

China's Effect on US Dollar
Performance in
Global Currency Markets

by

Somiran Gupta

An honors thesis submitted in partial fulfillment
of the requirements for the degree of
Bachelor of Science
Undergraduate College
Leonard N. Stern School of Business
New York University
May 2013

Professor Marti G. Subrahmanyam

Faculty Adviser

Professor Jennifer Carpenter

Thesis Adviser

Abstract

There is a large body of academic literature that focuses on China's currency management as a means of keeping the yuan cheap. This paper illuminates the other side of the story – making the US dollar rich. It documents evidence for the People's Bank of China's impact on US dollar returns in five other major currency markets. Further evidence is provided for the PBOC's impact on correlations between different US dollar returns. The results suggest China's currency policies profoundly impact the US dollar and its terms of trade. Thus, this paper explores a side of the China currency issue that has not been deeply considered. Surely the PBOC's actions keep the yuan cheap but it also makes the US dollar expensive.

Acknowledgements

The following people have been instrumental in helping me write this thesis. I would like to extend my deepest gratitude to each of them.

Professor Jennifer Carpenter for her continuous guidance, patience and encouragement over the last year. By always challenging me to explore new approaches, Professor Carpenter was invaluable in helping me craft my thesis.

Professor Robert Whitelaw for his timely and insightful inputs that helped me shape an intellectual curiosity into an interesting line of research.

My honors thesis classmates, especially Aditya, for keeping me motivated and always reassuring me that I wasn't in this alone.

My roommates, Shaaz, Suraj and Roger, for being my wall – of support, and to bounce ideas off.

My friends, Steve, for helping me address my Bloomberg Terminal inadequacies; **Manasi,** for being a keen critic and proofreader; and **Amy** for helping me keep a positive mental attitude through all the tummy rumbles.

My parents and sister without whom my NYU dream would not have become a reality, for giving me the freedom to make my choices but always being there two steps behind if I made a wrong one, and for being unconditional in their love and support.

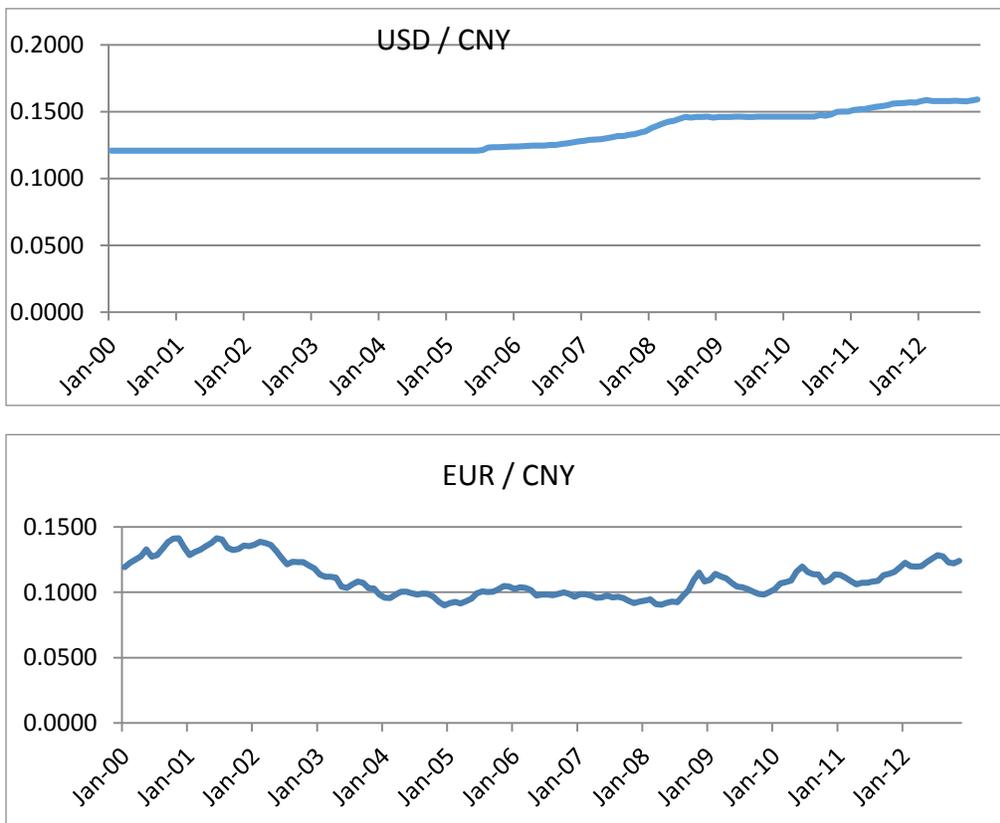
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1. Introduction

China's currency, the yuan, has received a lot of attention over the past decade as China's growth miracle has continued and it has become the world's largest exporter. There has been intense debate about the value of the yuan and it is no secret that the Chinese government, through its central bank, closely manages the value of its exchange rate. A cursory look at the time series of USD/CNY and EUR/CNY exchange rates (See Figure 1) makes patently clear which exchange rate China is managing against. In particular, the USD/CNY chart shows that China, at different points in the last decade, has pegged its currency value to the US dollar.

Figure 1: Historical Exchange Rate Comparison of USD/CNY and EUR/CNY



We often hear that China's currency management helps China promote cheap exports to the U.S and steal American manufacturing jobs. While this may be part of the story, China's exports also increased to the Eurozone and its regional neighbors over the last decade and China was not pegging its currency to any of these other currencies. In a recent study, Edward Lazear, the Chairman of the Council of Economic Advisers from 2006-09, argues that these facts suggest that the yuan's value is not the main force promoting Chinese exports and reducing America's competitiveness. In fact, as I demonstrate in this paper, China's intervention in currency markets has even broader effects than previously understood.

In this paper I focus on how China's currency management mechanisms affect the performance of the US dollar in other major currency markets. The paper provides evidence for such effects by conducting two lines of analysis. The first looks at China's effect on US dollar returns in global currency markets and the second looks at China's effect on correlations between different US dollar returns in currency markets. I begin with a brief overview of the literature in this field to provide context for my study. Next, I explain how China manages its currency value and I describe the currency management regimes pursued by China since 2000. Then I review the major developments in other currency markets used in my analysis. After providing this background, I present my hypotheses, an overview of my analytical methodology and the resulting findings. The paper concludes by considering the implications of my results and areas for further research.

2. Literature Review

A majority of the work around the yuan has focused on quantifying its undervaluation and what that means for the US economy and global trade in general. Several papers, relying on theories ranging from the Purchasing Power Parity model to the Equilibrium Exchange Rate models, have concluded that the Chinese yuan is significantly undervalued.

The International Monetary Fund estimated that the yuan was undervalued between 5 % and 27 % between 2006 and 2010. Goldstein and Lardy (2009) estimated that the yuan was 20 – 25% undervalued prior to the global financial crisis of 2008. This undervaluation was despite the yuan's consistent gains against the US dollar from 2005 to 2007. More recently, Lipman (2011) estimated an equilibrium value for the Chinese yuan and concluded that the yuan is undervalued by 37.5%. Scott (2011) sums up much of the current thinking about China's impact on the U.S. economy. He claims that China's currency manipulation makes China's exports cheap to the rest of the world and allows China to enjoy large trade surpluses. Echoing the sentiments of several economists and politicians in the United States, Scott says that China "has been a prime contributor to the crisis in U.S. manufacturing employment" and goes on to show that 2.8 million jobs in the U.S. (1.9 million in manufacturing) were "eliminated or displaced due to trade with China" between 2001 and 2010. Clearly, a lot of credence has been given to the idea that the Chinese currency is undervalued relative to some notion of 'fair' value.

While much of the academic literature has studied the *cheapness* of the yuan, this paper focuses on the other side of the story: the *richness* of the US dollar. Has China's currency policy propped up the value of the US dollar and made it *expensive* across global currency markets? In this paper, I present evidence of China's effect on US dollar performance across five other major currency markets.

3. Overview of Currency Markets

The foreign currency market is the largest market in the world. It is characterized by a tremendous volume of transactions and extreme liquidity. According to the Bank of International Settlements, the daily turnover in this market is over \$4.0 trillion. This is more than 12 times the average daily turnover of global equity markets and an annual turnover of more than 10 times world GDP (World Federation of Exchanges aggregate 2009).

The main participants in this market are commercial banks, investment banks, central banks and asset managers. The sheer volume of transactions, both speculative and commercial, creates a marketplace that is very noisy. Given the size of the market, it would be hard for any single player to have a significant influence on equilibrium prices. However, China's central bank, the People's Bank of China (PBOC), is the world's largest central bank by assets and aggressively intervenes in currency markets to buy US dollars. As my analysis will show, the PBOC is a major player in currency markets and its actions have a profound impact on equilibrium conditions worldwide, specifically on the value of the US dollar against other major currencies.

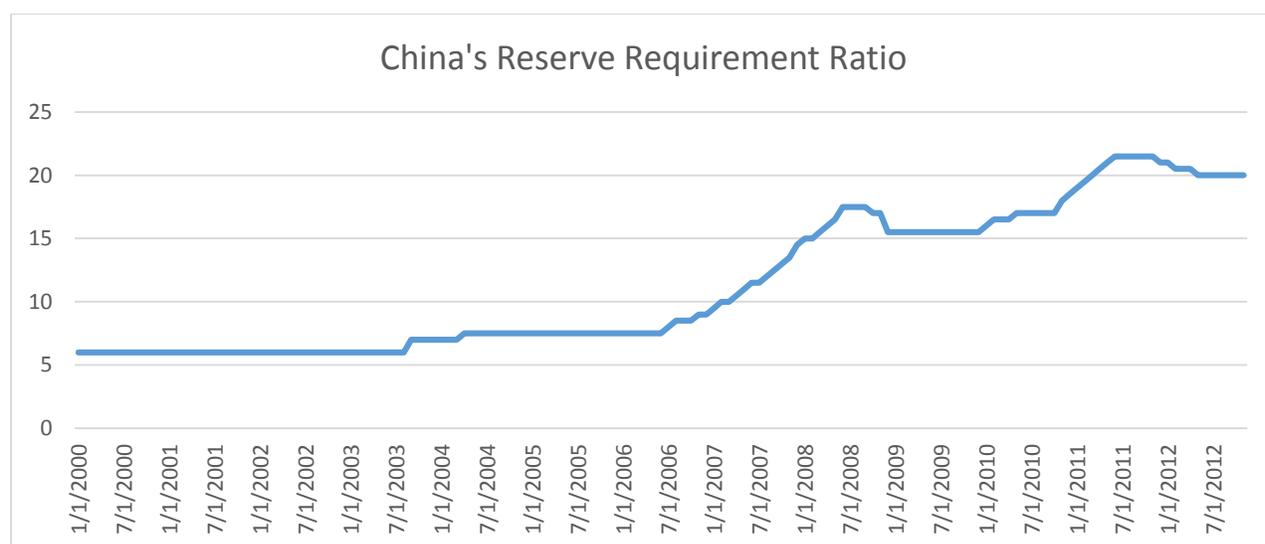
3.1 China's Currency Management Mechanism

China's central bank, the People's Bank of China (PBOC), has historically kept a close watch on yuan exchange rates. In a floating currency regime, trade surpluses typically lead to an increase in the value of the domestic currency. This is because as the world demands more of China's goods, it drives up the demand for yuan as well. This should drive its value up. However, this doesn't happen in China due to the PBOC's intervention in currency markets.

China has strict government controls on the export of its currency and its use in international transactions. As a result, transactions between Chinese companies and foreign buyers are settled in US dollars. Chinese companies then exchange their US dollars for CNY at commercial banks to conduct their daily business. Commercial banks in China have a *surrender requirement* according to which they must hand over all their foreign currency to the PBOC at the state-controlled exchange rate.

The PBOC must print yuan to supply it to commercial banks in exchange for the foreign currencies it receives. This injection of liquidity into the financial system can create inflationary pressures, so the PBOC must sterilize such interventions. It does this primarily by increasing bank deposit reserve requirements. The figure below shows how China has consistently increased its RRR over the years to sterilize currency market interventions.

Figure 2: Recent History of China's Reserve Requirement Ratio

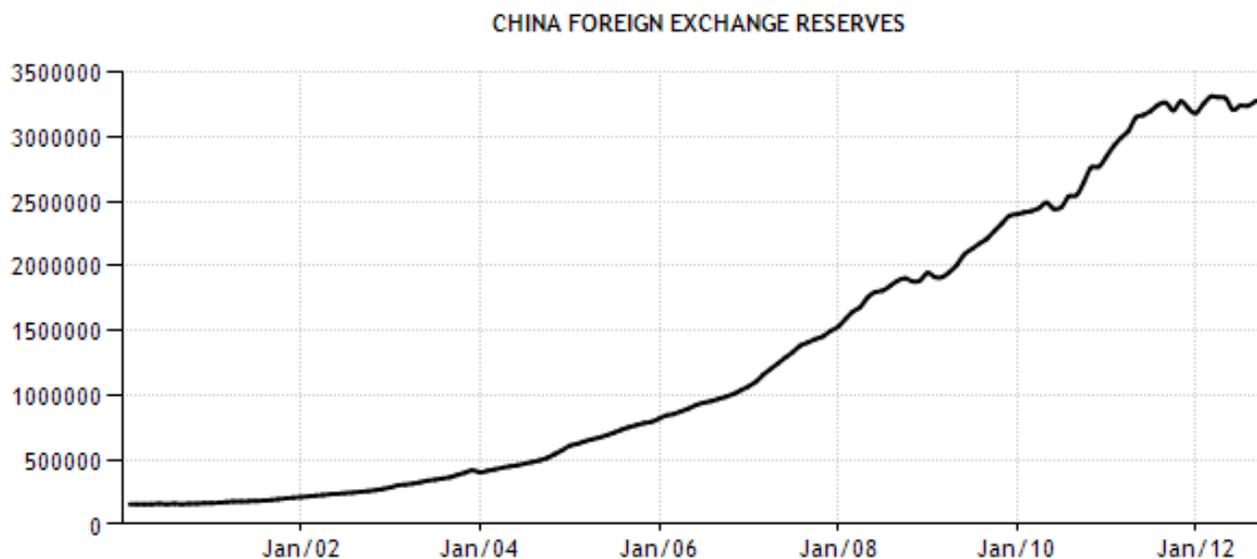


Source: Bloomberg

After the PBOC receives the foreign currency, mostly US dollars, from commercial banks, it transfers it to the Safe Administration of Foreign Exchange (SAFE), a government

agency that has authority to trade this currency in the market. A majority of this currency is invested in Treasuries. These actions have led to a pile up of foreign exchange reserves in China, as demonstrated in the chart below.

Figure 3: Recent History of China's Foreign Reserves (in \$ millions)



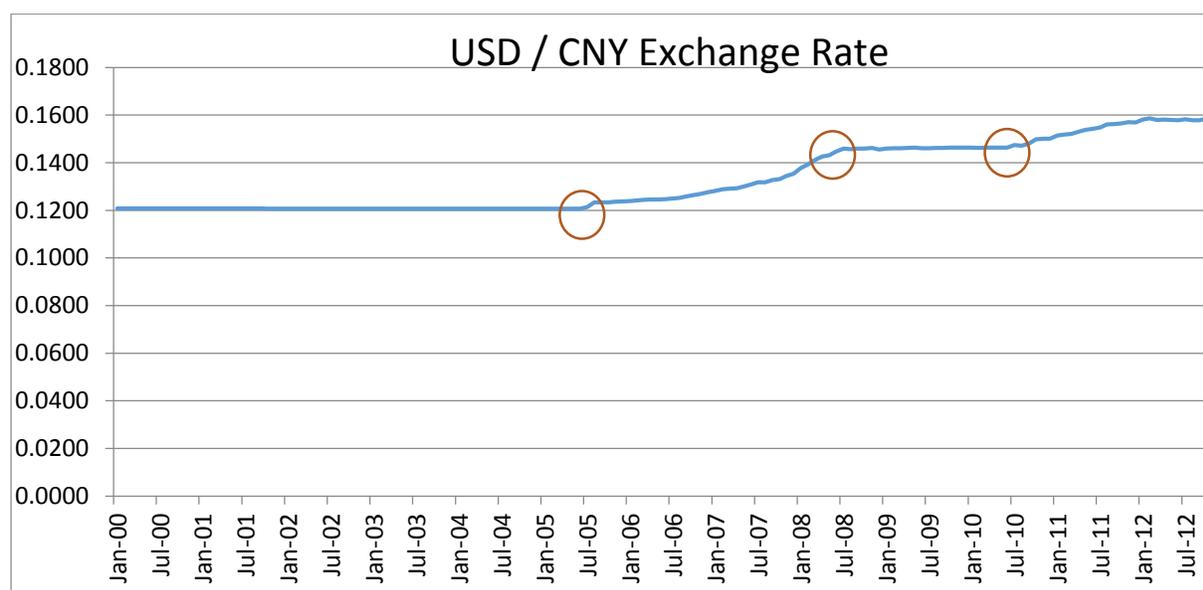
Source: Trading Economics

In summary, China buys US dollars from commercial banks by printing CNY (increasing supply of CNY) and then uses these US dollars to buy Treasuries on the open market (increase demand for US dollars). Thus, China's intervention mechanism is not just about keeping the value of the CNY low by increasing its supply, but also keeping the value of the US dollar high by increasing demand for it in the marketplace. This reasoning forms the basis for this research paper. How profound is China's effect on US dollar value? Does its demand for US dollars on the market (a direct consequence of its intervention mechanism) distort the value of the US dollar in global currency markets?

3.2 Recent History of China's currency

The data for our analysis of China's effect on US dollar performance begins in January 2000 and goes till November 2012. It is useful to distinguish four currency regimes adopted by the Chinese central government during this time.

Figure 4: The US Dollar to Chinese Yuan Exchange Rate



NOTE: The figure above calls out points in time where China's currency regime underwent a fundamental change. These are referred to as pivot points throughout the paper.

From 1997 to 2005, the CNY was pegged to the US dollar at 8.3 CNY/dollar. The exchange rate chart above shows that China effectively maintained a fixed exchange rate regime up until mid-2005. The flat line reflects that the PBOC had a very tight grip on the value of its currency and did not allow it to fluctuate at all. This helped China keep its exports competitive and promote jobs in their manufacturing sector both of which were key components of its economic growth.

In July 2005, leading news sources reported that the PBOC announced its decision to unpeg the CNY from the US dollar and introduce a more flexible exchange rate mechanism. The plan was to closely manage the value of the exchange rate and allow it to move within a daily trading band. In 2005, this band was set at 0.3% above or below the officially set daily reference exchange rate. Thus, the PBOC introduced more flexibility to its currency regime but still kept a close eye on its value. There are a variety of reasons behind China's decision to move off the peg. Allowing the gradual appreciation of its currency would help China balance its trade flows and reduce tensions as well. It would help reduce their import bill for commodities crucial to its growth such as iron ore and oil. Domestically, China was also combating inflation and a stronger currency would be a strong weapon to reduce imported inflation, especially in food and raw materials (Jeffries, 2010). In 2007, in a move to further increase the flexibility of its currency, the PBOC increased the daily trading band from 0.3% to 0.5% above or below the officially determined rate. As the chart shows, between mid-2005 and mid-2008, the CNY saw a period of steady appreciation against the US dollar.

In July 2008, China unofficially moved back to a pegged exchange rate regime to deal with the global financial crisis. China pegged the yuan at 6.8 CNY/USD to protect jobs in its manufacturing sector, which was extremely dependent on exports. China's move to freeze its exchange rate was also a means of avoiding volatile capital flows associated with the crisis and associated flights to quality. This was again a period where the PBOC was exerting very strong influence over the value of its currency and not allowing it to fluctuate at all.

In June 2010, China's central bank decided to move off the peg to the US dollar and allow its currency value to be more market-driven. The PBOC said it would keep its currency "stable at an adaptive and equilibrium level." In April 2012, the daily trading band was increased

to 1% above or below the daily reference exchange rate. Since mid-2010 the CNY has appreciated against the US dollar as shown in Figure 4.

This timeline of events clearly points to periods where China moved between a tightly managed USD/CNY exchange rate and a more market-driven one. Until July 2005, the CNY was pegged to the US dollar; between July 2005 and July 2008, it was a more market-driven currency and it appreciated against the US dollar. From July 2008 to June 2010 it was again pegged to the US dollar and from June 2010 onward, it has been more flexible. Based on both PBOC statements, and a simple visual inspection of Figure 4, the pivot points in China's exchange rate regime are the following:

July 2005 (transition from fixed peg to managed float)

July 2008 (transition from managed float to fixed peg)

June 2010 (transition from fixed peg to managed float)

This paper uses these pivot points to investigate the effect of PBOC's actions on US dollar performance in other major currency markets.

3.3 Selection of Currencies Used for USD Exchange Rate Analysis and Economic Background

The analysis in this paper studies US dollar performance across five major currency markets. I have chosen currencies that are both liquid and belong to countries that are important trading partners of the US. These are:

- 1) Euro (EUR)
- 2) British Pound (GBP)
- 3) Swiss Franc (CHF)

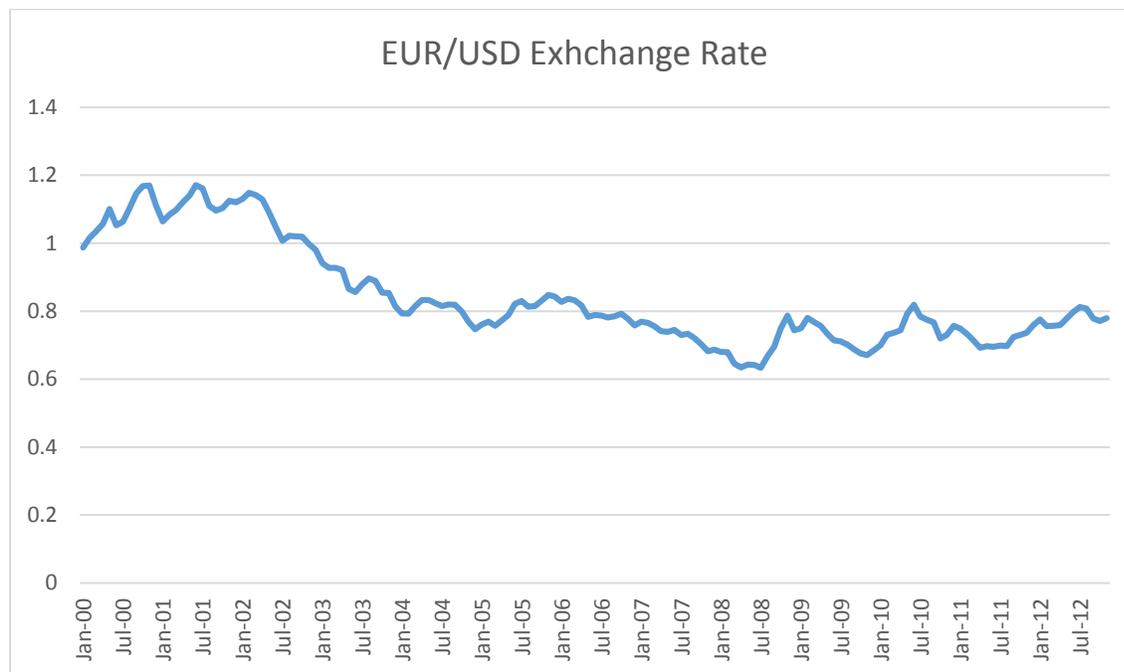
- 4) Canadian Dollar (CAD)
- 5) Japanese Yen (JPY)

Liquid currency pairs are preferred for analytical purposes since they lend themselves to robust currency data and have no market distortions or controls in the way they are traded. The most liquid currency pairs are EUR/USD, JPY/USD, GBP/USD, CHF/USD, CAD/USD and AUD/USD. The major trading partners of the US are Canada, the European Union, China, Japan, United Kingdom and Mexico (US Census Bureau, 2011). The currencies I have chosen to include in my analysis span both a majority of these lists and a wide geographic range of economic contexts. The Swiss Franc is known to be both a liquid and stable currency and was partially protected from the shocks of the Eurozone crisis and the ensuing actions of the European Central Bank. Thus, I have chosen to include the CHF/USD exchange rate in my analysis even though Switzerland is not an important trading partner for the US.

When examining currency fluctuations, it would be naïve to assume that the actions of the PBOC are the only factor affecting US dollar exchange rates. Therefore, I provide economic context for each of the currencies in this analysis in order to acknowledge other factors that affect currency values. This will help frame the analysis and guide the interpretation of the statistical results, since country-specific economic conditions and shocks cannot be overlooked.

3.3.1 Eurozone

Figure 5: The Euro to US Dollar Exchange Rate



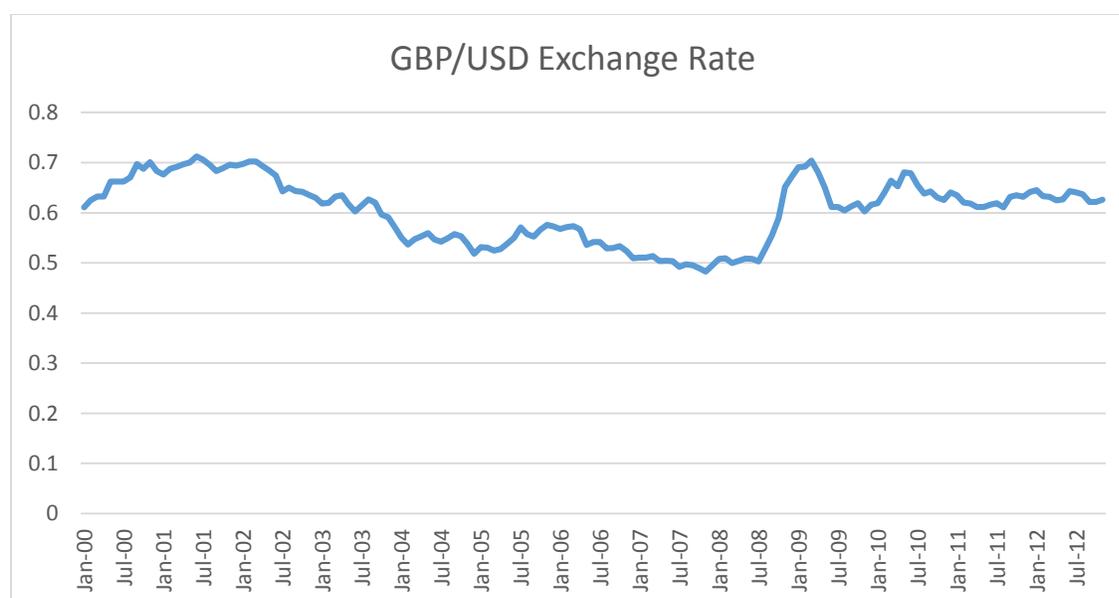
The Euro is the currency for Eurozone countries and is used by its 17 member countries. The currency was introduced at the start of 1999 and is the world's second largest reserve currency after the US dollar. The Euro is issued by the European Central Bank whose primary and only mandate is to maintain price stability within the Eurozone. The ECB, unlike other central banks, has a single mandate and is not obliged to concern itself with promoting sustainable growth and employment.

In general, over the past decade the Euro has appreciated against the currencies of its main trading partners. The chart above shows a similar trend with the US dollar. This is because the ECB has maintained tight control over the money supply in the Eurozone. In the last decade, the biggest shock to the performance and value of the Euro has come in the form of the sovereign

debt crisis that started in late 2009 in the aftermath of the global financial crisis. The Euro lost some of its value in the early stages of this crisis as sovereign debt levels in the Eurozone reached unsustainable levels and there was a crisis of confidence. The ECB started buying bonds issued by countries facing the crisis in an attempt to reassure markets. It also increased the intensity and volume of its refinancing operations by pumping liquidity into the banking sector. Theoretically these moves should lead to a loss in the value of the Euro. However, the currency has been relatively stable over the past 3 years. This is because the Euro is a major reserve currency and still attracts more than a quarter of the hard cash reserves held by the central banks of China and other countries. Additionally, the Eurozone has started pushing up interest rates recently whereas the United States and other major economies like Japan and the UK have all continued their quantitative easing mechanisms.

3.3.2 Great Britain

Figure 6: The British Pound to US Dollar Exchange Rate

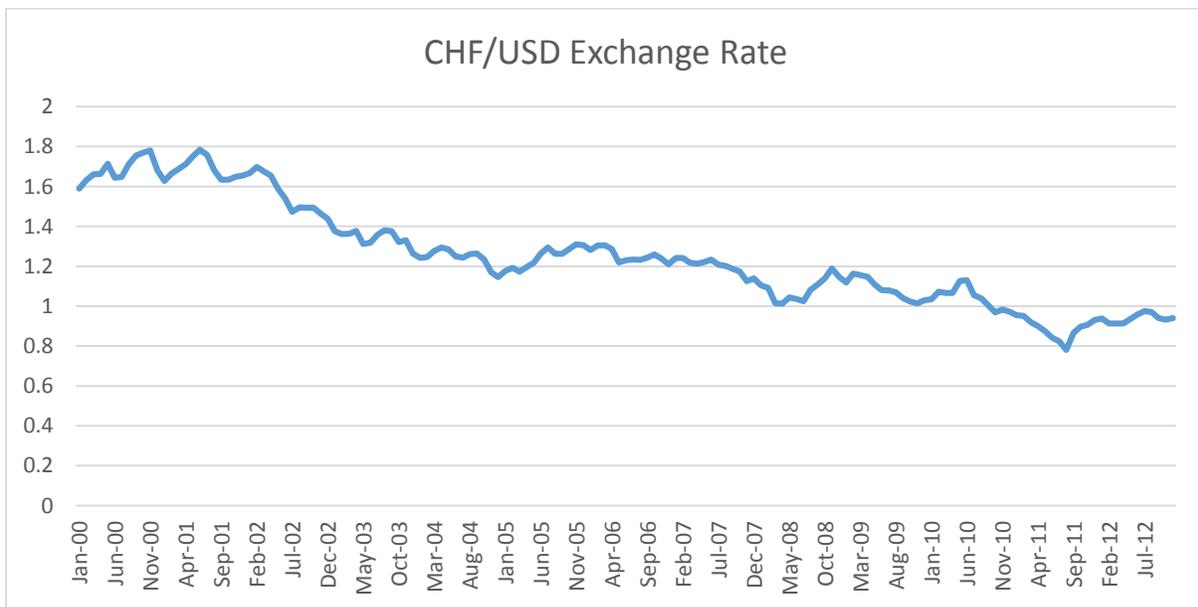


Over the last decade, the British economy grew in a stable and consistent manner. The global financial crisis of 2008 led to a recession in the British economy. The Bank of England, Britain's central bank, announced quantitative easing methods in 2009 to boost its struggling economy. It was the first time the UK's history that such measures had been adopted and interest rates were at their lowest levels as well. In 2012, the British economy slid into a double-dip recession on the back of productivity declines of British businesses.

Through the last decade, the pound has fluctuated a fair bit, reaching a low against the dollar in 2001 and rising to a record high in 2007. The increase in the value of the pound in 2006 and 2007 was a result of the Bank of England raising interest rates to combat domestic inflation. The pound suffered a steep fall in value through the crisis in 2008-09 as the economy suffered and quantitative easing mechanisms reduced the value of its currency.

3.3.3 Switzerland

Figure 7: The Swiss Franc to US Dollar Exchange Rate



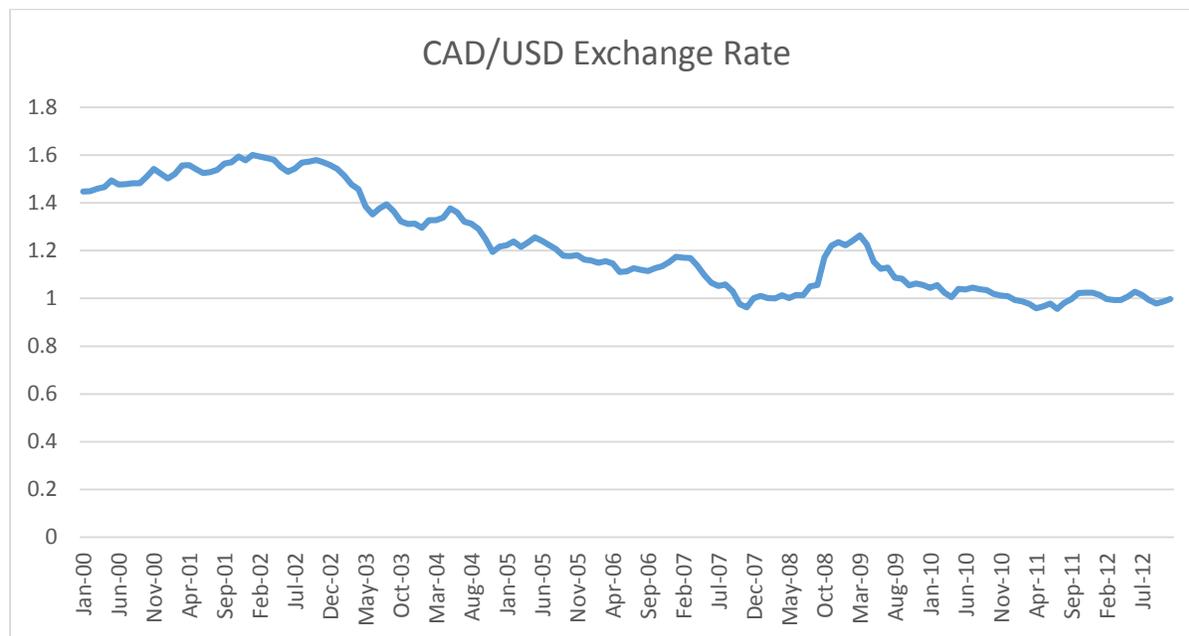
Switzerland's official currency, the Swiss Franc, is known to be one of the most stable currencies in the world. The Swiss economy is considered a safe haven for investors all around the world due to its monetary security, low inflation and political stability.

The Swiss economy experienced a slowdown at the start of the 2000s due to the recession in Western Europe and United States. However, the economy rebounded in 2003, assisted by low interest rates, and the Swiss Franc enjoyed a period of steady appreciation against the US dollar. The Franc start appreciating steeply after the Eurozone crisis hit as investors searched for safe places to invest their money. Demand for francs and franc-denominated assets was so strong that nominal short-term Swiss interest rates became negative. The Swiss Franc reached historically high levels in 2011 as the crisis continued and the Swiss National Bank was concerned about the extreme overvaluation of its currency. As a result of this overvaluation, Swiss exports became less competitive and amidst the global economic decline, this loss of competitiveness was hard to deal with. The tourism industry suffered as well and economic growth and employment were endangered by this massive overvaluation of the Swiss Franc.

In response to these conditions, the Swiss National Bank decided to intervene in currency markets by setting a minimum exchange rate for the franc to the euro. It was "prepared to buy foreign currency in unlimited quantities" to keep its value low and also keep interest rates at 0% indefinitely so that Swiss banks were not an attractive investment destination.

3.3.4 Canada

Figure 8: The Canadian Dollar to US Dollar Exchange Rate



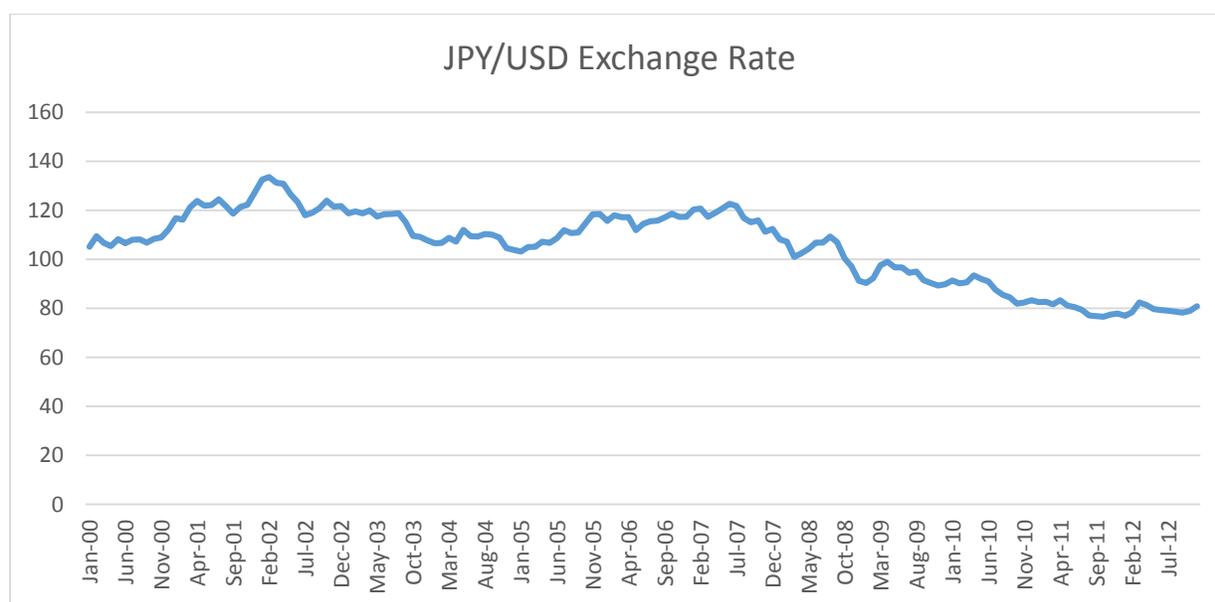
The Canadian economy has grown remarkably since the mid-1990s and its government has posted fiscal surpluses every year between 1996 and 2008. Canada's economic growth is dependent on its petroleum and real estate sectors. The technological boom in the U.S. at the start of the previous decade led to a fall in the Canadian dollar value against the US dollar and it reached an all-time low in 2002. Since then it made consistent gains against the US dollar until the financial crisis in 2008. The primary reason for the appreciation of the Canadian dollar has been the high prices for commodities such as oil, which is a chief Canadian export. Canada's resource sector is also a major source of foreign investment and thus commodity prices are crucial to the value of the Canadian dollar.

Canada's central bank, Bank of Canada, has not intervened in currency markets in the last decade and allows the Canadian dollar to float freely on the market. The only way it sometimes

influences the value of the dollar is by changing interest rates as it did in 2007. In late 2007, the Bank of Canada cut interest rates so that the Canadian dollar value would fall and boost exports to the U.S. During the financial crisis, the Canadian dollar suffered a further fall in value due to the “flight-to-quality” effect. Since its currency market is small, it is not considered a safe haven for international investors who flock to the US dollar in troubled times.

3.3.5 Japan

Figure 9: The Japanese Yen to US Dollar Exchange Rate



Japan’s economy suffered a recessionary slump that started in 1992 and lasted over a decade well into the 2000s. This period has been characterized by almost no economic growth and a deflationary spiral that near-zero interest rates weren’t able to solve. During this period, the Yen declined in value as well and hit its low against the US dollar in 2002. This was because the Bank of Japan’s policy of zero interest rates discouraged investments in Japan. Japan was the lender currency for carry trades and this further pushed down the value of the Yen.

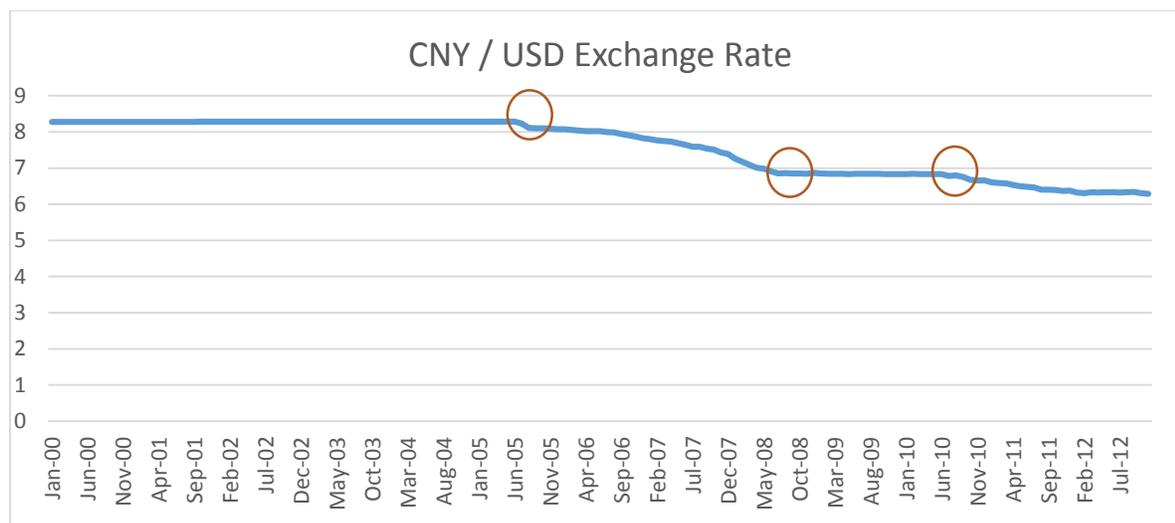
However, after the economic crisis in 2008, the Yen has been gaining value in global currency markets. Part of its gains against the US dollar are due to the quantitative easing in the U.S. The Yen is also considered a safe haven currency in times of a crisis and this has caused it to strengthen considerably. The 2011 Tsunami further strengthened the Yen due to capital inflows for reconstruction purposes.

4. Returns on the US Dollar in Global Currency Markets

I now turn the focus of this paper to discuss my primary analysis and its hypothesis, methodology and resulting findings. We know that when the PBOC intervenes in currency markets to keep its yuan cheap, it does this by buying US dollars on the open market. Basic economic theory suggests that this demand for US dollars should increase its value across all currency markets. In this section, I have tested whether evidence for this impact on US dollar value exists.

4.1 Hypothesis Development

To effectively analyze China's impact on the US dollar I have chosen to look specifically at currency values around the previously defined pivot points where China's currency management regime undergoes a change. These regime shifts offer an opportunity to test for the effect of PBOC's currency management mechanisms on the performance of the US dollar in currency markets.

Figure 10: The Chinese Yuan to US Dollar Exchange Rate

The figure above shows the value of the CNY / USD exchange rate. It is the inverse of figure 4 that shows the USD / CNY exchange rate. The pivot points have been highlighted here and this visual representation offers an insightful way of understanding how PBOC's actions affect US dollar value. For example, at the first pivot the PBOC stops actively managing their currency and in a way that allows the US dollar to fall in value, i.e. allows the yuan to rise in value. The analysis in this paper aims to investigate whether a similar drop in US dollar value manifests itself in other currency markets. The hypotheses for each pivot point are explained below.

Pivot 1 – July 2005: When China moves from a fixed peg to a more loosely managed float I expect the level of PBOC US dollar purchases to decrease since they don't need to keep the yuan at a fixed rate to the US dollar. With this decrease in PBOC activity, net demand for US dollars should fall. Thus, the value of the US dollar should fall in global currency markets post-July 2005. That is, the *returns on the US dollar should be lower post-pivot than pre-pivot across global currency markets.*

Pivot 2 – July 2008: Conversely, when China moves from a managed float to a fixed peg, I expect PBOC US dollar purchases to increase and net demand for US dollars to rise. Thus, the value of the US dollar should rise in global currency markets post-July 2008. That is, *the returns on the US dollar should be higher post-pivot than pre-pivot across global currency markets.*

Pivot 3 – June 2010: As in the case of Pivot 1, from a fixed peg to a managed float, *the returns on the US dollar should be lower post-pivot than pre-pivot across global currency markets.*

4.2 Research Methodology

Analyzing the performance of the US dollar across different currency markets around pivot points is an effective way of investigating the existence and magnitude of China's effect on US dollar value. The data used in my analysis are average monthly spot exchange rates and range from January 2000 to November 2012. The performance measure for the US dollar is its monthly returns, i.e. its appreciation against another given currency from the previous month to the existing month. At each pivot point, I analyze the returns on the US dollar against five major currencies in each of two ways:

- Using a three-month analysis period: I compute the average return on the US dollar in the three months preceding the pivot point. I then compute the average return on the US dollar in the three months following the pivot month. The difference between these two returns is then tested against our hypothesis.
- Using a six-month analysis period: I compute the average return on the US dollar in the six months preceding the pivot month and compare it to the average return on the US

dollar in the six months following the pivot month. The difference between these two returns is then tested against our hypothesis.

The difference between pre-pivot and post-pivot returns are analyzed using a one-sided t-test for two-sample difference of means. The primary assumptions underlying this test are that monthly currency returns are normally distributed and that variances pre- and post-pivot are equal. The null hypothesis is that post-pivot returns are equal to pre-pivot returns, i.e. the difference in returns is 0. The alternate hypothesis is that post-pivot returns are lower than pre-pivot returns for Pivot 1 and Pivot 3, and vice-versa for Pivot 2. The results of these tests are presented below.

4.3 Results

It is important to acknowledge that the analysis carried out here is a stylized one and focuses solely on the effect PBOC's intervention in currency markets has on US dollar value. In reality, there could be other factors at play in currency markets that could lead to time variation in expected returns. Subject to these limitations, the results of my analysis display a strong support for the hypotheses outlined earlier and open up avenues for further investigation.

For each pivot point, there are two tables – the first one shows the returns of the US dollar against the 5 other currencies using a 3 month analysis window and the second one shows the same for a 6 month analysis window.

4.3.1 Pivot Point 1: July 2005

Recall that the hypothesis for this case is that US dollar returns should be lower post-pivot in comparison to pre-pivot. *Thus, to reject the null hypothesis (pre-pivot returns = post-pivot returns), we are looking for t-statistics that are negative and significant.*

Table 1: July 2005 – 3 month analysis period

	Preceding 3-month Average Return (r_1)	Following 3-month Average Return (r_2)	Difference in Returns ($d = r_2 - r_1$)	T-statistic for 'd'
EUR/USD	2.764%	-0.272%	-3.036%	-2.9110477**
GBP/USD	1.560%	0.185%	-1.375%	-1.7451964
CHF/USD	2.528%	-0.043%	-2.571%	-2.543032*
CAD/USD	0.692%	-1.696%	-2.388%	-3.5029674**
JPY/USD	1.095%	0.731%	-0.364%	-0.4057161

* Significant at the 10 % level | ** Significant at the 5% level

Table 2: July 2005 – 6 month analysis period

	Preceding 6-month Average Return (r_1)	Following 6-month Average Return (r_2)	Difference in Returns ($d = r_2 - r_1$)	T-statistic for 'd'
EUR/USD	1.629%	0.448%	-1.18%	-1.6022881
GBP/USD	0.997%	0.714%	-0.28%	-0.5079609
CHF/USD	1.677%	0.544%	-1.13%	-1.5855276
CAD/USD	0.336%	-1.088%	-1.42%	-2.951937**
JPY/USD	0.769%	1.480%	0.71%	1.12020036

* Significant at the 10 % level | ** Significant at the 5% level

For the 3 month analysis, the results are generally consistent with the hypothesis. All the t-statistics are negative, showing that the average US dollar returns are lower post-pivot than pre-pivot. The returns are significantly lower in the Euro, Swiss Franc and Canadian dollar markets. The Pound and the Yen markets do not display statistically significant results but are directionally consistent with our hypothesis. For the 6 month analysis, the results are slightly weaker. 4 out of 5 currencies demonstrate the expected direction in currency movement and only the result from the CAD/USD exchange rate is significant.

The analysis of US dollar returns around this pivot point lends moderate credence to the hypothesis. This is against the backdrop of strong economic conditions in U.S. in 2005 which may have obscured the expected drop in the U.S. dollar value as per my hypothesis. There could have been other factors that masked any effect of the PBOC reducing its level of intervention in the currency markets.

4.3.2 Pivot Point 2: July 2008

The hypothesis for this case is that US dollar returns should be higher post-pivot in comparison to pre-pivot. *Thus, to reject the null hypothesis (pre-pivot returns = post-pivot returns), we are looking for t-statistics that are positive and significant.*

Table 3: July 2008 – 3 month analysis period

	Preceding 3-month Average Return (r_1)	Following 3-month Average Return (r_2)	Difference in Returns ($d = r_2 - r_1$)	T-statistic for 'd'
EUR/USD	-0.184%	2.700%	2.884%	3.10023479**
GBP/USD	0.558%	3.009%	2.451%	3.20098821**
CHF/USD	0.725%	2.331%	1.605%	1.66358624
CAD/USD	0.502%	1.347%	0.845%	1.20795239
JPY/USD	1.881%	0.077%	-1.804%	-1.9724988

* Significant at the 10 % level | ** Significant at the 5% level

Table 4: July 2008 – 6 month analysis period

	Preceding 6-month Average Return (r_1)	Following 6-month Average Return (r_2)	Difference in Returns ($d = r_2 - r_1$)	T-statistic for 'd'
EUR/USD	-1.096%	2.583%	3.68%	5.59336038***
GBP/USD	0.441%	4.819%	4.38%	8.08536937***
CHF/USD	-1.523%	1.735%	3.26%	4.77536425***
CAD/USD	0.241%	3.390%	3.15%	6.36410071***
JPY/USD	-0.808%	-2.525%	-1.72%	-2.6559497

* Significant at the 10 % level | ** Significant at the 5% level | *** Significant at the 1% level

For the 3 month analysis, the results partly conform to the hypothesis. The t-statistics are positive except that for the JPY/USD exchange rate. The US dollar gained value against the other four currencies post-pivot and the results are statistically significant in the Euro and Pound markets. The movement of the JPY/USD in the opposite direction is chiefly explained by two factors. One, Japanese investors have a strong home bias and in times of crisis they pull their money back into Japan. Thus in 2008, there was a large capital inflow into Japan. Two, the crisis led to the unwinding on carry trades globally and this reduced the downward pressure that existed on the Yen over the last decade due to its low interest rates. My results are much stronger in the 6 month analysis. Again, all the signs of the t-statistics conform to the hypothesis except for that of the JPY/USD. The t-statistics for the remaining four currencies are significant at the 1% level. Clearly, post-pivot US dollar returns are significantly higher than pre-pivot US dollar returns. Our results potentially lend credibility to the claim that the actions of the PBOC affect US dollar value across global currency markets.

However, it is important to note that these results are likely obscured by the global financial crisis that led to a ‘flight to quality’ amongst investors across the world. This led to a huge inflow of capital to the U.S. and drove the value of the US dollar up. Therefore, it is difficult to attribute our results around this pivot point solely to the actions of the PBOC.

4.3.3 Pivot 3: June 2010

The hypothesis for this case is that US dollar returns should be lower post-pivot in comparison to pre-pivot. *Thus, to reject the null hypothesis (pre-pivot returns = post-pivot returns), we are looking for t-statistics that are negative and significant.*

Table 5: June 2010 – 3 month analysis period

	Preceding 3-month Average Return (r₁)	Following 3-month Average Return (r₂)	Difference in Returns (d = r₂ – r₁)	T-statistic for 'd'
EUR/USD	2.777%	-0.723%	-3.501%	-3.3263064**
GBP/USD	2.093%	-2.097%	-4.190%	-4.2876787**
CHF/USD	1.695%	-2.581%	-4.276%	-4.2604118**
CAD/USD	-0.485%	-0.021%	0.464%	0.53361247
JPY/USD	0.708%	-2.403%	-3.111%	-3.2371346**

* Significant at the 10 % level | ** Significant at the 5% level

Table 6: June 2010 – 6 month analysis period

	Preceding 6-month Average Return (r₁)	Following 6-month Average Return (r₂)	Difference in Returns (d = r₂ – r₁)	T-statistic for 'd'
EUR/USD	2.830%	-1.302%	-4.13%	-5.5522098****
GBP/USD	2.058%	-1.377%	-3.43%	-4.9709038****
CHF/USD	1.793%	-2.193%	-3.99%	-5.6155682****
CAD/USD	-0.341%	-0.442%	-0.10%	-0.1649175
JPY/USD	0.530%	-1.807%	-2.34%	-3.4378908****

* Significant at the 10 % level | ** Significant at the 5% level | *** Significant at the 1% level

For the 3 month analysis, the results are generally consistent with my hypothesis. All the t-statistics are negative except that for the CAD/USD exchange rate. The US dollar lost value against the Euro, Pound, Swiss Franc and Yen and the results are statistically significant for all of them. In comparison, it was faring better against the Canadian dollar around this pivot point and this can be explained by the Bank of Canada's moves at this time to keep its interest rates low so that the Canadian dollar would be cheaper and its exports would be boosted. Similar to our Pivot 2 case, the results are much stronger when the 6 month analysis is considered. Now the CAD/USD t-statistic also shows a negative sign and conforms to the hypothesis even though it is

not statistically significant. The results for the other four currencies become significant at the 1% level. This shows that US dollar returns are significantly lower post-pivot than pre-pivot.

Thus the data around this pivot confirms our hypothesis that in June 2010 when the PBOC stopped interfering in currency markets as actively, the US dollar suffered a fall in value across global currency markets.

5. Correlation between Different US Dollar Returns

To reinforce the conclusions from the analysis above, I provide additional evidence of PBOC's muscle in currency markets. In particular, I demonstrate that PBOC activity becomes a common factor affecting US dollar performance across multiple currency markets by documenting an increase in correlations of various US dollar returns in periods of heavy PBOC intervention. This will lend further credibility to the claim that the PBOC's activities in currency markets have a profound impact on the US dollar.

5.1 Hypothesis Development

During periods of high PBOC intervention in currency markets (when the yuan is pegged to the US dollar) correlation between different US dollar returns should be higher than the correlation during periods of low PBOC intervention in currency markets (when the yuan is a managed float).

The rationale behind this hypothesis is that when the yuan is pegged, the PBOC intervention in currency markets pushes the US dollar value up against *all* global currencies. Since the PBOC intervention is a common factor affecting the performance of the US dollar across all currency markets in a similar manner, an increase in PBOC activity should drive

correlation up. When PBOC intervention is lower, the influence of other currency market factors should be felt more strongly on the US dollar returns and thus correlation should be lower.

5.2 Research Methodology

The correlations between different US dollar returns is not tested narrowly around the pivot points since these provides too few data points to meaningfully compare two correlations.

As a result, correlation is compared over two broad periods of time:

- 1) January 2000 to July 2005 – this is from the start of my data set to the point where China moves off the peg
- 2) July 2005 to July 2008 – this is from period when the yuan is a managed float after going off the peg in 2005 and returning to it in 2008.

The third period (July 2008 to June 2010) when the yuan is pegged again is not considered in this analysis as this was during the global financial crisis where all markets, currencies included, experienced severe volatility. High volatility obscures correlation results.

After I compute the correlations for different pairs of currency returns for both periods, I perform a one-sided test for statistical significance.

The null hypothesis is that correlation in the two periods is the same (i.e. the difference in correlations = 0).

The alternative hypothesis is that correlation is higher in period 1 than in period 2 (i.e. different in correlations > 0).

5.3 Results

The tables below show the correlations between pairs of US dollar currencies for monthly returns on the currency for both periods.

Table 7: Correlation in period from January 2000 to July 2005

	EUR / USD	GBP / USD	CHF / USD	CAD / USD	JPY / USD
EUR / USD	--				
GBP / USD	0.8057	--			
CHF / USD	0.9561	0.7937	--		
CAD / USD	0.5016	0.3396	0.4424	--	
JPY / USD	0.4133	0.4182	0.4492	0.3803	--

Table 8: Correlation in period from July 2005 to July 2008

	EUR / USD	GBP / USD	CHF / USD	CAD / USD	JPY / USD
EUR / USD	--				
GBP / USD	0.7439	--			
CHF / USD	0.9146	0.6368	--		
CAD / USD	0.2802	0.3903	0.1652	--	
JPY / USD	0.7379	0.4651	0.8710	0.0936	--

The hypothesis is that correlations in the first period should be higher. The following table presents the z-scores of the differences in correlations between the two periods.

Table 9: Z-scores for one-sided difference in correlations test

	EUR / USD	GBP / USD	CHF / USD	CAD / USD	JPY / USD
EUR / USD	**				
GBP / USD	0.722	**			
CHF / USD	1.594*	1.525*	**		
CAD / USD	1.223	-0.272	1.432*	**	
JPY / USD	-2.349	-0.271	-3.960	1.423*	**

* Significant at the 10 % level

Results in table 9 lend moderate support to the hypothesis and four out of ten pairs of currencies allow us to reject the null hypothesis. These are CHF/USD – GBP/USD, CHF/USD – CAD/USD, EUR/USD – CAD/USD, and CAD/USD – JPY/USD. Since correlations are being tested over broader periods of time, there are several factors affecting currency values and it is hard to pinpoint the effect that the intervention of the PBOC has on the US dollar over such long periods of time. The study around specific pivot points for the returns on the US dollar thus yield more robust results.

6. Implications and Directions for Future Research

The analysis in this paper has shown that the currency policies of China's central bank have a profound effect on the U.S. dollar. Academic work and mainstream rhetoric in this field have focused on the undervaluation of the yuan and its implication for trade flows and jobs in America. As this paper demonstrates, the actions of the PBOC also have the effect of driving up the US dollar in other major currency markets.

When the PBOC actively intervenes in markets, as it did until 2005 and between 2008 and 2010, it bids up the value of the US dollar against other currencies. This has far-reaching implications for the global economy. The United States' terms of trade are adversely affected since the dollar is artificially propped up in global currency markets. Among several other effects, a stronger US dollar is bad news for US exporters and US entities operating abroad. The effect is not just on the US dollar but also on all other currencies and economies connected to the US. At a very basic level, the actions of the PBOC are distorting the value of the US dollar in the currency market.

These results can help inform future discussions about China being a currency manipulator by keeping the yuan cheap. Evidently, there is more to this story. The US dollar is also being kept rich. The results of this paper should help inform international opinions on whether practices such as these are to be permitted in an era of free trade and free capital flows around the world. Should one player be allowed to exert such a great degree of influence on currency markets?

These implications can be better analyzed and understood through further research along the same lines. The analysis in this paper uses the different Chinese currency regimes, pegged and managed float, as proxies for differential periods of central bank activity in currency markets. It makes the assumption that a pegged currency requires *more* intervention than a managed float, but it doesn't quantify this. A more direct test would involve data on actual PBOC US dollar purchasing activity.

Other possible extensions would explore the impact on the US dollar of the internationalization of the Chinese yuan, loosening of its capital controls or a decision by China to invest in assets other than US treasuries. Is China's participation in the US treasury market

distorting the yields on these securities? These are all interesting questions focusing on the role of one financial institution, the People's Bank of China, in today's global economic system.

7. Conclusion

China's currency has undergone a lot of *managed* change in the last decade. It has appreciated a great deal against the US dollar and complaints about its undervaluation have subsided. In the past two years, the volatility of returns in the USD-CNY market are very similar to those in the USD-EUR market (2.6 % and 2.1% respectively) reflecting the fact that China may not be managing its currency as closely anymore.

However, its currency market interventions in the past decade have had a profound effect on US dollar performance in global currency markets and this has not received sufficient attention in academia or mainstream media. By looking at three specific points in the last decade, July 2005, July 2008 and June 2010, where the level of PBOC activity in currency markets undergoes a fundamental change, I have investigated the PBOC's impact on the US dollar. The results largely conform to the hypothesis and are statistically significant as well. The US dollar experiences a fall in value when the PBOC decreases its intervention in currency markets and vice-versa.

This analysis also looks at the flipside of the China currency value issue as it has been regularly presented. The focal point of economic and political commentary has been the undervaluation or cheapness of the yuan. But based on my analysis in this paper, there seems to be a valid case for claiming that the same interventions by the PBOC result in an overvalued or rich US dollar.

The implications go much further than an attempt by China to promote its exports. By bidding up the value of the US dollar, China adversely affects the US' terms of trade in multiple global markets. This not only calls for further research in this field but could shape policy discussions moving forward. Should any one financial institution be allowed to influence such a large market? What are the risks associated with this? The PBOC's effect on US dollar value is a profound one and understanding its ramifications is important for the future. When the global economy faces its next major case of currency management, it can then be better equipped to understand its different implications and how to deal with it.

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