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A Period Assessment of Exchange Rate Movements and Trade Flows Between the US and China

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Abstract

The behavior of the exchange rate between the Chinese yuan and the US dollar has transitioned through four notable phases since 1995. This study explores the long-term (growth) and short-term (cycle) relationships between the yuan/\$ exchange rate and goods trade flows between China and the US during each of these phases. Main findings support traditional thinking for the long-term: a depreciating dollar is correlated with accelerated growth in US exports to China and diminished growth in US imports from China, and a fluctuating exchange rate suggests mild growth in trade flows between the two nations. We find a non-linear relationship between exchange rate movements and goods trade flows in the short term, which implies the size of the overall impact of an exchange rate movement on goods trade will depend on the existing strength of the dollar. These results are connected to on-going discussions on trade policy between these two countries and imply China has reduced incentive to purposely manipulate exchange rates to benefit their own export sector.

Keywords: Exchange rate, goods trade with China, currency manipulation

According to the US Census Bureau (2020), China is currently the third largest export market for US goods and the largest source of imported goods to the US, with total two-way goods trade between the two nations amounting to approximately \$557 billion (2019 data). The futures of many firms and workers in both countries depend crucially on the prevailing exchange rate between the Chinese yuan and the US dollar as it affects sales in the import and export sectors. China, which actively manages the value of the yuan, is occasionally branded a ‘currency manipulator’. The central bank of China is accused of maintaining a high yuan per dollar [yuan/\$] exchange rate to make Chinese products more attractive and drive out competitors. Ascertaining if China has any incentive to manipulate the value of the yuan in this way has become of interest to policy-makers.

According to conventional economic thinking, an appreciation of the US dollar against the Chinese yuan (a rise in the yuan per dollar [yuan/\$] exchange rate) benefits some but harms others. Buyers get more yuan for each dollar exchange making a dollar is worth more in terms of Chinese goods, *ceteris paribus*. Imports from China become more attractive. US firms that rely on Chinese firms for raw materials, intermediate inputs and final goods benefit from lower costs and earn higher profits. Jobs in these firms become more stable, which benefits workers.

Arguably, lower prices are passed on to consumers allowing for improved standards of living. On the flip side, the fall in the prices of foreign goods makes it more difficult for US-based businesses to compete with their Chinese counterparts in the American market. These businesses stand to lose market share, and the jobs in these firms become less stable.

An opposite effect happens in US export sector, with an appreciation of the dollar making American goods more expensive for Chinese firms and consumers. American firms that export final products to the Chinese market, American firms that produce intermediate goods for Chinese producers, and Chinese firms that source final products from the US tend to lose profits and market share. Employment in these businesses become less stable. Conversely, Chinese producers who compete with American companies in Chinese markets stand to gain market share as the prices charged by their foreign competitors rise.

A similar effect is expected in growing economies where there is persistent average growth in the level of imports and exports. A persistent appreciation of the dollar over time would accelerate the growth rate of imports but decelerate the growth rate of exports. In circumstances where international trade is a large component of the economy, this effect may impact the GDP growth rate (depending on magnitude).

The US-China trade relationship is of particular interest to politicians and policy makers who are concerned about import-export enterprises and the workers employed by them. China has occasionally been branded as a ‘currency manipulator’; it is suggested that China is keeping the value of the yuan artificially low (the yuan/\$ exchange rate high) to support its export sector and drive American producers out of the market. This argument tends to appear whenever the yuan loses value. Analyzing the yuan/\$ exchange rate has thus drawn much attention.

Some researchers attempt to estimate the amount by which the existing yuan is incorrectly valued. Doing this often involves constructing an estimate of an ‘equilibrium exchange rate’ then comparing that to the actual exchange rate. Examples include Chen, Deng

and Kemme (2008), Wang, Hui and Soofi (2007), Cheung, Chinn and Fujii (2007) and Sato et al (2012). These studies vary in complexity and produce mixed results. We, however, are interested in establishing motive for China to gradually engage in currency manipulation. Specifically, we want to assess the impact of a small movement in the current yuan/\$ exchange rate on the goods sector. Does China deserve the label of ‘currency manipulator’ in the goods market whenever there is a small drop in the value of the yuan?

In this analysis, we explore how long-term and short-term fluctuations in the yuan/\$ exchange rate relate to goods trade. We take a period-by-period approach and look at the statistical connection between the exchange rate and goods flows during four specific time frames. This focused analysis is possible because of occasional changes in China’s management of the yuan (see Das 2019 for background). From 1995 to 2005, China operated a rigid fixed exchange rate regime where the value of the yuan was pegged at approximately 8.3 yuan/\$ with little to no deviation from this set target. In June of 2005, China began to take a more flexible approach and relaxed its control of the yuan. The yuan/\$ exchange rate fell over time until mid2008 (the onset of the Great Recession) where it was again rigidly fixed at approximately 6.8 yuan/\$. After the crisis (2010 – present), the exchange rate was again allowed to float in a managed way. During this period, the exchange rate fluctuated within a band of 6.0 yuan/\$ and 7.2 yuan/\$ (both increases and decreases did occur). While China does not have a fully-floating currency, there are now enough subtle movements in exchange rates to trace out its current impact on goods trade. Our intention is to use information from these periods to identify if there is incentive in the goods market for China to keep the value of the yuan low.

The remainder of this article proceeds as follows. We first describe the role of the yuan/\$ exchange rate in recent policy discussions. Subsequently, we use data collected from the Federal Reserve Economic Data database to perform a time series analysis of both long-term trends and short-term fluctuations in the traded goods market for three distinct periods: 1995-2005, 2005-2008 and 2010-2019. We present our findings and end with a discussion of how the results affect Chinese-American trade policy debates.

Context: The Dollar, Globalization and China

Two key factors matter when discussing the yuan/\$ exchange rate and its impact on goods trade: the dominance of the US dollar as a global currency and trends in globalization. The adoption of the Bretton Woods Agreement after World War II aided the rise of the US dollar as a leading global currency. At the time, the American economy was relatively stable and the US maintained healthy levels of global trade while Europe and Japan were rebuilding. Under the 1944 Bretton Woods Agreement, other countries pegged their currency to the US dollar while the US dollar was pegged to gold (a ‘gold standard’). The dollar, seen as a substitute for gold, replaced the British pound-sterling as international ‘reserve currency’ and a widely-accepted ‘means of payment’ for international transactions. See Eichengreen (2005) for a detailed discussion. The dollar has been a strong player in currency markets ever since, despite the collapse of Bretton Woods in 1971, the end of the gold standard in 1971, and the revival of European and Japanese economies in the late 1950s.

Globalization accelerated during the post-war era due to movements towards liberalized trade. The General Agreement on Tariffs and Trade (1947) and its replacement by the World

Trade Organization (1995) rules helped usher in an era of lower tariffs and fewer trade restrictions. As expected, tariff rates fell on average after World War II (Irwin, 1998) and remained low. Large bi-lateral and multi-lateral trade agreements began to emerge, and numerous economies became more integrated. Agreements and organizations that accomplished this include the European Free Trade Association in 1960, the Andean Community in 1969, the Caribbean Community and Common Market in 1973, the Organization of African, Caribbean and Pacific [ACP] States in 1975, the Arab Cooperation Council in 1989, the North American Free Trade Agreement [NAFTA] in 1992, the Maastricht Treaty in Europe in 1992, the ASEAN Free Trade Area in Southeast Asia in 1992, the Black Sea Economic Cooperation Zone in 1992, the Central America Free Trade Agreement in 2004, the ASEAN-Australia-New Zealand Free Trade Area in 2010, the Trans-Pacific Partnership in 2016 and the African Continental Free Trade Area in 2019. These multinational trade agreements stimulated international trade and resulted in production chains becoming more global as the more developed economies looked to the rest of the world as a source of cheap inputs, low-cost labor and inexpensive final products. Policy efforts promoting freer trade continue to be developed, stimulating globalization.

The broad acceptance of the dollar and the effects of globalization crisscrossed with US policy discussions in the late-1990s. Craig and Humpage (2003) noted that the dollar had been on a depreciating trend relative to a basket of currencies from the mid-1980s to the mid-1990s. In 1995, this trend reversed and the dollar began on a path of universal appreciation. The source of this appreciation seemed to be high interest in US products and a well-performing US economy. See Lindsey (2001), Bergsten (2001) and Craig and Humpage (2003) for more elaborate discussion of intensified interest in US manufactured and high-tech products. Discussions of a ‘strong dollar policy’ ensued, which further reinforced the dollar’s appreciation.

An appreciating dollar helps some but harms other. Several US manufacturers faced stronger competition against cheaper imported goods during the dollar’s appreciation trend, while foreign manufacturers benefited from stronger demand. Foreign buyers lost interest in some US products, and job losses appeared in some US industries. From the mid-1990s to 2005, the US experienced an overall worsening of the trade deficit.

During this same period, China had pegged the value of the yuan rigidly to the dollar. Although the dollar was appreciating against other currencies, its value against the yuan remained fixed. At the set exchange rate, Chinese manufacturing was growing. Supply chains were turning to countries like China as a source of low-cost manufactured products, and stronger economic growth around the world pushed up demand for Chinese imports. Like many other countries, the US turned to China for goods, and China became a more influential US trading partner. As more manufactured goods were sourced from China, firms and workers in the US manufacturing and export sectors became increasingly concerned about losing their livelihoods.

In 2005, a change in China’s exchange rate policy mitigated fears from US manufacturers and exporters for a short time. China loosened control of the exchange rate, and the dollar began to depreciate against the yuan. Prices for Chinese-made products became relatively higher for American buyers, and American goods became relatively cheaper for Chinese buyers. The yuan/\$ rate continued on this depreciating trend until the onset of the Great Recession in 2008.

During the 2008 recession, China returned to a rigid peg and fixed the value of the yuan to about 6.8 yuan/\$. In 2010, however, China again relaxed control and allowed the value of the yuan to fluctuate. From 2010 to 2014, the yuan/\$ exchange rate fell, again relieving some pressure on US manufacturers' ability to compete with China. After 2014, the dollar began to strengthen against the yuan resulting in the resurfacing of fears about job migration in the American goods sector.

China, now one of America's largest trading partners, draws criticism when concerns about industry competition and job loss emerge. These concerns influence policy, which affect global trade. In 2018, the Trump administration implemented a series of protectionist policies which increased trade restrictions and tariffs. China presently remains a much-cited target, although some of these restrictions have impacted other countries. China was labeled as a 'currency manipulator' in August 2019 (Imbert, 2019) after one such tariff increase, and accusations that China was intentionally increasing the yuan/\$ exchange rate to gain a competitive advantage were raised.

The argument that China is guilty of currency manipulation was not entirely unexpected. China's impressive growth and increasing prominence in the global economy, combined with a series of Chinese policies related to business subsidies and relaxed intellectual property laws, may have motivated some politicians to raise alarms about unfair trade practices in recent years (Navarro and Roach, 2012). Ramirez (2013) shows that conditions within the US political system, specifically the influence that special interest groups exert on Congress, have also contributed to occasionally labeling China as a 'currency manipulator'. Intense allegations of currency manipulation have encouraged a growing number of researchers to track the yuan and examine China's exchange rate policy.

Researchers have studied how movements in the yuan/\$ exchange rate affect various outcomes, particularly the trade balance. For example, Hoggarth and Tong (2007) analyze the yuan's impact on China's own imports of consumer goods from other Asian countries. Xing (2012) explores the connection between the value of the yuan and China's processing trade (assembling imported inputs and exporting the final product). Hashemzadeh (2019) looks at the connection between movements in the yuan and US imports. These studies and others like them typically rely on OLS, time series methods or panel data to estimate the relationship between the yuan and selected variables of interest.

The empirical investigation we perform in this study further explores the impact of a changing yuan/\$ exchange rate. We use a mixture of time series methods and OLS to estimate how changes in the exchange rate affects imports and exports between the US and China. We limit our attention to goods flows only. Our goal is to use this information to deduce if there is any incentive in the traded goods market for China to change its currency policy.

Analysis of the Chinese Exchange Rate

Data

Data are collected from the Federal Reserve Bank of St. Louis (FRED) databank. This data is monthly, not seasonally adjusted, and covers 1995m7 through 2019m12. Data included in the analysis:

- The yuan/\$ exchange rate [number of yuan per \$1].
- US exports of goods by F.A.S. basis to mainland China, \$millions.
- US imports of goods by customs basis from mainland China, \$millions.
- US exports of goods by F.A.S. basis to world, \$millions.
- US imports of goods by customs basis from world, \$millions.
- Real broad effective exchange rate [REER] for China, index 2010=100.
- Real broad effective exchange rate [REER] for US, index 2010=100.
- Consumer Price Index [CPI]: All items for the US, index 2015=100.
- Consumer Price Index [CPI]: All Items for China, index 2015=100.

Natural logs are taken for the measures of imports and exports. Seasonal adjustment is made for all measures *except* the yuan/\$ exchange rate (for which we do not observe a seasonal pattern). We applied the X13 automatic seasonal adjustment option in EViews to remove the seasonal component from the data (the series is ‘de-seasoned’ to eliminate the impact of monthly patterns on the broad, longer-term results). Period-to-period percent change is taken for the CPI measures to obtain a measure of the inflation rate (adjusted to be measured in percent, %).

A plot of the yuan/\$ exchange rate is shown in Figure 1 below. We observe four distinct periods within which we will analyze the long-term and short-term impact of exchange rates on goods flows:

- *Period 1: 1995M7 – 2005M6.* A stable, fixed exchange rate with only slight fluctuations between 1995 and 1999. During this period, we should see ‘nonsystematic’ movements in trade that are effectively free of influence from the exchange rate.
- *Period 2: 2005M7 – 2008M7.* A weakening dollar. Since the exchange rate is moving in only one direction, we should see a robust impact of exchange rates on the trends of imports and exports.
- *Period 3: 2008M8 – 2010M7.* The Great Recession. A fixed exchange rate, but economic turmoil occurring in the US and elsewhere is present which may obscure the findings. We omit this period from the rest of our analysis due to the severity of the economic crisis and its impact on many parts of the economy.
- *Period 4: 2010M8 – 2019M12.* A managed exchange rate with fluctuations. There is more volatility in this period, so we should see a clearer impact of exchange rate changes on short-term fluctuations in imports and exports.

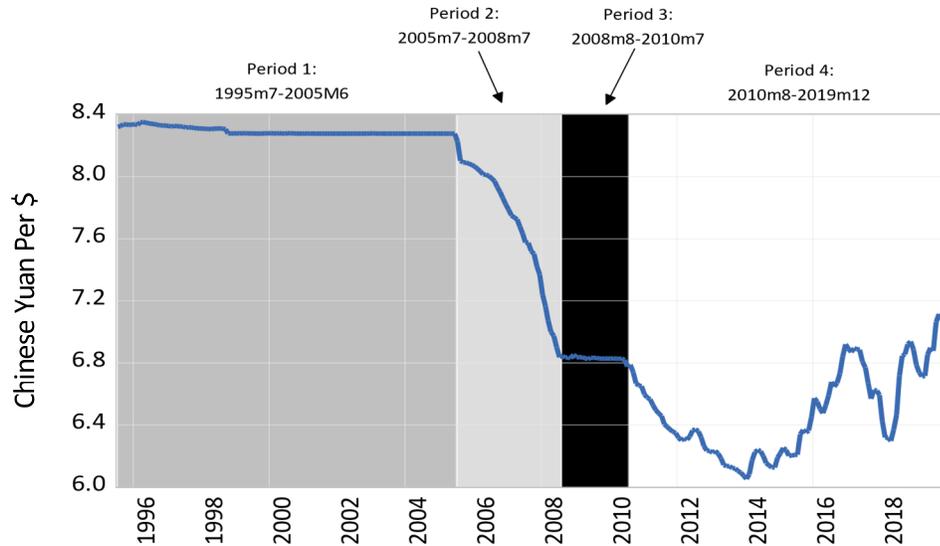


Figure 1: The Behavior of Yuan/\$ Exchange Rate, 1995-2019

Long-term Trend Analysis

We first assess the broad, longer-term movements in both exchange rates and goods flows. It is noteworthy to mention that both exports (from the US to China) and imports (from China to the US) have exhibited persistent overall growth in periods 1, 2 and 4 regardless of exchange rate movements (see figures 2A and 2B). Underlying growth in goods trade can be attributed to factors such as technology change, population/employment growth, capital deepening, policy impacts and other sources of trade sector growth. We can see a sort of

‘baseline’ growth clearly in period 1 where the yuan/\$ exchange rate was virtually fixed. The growth in exports and imports during this period would be due to economic factors other than the exchange rate.

In periods 2 and 4, there are exchange rate movements which either accelerate or decelerate goods trade. Period 2 shows a constantly falling exchange rate which allows us to identify how persistent depreciation of the dollar speeds up or slows down goods trade growth. Period 4, which contains more volatile exchange rate movements in both directions, represents the present exchange rate regime and describes the current ‘norm’ for trade growth.

To extract a broad growth trend for log imports and log exports in each of periods 1, 2 and 4, we use a simple linear trend model (equation 1). The model is applied to each period separately.

$$x_t = \alpha + \beta t + e_t, \quad t = \text{time indicator} \quad (1)$$

In equation 1, $\Delta x^t / \Delta t = \beta$. When the data is in natural logs, β represents an average growth rate for the series (given the coefficient is small). This method is simple yet effective. We opt not to use a more complicated trend model to avoid picking up short-term movements that will be analyzed separately. The results for exports (from the US to China) and imports (from China to the US) are illustrated below in figures 2A and 2B, and summarized in table 1.

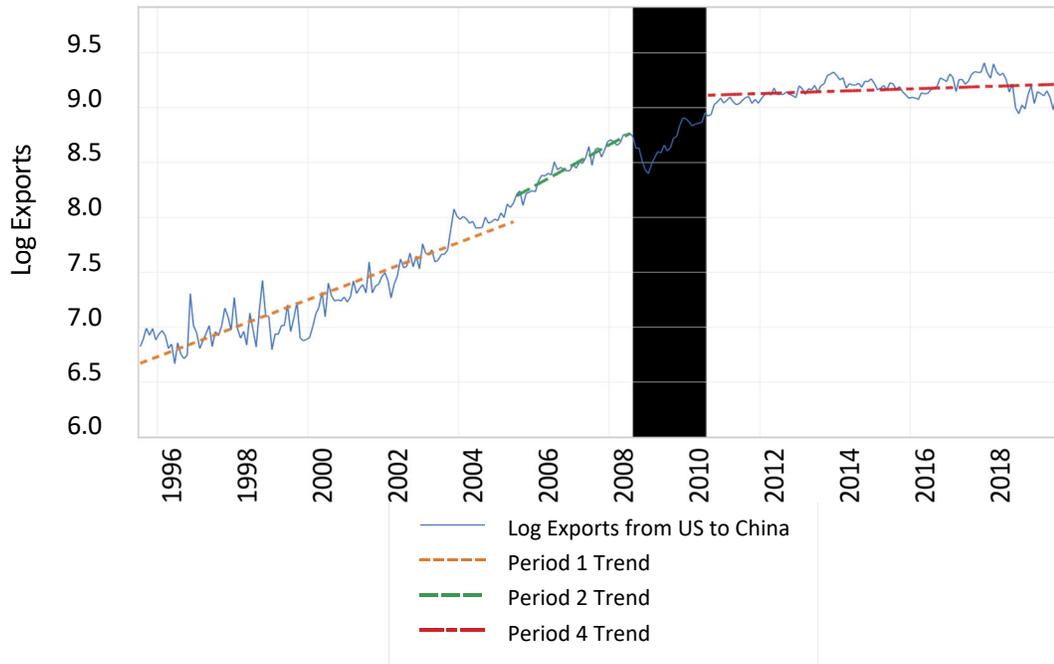


Figure 2A: Log of Exports from US to China, 1996-2018

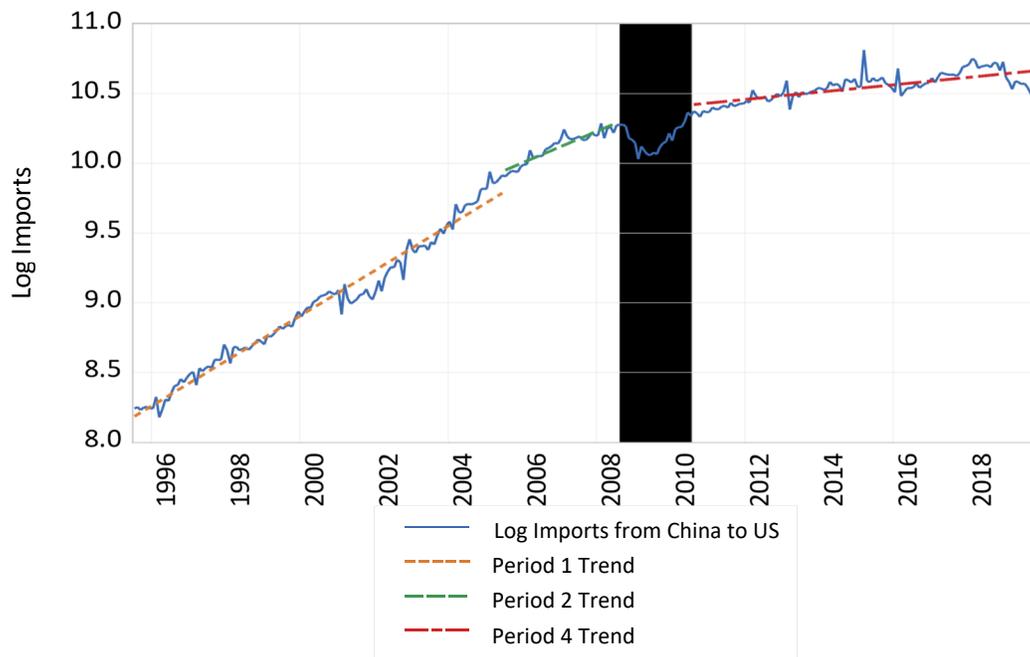


Figure 2B: Log of Imports from China to US, 1996-2018

	Period 1 1995m7-2005m6	Period 2 2005m7-2008m7	Period 4 2010m8-2019m12
Log exports from US to China	0.0108 {1.08%} [0.0004]	0.0157 {1.57%} [0.0008]	0.0009 {0.09%} [0.0003]
Log imports from China to US	0.013458 {1.35%} [0.0002]	0.009409 {0.94%} [0.0006]	0.002196 {0.22%} [0.0002]

Table 1: Coefficient on Time Variable from OLS Regression when Detrending: Coefficient, {Coefficient Expressed as Growth Rate in %}, and [Standard Error]

All estimates for β shown in table 1 are statistically significant at the 1% level. For goods exports from the US to China, there was moderate growth in period 1 when the yuan was fixed. Export growth picked up in period 2 when the dollar started to depreciate against the yuan as theory would predict. After the recession (period 4), export growth slowed down and fell below its pre-recession level. This latter result is likely due to the relative weakness of the dollar during this time compared to periods 1 and 2. Added exchange rate uncertainty associated with the yuan's flexibility during this period may have also hindered export growth.

When looking at import growth, we see high growth in period 1 followed by a fall in growth in period 2. This again is as predicted: a depreciation of the dollar makes imports from China more expensive and dampens import growth. In period 4, we see further slowing in import growth. Again, additional weakening of the dollar plus exchange rate uncertainty during this period contributed to reduced import growth.

The theoretical relationship between trade and the exchange rate is a two-way relationship: changes in exchange rates affect trade flows, and changes in trade flows affect exchange rates. The relationship between these variables depends what changes first. *Ceteris paribus*, if the dollar depreciates first (i.e. the exchange rate is impacted by something that does not directly affect imports/exports), people who trade dollars for yuan (to buy imports) get a worse deal and people who trade yuan for dollars (to sell exports) export get a better deal. Imports should rise and exports should fall. This is exactly what we see in period 2: growth in imports from China decelerate (smaller estimate of β for period 2 in table 1) and growth in exports from China accelerate (larger estimate of β for period 2 in table 1).

Alternatively, if something causes imports/exports to change first (i.e. trade is impacted by something which does not directly affect exchange rates), then the exchange rate may rise or fall depending on the nature of the change. For example, a sudden burst in consumer income will encourage Americans to import more foreign products causing import growth to accelerate. To buy the imports, Americans supply more US dollars to acquire yuan causing the dollar to depreciate. A fall in the yuan/\$ exchange rate is then correlated to a rise in import growth. On the other hand, if export demand decreases (e.g. a decrease in demand from China), then fewer dollars are demanded by Chinese buyers causing the dollar to depreciate. A fall in the exchange rate is correlated with a fall in export growth. We do not see these effects occurring in period 2, suggesting exchange rate changes have been impacting trade (and not so much vice versa).

By looking at period 2 when the yuan/\$ exchange rate persistently decreased, we can isolate a general impact of the exchange rate on the longer-term trend. The yuan/\$ exchange rate fell from 8.23 to 6.84 (a 1.39 unit decrease). The average growth rate of US exports to China increased from 1.08% to 1.57% (0.49% increase) during this time. This implies a one unit drop in the yuan/\$ the exchange rate accelerates average growth in exports by approximately 0.35%. The growth rate of imports from China decreased from 1.35% to 0.94% (a change of 0.41%) during this period, implying a one-unit yuan/\$ fall in the exchange rate decelerates growth in imports by approximately 0.29% on average.

This is not easy to do for period 1 since the exchange rate is fixed, nor is it easy to do for period 4 as the exchange rate is more volatile (in both directions) and imports/exports were both flat. Instead we turn to short-term fluctuation analysis, which is particularly useful for period 4.

Short-term Analysis

Given the above long-term trends, we next explore the short-term cycle patterns to enrich the analysis. The residuals (e_t) from the de-trending regressions of equation (1) above represent *percent deviation from the growth trend* since natural logs of imports/exports are used. These residuals are adjusted so they are measured in percent and represent the ‘cyclical component’ of each series. See figure 3A – 3D for the cyclical components of US imports and exports both to China and the rest of the world.

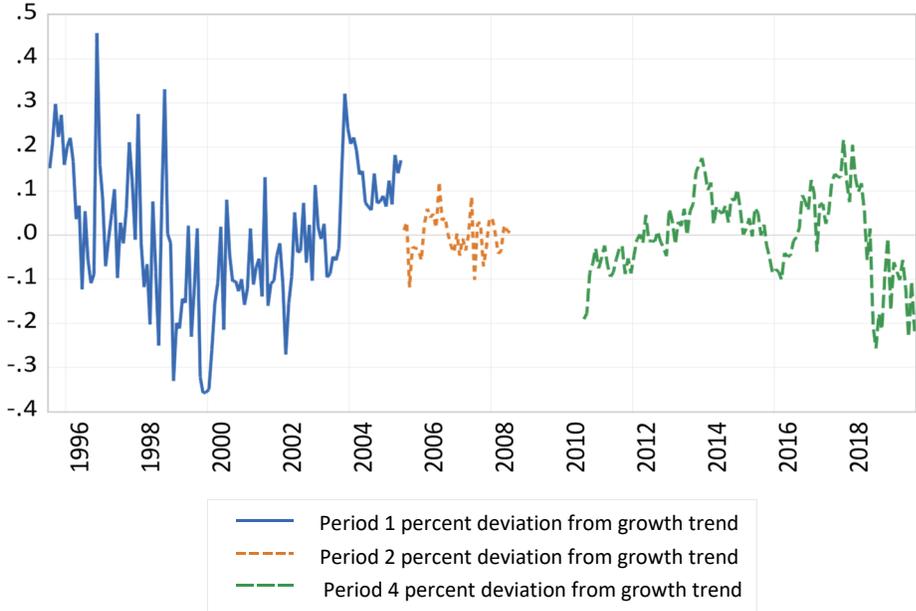


Figure 3A: Log Exports from US to China, 1995-2018, Deviations from Growth Trend

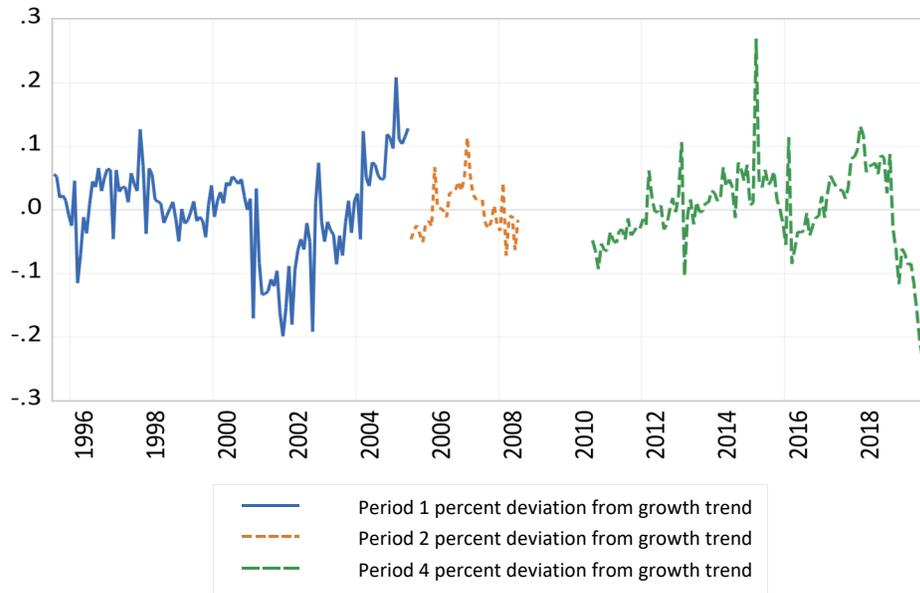


Figure 3B: Log Imports from China to US, 1995-2018, Deviations from Growth Trend

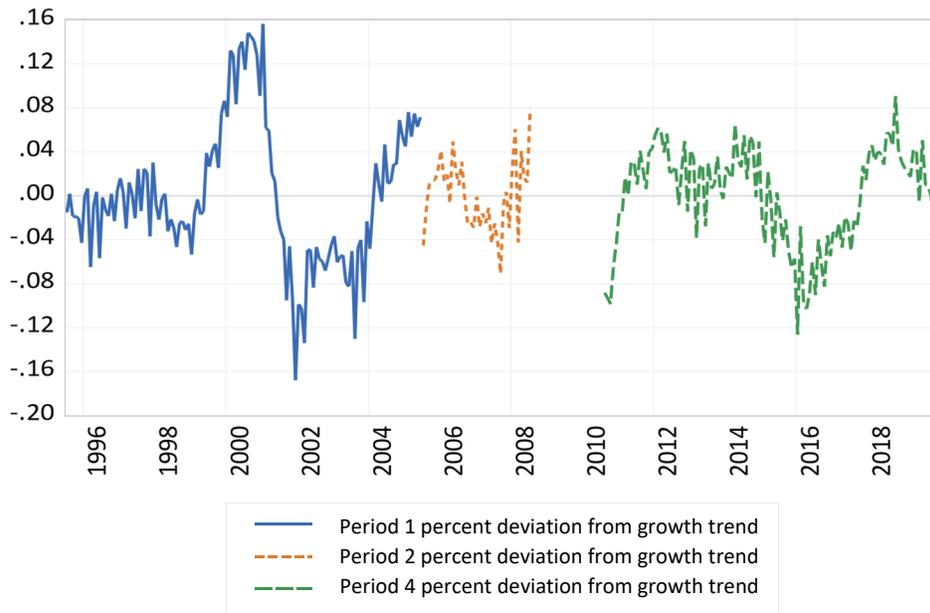


Figure 3C: Log Exports from US to World, 1995-2018, Deviations from Growth Trend

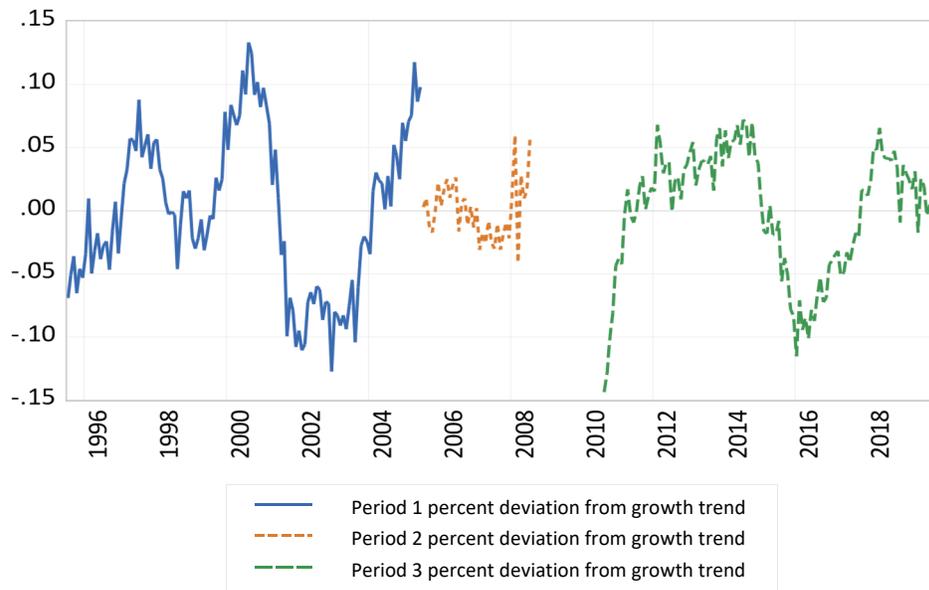


Figure 3D: Log Imports from World to US, 1995-2018, Deviations from Growth Trend

We wish to create a set of regression analytics to capture the relationship between short-term movements in trade flows and various factors which affect them. In the regressions that follow, the cycles for exports (from US to China) and imports (from China to US) are dependent variables. The explanatory variables consist of a constant term, the yuan/\$ exchange rate (the main variable of interest), the yuan/\$ exchange rate squared (to capture non-linear effects), the Chinese and US inflation rate (to capture differences in prices), the broad real effective exchange rates (REERs - to capture the effects from changes in a broad basket of currencies) and the cycle components of total exports (from US to the world) and imports (from world to US) (to capture broad patterns in American goods trade).

The rationale behind adding squared terms for the exchange rate is based on an earlier empirical study by Hashemzadeh (2019) which supports the likelihood of a significant non-linear relationship between US imports and the value of the yuan. Hashemzadeh concluded that if the Chinese currency depreciates from 33 cents to 14 cents (3.03 yuan/\$ to 7.14 yuan/\$), the natural log of imports from China to US increases from approximately 4 to 9 (approximately 125 percent increase in the natural log of imports). However, there does exist a minimum price for the yuan below which it becomes unprofitable for China to increase exports to the US via currency devaluation. The empirics of this work also demonstrates that net exports from China to the US begins to diminish when the value of yuan drops to approximately 14.2 cents (7.04 yuan/\$) or less. We feel it is worth including this type of non-linearity since other studies considering non-linear patterns in exchange rates have also been conducted (albeit with varying degrees of success). See Diebold and Nason (1990), Taylor and Peel (2000), Sarno (2003), and Allen et al. (2016) for a sample.

The inclusion of the REERs, which are more general measures of exchange rates (currency relative to a basket of other currencies), pose a potential problem. The yuan and the dollar are components of these, and a multicollinearity problem may arise as a result. If the

yuan/\$ exchange rate and the REERs are too highly correlated then we really need only one of the two variables in the regression. Correlations between the exchange rate and the REERs are plotted in figure 4. A severe correlation appears for period 2. When we construct the model for period 2, we will consider versions with and without the REER.

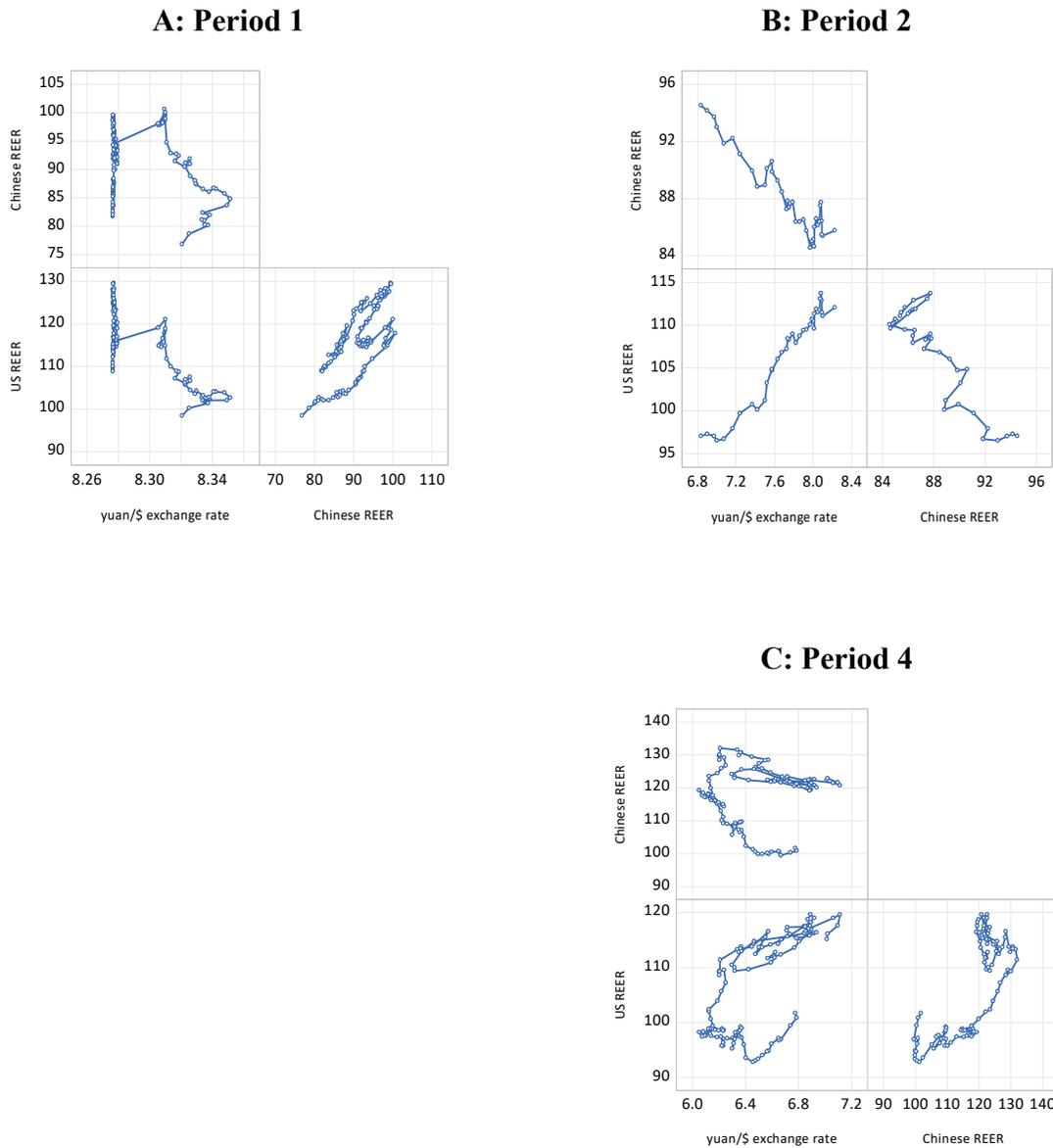


Figure 4: Correlation between the Yuan/\$ Exchange Rate and the REER.

The results from the period 1 regression model appear in table 2A and 2B below. Both the exchange rate and the exchange rate squared are shown to be statistically significant. Note that the coefficient on these variables appears quite high. The reason for this is because there were only very minute changes in exchange rates during this period (the exchange rate was aggressively fixed). These tiny changes did matter, but ended up receiving a very heavy weight in the OLS procedure due to their size. Inflation rates, REERs and trade flows with the rest of the world are likely better predictors of the cyclical movements in import/export growth during this time.

Dependent Variable: Cycle of Log Exports from the US to China (%)

Sample: 1995M07 2005M06

Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	-8622.094	3008.989	-2.865	0.005	***
yuan/\$	2075.098	724.335	2.865	0.005	***
(yuan/\$) ²	-124.837	43.591	-2.864	0.005	***
Chinese inflation rate	0.087	0.036	2.410	0.018	**
US inflation rate	-0.046	0.070	-0.664	0.508	
Chinese REER	-0.020	0.005	-3.872	0.000	***
US REER	0.006	0.005	1.226	0.223	
cycle of log exports from US to World	-0.279	0.213	-1.310	0.193	
R-squared	0.377				
Adjusted R-squared	0.338				
S.E. of regression	0.128				
F-statistic	9.679				
Prob(F-statistic)	0.000				
Akaike info criterion	-1.204				

† *** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 2A: Exports from US to China, Period 1

Dependent Variable: Cycle of Log Imports from China to the US (%)

Sample: 1995M07 2005M06

Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	-5599.796	1044.966	-5.359	0.000	***
yuan/\$	1349.567	251.561	5.365	0.000	***
(yuan/\$) ²	-81.300	15.140	-5.370	0.000	***
Chinese inflation rate	0.030	0.012	2.430	0.017	**

US inflation rate	0.001	0.024	0.027	0.979	
Chinese REER	-0.004	0.002	-2.179	0.031	**
US REER	-0.004	0.002	-2.050	0.043	**
cycle of log imports from World to US	0.447	0.082	5.442	0.000	***
<hr/>					
R-squared	0.647				
Adjusted R-squared	0.625				
S.E. of regression	0.045				
F-statistic	29.353				
Prob(F-statistic)	0.000				
Akaike info criterion	-3.320				

†*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 2B: Imports from China to US, Period 1.

Results for period 2 appear in tables 3A – 3D. We first consider the model with the REERs included. The model for cycles in log exports has a poor fit with only the US inflation rate being a significant predictor. When we exclude the REER, the fit improves in terms of the Akaike info criterion (AIC) which has decreased. However, none of the variables in the model are significant. The AIC has increased for the model of imports, suggesting that dropping the REER from the model was not effective. We cannot say much about cyclical movements in exports to China using this model, but we can infer some insights for imports using the results shown in table 3B. Again, we see the exchange rate and exchange rate squared are statistically significant, as are the REERs and global imports for the US.

Dependent Variable: Cycle of Log Exports from US to China (%)

Sample: 2005M07 2008M07

Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	6.537	6.196	1.055	0.300	
yuan/\$	-1.255	1.446	-0.868	0.392	
(yuan/\$) ²	0.073	0.092	0.790	0.436	
Chinese inflation rate	-0.007	0.025	-0.272	0.787	
US inflation rate	-0.053	0.028	-1.901	0.067	*
Chinese REER	-0.017	0.012	-1.400	0.172	
US REER	0.003	0.009	0.313	0.757	
cycle of log exports from US to World	-0.133	0.331	-0.403	0.690	
<hr/>					
R-squared	0.160				
Adjusted R-squared	-0.042				

S.E. of regression	0.049
F-statistic	0.791
Prob (F-statistic)	0.601
Akaike info criterion	-2.996

†*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 3A: Exports from US to China, Period 2, REER Included

Dependent Variable: Cycle of Log Imports from China to the US (%)

Sample: 2005M07 2008M07

Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	-8.376	3.788	-2.211	0.035	**
yuan/\$	2.463	0.902	2.730	0.011	**
(yuan/\$) ²	-0.184	0.058	-3.167	0.004	***
Chinese inflation rate	0.013	0.015	0.887	0.382	
US inflation rate	0.004	0.017	0.217	0.830	
Chinese REER	-0.016	0.007	-2.500	0.018	**
US REER	0.017	0.005	3.374	0.002	***
cycle of log imports from World to US	0.627	0.289	2.170	0.038	**
R-squared	0.578				
Adjusted R-squared	0.476				
S.E. of regression	0.028				
F-statistic	5.664				
Prob(F-statistic)	0.000				
Akaike info criterion	-4.122				

†*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 3B: Imports from China to US, Period 2, REER Included

Dependent Variable: Cycle of Log Exports from US to China (%)

Sample: 2005M07 2008M07

Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	0.462	4.527	0.102	0.919	
yuan/\$	-0.110	1.203	-0.092	0.928	

(yuan/\$) ²	0.007	0.080	0.086	0.932
Chinese inflation rate	-0.018	0.023	-0.812	0.423
US inflation rate	-0.039	0.026	-1.524	0.138
cycle of log exports from US to World	0.030	0.305	0.098	0.923

R-squared	0.101
Adjusted R-squared	-0.044
S.E. of regression	0.049
F-statistic	0.693
Prob(F-statistic)	0.632
Akaike info criterion	-3.034

†*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 3C: Exports from US to China, Period 2, REER Excluded

Dependent Variable: Cycle of Log Imports from China to US (%)

Sample: 2005M07 2008M07

Included observations: 37

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	-12.689	3.420	-3.710	0.001	***
yuan/\$	3.350	0.908	3.689	0.001	***
(yuan/\$) ²	-0.221	0.060	-3.668	0.001	***
Chinese inflation rate	-0.007	0.016	-0.456	0.651	
US inflation rate	0.007	0.018	0.384	0.704	
cycle of log imports from World to US	0.823	0.324	2.542	0.016	**

R-squared	0.387
Adjusted R-squared	0.288
S.E. of regression	0.033
F-statistic	3.915
Prob(F-statistic)	0.007
Akaike info criterion	-3.858

†*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 3D: Imports from China to US, Period 2, REER Excluded

Results for period 4 appear in tables 4A and 4B. The exchange rate is significant in the model of exports, but its squared value is not. The square of the exchange rate is significant in

the model of imports, but the linear value of the exchange rate is not. A milder relationship between exchange rates and imports/exports appears compared to the other periods.

Dependent Variable: Cycle of Log Exports from the US to China (%)

Sample: 2010M08 2019M12

Included observations: 113

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	11.591	5.988	1.936	0.056	*
yuan/\$	-3.207	1.769	-1.813	0.073	*
(yuan/\$) ²	0.200	0.129	1.546	0.125	
Chinese inflation rate	-0.013	0.026	-0.516	0.607	
US inflation rate	0.073	0.040	1.840	0.069	*
Chinese REER	-0.013	0.005	-2.496	0.014	**
US REER	0.021	0.007	3.168	0.002	***
cycle of log exports from US to World	0.010	0.180	0.055	0.956	
R-squared	0.388				
Adjusted R-squared	0.347				
S.E. of regression	0.077				
F-statistic	9.494				
Prob(F-statistic)	0.000				
Akaike info criterion	-2.214				

[†]*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 4A: Exports from US to China, Period 4

Dependent Variable: Cycle of Log Imports from China to the US (%)

Sample: 2010M08 2019M12

Included observations: 113

Variable	Coefficient	Std. Error	t-Statistic	p-Value	Significance [†]
constant	-6.215	4.719	-1.317	0.191	
yuan/\$	2.086	1.396	1.494	0.138	
(yuan/\$) ²	-0.189	0.102	-1.851	0.067	*
Chinese inflation rate	0.015	0.019	0.794	0.429	
US inflation rate	-0.014	0.029	-0.478	0.634	
Chinese REER	-0.008	0.004	-2.219	0.029	**
US REER	0.015	0.005	3.087	0.003	***

cycle of log imports from World to US	0.334	0.138	2.424	0.017	**
R-squared	0.413				
Adjusted R-squared	0.374				
S.E. of regression	0.057				
F-statistic	10.539				
Prob(F-statistic)	0.000				
Akaike info criterion	-2.839				

†*** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 4B: Imports from China to US, Period 4

We can trace out the overall impact of exchange rate changes on imports/exports using the above results. Since exchange rates and squared exchange rates are included in the regression, we must first perform a bit of algebra. Given the general form of the above regressions:

$$y_t = a + b_1x_t + b_2x_t^2 + cz_t + e_t \quad (2)$$

which suggests:

$$\Delta y_t / \Delta x_t = b_1 + 2b_2x_t \quad (3)$$

The impact of the exchange rate on the dependent variable will depend on the value of the exchange rate at any point in time. Figure 5 plots the marginal impact of the exchange rate on the short-term fluctuations for imports (period 2 and period 4 only) and exports (period 4 only). Only impacts at the 10% significance level in the above regressions are shown. Period 1 is omitted due to the rigidly fixed nature of the exchange rate.

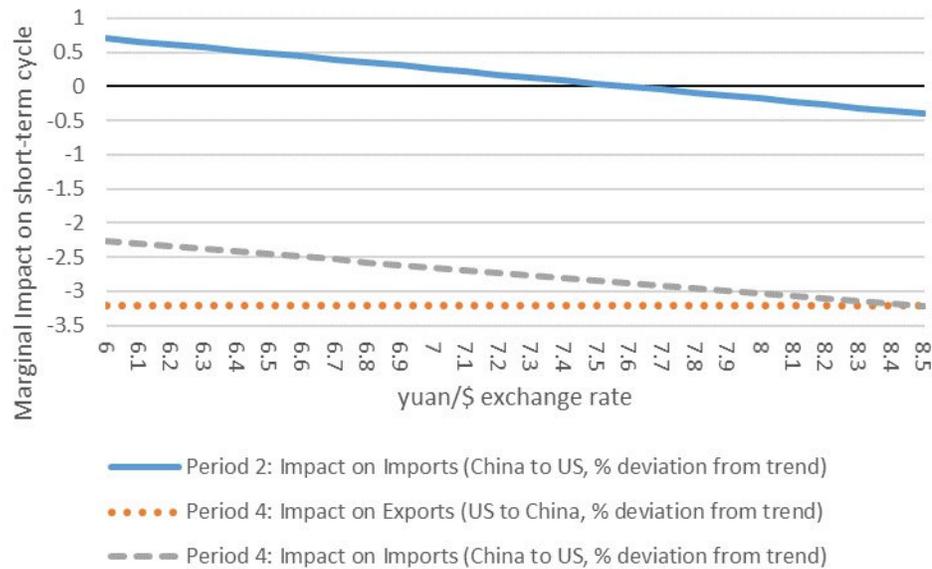


Figure 5: Short-term Marginal Impact of Yuan/\$ Exchange Rate on Trade Flows Between the US and China, 1996-2018

These results show that in period 2 when the yuan/\$ exchange rate fell from 8.23 to 6.84, the impact was initially positive (a marginal *fall* in the exchange rate increases short term import deviation from trend by about 0.27 percentage points when the exchange rate is 8.23) but then became negative (a marginal fall in the exchange rate decreased short-term import deviation from trend by about 0.35 percentage points when the exchange rate is 6.84). To put it lucidly, if imports are growing on trend when the exchange rate is 8.23 yuan/\$, a marginal fall in the exchange rates will push imports up 0.27% above trend. However, if imports are growing on trend when the exchange rate is 6.84 yuan/\$, a marginal fall in the exchange rate will push imports up 0.35% above trend.

In period 4, the yuan/\$ exchange rate fluctuated between 6.0 and 6.9. In this range, a marginal increase in exchange rates negatively affects *both* short term import and export deviations from their respective trends. The impact on exports is always the same, but the impact on imports depends on the value of the exchange rate. The higher the exchange rate, the stronger the movement in imports. For example, when the exchange rate is 6.2 yuan/\$ and imports are growing on trend, a marginal increase in exchange rates will drive imports down about 2.3% below trend. When the exchange rate is 6.8 yuan/\$ and imports are growing on trend, a marginal increase in exchange rates will drive imports down by about 2.6% below trend. This implies that an intentional increase of the yuan/\$ exchange rate by China to bolster US imports of Chinese goods can only go so far. Long-term import growth rises under this policy, but short-term growth seems to decline.

Major Findings and Policy Discussion

Our period-level analysis shows the impact of yuan/\$ exchange rate movements on the growth of goods trade between the US and China for both the long-term (trend) and the short-term (cycle). We can summarize our findings as follows:

Long-term average growth.

- Persistent changes in the yuan/\$ exchange rate does affect long-term growth of goods trade.
- Comparing period 1 (1995 – 2005 when the exchange rate was rigidly fixed) to period 2 (2005-2008, when the dollar depreciated) suggests a one unit drop in the yuan/\$ the exchange rate accelerates average growth in US exports to China by approximately 0.35% and decelerates average growth in US imports from China by approximately 0.29%.
- The current (period 4, 2010-2019) managed float of the yuan has made long-term growth milder for both imports and exports compared to when the exchange rate is fixed (period 1). This is due to offsetting effects of small appreciations and depreciations of the dollar coupled with a comparatively low yuan/\$ exchange rate.

Short-term average growth.

- In period 4, there seems to be a constant impact of exchange rate movements on US exports to China. A one unit rise in the yuan/\$ exchange rate implies a decrease in export growth by approximately 3.2% from trend.
- There is a non-linear, overall negative short-run impact of exchange rate movements on US imports from China in period 4. The magnitude of this impact depends on the current value of the exchange rate. A greater yuan/\$ exchange rate leads to more downward pressure on import growth in the short term when the dollar appreciates slightly. The short-term effect of the yuan/\$ exchange rate on import growth seems to counterbalance its long-term effect.

There is plenty of confusion, suspicion and opinion related to China's monetary authority manipulating exchange rates to expand manufacturing, exports, employment opportunities and per-capita income. This is happening during an era of greater globalization where countries like China are expanding their influence on established international trade and economic associations. The Chinese government and Chinese industries, both large and small, are tirelessly upgrading to support larger trade volumes and innovating modern manufacturing and logistics systems to compete with the advanced economies of the west. China's manufacturing sector and overall economic performance seem to be improving on their own without added help from the exchange rate. We must carefully assess whether there are any incentives to engage in currency manipulation at all in this environment. In general, our analysis suggests intentional persistent increases in the exchange rate appear to have some long-term benefits for China with some

countervailing short-term costs. The net gain may not be so large as to encourage China to adopt or stick to a policy of currency manipulation.

The apparent commitment of US policy makers to maintain the value of the ‘king dollar’ against a broad array of world currencies has been instrumental in shaping the US trade policy since the crash of the dollar/gold relationship in the mid-1970s (Amadeo, 2018). Influential politicians and consultants continue to recommend a weaker dollar to raise the demand for US exports and discourage US buyers from demanding foreign goods. However, others such as

Larry Kudlow, the present director of the National Economic Council of the President, and his colleagues Stephen Moore and Art Laffer, have been advocating ‘strong dollar’ policy (2018). Nevertheless, a strengthening of the dollar due to foreign factors, such as currency manipulation, is viewed with strong criticism. If China purposely appreciates the dollar to bolster exports to the US, they are accused of ‘stealing American manufacturing jobs’ beyond the natural progression of the Chinese economy under liberal trade.

There is still some concern about maintaining an artificially strong dollar from either side. Theoretically, if the exchange rate between the dollar and the yuan is allowed to adjust to its competitive level, the US trade deficit with China and the rest of the world would narrow considerably resulting in much greater US exports and restoration of millions of US jobs. Robert Scott has noted “absent aggressive efforts to reduce the overvalued dollar, policies of trading partners and the vagaries of financial markets will soon lead to a rising dollar, putting continued upward pressure on the trade deficit, and downward pressure on employment and output in US manufacturing.” (2018) We find evidence of this in our analysis in the long term: a weaker dollar would accelerate exports and decelerate imports.

Conclusion

Our empirical investigation of the trade data between China and the United States explores the impact of the yuan/\$ exchange rate on both the long-term trend and the short-term fluctuations (cycle) of imports from China to the US and exports from the US to China. Over-all, our investigation reveals that marginal changes in the yuan/dollar exchange rate significantly impact the flow of imports and exports between the two economies, but there is only mild evidence that China has incentive to purposely exploit this relationship.

Like many empirical analyses, one key shortcoming of the analysis above is the omission of potentially important variables (such as future expected exchange rate movements, interest rates, central bank policies and overall economic performance). Changes in labor costs, changes environmental and manufacturing regulations, easier access to global markets, income growth and the strength of financial markets all continue to occur which affects both goods trade and exchange rates. Exploring these factors is left for future work. The most important recent factor is trade policy. The movement towards freer trade suffered a set-back in 2018 when tariffs and other trade regulations were strengthened. Changes in trade policy will affect the growth path of both goods trade and exchange rates. We must wait for more data to fully assess the effect.

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