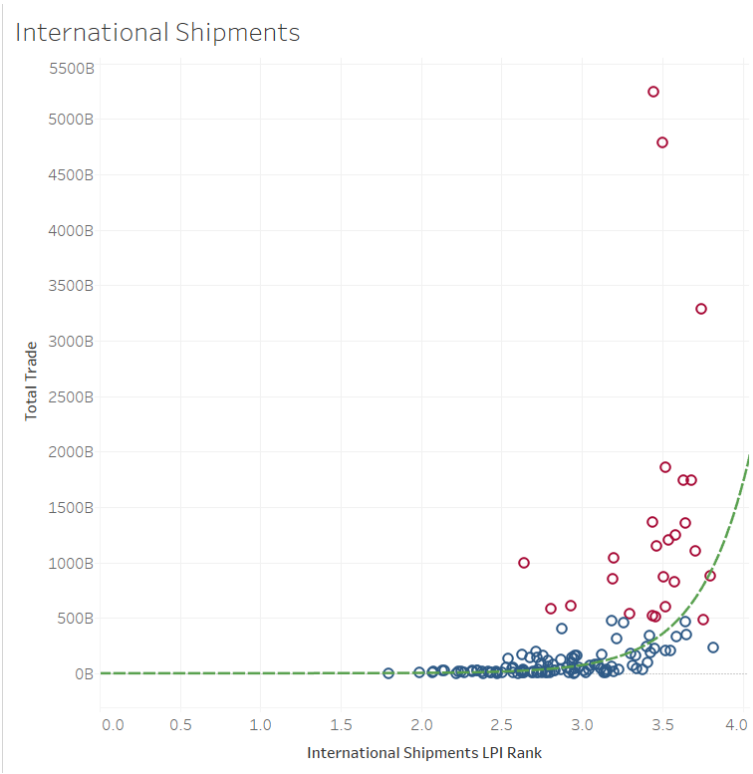
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	3.504E25	1.752E25	42.46	<.0001
Error	131	5.405E25	4.126E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	38298951	80782986	-1.215E8	1.9811E8
b	7.9491	1.6627	4.6598	11.2383

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9986758
b	-0.9986758	1.0000000


Observed 'Total Trade' by 'International shipments'
Total Trade
6E12
4.5E12
3E12
1.5E12
0
1.50
2.13
2.75
3.38
4.00
International shipments


International Shipments
Total Trade
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
International Shipments LPI Rank

Appendix I – Net Trade vs. Logistics Competence LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

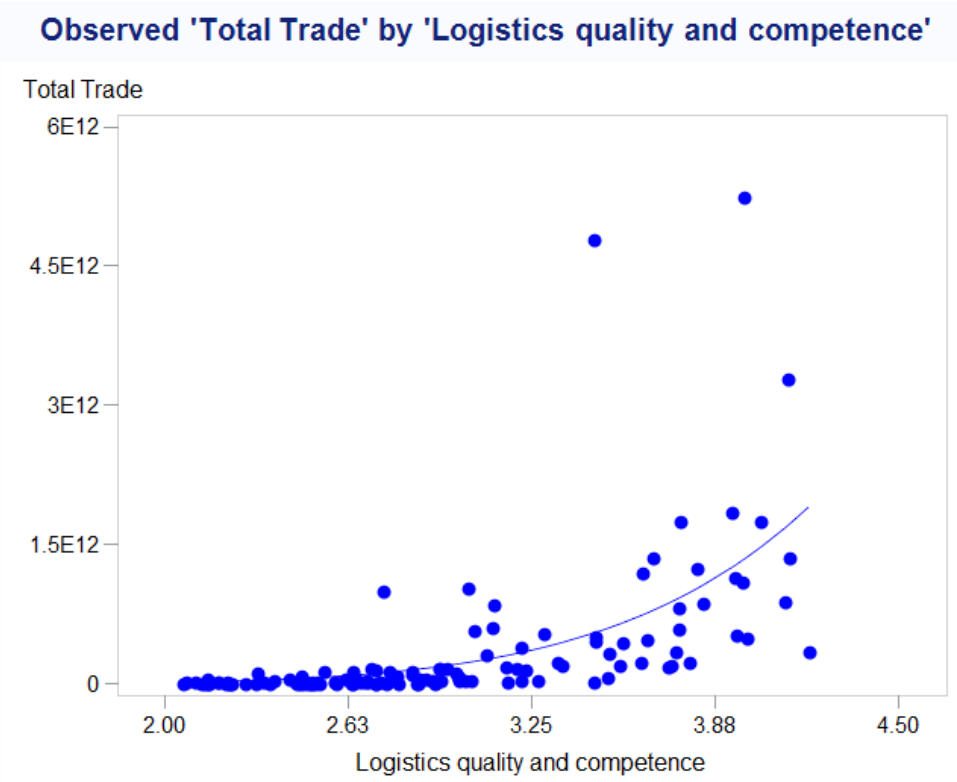
Estimation Summary	
Method	Marquardt
Iterations	82
Subiterations	113
Average Subiterations	1.378049
R	3.268E-6
PPC(a)	0.000057
RPC(a)	0.000356
Object	3.55E-10
Objective	4.823E25
Observations Read	133
Observations Used	133
Observations Missing	0

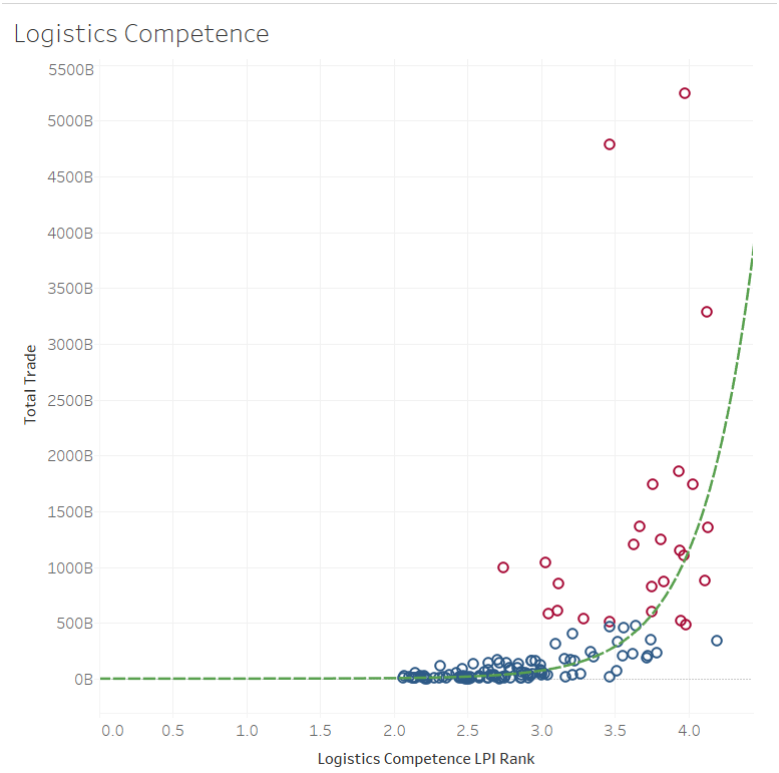
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	4.086E25	2.043E25	55.49	<.0001
Error	131	4.823E25	3.682E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	1.7576E8	2.6981E8	-3.58E8	7.0951E8
b	6.4830	1.1356	4.2366	8.7295

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9980863
b	-0.9980863	1.0000000


Observed 'Total Trade' by 'Logistics quality and competence'
Total Trade
6E12
4.5E12
3E12
1.5E12
0
2.00
2.63
3.25
3.88
4.50
Logistics quality and competence


Logistics Competence
Total Trade
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Logistics Competence LPI Rank

Appendix J – Net Trade vs. Tracking & Tracing LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

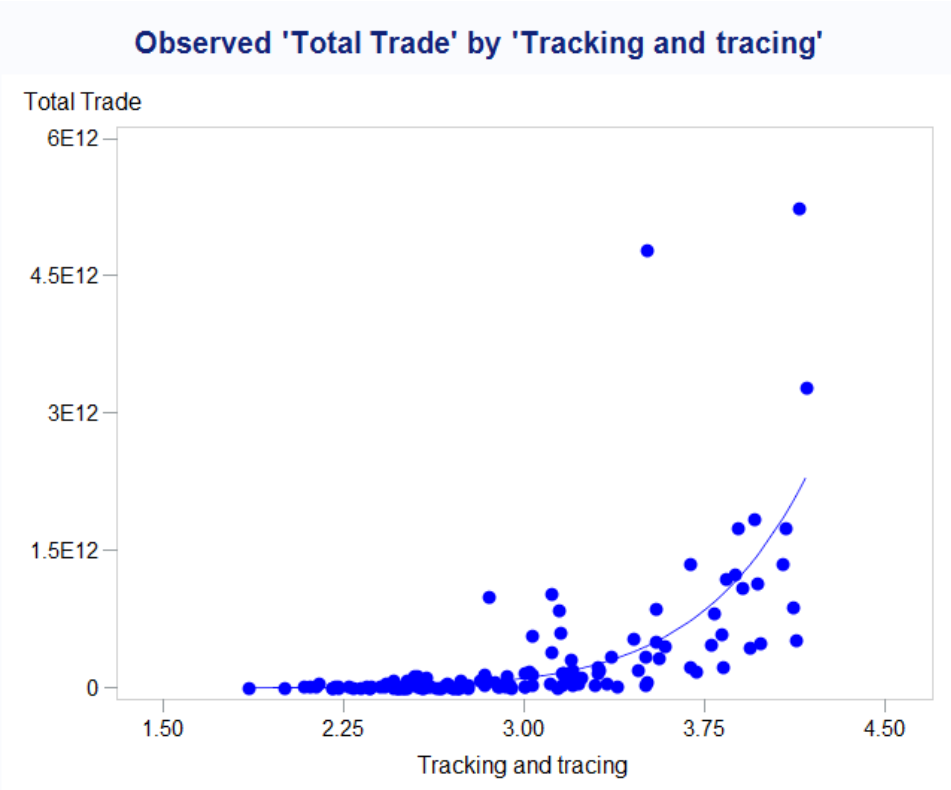
Estimation Summary	
Method	Marquardt
Iterations	89
Subiterations	118
Average Subiterations	1.325843
R	4.887E-6
PPC(a)	0.000111
RPC(a)	0.0004
Object	3.94E-10
Objective	4.143E25
Observations Read	133
Observations Used	133
Observations Missing	0

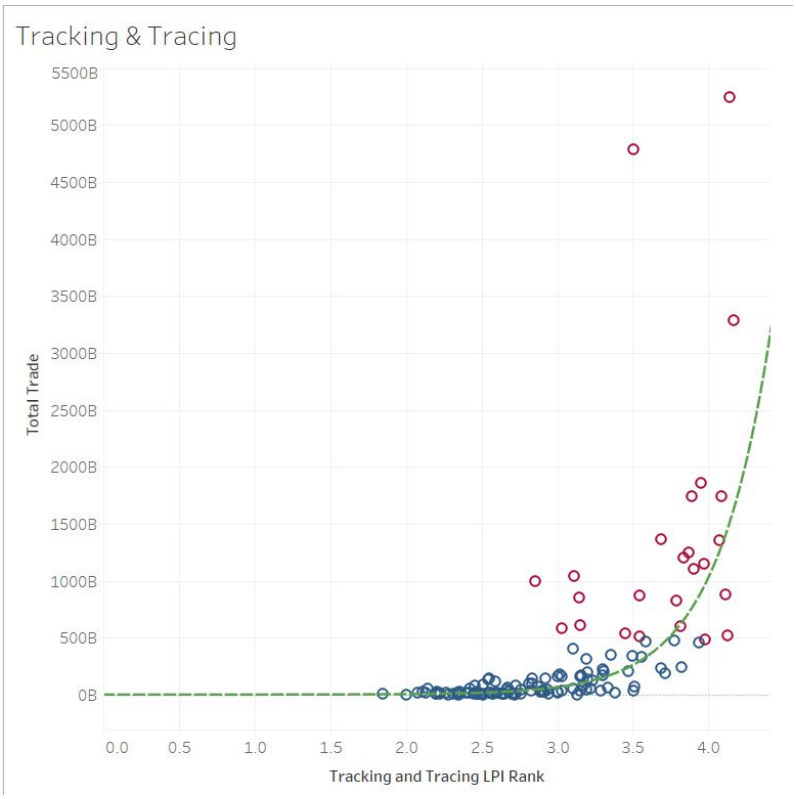
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	4.766E25	2.383E25	75.35	<.0001
Error	131	4.143E25	3.163E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	3666485	7302294	-1.078E7	18112163
b	9.3501	1.4439	6.4937	12.2065

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9991632
b	-0.9991632	1.0000000


Observed 'Total Trade' by 'Tracking and tracing'
Total Trade
6E12
4.5E12
3E12
1.5E12
0
1.50
2.25
3.00
3.75
4.50
Tracking and tracing


Tracking & Tracing
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
Total Trade
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Tracking and Tracing LPI Rank

Appendix K – Net Trade vs. Timeliness LPI Nonlinear Regression

Nonlinear Regression Results

The NLIN Procedure

NOTE: Convergence criterion met.

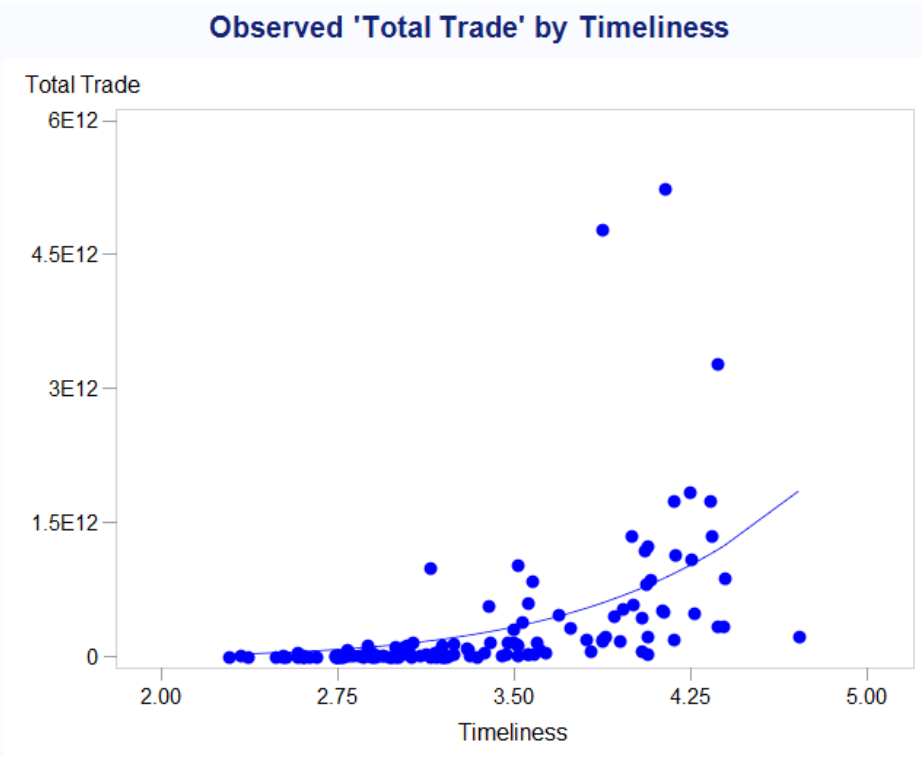
Estimation Summary	
Method	Marquardt
Iterations	67
Subiterations	90
Average Subiterations	1.343284
R	8.483E-6
PPC(a)	0.000162
RPC(a)	0.000329
Object	1.51E-10
Objective	5.503E25
Observations Read	133
Observations Used	133
Observations Missing	0

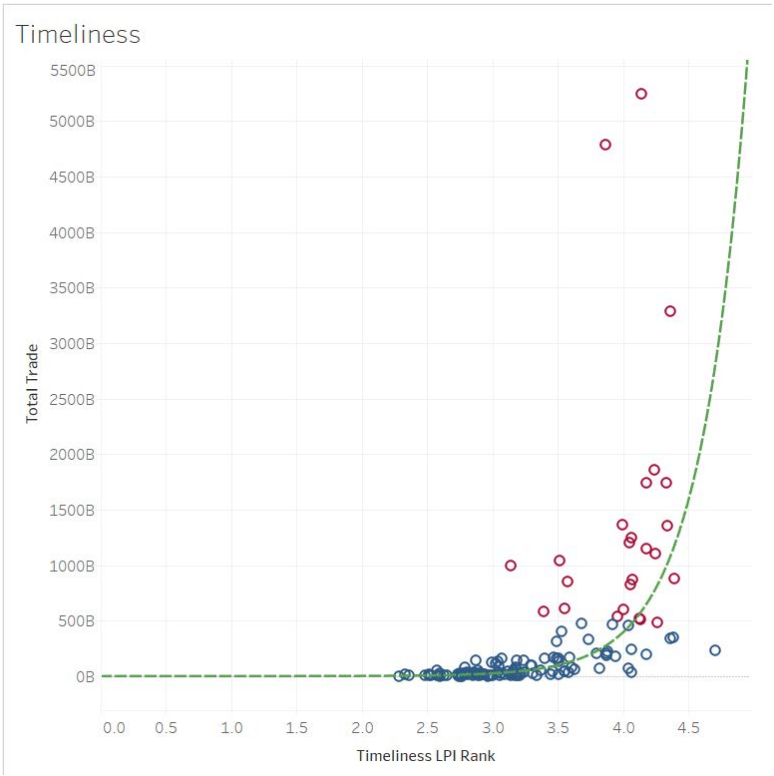
Note: An intercept was not specified for this model.

Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	2	3.406E25	1.703E25	40.55	<.0001
Error	131	5.503E25	4.2E23		
Uncorrected Total	133	8.909E25			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
a	2.5379E8	4.2367E8	-5.843E8	1.0919E9
b	5.7442	1.1787	3.4125	8.0759

Approximate Correlation Matrix		
	a	b
a	1.0000000	-0.9977852
b	-0.9977852	1.0000000


Observed 'Total Trade' by Timeliness
Total Trade
6E12
4.5E12
3E12
1.5E12
0
2.00
2.75
3.50
4.25
5.00
Timeliness


Timeliness
5500B
5000B
4500B
4000B
3500B
3000B
2500B
2000B
1500B
1000B
500B
0B
Total Trade
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Timeliness LPI Rank

Appendix L – Quantitative Analysis 2 Remaining 21 Variables

EF (Fearon)
Ease of Doing Business
Air transport, freight (million ton-km)+Mean(2014 [YR2014])
Air transport, passengers carried+Mean(2014 [YR2014])
Air transport, registered carrier departures worldwide+Mean(2014 [YR2014])
Business extent of disclosure index +Mean(2014 [YR2014])
Cost to export (US$ per container)+Mean(2014 [YR2014])
Cost to import (US$ per container)+Mean(2014 [YR2014])
Documents to export (number)+Mean(2014 [YR2014])
Documents to import (number)+Mean(2014 [YR2014])
Fixed broadband subscriptions+Mean(2014 [YR2014])
Fixed telephone subscriptions+Mean(2014 [YR2014])
Internet users (per 100 people)+Mean(2014 [YR2014])
Labor force, total+Mean(2014 [YR2014])
Mobile cellular subscriptions+Mean(2014 [YR2014])
Quality of port infrastructure, WEF
Secure Internet servers+Mean(2014 [YR2014])
Tariff rate, applied, simple mean, all products (%)+Mean(2014 [YR2014])
Tariff rate, applied, weighted mean, all products (%)+Mean(2014 [YR2014])
Time to export (days)+Mean(2014 [YR2014])
Time to import (days)+Mean(2014 [YR2014])

Appendix M – Overall LPI vs. 21 Variables (<.05 Significance)

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	15	2.39292	0.15953	24.07	0.0001
Error	7	0.04639	0.00663		
Corrected Total	22	2.43930			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-0.05780	0.28717	0.00026841	0.04	0.8462
Air transport, registered carrie	-0.00000780	0.00000187	0.11519	17.38	0.0042
Business extent of disclosure in	0.03200	0.01294	0.04051	6.11	0.0427
Cost to export (US$ per containe	0.00051410	0.00012036	0.12090	18.24	0.0037
Cost to import (US$ per containe	-0.00027573	0.00008442	0.07069	10.67	0.0137
Documents to export (number)+Mea	0.07565	0.02151	0.08193	12.36	0.0098
Documents to import (number)+Mea	0.14815	0.02748	0.19263	29.07	0.0010
Fixed broadband subscriptions+Me	-0.00000141	4.061708E-7	0.08023	12.11	0.0103
Fixed telephone subscriptions+Me	8.628191E-7	1.993598E-7	0.12412	18.73	0.0034
Internet users (per 100 people)+	0.01673	0.00328	0.17225	25.99	0.0014
Labor force, total+Mean(2014 [YR	1.235991E-8	4.895146E-9	0.04225	6.38	0.0395
Mobile cellular subscriptions+Me	-1.3865E-8	3.181863E-9	0.12582	18.99	0.0033
Quality of port infrastructure,	0.10318	0.02530	0.11020	16.63	0.0047
Secure Internet servers+Mean(201	0.00028265	0.00004465	0.26550	40.07	0.0004
Tariff rate, applied, weighted m	0.03150	0.00890	0.08305	12.53	0.0095
Time to import (days)+Mean(2014	-0.01211	0.00267	0.13602	20.53	0.0027

Summary of Backward Elimination								
Step	Variable Removed	Label	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	Tariff rate, applied, simple mea	Tariff rate, applied, simple mean, all products (%)+Mean(2014 [YR2014])	20	0.0001	0.9893	20.0106	0.01	0.9346
2	Ease of Doing Business		19	0.0001	0.9891	18.0208	0.02	0.9001
3	Air transport, passengers carrie	Air transport, passengers carried+Mean(2014 [YR2014])	18	0.0002	0.9890	16.0381	0.05	0.8361
4	Time to export (days)+Mean(2014	Time to export (days)+Mean(2014 [YR2014])	17	0.0007	0.9883	14.0998	0.24	0.6515
5	Air transport, freight (million	Air transport, freight (million ton-km)+Mean(2014 [YR2014])	16	0.0011	0.9873	12.1986	0.45	0.5323
6	EF (Fearon)		15	0.0063	0.9810	10.7885	2.95	0.1365

Parameter Estimates									
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type I SS	Type II SS	Standardized Estimate
Intercept	Intercept	1	-0.05780	0.28717	-0.20	0.8462	148.27650	0.00026841	0
Air transport, registered carrie	Air transport, registered carrier departures worldwide+Mean(2014 [YR2014])	1	-0.00000780	0.00000187	-4.17	0.0042	1.08992	0.11519	-1.05675
Business extent of disclosure in	Business extent of disclosure index (0=less disclosure to 10=more disclosure)+Mean(2014 [YR2014])	1	0.03200	0.01294	2.47	0.0427	0.02251	0.04051	0.21384
Cost to export (US$ per containe	Cost to export (US$ per container)+Mean(2014 [YR2014])	1	0.00051410	0.00012036	4.27	0.0037	0.02751	0.12090	1.80270
Cost to import (US$ per containe	Cost to import (US$ per container)+Mean(2014 [YR2014])	1	-0.00027573	0.00008442	-3.27	0.0137	0.00793	0.07069	-1.41164
Documents to export (number)+Mea	Documents to export (number)+Mean(2014 [YR2014])	1	0.07565	0.02151	3.52	0.0098	0.17590	0.08193	0.31551
Documents to import (number)+Mea	Documents to import (number)+Mean(2014 [YR2014])	1	0.14815	0.02748	5.39	0.0010	0.01582	0.19263	0.75679
Fixed broadband subscriptions+Me	Fixed broadband subscriptions+Mean(2014 [YR2014])	1	-0.00000141	4.061708E-7	-3.48	0.0103	0.01586	0.08023	-2.99592
Fixed telephone subscriptions+Me	Fixed telephone subscriptions+Mean(2014 [YR2014])	1	8.628191E-7	1.993598E-7	4.33	0.0034	0.00759	0.12412	3.74147
Internet users (per 100 people)+	Internet users (per 100 people)+Mean(2014 [YR2014])	1	0.01673	0.00328	5.10	0.0014	0.27356	0.17225	0.69481
Labor force, total+Mean(2014 [YR	Labor force, total+Mean(2014 [YR2014])	1	1.235991E-8	4.895146E-9	2.52	0.0395	0.12486	0.04225	0.44284
Mobile cellular subscriptions+Me	Mobile cellular subscriptions+Mean(2014 [YR2014])	1	-1.3865E-8	3.181863E-9	-4.36	0.0033	0.04730	0.12582	-1.01323
Quality of port infrastructure,	Quality of port infrastructure, WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards)+Mean(2014 [YR2014])	1	0.10318	0.02530	4.08	0.0047	0.08852	0.11020	0.48273
Secure Internet servers+Mean(201	Secure Internet servers+Mean(2014 [YR2014])	1	0.00028265	0.00004465	6.33	0.0004	0.24166	0.26550	1.09510
Tariff rate, applied, weighted m	Tariff rate, applied, weighted mean, all products (%) +Mean(2014 [YR2014])	1	0.03150	0.00890	3.54	0.0095	0.11794	0.08305	0.41396
Time to import (days)+Mean(2014	Time to import (days)+Mean(2014 [YR2014])	1	-0.01211	0.00267	-4.53	0.0027	0.13602	0.13602	-0.55620

Appendix N – Overall LPI vs. 21 Variables (<.02 Significance)

Summary of Backward Elimination

Step	Variable Removed	Label	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	Tariff rate, applied, simple mea	Tariff rate, applied, simple mean, all products (%)+Mean(2014 [YR2014])	20	0.0001	0.9893	20.0106	0.01	0.9346
2	Ease of Doing Business		19	0.0001	0.9891	18.0208	0.02	0.9001
3	Air transport, passengers carrie	Air transport, passengers carried+Mean(2014 [YR2014])	18	0.0002	0.9890	16.0381	0.05	0.8361
4	Time to export (days)+Mean(2014	Time to export (days)+Mean(2014 [YR2014])	17	0.0007	0.9883	14.0998	0.24	0.6515
5	Air transport, freight (million	Air transport, freight (million ton-km)+Mean(2014 [YR2014])	16	0.0011	0.9873	12.1986	0.45	0.5323
6	EF (Fearon)		15	0.0063	0.9810	10.7885	2.95	0.1365
7	Business extent of disclosure in	Business extent of disclosure index (0=less disclosure to 10=more disclosure) +Mean(2014 [YR2014])	14	0.0166	0.9644	10.3505	6.11	0.0427
8	Labor force, total+Mean(2014 [YR	Labor force, total+Mean(2014 [YR2014])	13	0.0072	0.9572	9.0258	1.61	0.2398
9	Fixed broadband subscriptions+Me	Fixed broadband subscriptions+Mean(2014 [YR2014])	12	0.0117	0.9455	8.1227	2.45	0.1518
10	Documents to export (number)+Mea	Documents to export (number)+Mean(2014 [YR2014])	11	0.0120	0.9335	7.2541	2.21	0.1681
11	Time to import (days)+Mean(2014	Time to import (days)+Mean(2014 [YR2014])	10	0.0258	0.9077	7.6782	4.26	0.0633
12	Tariff rate, applied, weighted m	Tariff rate, applied, weighted mean, all products (%)+Mean(2014 [YR2014])	9	0.0529	0.8549	10.6492	6.87	0.0223
13	Air transport, registered carrie	Air transport, registered carrier departures worldwide+Mean(2014 [YR2014])	8	0.0195	0.8354	10.4842	1.75	0.2090
14	Quality of port infrastructure,	Quality of port infrastructure, WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards)+Mean(2014 [YR2014])	7	0.0237	0.8117	10.7117	2.01	0.1777
15	Cost to import (US$ per containe	Cost to import (US$ per container)+Mean(2014 [YR2014])	6	0.0133	0.7984	9.9638	1.06	0.3195
16	Cost to export (US$ per containe	Cost to export (US$ per container)+Mean(2014 [YR2014])	5	0.0022	0.7962	8.1712	0.18	0.6812

Linear Regression Results

Model: Linear_Regression_Model
Dependent Variable: LPI

Number of Observations Read	27
Number of Observations Used	23
Number of Observations with Missing Values	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1.94210	0.38842	13.28	<.0001
Error	17	0.49720	0.02925		
Corrected Total	22	2.43930			

Root MSE	0.17102	R-Square	0.7962
Dependent Mean	2.53906	Adj R-Sq	0.7362
Coeff Var	6.73550		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Type I SS	Type II SS	Standardized Estimate
Intercept	Intercept	1	0.96803	0.28891	3.35	0.0038	148.27650	0.32834	0
Documents to import (number)+Mea	Documents to import (number)+Mean(2014 [YR2014])	1	0.16512	0.03211	5.14	<.0001	0.11871	0.77364	0.84350
Fixed telephone subscriptions+Me	Fixed telephone subscriptions+Mean(2014 [YR2014])	1	1.615137E-7	5.644339E-8	2.86	0.0108	0.70048	0.23948	0.70038
Internet users (per 100 people)+	Internet users (per 100 people)+Mean(2014 [YR2014])	1	0.01656	0.00414	4.00	0.0009	0.52891	0.46719	0.68770
Mobile cellular subscriptions+Me	Mobile cellular subscriptions+Mean(2014 [YR2014])	1	-1.39225E-8	4.112741E-9	-3.39	0.0035	0.09848	0.33516	-1.01743
Secure Internet servers+Mean(201	Secure Internet servers+Mean(2014 [YR2014])	1	0.00016271	0.00003953	4.12	0.0007	0.49551	0.49551	0.63039

Collinearity Diagnostics

Number	Eigenvalue	Condition Index	Proportion of Variation: Intercept	Documents to import (number)+Mea	Fixed telephone subscriptions+Me	Internet users (per 100 people) +	Mobile cellular subscriptions+Me	Secure Internet servers+Mean(201
1	4.05953	1.00000	0.00066152	0.00068049	0.00622	0.00792	0.00403	0.01094
2	1.15005	1.87880	0.00303	0.00338	0.02389	0.00030148	0.00273	0.13396
3	0.48855	2.88259	0.00053070	0.00000302	0.11822	0.02228	0.01761	0.44649
4	0.22454	4.25194	0.00109	0.00912	0.00560	0.49724	0.01836	0.22546
5	0.06978	7.62750	0.01684	0.00093642	0.77501	0.04821	0.62245	0.11873
6	0.00755	23.19201	0.97784	0.98588	0.07107	0.42405	0.33481	0.06442

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