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Abstract

The foreign exchange market is the largest and most liquid in the world and according to the Bank for International Settlements foreign exchange trading averages over five trillion dollars a day. The foreign exchange market is largely made up of institutional investors, corporations, governments, banks, as well as currency speculators. With the large size of the foreign exchange market one can see how an increase in uncertainty surrounding a specific exchange rate could have a huge effect on a nations overall economic function. The goal of this paper will be to measure the economic effects of volatility in the exchange rates in BRICS nations on international trade flows.

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Chris Collins

I. Introduction

The foreign exchange market is the largest and most liquid in the world and according to the Bank for International Settlements foreign exchange trading averages over five trillion dollars a day. The foreign exchange market is largely made up of institutional investors, corporations, governments, banks, as well as currency speculators. With the large size of the foreign exchange market one can see how an increase in uncertainty surrounding a specific exchange rate could have a huge effect on a nation's overall economic function. The goal of this paper will be to measure the economic effects of volatility in the exchange rates in BRICS nations on international trade flows.

International trade has grown exponentially in the time following the end of the Second World War. In the last couple of decades, transport and communication costs have decreased across the world, and preferential trade agreements have become more and more common, particularly among developing countries. The effect trade has on developing countries is a vital part of my research as I plan to look at the five largest emerging markets in the world currently. The BRICS nations include

Brazil, Russia, India, China, South Africa. The data set I chose to study is a key issue facing both the world economy, as their increased consumption will bring about a new level of global demand, and geo-politics. These potentially politically powerful nations have their own set of political ideals to be met as they move from emerging markets to developed nations. In addition, the BRICS nations are a good study because the effect international trade has on the BRICS economies as they are all largely export driven economies. The BRICS members are all leading developing or newly industrialized countries, but they are distinguished by their large, sometimes fast-growing economies and significant influence on regional affairs according to the IMF. The five BRICS countries combine for over 41% of the world population and have a combined nominal GDP of 16.6 trillion U.S. Dollars accounting for 22% of the gross world product. The World Bank expects the BRICS countries to grow this year by an average rate of 5.3% ("Developing Countries Gain Ground in Tech Revolution," 2016). Due to the large portion of both the population and the world production that these five countries represent, they represent a vital area of economic research as they

make the transition from developing to developed countries.

This paper proceeds as follows: Section II reviews the previous literature on the topic of exchange rate volatility and the impact on trade flows; Section III describes the underlying theoretical model which will be the basis of the paper; Section IV describes the data and the empirical framework used to explain the research question; Section V explains the regression results; and Section VI presents the conclusions and policy recommendations from the research.

II. Literature Review

The established literature surrounding the topic of exchange rate volatility and trade flows has the general consensus that exchange rate volatility has a negative impact on levels of aggregate trade for a nation. In trade flow analysis literature there are three main paths to take when looking at the exchange rate volatility and its effect: trade flows between one country and the rest of the world, aggregate trade flows between two countries, or trade flows between two countries for a specific commodity (Aftab, 2017). The impact of exchange rate volatility on trade flows remains a heavily researched topic in international economics. From the theoretical perspective, the common view is that higher exchange rate uncertainty reduces risk-ad-

justed expected revenue and hence the incentives of risk adverse traders to engage in foreign contract (Choong, 2010). The effect of the exchange rate, as stated in the journal article by Choong, depends upon the risk-adversity levels of the traders that are engaging in the foreign exchange. This idea will be further expanded when the theoretical framework of this paper is discussed.

The increase in exchange rate volatility since 1973 has had indeterminate effects on international export and import flows. Although it can be assumed that an increase in risk may lead to a reduction in economic activity, the theoretical literature provides justifications for positive or insignificant effects as well (Hegerty, 2007). While most of the literature agrees that increased exchange rate volatility has negative impact on trade flows, this paper by Hegerty brings about the counter argument that the results can either be insignificant, or based on the risk-preferences of the trader, can have positive effects. With the results from exchange rate volatility's effect on trade flows at times being left up to producer preferences, it makes sense to have the underlying economic theory of this paper come from behavioral economics. In a similar voice as the Hegerty article, an IMF paper from 2004 says, "The proliferation of financial hedging instruments over the last 20 years could reduce firms' vulnerability to the risks

arising from volatile currency movements. In addition, for multinational firms, fluctuations in different exchange rates may have offsetting effects on their profitability. As a growing fraction of international transactions is undertaken by these multinational firms, exchange rate volatility may have a declining impact on world trade.” The article essentially is saying that as corporations grow larger and smarter with their investments, they are being increasingly better at managing exchange rate risks.

Portions of the exchange rate volatility literature have brought up the notion that exchange rate volatility and trade flows are asymmetric variables, while the large majority of the established literature claims they are symmetric variables. The view of my paper is that exchange rate volatility and trade flows are symmetric variables, however, my paper also takes the additional point that the level of the effect of exchange rate volatility on trade flows is based on risk-adversity of traders. A recent article on the subject from the University of Vienna provides a juxtaposition between the traditional approach and this new method which it calls the “fuzzy approach” (Kunst, 2012). The traditional panel approach is contrasted with an alternative investigation based on fuzzy logic. The key elements of the fuzzy approach are to set fuzzy decision rules and to assign membership functions to the fuzzy

sets intuitively based on experience (Kunst, 2012). The fuzzy approach relies upon the assumptions and results of previous studies to be the basis for its membership functions. The paper concludes that both approaches yield close to the same results and can thus be used as complimentary methods for analyzing the issue. If this new method had been found to yield more reliable regression results then that would have been the style of study for this paper but that is not the case. This paper will stick to the traditional method for the aggregate trade of a specific country as this will be more feasible given the time constraints of this research.

III. Economic Theory

The underlying economic theory of this research paper comes from behavioral economics, given the speculative nature of foreign exchange markets, and is that of Prospect Theory. Prospect Theory describes the way people choose between probabilistic alternatives that involve risk, where the probabilities of outcomes are known. The probabilities of the outcomes will be known once the formula to calculate exchange rate volatility is used, where the probability of a lower level of aggregate trade rises when volatility rises and vice versa, then Prospect Theory can be applied.

Prospect Theory states that people make decisions based on the potential value of gains and

losses rather than the final outcome (Kahneman, 2013). The model is descriptive, as it tries to model real-life choices as opposed to optimal decisions as other models do. In particular, people decide which outcomes they consider equivalent, set a reference point and then consider lesser outcomes as losses and greater outcomes as gains. In the subsequent evaluation phase, people behave as if they would calculate a utility, based on the potential outcomes and their respective possibilities, and then they choose the prospect having the higher utility. For example, consider trade levels at the same level as the previous year an equivalent value for a specific national economy, any value above a gain and any value below a loss. Based on the risk component of either choice the utility maximizing situation would then be chosen by the nation based on the probability of facing either those gains or losses. With that being said, these aforementioned probabilities are subjectively determined and are not accessible through the data so assumptions must be made.

Once the data has been used to calculate exchange rate volatility, the weighing of the outcomes of either trading or choosing to buy and sell goods domestically becomes the next focus of the theory. The risk-adversity of the traders comes into play to help find the potential outcomes of the situation to apply Prospect Theory. To find a useable way to

calculate risk-adversity, to apply Prospect Theory, there is an assumption made regarding risk-adversity and national credit rating. To apply this theoretical framework the assumption made is that countries that have the higher credit ratings have a higher risk-adversity and the countries with lower credit ratings have lower risk-adversity or in other words are risk-seeking. This assumption is grounded in the fact that the countries with higher credit rating actively take steps to keep this rating high by avoiding activities such as irresponsible deficit spending or political turmoil. Thus, are more risk adverse compared to a country that does not. The relationship between risk and the national credit rating will be explained further in the next section. The hypothesis for my research, based on the concepts and literature previously examined, is that increased exchange rate volatility will have a negative impact on aggregate trade flows for the BRICS countries, the more risk-adverse the domestic country is the larger the negative impact on trade.

IV. Empirical Model

The hypothesis will be tested using an OLS regression to analyze the overall long term trends of the series. Previous studies that have assessed the impact of exchange rate volatility on trade flows have basically included a scale variable such as real income, a relative price term measured by the

real exchange rate, and a measure of exchange rate uncertainty constructed as volatility of the real exchange rate. Therefore, following this form I begin with standard specifications:

$$\text{Level of Exports} = \alpha + \beta_1(\text{Real Exchange Rate}) + \beta_2(\text{Volatility}) + \beta_3(\text{GDP}) + \beta_4(\text{Risk})$$

The equation variables are defined in the upcoming paragraph. The dependent variable looked at in this paper in *level of exports* for each country. *GDP*, and therefore *exports*, is looked at in terms of 2010 U.S. Dollars so the values are adjusted to reflect 2010 pricing and are thus not affected by nominal fluctuations and inflation. *GDP* is the gross domestic product of country *X* and provides the regression with a scale variable. The coefficient is assumed to be positive for this scale variable since the relationship between *GDP* and *export levels* is a relatively direct and agreed upon one among economists. *Real exchange rate* gives a variable to account for the *exchange rate* in country *x* over the period. We know that as a currency depreciates, the *level of exports* increase so it is assumed that this variable should be negatively related to the dependent variable. *Volatility* gives the measure for the exchange rate volatility of the series. This variable is calculated from a formula using the previous levels of the currency exchange rate, and the hypothesis suggests that this variable has a negative relation-

ship with the *level of exports*. *Risk* is the measure of “riskiness” of doing business in country *x*. *Risk* is calculated by taking the Standard and Poor’s credit rating for each country and using the valuation system of S&P to turn this arbitrary valuation into something that can be used in regression analysis. For example, the U.S. has a credit rating of AA+, which translates to a 95 on a 100 point scale. Mexico has a credit rating of BBB+ which translates to a 65 on a 100 point scale. A country which scores 100 on the scale has low levels of risk when conducting business there, so it is assumed that outside countries would continue to conduct business with those low-risk countries even as exchange rate volatility increases. Therefore, based on the favorable business climate associated with a high S&P credit rating, exchange rate volatility will have a smaller impact on the *level of exports* for one such country when compared to a country with a lower credit rating. These four variables will combine to give the level of exports for the specific country in question so this regression will need to be run five times for the five different BRICS countries.

Datasets will be taken from the IMF database for International Financial Statistics. This database is appropriate because it has the required information that I need to run my regressions as well as being from a credible source that is the Internation-

al Monetary Fund. There is workable data on all five of the BRICS countries but there will need to be some adjustments made due to the fact that the Soviet Union's collapse is right in the middle of my study period, which is from 1980 to 2016. There are also gaps in the data sets for both China and South Africa due to government concealment of data and apartheid respectively.

V. Descriptive Statistics

Country	Quarterly Level of Exports	Quarterly Exchange Rate	Exchange Rate Volatility	GDP	Credit Rating
Brazil	36,320.10	1.30	0.33	1,571,031,624,321.63	44.58
Russia	99,281.36	28.11	0.09	1,267,658,778,730.55	48.84
India	36,650.75	35.19	0.04	933,979,873,615.54	51.20
China	262,946.78	6.02	0.03	2,980,318,192,264.75	71.02
South Africa	17,295.23	5.63	0.07	280,925,097,430.49	57.20

The above table presents the average values of each variable across the countries, which gives a comparative look at each before beginning to analyze the regressions run. The table shows that China leads the group in all variables except quarterly exchange rate where Brazil has the strongest currency relative to the U.S. Dollar. South Africa registers the lowest level of exports and GDP by far where as Brazil and India have approximately the same levels of exports but Brazil has a roughly 50% higher GDP. This goes to show how much more of an impact exports has on the Indian economy compared to the Brazilian economy. Brazil has the highest level

of exchange rate volatility, at more than triple the next highest, but interestingly has the lowest exchange rate which could suggest currency issues for Brazil despite the current strength of the currency.

VI. Tabulation of Results

The results from the five different regressions run in this research study are presented below. Each table includes the four independent variables of the study, as well as the R-squared value of each regression along with the size of the sample that was run. The tables are followed by an explanation of the results specific to each BRICS nation. Table 1 begins with India.

Table 1: Regression Results for Indian Level of Exports

Quarterly Exchange Rate:	-1323.305
Exchange Rate Volatility:	116873.209
GDP:	9.506E-8**
Credit Rating:	-750.093
Adjusted R-squared	.399
Sample Size	188

* Significance at the .10 Level
 **Significance at the .05 Level
 ***Significance at the .01 Level

Above is the regression results that have been found for the country of India from 1980 to 2016. The regression used the four independent variables to attempt to find a relationship between each of those variables and the dependent variable which is that of levels of exports for the Indian economy. The only variable that was found significant for this economy was that of GDP. GDP was included as a scale variable because the assumption economists make that GDP and levels of exports are

closely related and have a positive relationship so this is as I would expect. The quarterly exchange rate is not a significant variable but, with that being said, it does have the predicted sign. The negative relationship between levels of exports and the exchange rate is solidified here as depreciation in currency increases the level of exports. Credit rating also is not significant but has a negative relationship with levels of exports so this suggests that as the country moves towards a higher level on the risk scale the level of exports also decrease. This moving towards a higher level on the risk scale corresponds with a higher credit rating and thus a decreased potential risk of doing business in that certain country. This relationship goes against my predictions that an increase in credit rating of a country does not bring about a corresponding increase in the level of exports for that economy. The main object of this study was to look into the effect of our fourth variable, exchange rate volatility, on the levels of exports. For India this variable is again insignificant so there is no measureable relationship between the exchange rate volatility and export levels as found through this regression. The coefficient for India of exchange rate volatility is positive as well which is not what was hypothesized in this paper. The Adjusted R-squared is .399, this means that 39.9% of the variance in the regression is due to

the independent variables.

Table 2: Regression Results for South African Level of Exports

Quarterly Exchange Rate:	-2156.253
Exchange Rate Volatility:	19594.393
GDP:	2.390E-7***
Credit Rating:	-207.921
Adjusted R-squared	.219
Sample Size	188

* Significance at the .10 Level
 **Significance at the .05 Level
 ***Significance at the .01 Level

The regression results for South Africa are similar to that of India which was just discussed. The only statistically significant variable in determining the levels of South African exports was GDP and was significant to the .01 level. The other three, exchange rate, volatility, and credit rating, all are not significant and have the same signs as do the previous regression. This data serves to solidify the position found in the first regression that the hypothesis was not supported by these sets of data. With that being said the South African datasets had some holes in them because the information was not well recorded during the apartheid era and this could have affected the regression results. The Adjusted R-squared for this regression is .219, this means that 21.9% of the variance in the regression is due to the independent variables.

Table 3: Regression Results for Brazilian Level of Exports

Quarterly Exchange Rate:	-4550.141
Exchange Rate Volatility:	6693.323
GDP:	7.490E-8*
Credit Rating:	423.162
Adjusted R-squared	.276
Sample Size	188

* Significance at the .10 Level
 **Significance at the .05 Level
 ***Significance at the .01 Level

The third regression that was run features the economy of Brazil and, again, has one signifi-

cant independent variable that is GDP. Three of the signs of the coefficients are the same as what has been previously recorded in this study, but there is a change in the sign of the coefficient for the country's credit rating. With that being said this variable is still statistically insignificant but this new positive relationship between credit rating and export levels that this regression suggests is more in line with the hypothesis of this paper. This positive relationship between credit rating and export levels for Brazil would suggest that as the credit rating of Brazil improves so does the level of exports suggesting that foreign economies have increased confidence when conducting business in Brazil and thus exports increase. The Adjusted R-squared for this regression is .276, this means that 27.6% of the variance in the series is due to the independent variables.

Table 4: Regression Results for Russian Level of Exports

Quarterly Exchange Rate:	-2642.574
Exchange Rate Volatility:	2176.653
GDP:	3.410E-7***
Credit Rating:	-1930.863
Adjusted R-squared	.285
Sample Size	188

* Significance at the .10 Level
 **Significance at the .05 Level
 ***Significance at the .01 Level

The regression run for Russian exports has similar results to the regression run for India. The only significant variable is GDP this time at the .01 confidence interval and reverts back to the same signs associated with the first two regressions where both GDP and volatility have positive coefficients while credit rating and exchange rate have negative

coefficients. The data for the Russian economy has gaps in its information as the collapse of the Soviet Union happening during the period of study. With that being said the fact that this is now the third regression that has both the same significance and signs of the coefficients we can begin to draw some solid conclusions from the run regressions. The Adjusted R-squared value of this regression is .285, this means that 28.5% of the variance of the series is due to the independent variables.

Table 5: Regression Results for Chinese Level of Exports

Quarterly Exchange Rate:	-17828.717
Exchange Rate Volatility:	236938.972
GDP:	8.363E-8**
Credit Rating:	9106.540
Adjusted R-squared	.410
Sample Size	188

* Significance at the .10 Level
 **Significance at the .05 Level
 ***Significance at the .01 Level

The fifth and final regression that was run was for China. China follows suit with all of the other regressions in having GDP be the only variable that was found significant in affecting the level of Chinese exports and is significant at the .05 confidence interval. The coefficient for exchange rate has a positive sign as it does in the previous four regressions, likewise volatility is positive as it is with the others. It is interesting here that even in China, where currency manipulation is a governmental strategy to keep exports high, that exchange rate volatility does not have a negative effect on exports. Even though the government intentionally keeps exchange rate volatility low, the regression results suggest

that there are limited consequences to the level of exports based on exchange rate volatility. The credit rating here follows the country of Brazil in that this regression finds a positive relationship between the level of exports and credit rating. This may be simply an arbitrary finding because China has had huge growth in its exports over the data period as well as a relatively constant increase in its credit rating, in large parts due to its economic growth, so these results could be spurious. The Adjusted R-squared value of this series is .410 meaning that 41% of the variance in the series is due to the independent variables.

VII. Conclusion

This paper investigates the relationship between a specific country's level of exports and exchange rate, exchange rate volatility, GDP, and credit rating. The timeline of this study is from 1980 to 2016 and looks into the five BRICS countries, Brazil, Russia, India, China, and South Africa. The main independent variable for this study was that of exchange rate volatility. It was hypothesized that exchange rate volatility would be both statistically significant and be negatively related to the level of exports for each country.

The findings for the five regressions are that only the GDP variable of this study is statistically significant in determining the level of exports for the

BRICS countries. Inconsistent with my hypothesis the regression found that not only is exchange rate volatility not a significant determinant of the level of exports but also that the insignificant coefficient had a positive sign suggesting a positive relationship between volatility and exports. The insignificance of this relationship could be due to many factors; I believe it is due to the high rates of growth all of these economies have experienced during their development. These high growth rates could be responsible for limiting the potential negative effects due to exchange rate volatility, simply by the immense rates of growth, and thus making the variable insignificant.

Further research in this topic could be to potentially see how exchange rate volatility effects a country that has been fully developed so large scale growth cannot outweigh the variance in the series due to volatility. A policy application for the BRICS countries would be to engage in floating currency policies since there is minimal risk to export levels of doing so as suggested by the results of this paper. As the BRICS countries move forward towards becoming developed nations their development will have large scale effects on the overall world's economy and should be researched to better understand transitional economics.

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