The Shifting Dynamics of International Reserve Currencies

by

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Abstract

RIGHI, ROBERT J. - The Shifting Dynamics of International Reserve Currencies

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Throughout most of post World War II period, the United States dollar has been globally accepted as the dominant reserve currency. This dominance comes with "exorbitant privilege" or special benefits such as not having a balance of payments problem. Therefore, with the shifting of global geopolitical balance of power in the age of Trump, along with the recognition by the IMF of the Chinese renminbi as an international reserve currency in 2015, it is important to understand the modern influence of reserve currencies. We provide an updated study of the status of the dollar, the euro, and in particular, the renminbi as it is an upcoming reserve currency. To do so, we use currency exchange rate data and apply modified workhorse regression models analyzing the co-movement of 149 countries' currencies with each of the five major reserve currencies. We are then able to assign each country's gross domestic product at purchasing power parity to a reserve currency bloc in order to obtain a global sphere of influence for each reserve currency. We find that the United States retains its dominance but faces challenges from the renminbi and the euro in recent years as the international monetary system becomes tri-polar. We analyze particular current events in specific countries and regions to help explain why we see this shifting dynamic.

Table of Contents

Chapter One
Introduction

A. Statement of Purpose

The purpose of this thesis is to investigate the relative decline of the United States dollar (USD) as a reserve currency. In particular, we want to quantify the use of renminbi (RMB) as an upcoming reserve currency and predict its future impact. Our work seeks to provide an updated view of the international monetary system and compare these results to what previous researchers have found. This is extremely important, for many reasons to be discussed, but particularly as the Chinese currency has gained more recognition in recent years, there has been a very large increase in Chinese investments and trade, and there have been shifting political climates globally.

B. Background

Leading up to the 1950's the United States did not have the dominant reserve currency as Great Brittan did. As seen in Figure 1 that changed drastically as the dollar has been dominant ever since. However, in recent years we now see a rise in other currencies to rival the dollar. This work will investigate the global influence of the major reserve currencies including the RMB and analyze the impacts that a paradigm shift will have on the global economy.

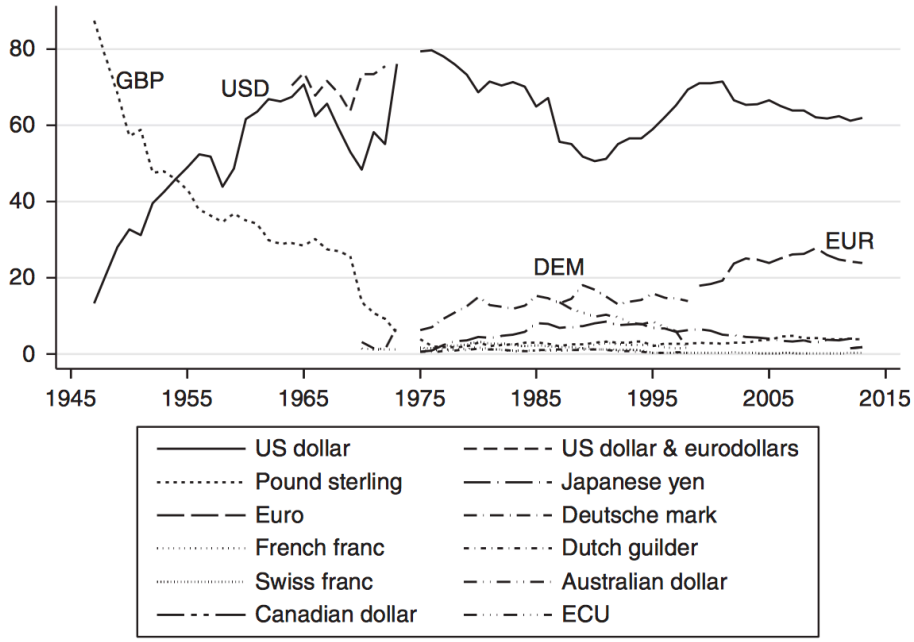

Figure 1- Currency Composition of Globally Disclosed Foreign Exchange Reserves in percent.

Source: Eichengreen, Chitu, and Mehl (2016)

Reserve currencies are held by countries' central banks in order to be used in international transactions. This includes investments and debt obligations. They also are used to manage exchange rates. Reserve currencies have long been studied to gain a better understanding of international finance and trade. Throughout most of the modern day history of the international monetary system, the United States has played a dominant role. There are large economic implications for the United States having the dominant reserve currency. One such implication is that there is a very high demand for the USD and countries have a significant interest in seeing the dollar do well. The US has what is known

as “Exorbitant Privilege,” that is it will not have a balance of payments problem as all of its transactions are done in the USD. In addition, since the United States controls the money supply it benefits from seigniorage or the value gained by minting money. However, there are some negatives associated with being the dominant reserve currency. This would include increased spending, and possibly cheaper imports hurting domestic firms. However, being the major reserve currency is in large part beneficial.

Therefore, it is extremely important to study the international monetary system and to examine the shifts that occur over time. The international reserve system as a whole can be criticized with an overreliance on the dollar, and the United States unfairly taking advantage of the benefits of being the major reserve currency. An example can be seen with the large amounts of spending the United States had in the Vietnam War, which led to the end of the Bretton Woods system in 1971. Conversely, the USD can provide stability, liquidity, and safe assets in times of financial crises. It provides a reliable network and a common currency that most countries use in international exchanges and transactions.

Despite these arguments, there has been a push for diversification. In fact, recent years have seen that there has been diversification in the international monetary system particularly with the rise of the euro leading to a bi-polar system. We would like to examine China’s role in this increased diversification, particularly in the years after 2015, when the RMB was officially recognized as a reserve currency in a political climate characterized by a Chinese push for global power and a United States shift toward nationalism in the age of Trump. As the

reserve system shifts to a tri-polar system there are many economic implications for the United States in terms of its exorbitant privilege.

C. Structure of Thesis

This thesis consists of five chapters with Chapter One and Chapter Five being the introduction and the conclusion. Chapter Two will detail previous works on reserve currencies. This will look at why the study of reserve currencies, and subsequently this thesis is important. It will also detail previous methods of studying reserve currencies and detailing how the methods we used were developed. Chapter Three will discus the methods of analysis that were employed in this thesis such as workhorse regression methods, forecasting, and identifying currency blocs. Finally, Chapter Four will outline our results and their significance.

Chapter Two
Literature Review

A. Introduction

This chapter is dedicated to analyzing the relevant literature pertaining to this work. More specifically, we will look at three major topics of discussion. The first area of interest is the role international reserves from a historical perspective. This allows us to frame the importance of our study in a historical context. Next, we would like to describe China's potential for, as well as the barriers to, establishing a major global reserve currency. Finally, we will discuss various methods that have previously been used to measure the size of reserve shares. In addition, we will describe the most important work relating to this research, and highlight the ideas and topics that will be built upon.

B. History of International Reserves

There have been many major events in the history of the international monetary system that have overtime shaped it into what we see today and have allowed for the diversification that this work seeks to study and understand. The first major event that we would like to discuss is the formation of the Bretton Woods system in 1944. The landmark conference in New Hampshire laid the foundation for the modern day international monetary system. This system maintained international exchange rates by backing currencies by gold. It also

allowed the United States to establish a global reserve currency, particularly because of the United States control of the global gold shares. This truly was an impactful event that gives researchers a timeframe to start studying international reserves.

The first major focus of Eichengreen, Chitu, and Mehl (2016) was to expand the data back in time to create a reliable look at this timeframe post Bretton Woods. As the paper discusses, when the Bretton Woods system began to take place the United States dollar (USD) was not always the major reserve currency. In fact, it was the British pound (GBP) that held this distinction. The researchers attribute this to relations that Great Brittan had following World War II. Many countries held ties to the British Empire and part of that allegiance involved holding the GBP. Yet as this work shows, in the early 1950's there was a drastic shift to the USD as the major reserve currency that has continued until today.

Importantly, this shows that not only are there changes in the reserve currency market, but they can be extremely drastic. Therefore we can reason that it is quite possible that an important event, like the recognition of the Chinese renminbi (RMB) by the IMF as an international reserve currency, can trigger a dramatic change in the global shares of reserves. On the other hand, Eichengreen, Chitu, and Mehl's research expanding data back in time shows that after this shift the United States share has remained relatively constant particularly after the establishment of the euro, which will be discussed in further detail later on.

The second major focus of Eichengreen, Chitu, and Mehl is to analyze how reserve currencies were impacted with the fall of the Bretton Woods system. The end of the Bretton Woods system can be characterized as overspending by the United States on the Vietnam War. This spending led to an inability to back the dollar by gold, which eventually caused the United States to end the Bretton Woods agreement in 1971. Many countries viewed, and still argue today that the spending was an abuse of the United States' exorbitant privilege. By any means it created a significant change in the system of reserves.

Eichengreen, Chitu, and Mehl's research looks at the main differences prior to and after this time. What these researchers find is that post Bretton Woods there is a decrease in the importance of network effects and an increase in importance of policy credibility effects. That is, countries post Bretton Woods can see financial gains by holding one particular currency over another due to the floating exchange rates as opposed to the fixed rates seen earlier. In addition, with the more diversity of currency in the market there is less importance on what other countries choose to hold. Interestingly, the findings show that policy aimed at discouraging use of another currency has a greater impact on which reserve currencies are used than policies bolstering a particular one.

Since we see countries having a greater ability to diversify which reserve currencies they hold, it opens the door for new currencies to take hold and gain a significant global share. Meanwhile, the United States must be more active to hold onto its share. Especially because, as Eichengreen, Chitu, and Mehl state, there are stark benefits to diversification as countries now have the ability to

monetize their reserves according to the "upheaval hypothesis." The upheaval hypothesis asserts that the reserve currency system has altered after the shift from fixed to flexible exchange rates. This certainly plays a role as the RMB is recognized as a reserve currency.

We begin to see even more diversification in the international monetary system with the formation of the Euro starting in 1999. Papaioannou and Portes (2008) evaluate the international status of the Euro in the first few years after its formation. The work saw that the euro had taken a foothold in global reserve shares, and predicted a gradual convergence of the shares of the USD and euro in the future. It was found that an era defined by globalism and increase in global trade was a determining factor in the Euro becoming a dominant reserve currency.

The euro has maintained a relatively constant share of global reserves since their paper was written, but that does not discount the possibility that it will gain more. It does emphasize the ability for a new currency to become a major player as an international reserve. It would also be very interesting to compare how the RMB does in its initial years as a reserve currency compared to the euro. This is unfortunately a hard comparison to make, however, as there are some key differences between the two. Namely, many European countries had already established their currency as international reserves prior to the formation of the euro. The euro in turn already had a place in the market to take. This would have to be factored out in any comparison that is to be made between the RMB and the euro.

The International Monetary Fund (IMF) recognized the RMB as a reserve currency in 2015. We argue that this is a major event to help diversify the international monetary system. Our goal is to study the effects this change had internationally in the few years after it occurred. We will be able to do this by studying the RMB and its influence globally.

Historically major events do tend to have big impacts on the diversification of the international monetary system. This is true with both the formation and demise of Bretton Woods, and the implementation of the euro. Adding to the importance of this work, these events serve to bolster the idea that because the RMB was recognized as a global reserve currency, it could serve a major role internationally. We will subsequently further discuss the current international conditions that add even more weight to this argument in the next sections.

C. The Current State of China and Status of RMB

There have been many debates over the ability of China to be a major player internationally. For example Zhou (2009) argues that because of China's growth, size, and growing trade networks it is destined to play a major role. Zhou also looks at the Chinese position that there is an overreliance on the dollar and that the RMB serves as a currency to help diversify the international reserve system. On the other hand Prasad (2015) argues that China faces too many

barriers, particularly with its political policies, and limitations that it has with the capital account as well as exchange rate.

Dollar (2018) looks at the arguments for and against China. First, the researcher recognizes that China is in a good position to have a major reserve currency in the future referencing the formidable traits listed above. However, Dollar argues that there are many impediments to its immediate and future rise. The author states that the main barrier that China faces is the freedom of its financial assets. The research finds that countries are less willing to take up a reserve currency if its capital account is closed.

China has many current policies that restrict both the access that foreigners have to Chinese assets as well as access that citizens have to financial assets. Other countries prefer to have open access, as the capital account is a large medium of exchange of foreign currencies. Therefore, Dollar argues that China will not be able to establish itself until it makes changes in regards to the capital account. Once China is able to make these changes then the other factors will kick in to succeed on the international market.

Moreover, there are additional problems China faces in order to make these accounts more open. More specifically, this is the case with its exchange rates. China has in the past pegged its currency to the USD. That is the RMB will follow along with the rates of the USD. In addition, China has been accused of manipulating its currency and not allowing for it to be free floating, but instead keeping it in a desired range. Revisiting the upheaval hypothesis this poses a significant barrier to China's international status. There would be very little

reason to choose the RMB as the dollar would provide a safer alternative with the same upside.

Subsequently as China opens its capital account it quite possibly can face a currency appreciation crisis. Access to financial assets can create a large demand for the RMB. Therefore, we could see the value of the RMB skyrocket. This could in turn be detrimental to the Chinese economy being a manufacturing exporter. China relies on its ability to produce cheap exports, which is in part why it has been accused of devaluing currency. So changes must occur over a longer period of time.

However, China has been the exception to the rules in many cases. As Dollar discuses, the country has extremely high development and economic growth for the institutions and rule of law relative to other countries. It is therefore reasonable to think that China can be an exception to the rule for international reserves as well. This is especially true because of its global influence in trade, and the recent stances on promoting the RMB globally. China, according to Dreher et al. (2017), spent about 80 billion USD in developing countries for infrastructure. This was a part of its Belt and Road project to expand trading networks and infrastructure.

Dollar argues that this project actually is an example of stalled progress of the RMB in the international market. The reason is that China used mostly USD to pay for the development. In fact, only 2.6 percent was denoted in RMB. We argue the exact opposite: which is, despite most of the development being done in USD this is a major step to becoming a major world currency. Primarily this is

expanding China's influence globally through trading blocs and importantly lays a foundation for a high volume of future global payment to be done in RMB.

Summers (2015) states that the One Belt, One Road Project involves connecting more than 60 countries that account for about a third of the entire global GDP. This is a major project in which China stands to possibly gain a lot from. Building a larger trade network expands the sphere of Chinese influence in trade, and can expand the RMB's global influence. With an increase in trade volume we would expect an increase of use in the RMB in global transactions.

This process will take a long time and the effects will not be seen immediately, as Ferdinand (2016) puts the project's time frame at around thirty to thirty-five years. Yet it does highlight China's willingness to expand globally and its desire for global influence. There are many factors that have presented themselves in the three years following the IMFs recognition of China as an official reserve currency. China's expanding role internationally, coupled with global attitudes along with European and American policy, has created an interesting environment for the global role of the RMB that we argue is incredibly important to study in order to gauge the international monetary system now as well as to help understand the outlook of what we can expect in the future.

There is a plethora of United States policy that have direct implications for the USD as a reserve currency as well as the RMB, which we argue are of a vital importance as to why the 2015-2018 timeframe must be studied. The most important is the election of Trump in 2016 that marks a shifting United States view from a globalist foreign policy to a more nationalistic one. We believe there

are three important policy points that have deterred or will deter countries from using the USD as a reserve currency and instead use other alternatives such as the euro or the RMB. The Trump administration's stance on trade, the removal from the Iran Deal, and sanctions on Russia all can lead to impactful changes that our work looks to study.

Trump has vehemently expressed his views on United States trade and the need for reform in international trade deals. One major policy that has major economic implications is the implementation of tariffs placed on international goods. For instance, according to Conca (2018) Trump has levied a 25% percent tariff on steel and 10% on solar aluminum. As this article states, this opens the door to a trade war as other countries place tariffs on United States products as well.

This leads to a concept that Sheu and Kundu (2017) discuss known as trade diversion. Trade diversion is the shifting of trade to a less efficient exporter as the result of trade deals that reduce tariffs and barriers to trade. As the United States leaves trade deals and imposes tariffs, we expect countries to shift away from United States trade. With the reduction of trade the United States has with China, China will in turn seek other trade partners to "unload" its goods. In addition, China becomes a much more attractive country to trade with, as an alternative to the United States, as it expands and makes significant investments promoting international trade in the One Belt and One Road project. Again we argue that this in turn bolsters the need, or desire to use alternatives to the USD in international exchanges.

This is due to the fact that there will be less volume of trade done with the United States with these tariffs. In addition, there will be less direct exchanges with the United States. So, countries may view it more practical, especially with the Chinese views on globalization stated before, to use their own currency or other countries' currencies when doing deals with them that do not involve the United States. It would simply be more efficient to establish networks to use the RMB in these transactions. We believe that these recent events can have a major impact on the global influence of the RMB as China continues to expand its trading networks and infrastructure.

The next policy that we would like to assess is the United States withdrawal from the Iran deal. There has certainly been both support and opposition in United States politics. Barnes and Barron (2018) discuss the history of the policy, as well as the implications for a United States withdrawal from the deal. The work mentions that the United States European allies are not happy with the United States policy actions in this manner and discuss the future outlook there. Some allies are reluctantly supporting the United States, while others are weighing their own options. Barnes and Barron mention that the future outlook for United States and Iranian relations is certainly rocky, but this could certainly get backlash from the Europeans.

The Iran policy is directly related to the relationship that the United States has with Russia. Slav (2018) talks about sanctions the United States has on Russia and Iran, and the impact that this will have on the dollar. Mostly the two "sanction buddies" will look for ways to undermine the United States. The two countries

have long discussed an oil-for-goods exchange program to divert the sanctions for use of the USD in transactions with Iran. In addition, as Europeans are upset by the United States withdrawal from the Iran deal, there has been talk of establishing networks to doing a large amount of global transactions in the Euro or Swiss franc, which would greatly hurt the USD dominance as a reserve currency. One such attempt, by the European Union, specifically by France, Germany, and the UK, is the institution of INSTEX (Instrument in Support of Trade Exchanges). This may not succeed, but is yet another indicator that countries might be trying to escape from the adverse effects of the USD reserve currency monopoly. Slav also discusses the influence of pricing oil in euros as opposed to dollars. The Russians are making a strong push to circumvent the dollar, and Russian oil companies are urging Western commodity traders to pay in euro. This is yet other example of the importance of the 2015-2018 and the shifting dynamic involving the de-dollarization of the international reserve network.

China's role as a developing global player can very much accelerated, particularly due to the global political climate that we witness today. As we have mentioned, it has many positive attributes that would make it a viable option for an increased role in the international monetary system. Despite also facing many barriers to entry, it has been known to be an "exception to the rule" in many instances. In addition, in recent years China has made major pushes towards globalization, making significant investments in infrastructure and trade networks. Coinciding with the IMF's recognition of the Chinese Yuan as a reserve currency

is an extremely unique political environment globally characterized by President Trump and pushes towards nationalism. We believe that all of this combined solidifies the years post 2015 as extremely important to study in order to get a full understanding of the past, current, and future of the international monetary system.

D. Previous Methods

Much of the work that has previously been discussed studies the shares and explicit use of various currencies globally to gauge each currency's role and influence. For example Eichengreen, Chitu, and Mehl (2016)**,** as discussed earlier, analyze network and policy effects by looking at the size of the shares of reported reserves. Although the work does a great job of expanding the data set back in time, there is still little data for the RMB. That is inherently due to the fact of how recent IMF reporting of the RMB is. Furthermore, Eichengreen, Chitu, and Mehl show that there are a lot of holes in IMF reporting that despite a relatively good job of plugging, it still creates problems when combining data sets from various sources over a long time frame would have.

This then begs the essential question of this research. How do we accurately measure the RMB's influence as a reserve currency in an international monetary system that has recently shown signs of diversifying? To answer this we turn to work done by Tovar and Nor (2018) introducing an alternative approach to measuring the influence of reserve currencies than the typical one found in other

literature. More specifically, calculating the influence that each major currency bloc has on other currencies. This work from 1969-2015 will serve as the foundation for our research as we focus on the more recent time period for the reasons discussed in the previous sections.

Tovar and Nor study currency co-movements of national currencies with reserve currencies to determine what reserve currency bloc each national currency is a part of. It is then possible to calculate the global share of GDP that each reserve currency influences. The results indicate that the USD is dominant with a global share of GDP of about 40 percent. Interestingly, this is followed by the RMB with about a 30 percent share of global GDP. Finally the Euro holds around 20 percent. This indicates that the sphere of influence of the RMB is larger than otherwise thought in work analyzing reserve currency shares. In addition, the RMB going into 2015 already has an established influence globally.

In order to calculate each sphere of influence Tovar and Nor built on Frankel and Weis's (1994) methodology for analysis using workhorse regressions. This methodology is argued to have some drawbacks particularly with the fact that the RMB has been pegged to the USD in the past, which presents a collinearity problem. So to address these concerns the researchers employ Kawai and Pontines' (2016) approach to analyzing the sphere of influence of the RMB.

There is a major difference between the work of Kawai and Pountines and Tovar and Nor. That is Kawai and Pountines looked at the sphere of influence of the RMB in Asia whereas Tovar and Nor were able to expand this approach to the global scale. Kawai and Pountines believed that if a large effect were to be

measured for the RMB it would be more localized in the Chinese region. Tovar and Nor were able to verify that this effect was in fact extended globally.

To measure the global effect the researchers calculated a relative and absolute sphere of influence for each of the major reserve currency to gather an in depth look at the historical and recent state of the international monetary system. This is groundbreaking work that we look to expand upon by incorporating the most recent three-year period. We will also look to duplicate their results and corroborate their findings.

The work found that the transition from a bi-polar reserve system to a tri-polar system is well underway. However, the USD still, as is the case historically, plays the dominant role. A lot of the RMB's influence is attributed to BRICs currencies. BRIC refers to Brazil, Russia, India and China. These countries are grouped because they are at a similar stage of economic development. Interestingly, the influence of the RMB is more on BRICS currencies as opposed to playing a central role in Asia. Part of our work will be devoted to seeing if in the last few years this makeup of the RMB's influence has changed. That is we will look to see if the RMB dominance is extended beyond the BRICS currencies. With that said, the RMB dominance in these countries is extremely important. We expect that as these countries continue to grow, so will the role of the RMB internationally.

The researchers also looked at the reserve currency blocs and how they changed over time. First there was a decrease in the use of the dollar following the end of the Bretton Woods agreement. Furthermore, there were decreases in each

region during the respective financial crises that were faced (ERM crisis decreased the European share whereas 2007 decreased the dollars). Finally, there was a large increase in the European shares following the introduction to the Euro. These findings add light to the fact that major economic events, particularly those pertaining to the international monetary system, do greatly impact the influence of reserve currencies. Thus far, we have seen ample evidence to suggest that there would be a shifting dynamic of the RMB following the recognition as a reserve currency by the IMF in the age of Trump.

In addition to studying the influence of each major reserve currency the work also analyzed what factors play an important role in determining a currencies influence. What was found was that networking effects play a big role still, somewhat contrasting the work on the upheaval hypothesis. In addition the size of a country matters, and as we stated before China has seen unprecedented growth in recent history. Finally debt levels hurt the size of blocs and current account surpluses undermine them.

These works lay the groundwork for how our research will be conducted. Another interesting avenue that could be explored in the future is the role of the demand for oil in determining the influence of a reserve currency. As we discussed earlier there is the prospect of Russia pricing oil in Euros. It is therefore possible to remove the influence of oil to get a true "influence" of each reserve currency. This would also give an idea of the importance of oil and how shifting global dynamics will impact the influence of each respective reserve currency.

E. Conclusions

The formation of the Bretton-Woods system in 1944 laid the groundwork for the international monetary system that we have today. However, many major events including its demise in 1971 have led to many changes along the way. Particularly over time there has been a shifting dynamic allowing for the diversification of reserve currencies, and many major global players rising to be formidable candidates for reserve currencies. We have already seen this to be the case with the euro.

We expect this to be the case with the RMB as well. As many researchers have already seen, the Chinese currency already plays a role internationally. We believe that with a combination of the current global political climate, China's rise in terms of GDP and FDI as well as significant investment in trade in the One Belt, One Road project, and the IMFs formal recognition of the Chinese currency as an official reserve currency all bolster the RMBs influence in global markets. We will be able to test this theory by imploring previous methods into co-movement of currencies with the major reserve currencies. This will in turn allow us to see what change, if any, the Chinese Yuan experienced post 2015.

Chapter Three
Methods

A. Introduction

In this chapter we will provide a detailed description of our research methodology. This includes the data and the models that we use, as well as other tools that we applied in our analysis. Our work employs modified workhorse regressions as well as other techniques to analyze the role of major reserve currencies on the global scale. We seek to show an updated view of the influence of reserve currencies globally. This is especially important in the age of Trump and with the formal recognition of the RMB as an international reserve currency. In this section we will explain our choice of the model as well as defend the various methods that we use. This chapter will be split into three different sections. The first will detail our data discussing what data was used, where the data came from, and the process of cleaning the data. The second section will outline our empirical model and the reasons for choosing this method as opposed to other alternatives. Finally, the third section will discuss additional steps we took in our analysis. This includes addressing and ruling out potential problems that we face.

B. Data

Our work uses exchange rate data as reported by the International Monetary Fund (IMF). The IMF has near global membership, as it is comprised of 189 countries. The IMF's main goal is to ensure the stability of the international monetary system. They also provide reliable, up to date economic data. For exchange rate data we use end of period monthly data reported by the *IMF's International Financial Statistics*. Our model uses exchange rates per USD for reasons explained in the next section. To visualize the data that will be used for this research, log scale exchange rates in terms of USD can be seen in Figure 2.

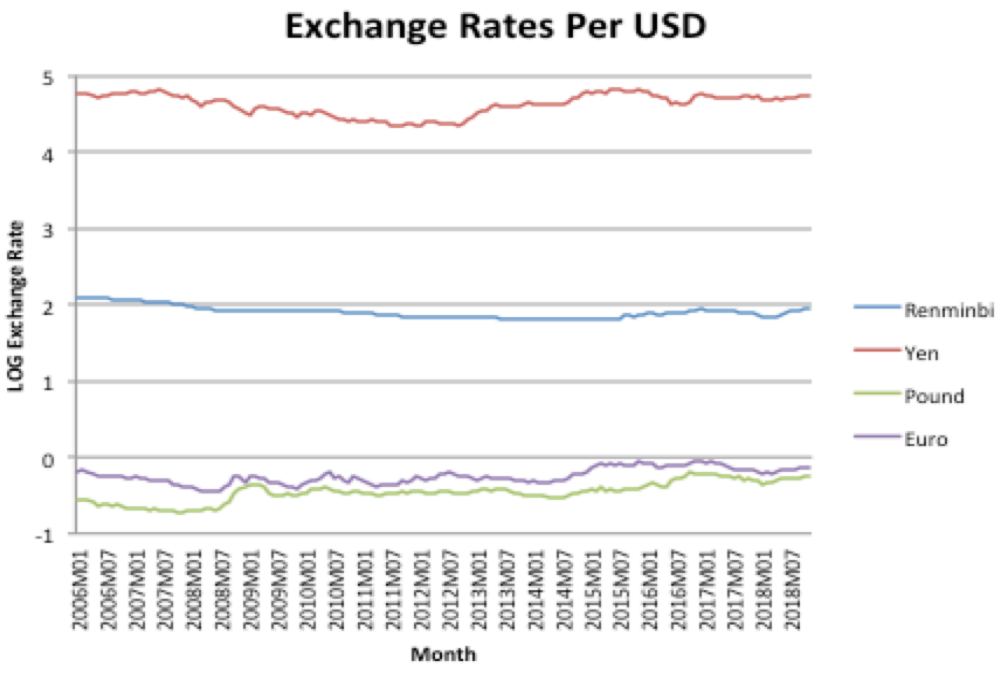

Figure 2- Log scale end of period monthly exchange rates per USD for 2006M1-2018M11.

Source: IMF

We chose our time frame from 2006M1-2018M11 for multiple reasons. First, we see very low correlation between the United States dollar and the renminbi. We found the correlation to be .546, which is extremely encouraging for the use of this time period in our results. This is especially true considering that there were time periods where the RMB was directly pegged to the USD with a perfect correlation of 1.This also implies this is actually a period of relatively free floating for the renminbi backing up historical accounts. As we will discuss later, this greatly helps to deal with the multicolinearity of our model. The second reason we used this time period is that our work looks to paint an up to date picture of the global influence of major currencies. Since China's currency started to become a large global player during this time, it is imperative that it is the focus of our study. Finally, this allows for a large sample of countries with complete data. We use a representative sample of 149 countries to estimate the global influence of the reserve currencies. Countries whose data was incomplete were removed from our sample. In addition, we argue our 155 data points are sufficient to create a respectable sample size for the model.

Our data for gross domestic product at purchasing-power parity (GDP-PPP) is obtained from the *IMF's World Economic Outlook database*. We use the individual share of GDP-PPP an individual country has in a given year. This is annual data reported at the end of each period. Our work uses the global shares of GDP-PPP for 2018. This is to ensure that our results are reflexive of the time period that we are using, as well as to provide a clear scope of the current outlook.

C. Model

This work utilizes models employed by Tovar and Nor (2018). These models are difference in log workhorse regression models that were initially used by Frankel and Wei (1994). They are designed to analyze co-movement of international currencies with the major reserve currencies. However, there were some drawbacks to Frankel and Wei's equation. Namely, the biggest problem was the fact that the effects of the RMB were not measured. This at the time was understandable, but as the RMB came into fruition and a major reserve currency, it needed to be included. Therefore Tovar and Nor use a modified approach used by Kawai and Pontines (2016). This model measured the effect of the RMB. Kawai and Pontines' model only focused on a localized region in Asia in their analysis. Therefore, Tovar and Nor extended this model on the global scale. They were the first researchers to do a global scale of this kind of analysis. We will employ the same equation that Tovar and Nor used in their work. Our work will then show an updated picture of the various reserve currencies on the global scale in the age of Trump and post official recognition of the RMB as a reserve currency by the IMF. The model is expressed in the following form:

$$\Delta\log(x/USD)_t = \beta_0 + \beta_1\Delta\log(EUR/USD)_t + \beta_2\Delta\log(GBP/USD)_t + \beta_3\Delta\log(JPY/USD)_t + \beta_4\Delta\log(RMB/USD)_t + \varepsilon_t \quad (1)$$

where x is an individual country and USD serves as our choice for the numeraire currency. Our dependent variable is the logarithmic change in of a country's

currency in terms of the USD. The regression coefficients represent the weight each major reserve currency has on currency x. Since we use difference in log we can calculate the "inferred" United States effect. This is done by the constraint $\beta_5 = 1 - \beta_1 - \beta_2 - \beta_3 - \beta_4$.

Tovar and Nor (2018) use equation (1) throughout their work but express collinearity problems with the RMB as it was pegged to the USD for a long period of time. They address these problems by employing a second two-stage model. In this work we use an alternative method to address these problems. That is, we use a sample period in which the RMB was not pegged to the USD. As stated before our period will range from 2006-2018. By choosing the USD as our numeraire currency, as well as leaving it out of our initial model and calculating the effect afterwards, we are able to alleviate the collinearity problem.

Our methods use a comprehensive list of 149 countries to create a balanced sample to estimate effects. We will repeat equation (1) 149 times running the regression once for each country in our sample. In each case we will note the highest coefficient in the model. Country x will then be placed into the reserve currency bloc for whichever has the highest coefficient. So by calculating the weight of each reserve currency on each individual country we can calculate the sphere of influence each reserve currency has. We obtain the size of reserve currency blocs by assigning a country's GDP-PPP reported by the IMF global outlook data to the country whose reserve currency has the greatest influence on that country's currency, as found from the coefficients in (1).

Our methods serve as an alternative to traditional studies about reserve currencies. Typical studies look mostly as shares of reserve currencies and factors that affect reserve currencies. Our methods are beneficial in that we can measure the direct effect the reserve currencies themselves have internationally. They are also useful in that they not only paint a picture on the global scale with currency blocs, but we can also point to individual countries and how each currency is directly impacted. This allows us to put countries and regions into historical context as well as utilize traditional findings to support or explain our results. In addition, our methods allow for measuring the effect of the RMB both prior to and post being officially recognized as a reserve currency by the IMF in 2015.

D. Additional Methods

This section is devoted to addressing concerns with our model as well as discussing additional steps that were taken. The first problem that we incurred was with autocorrelation. This is measured by the Durbin-Watson statistic. Durbin-Watson always has a value between 0 and 4 with a value of 2 meaning there was no autocorrelation detected in the sample. If the value is less than 2 it implies there is positive autocorrelation detected in the sample while greater than two is negative autocorrelation. This is a very useful tool to have considering our data is time series.

We ran a significance test on our Durbin-Watson statistic for each of the 149 models at the 1 percent level. We had 155 observations in each regression as

well as 4 right hand side variables. Our lower bound was 1.57 and our upper bound was 1.679. First if the statistic is greater than 2 we subtract it from 4. Then, if the statistic is greater than the upper bound and less than 2 then we fail to reject the null hypothesis that there is no autocorrelation. We found this to be the case in most of our models. However, if the Durbin-Watson statistic is lower than the lower bound then we reject the null hypothesis and there is autocorrelation present. This was the case in almost one third of our models. There is a third case for this significance test. That is, the test is inconclusive if the Durbin-Watson statistic is in between the lower and upper bounds. To err on the side of caution we took a conservative approach in which we failed to reject the null if the statistic was between the two bounds.

Our next step in this process of dealing with autocorrelation was to run autoregressive models for each case autocorrelation was found. The first step in the process is running (1) at time t, however we believe the error in this case is not random as seen in the first order autoregressive error structure, which is expressed in the following form:

$$\varepsilon_t = \rho\varepsilon_{t-1} + e_t \qquad (2)$$

In (2) e_t is random error. To extract this random error we then run (1) at time t-1 and multiply through by ρ. Subsequently we subtract this from (1) at time t. This yields:

$$\Delta\log(x/USD)_t = \rho\Delta\log(x/USD)_{t-1} + \beta_0 - \rho\beta_0 + \beta_1\Delta\log(EUR/USD)_t - \rho\beta_1\Delta\log(EUR/USD)_{t-1} + \beta_2\Delta\log(GBP/USD)_t - \rho\beta_2\Delta\log(GBP/USD)_{t-1} + \beta_3\Delta\log(JPY/USD)_t - \rho\beta_3\Delta\log(GBP/USD)_{t-1} + \beta_4\Delta\log(RMB/USD)_t - \rho\beta_4\Delta\log(GBP/USD)_{t-1} + \varepsilon_t - \rho\varepsilon_{t-1} \quad (3)$$

Note that if we solve for e_t in (2) the result is precisely the error term in (3) allowing for random error in our model. A major problem with autoregressive models is the impact they have on coefficients. However, this is not the case with the results of our models. In every case the coefficients only changed very slightly, and the largest coefficient never changed in our autoregressive model. In addition the significance of the coefficients never changed. This allows us to rule out autocorrelation as a major problem in our models. This is expected as using difference in logs already minimizes the effect of autocorrelation.

We also wanted to delve into the predictive power of or regressions. One way to do so is to calculate the R-squared predicted values. R-squared predicted is a measure for how well the model makes predictions. It is also useful in that it is a good indicator on if the model overfits the data. The statistic is calculated by removing a data point, running the regression, predicting the removed data point, and then comparing that predicted point to the actual observed value. This process is then repeated for all of the data points.

Another useful tool for analyzing the predictive power of our models is forecasting. This is done in a similar fashion as the predicted R-squared. However, instead of predicting every point separately we can reduce our sample size to 2006-2015 and predict from then on. For individual countries this is an extremely useful tool. Particularly if we believe that there is a stark difference due to the recognition of the RMB as a reserve currency we would see poor predictions with high error. We can apply this method to a select group of key counties such as the Russian Federation and Brazil.

E. Conclusions

We believe that our methods achieve the goals that we have set. They provide an accurate up to date look at the current state of major reserve currencies through reliable and updated data. In addition our time period of interest has low multicolinearity. Multicolinearty poses many problems for time periods where the RMB is pegged to the USD. We were able to account for autocorrelation. Using difference in logs mostly accounts for autocorrelation on its own, but we were able to further address this problem through the use of autoregressive models. Finally we were able explore the predictive power of our models. With the implementation of these methods and techniques we believe we can provide reliable and accurate results.

Chapter Four
Results

A. Introduction

In this section we will outline the results of our analysis. Our results will be detailed in two ways. First, we will look at countries at the individual level. More specifically, we will look at important cases for particular countries, and then discuss the reasons for certain currency reserve influences. This includes Russia, which in recent years has attempted to circumvent United States' sanctions. In addition we look at regions such as Central America, Africa, and the Middle East and discuss general trends we observe with countries in the region. We will also point out some anomalies in our results such as Israel, Brazil, and Mexico, which we previously expected to be more in line with the USD. We will then be able to comment on the importance of our results on the global scale. This entails establishing and analyzing currency reserve blocs and discussing the current state of the international monetary system. We calculate both absolute and relative currency blocs and discuss the viability of their use. We will then comment on future implications that our results have.

B. Regression Results

Table 1 displays the correlation matrix for the currencies in terms of the USD. There is very little to no correlation between these currencies. The

correlation between the pound and the euro is .718 but we do not see this as a cause for concern. They pound also has minor global influence relative to the other three reserve currencies, as we will discuss later on.

Currency	EURO	RMB	YEN	POUND
EURO	1	-0.118719323	0.47868885	0.718113447
RMB	-0.11871932	1	0.370757467	-0.427632543
YEN	0.47868885	0.370757467	1	-0.013579476
POUND	0.718113447	-0.427632543	-0.01357947	1

Table 1 - Correlation matrix of exchange rates in terms of USD from 2006-2018.

Source: IMF

We start by looking at Russia. This country is of particular interest to our work for multiple reasons. The sheer size of Russia makes it important on the global scale, especially for the outlook of the international monetary system. However, it is primarily interesting in its current state because of the sanctions that the United States have imposed on Russia and Russia's desire to circumvent these sanctions by using other currencies in international transactions. Therefore it comes as no surprise that the weight the USD has on the Russian ruble is not significantly different from zero. However, what is interesting is that the Chinese RMB accounts for the largest portion of movement in the ruble. We also see a very large effect for the euro. Both the euro and the RMB are statistically significant at the 5% level in the autoregressive error model.

It is clear from our results that Russia has taken steps to circumvent the dollar. Russia is aligning itself almost evenly with China and Europe. Importantly, it is an example of a large portion of the international monetary system where the

USD is not a major factor. This is, at least in some sense, an indication that the United States can lose its global dominance if countries are unhappy with the United States. It certainly shows that the USD in the current make up of the international monetary system is sharing the world stage with other major currencies.

The predicted R Squared for this model is .168. This is in general not good. However, it is close to the R Squared Adjusted for our model of .23. This tells us we are not over fitting the data. Additionally we restricted the sample size from 2006-2015. We then used this model to forecast 2015-2018. This can be seen in Figure 3. The predicted values are plotted in orange and the actual values are plotted in blue. Overall our model did a poor job predicting in this case. The mean absolute percent error was 55 and the root mean squared error was 36.88. We attribute this to fundamental changes in Russia's use of international currencies, particularly pertaining to the sanctions placed by the United States. In this case this is represented by a shift in the intercept, which can be seen in Figure 3.

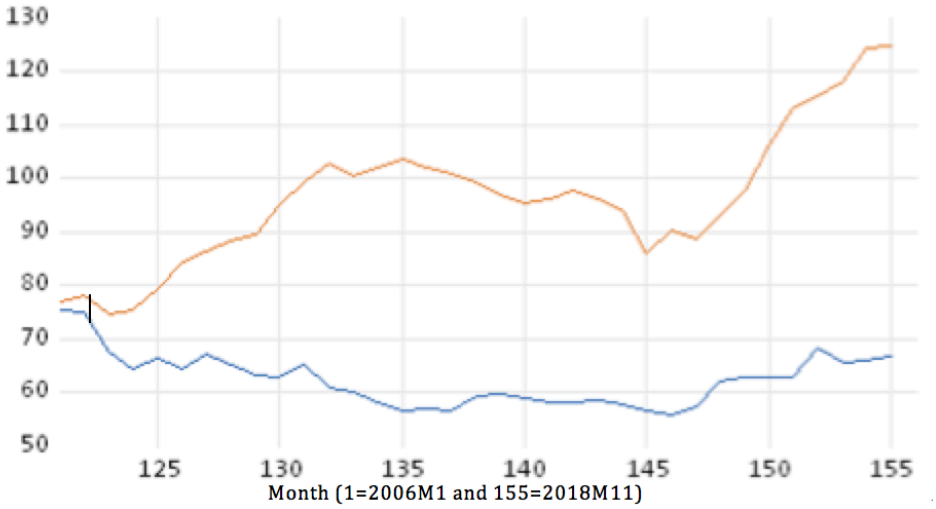

Figure 3- Predicted exchange rate values from 2015-2018 for the ruble plotted in orange. The actual values are plotted in blue. The x-axis is month with 2006M1=1 and 2018M11=155.

Another major country of interest is Brazil. We found that the euro has the largest effect on the Brazilian real. Our models show that the euro accounts for about 58% of movement in the real. This is statistically significant at the 5% level. We also saw that the RMB accounts for about 26% of movement in the real, however this was not significant. This result is somewhat surprising. Particularly, with the proximity to the United States, and with the United States being a large trading partner of Brazil, we would expect that the USD would affect the real more than its reserve currency counterparts, as is the case with most Central American countries and in other South American countries like Uruguay. Yet we only see a weight of 3%. Brazil is also not the only example of a South American country with similar results but it is certainly the largest. However, these results can be explained.

According to the Observatory of Economic Complexity (OEC) 42 percent of Brazilian exports are to Asia with 20 percent going to Europe and 17 going to North America. Similarly Brazils imports predominantly come from Asia and Europe at 36 and 27 percent respectively. Brazil has a strong iron-ore trading network with Europe and Asia. Therefore, it is reasonable to understand why these are the currencies that have such a large effect on the real, as well as in other South American countries with the mineral trade. There has also been a substantial amount of foreign direct investment (FDI) from China into Brazil in recent years. As Chinese firms shift their focus to the service sector there has been a substantial increase in FDI in Latin America and in particular Brazil. According to the OECD flows of FDI from China into Latin America have reached over 110 billion dollars with 60 billion going to Brazil (Avendano, MelGuizo, and Miner 2017).

We also found many African countries whose currency is greatly impacted by the euro. The euro accounts for about 95% of movement in the CFA franc. This is again statistically significant at the 5% level. The pound is also shown to have a weight of 1% statistically significant at the 5% level. As was the case with Brazil, Europe imports a lot of natural resources from Africa. Cote D'Ivoire for example sends 11 percent of its exports to Germany according to the OEC. About 10 percent go to the Netherlands with 6.5 percent going to France. This is substantially more than the 10 percent to the United States.

Economic ties between Europe and Africa go well beyond just trade. Africa first started facing European aggression in the 1870's. In 1884 the Berlin

Conference was held to divide Africa amongst the European countries (Davies 2010). European colonization in Africa has greatly affected political and economic ties ever since. Since there is such a large European presence in Africa, it comes as no surprise that the euro has such a large effect on African currencies.

We similarly see that the USD has a lot of influence in the Middle East. The United States is actively involved in this region and has been for a long time. This is true both militarily and economically with regards to oil. The United States also has historically had a large FDI in the region. Many of the countries in this region are greatly impacted by the United States and the United States dollar. For example, the United Arab Emirates dirham is directly pegged to the USD. We also see in the autoregressive error model for Yemen, the USD accounts for 99% of the movement of the Yemeni rial. Throughout this time period the rial had mostly been pegged to the USD as well. In addition, the USD has the largest weight on the Afghan afghani. We found that the USD accounts for 63% of movement in the afghani. We did find that the RMB accounts for 29% of movement. This was statistically significant at the 5% level. So there are other influencers in the Middle East, but predominantly this region is a United States stronghold in terms of currency movement.

One surprise to be noted was Israel. Israel is a key political ally of the United States in the Middle East. It is reasonable to suspect that the USD would have the largest influence on the Israeli new shekel. However, this is not the case. The USD does account for around 11% of movements in the new shekel, which is a considerable amount, but it is not the largest weight. That belongs to the RMB

at around 38%. This was significant at the 10% level. The euro is significant at the 5% level and has a weight of around 32%. Also, the pound was significant at the 5% level and accounts for around 16% of movement in the new shekel. We also found that the yen has a 2% weight but this was not statistically significant.

Israel is so aligned with the United States; it begs the question why is its currency so greatly influenced by the RMB? Abrams (2018) describes China and Israel as both being very pragmatic countries. They expand partnership, test new markets, and seek new trade opportunities. Recently Israel has been developing new bilateral trade relationships. In particular, they have greatly expanded economic relationships with China. Abrams states that this is because China is significantly interested in Israel's technology sector, while Israel welcomes Chinese investments. We argue that the results of our regressions and the RMB influence on the new shekel are reflexive of the recently and quickly expanding economic ties that have been observed between China and Israel.

The R Squared Adjusted for our model of Israel is .32 and our R Squared Predicted is .3. Again these both in general are not high but they are similar which tells us our model is not over fitting. When we restrict our sample and forecast 2015-2018, the model does a decent job of predicting. The root mean squared error is .3 and the mean absolute percent error is 7.1. Like Russia we see a small downward shit of the intercept in this case. This can be seen in Figure 4.

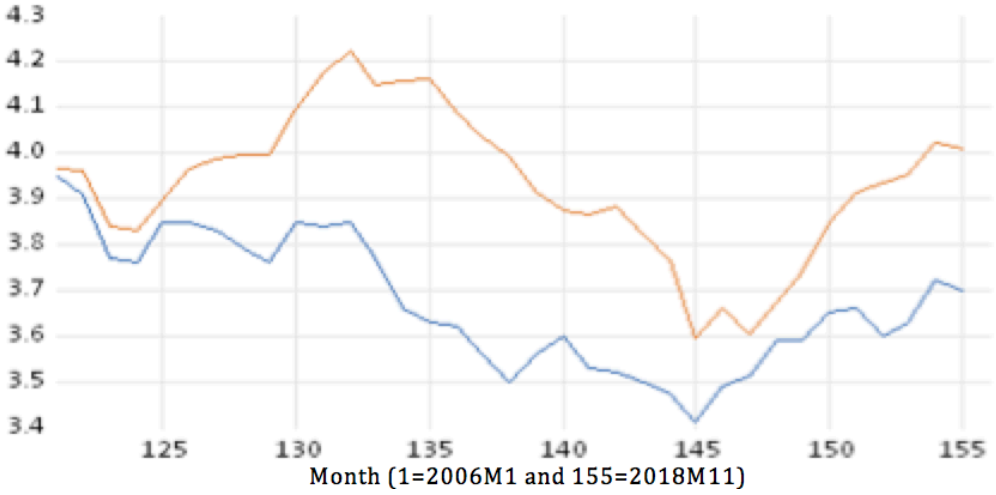

Figure 4- Predicted exchange rate values for the new shekel plotted in orange. The actual values are plotted in blue. These values are predicted from 2015-2018. The x-axis is month with 2006M1=1 and 2018M11=155.

Mexico is a similar case to Israel. Despite sharing boarders with the United States, the USD is not the biggest influencer of the Mexican peso. We found the RMB to have the largest weight but this was not statistically significant. We found the euro to account for 34% of the movements of the peso and this was statistically significant at the 5% level. Mexico is similar to the case of Israel in that is a pragmatic country. However, there is a large difference here. In recent years Mexico has aligned itself more with China, especially in terms of trade. This is occurring because of a more hostile relationship that Mexico has with the United States, particularly with the period of renegotiation of the North American Free Trade Agreement.

C. Global Impacts

Based on our regression results for each country individually we assigned global shares of GDP-PPP to each reserve currency. These are known as currency blocs. We constructed our reserve currency blocs in two ways. The first were absolute currency blocs. This involved assigning each country to a reserve currency solely based on which reserve currency accounted for the most movement in that particular country's currency. The next were relative currency blocs. In this case each country's global share of GDP-PPP was split between each of the major reserve currencies based on the coefficients in each individual regression.

First we will discuss the absolute currency blocs. The results can be seen in Table 2. About 5% of the global share of GDP-PPP was unaccounted for. This is for two reasons. The first is that not every country had GDP-PPP data. The second is that not every country had complete data on exchange rates from 2006-2018. However we feel that this is a very good representation of the current state of the international monetary fund. We find, like Tovar and Nor (2018), that the international monetary system is now tri-polar. China has a strong foothold in the global economy. Surprisingly we find that in this time period the United States has a share of 31.21 which is less than the 40.7 Tovar and Nor found from 2011-2015. Interestingly we do not see an increased share for China. They found the Chinese share to be 32.5 where we find it to be 30.07. It is Europe that sees the increased share from 19.5 to 27.43. That leads us to believe that as the dollar loses

grip in the international monetary system, it will be the euro that makes up this ground.

	US	Europe	China	Japan	UK
Absolute Share	31.2	27.4	30.1	4.2	2.2
Tovar and Nor (2018)	40.1	19.5	32.5	4.8	2.5

Table 2- Absolute currency bloc of global shares of GDP-PPP in percent (Approx. 5% of global GDP-PP is unaccounted for in our work)

We then turn to the relative currency blocs. The results can be seen in Table 3. We see similar results as the absolute bloc in that there is a tri-polar system. However, we see in this case that the US bloc is not the dominant one and that in fact the Chinese bloc is. This is very surprising. However, we do not see these results as reliable as the absolute blocs. This is mostly because they are much more vulnerable to error in our estimations. For example in the relative bloc we find Japan to have 3.22% of global GDP-PPP, however this is less than its own GDP. This is because we are relying on the culmination of many insignificant coefficients in which many appear as negative. This is opposed to basing the blocs on strongly significant coefficients like we do for the absolute bloc.

	US	Europe	China	Japan	UK
Relative Share	25.2	28.2	31.8	3.2	6.8
Tovar and Nor (2018)	39	20.3	31.6	5.3	4

Table 3- Relative currency bloc of global shares of GDP-PPP in percent (Approx. 5% of global GDP-PP is unaccounted for)

Our results have major impacts on the global scale. Figure 5 shows a map graph for each absolute currency bloc. Clearly neighboring countries are more prone to being included in a major bloc, with some exceptions. This includes Mexico and Canada which Tovar and Nor (2018) find to be in the US bloc. This is another example of the decline of the Unites States global economic influence in the past few years. It is clear that there are three major reserve currency blocs and that the international monetary system in its current state is tri-polar.

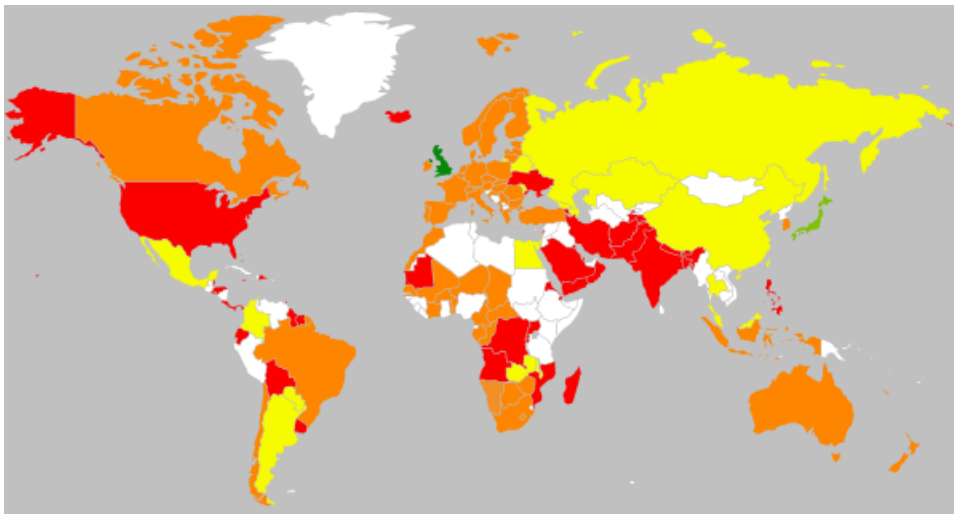

Figure 5- Map graph of absolute major reserve blocs. Red represents the US, yellow China, orange Europe, dark green UK, light green Japan, and white countries do not have complete data.

We also have to consider the argument that we need to remove the country's own GDP-PPP from the bloc. By subtracting this out from the absolute shares we see that the United States and Europe become virtually even at 16% of global GDP-PPP. China goes to 11% and both the UK and Japan go to 0%. This does not change the overall scope of our results. It does however, bode in favor of Europe, which throughout this analysis has shown strong upticks in comparison to the work of Tovar and Nor.

D. Conclusions

Our results show a tri-polar international monetary system. This is directly in line with the results found by Tovar and Nor (2018). However, we see an increase in the influence of the Euro over our time frame from 2006-2018 in addition to a decrease in the dominance of the dollar. We see geographical changes such as Canada and Mexico changing from the US bloc to the Euro bloc and Chinese bloc respectively. We additionally found that the Chinese renminbi has a bloc of around 30% of the global share of GDP-PPP. Surprisingly with the recognition of the Chinese RMB as a reserve currency in 2015 there does not seem to be a rise in its sphere of influence. It is the Euro whose influence seems to grow as the dollar's influence falls. We find that in absolute terms the United States still dominates the international monetary system, but in relative terms its influence has declined.

Chapter Five
Conclusions

A. Future Work

There is a lot of room for future work in this area. Most importantly, as more exchange rate data becomes available these results can be updated to reflect the time period. As this work has shown many factors including political events and policy decisions can change the landscape of the international monetary system and it is important to understand these changes. More work can be done for the prediction of the future outlook of currency blocs. Autoregressive integrated moving average (ARIMA) models can be used to predict exchange rates for major reserve currencies, which can then be used to predict the major influencers in the near future. Finally, more work can be done to integrate traditional methods of studying reserve currencies with the methods used in this research. This would allow for a more complex analysis and a greater understanding of reserves and the international monetary system.

B. Summary of Work and Closing Statements

Using workhorse regression methods on exchange rate data from 2006-2018 we were able to provide an updated look at the international monetary system in a time where the international geopolitical climate is changing and China has gained more recognition. We find that the United States dollar is still

the dominant reserve currency with its global share of GDP-PPP at 31.21 percent. However, we show that it has experienced a decline in recent years for many reasons such as increased Chinese investment and the circumvention of US-imposed sanctions by countries like Iran and Russia. Importantly, we showed that there were major changes that occurred at the country level compared to previous periods. This included changes in the major currency influencer of Canada and Mexico. Finally, our work shows that we are presently in a major time period of potential transition in terms of the international monetary system.

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Appendix
Variable Descriptions

Variable	Name in Data Set	Description
X/USD	ANY COUNTRY NAME	International Monetary Fund end of period monthly exchange rates per USD of currency of country X from 2006M1-2018M11.
EUR/USD	euroarea	International Monetary Fund end of period monthly euro exchange rates per USD from 2006M1-2018M11.
RMB/USD	chinaprmainland	International Monetary Fund end of period monthly renminbi exchange rates per USD from 2006M1-2018M11.
GBP/USD	unitedkingdom	International Monetary Fund end of period monthly pound sterling exchange rates per USD from 2006M1-2018M11.
JPY/USD	japan	International Monetary Fund end of period monthly yen exchange rates per USD from 2006M1-2018M11.
Gross Domestic Product at Purchasing Power Parity	GDP-PPP	Country 2018 global share of Gross Domestic Product at Purchasing Power Parity provided by the International Monetary Fund.