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Abstract

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JEL: F1, F2

Keywords: Exchange Rate, Pass-through, Bilateral Trade, Gravity Model

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1 Introduction

Exchange rate movement and its pass-through to changes in domestic prices have been topics of wide concern among economists. However, relatively few studies have empirically investigated the relationship between exchange rate movements and trade flow. This paper fills this gap by investigating the effect of the appreciation of the Chinese *Renminbi* (RMB) on imports to the U.S. from China.

Today, China has replaced Mexico as the second-largest trading partner with the U.S. In July 2005, China abated its fixed exchange rate to the U.S. dollar but pegged its currency to a basket of currencies. Since then, the RMB has appreciated by about 20% against the U.S. dollar, from 8.3 to 6.8 RMB per dollar. Simultaneously, China's bilateral trade surplus from the U.S. decreased from US$232 billion in 2006 to US$114 billion in 2008. This raises the question: has the RMB appreciation decreased the imports to the U.S. from China?

The economic intuition behind this question seems straightforward: the appreciation of the RMB resulted in more expensive Chinese exports; consequently, exports diminished while imports increased. However, answering the question is not, by any means, trivial. It is widely recognized that bilateral trade volumes are affected by the trading countries' GDP, declining trade costs, and trade liberalization (Feenstra, 1998). The appreciation of the RMB would have a pass-through effect on American import prices, which in turn would affect the amount of imports to the U.S. from China. By this means, the exchange rate has an effect on the domestic import price similar to that of tariffs, which has been recognized as the *symmetry* hypothesis between tariffs and the exchange rate (e.g., see Feenstra, 1989). Therefore, the effect of exchange rate movements on bilateral trade remains an empirical issue.

The gravity model is perhaps the only one model that can successfully explain the growing trade volumes. In its simplest version, the gravity model suggests that the bilateral trade volume is directly proportional to the trading countries' GDP (Tinbergen, 1962). I therefore adopt a theoretical gravity model with general equilibrium to access the effect of appreciation of the RMB on Sino-U.S. bilateral trade. The innovation of this paper is that I explicitly introduce the exchange rate into the theoretical gravity framework, hence am able to estimate the effect of the yuan's revaluation on imports to the U.S. from China.[1] Extensive analysis suggests that the revaluation of the Chinese yuan significantly reduced imports to the U.S. from China. Chinese exchange rate movements are helpful in reducing the bilateral Sino-U.S. trade imbalance and accordingly in avoiding a possible trade war between the two countries.

This paper joins a growing literature on exchange rates and trade. As introduced by Goldberg and Knetter (1997), there are three related strands in the mainstream literature about exchange rates and goods prices. They cover the pass-through of exchange rates, the law of one price, and pricing-to-market. Feenstra (1989) found that the symmetry hypothesis between tariffs and exchange rates is easily supported using Japanese and U.S. data. This seminal work also suggests that there is a symmetric response of import prices

[1] In this paper I do not consider strategic trade policies used by either the home or foreign country to introduce the "terms of trade" changes. The only reason for terms of trade changes is the stylized fact that the U.S. is the largest economy in the world today.

to changes in import tariffs and bilateral exchange rates.

Regarding the previous research on the Sino-U.S. trade and exchange rate, Thorbecke and Zhang (2006) estimated that the Sino-U.S. real exchange rate in the long run is around a unit. By including China's other main trading partners except the United States, Thorbecke and Smith (2010) rationalized that the appreciation of the RMB helps to reduce the bilateral Sino-U.S. trade imbalance. In particular, a 10% RMB appreciation leads to a decrease of 12% in ordinary exports and 4% in processing exports. The asymmetric effects of RMB appreciation on processing trade and ordinary trade are also explored by Mann and Plueck (2007). Bergin and Feenstra (2008) explored how a change in the share of U.S. imports from a country like China with a fixed exchange rate could affect the pass-through of the exchange rate to import prices in the U.S. By way of comparison, the main aim of the present paper is to determine how movements of the exchange rate affect imports to the U.S. from China when the terms of trade improvement for importers and the incomplete pass-through of the exchange rate are allowed. Last but not least, Yu (2009) suggested that the RMB appreciation against the dollar significantly reduced China's exports to the United States but had no significant effects on China's exports to Japan by using three-stage least-square (3SLS) estimations.

To explore fully the effect of the RMB exchange rate on imports to the U.S. from China, my estimations are based on a theoretical gravity framework; however, I do not attempt to predict the exchange rate's influence theoretically, but rather to use a tightly specified theory to inform the empirical analysis. It turns out that the structural parameters based on the theoretical framework help us to understand the impact of the exchange rate on trade.

The remainder of this paper is organized as follows. Section 2 briefly introduces China's exchange rate reform in the past decade. Section 3 presents a theoretical gravity equation that includes the exchange rate. Section 4 introduces the estimation methodology. Section 5 discusses the estimation results and presents robustness checks. Section 6 concludes the paper.

2 China's Exchange Rate Reform

China claimed to move toward a market economy in 1992. Shortly afterwards, the exchange rate in China was fixed at the level of 8.3 RMB per dollar from 1994. During the East Asian Financial Crisis (1997–1998), many countries depreciated their own currencies to mitigate the negative shocks caused by the crisis. For example, the Thai baht was depreciated by around 40%. In contrast, China insisted on maintaining the value of the RMB at the pre-crisis level. However, in July 2005 the RMB against the dollar was revaluated at 2%. In addition, the RMB was no longer solely pegged to the U.S. dollar. The peg was changed to a basket of currencies, including the U.S. dollar and the Japanese yen, among others. Since then, the Chinese currency has been appreciated to 6.83 RMB per dollar in December 2008, a 20% revaluation.

Why did the Chinese government revalue the RMB in 2005? One important reason was the surging bilateral trade imbalance with the U.S. From 2002 to 2006, the bilateral Sino-U.S. annual trade growth rate was more than 20%. In 2007, China had already replaced Mexico as America's second-largest trading partner when the bilateral trade total (including Hong Kong's re-exports) reached US$318 billion. Simultaneously, China also maintained a huge trade surplus with the U.S. In 2004, the bilateral trade surplus was US$161 billion.

Equally importantly, the Multi-Fiber Agreements, which set an upper bound for textile exports from China to the U.S., were automatically terminated in January 2005 according to the requirements set by the Agreement on Textiles and Clothing (ATC) in the Uruguay Round of the GATT. As a result, China's textile exports to the U.S. increased dramatically. In response to demands by special interest groups, such as labor unions, the U.S. Congress threatened to impose trade sanctions on China if it did not "voluntarily" restrain its exports to the U.S. In order to avoid a further bilateral trade war, the Chinese government agreed to revaluate its RMB against the dollar by 2% on July 21, 2005. In addition, the exchange rate was allowed to fluctuate within a restricted band.

In this paper I focus on how the recent structural change in 2005 has affected the Sino-U.S. bilateral trade. At first glance, as shown in Figure 1, the imports to the U.S. from China kept an increasing trend over the years 2002–2008. Simultaneously, the Sino-U.S. exchange rate, measured as RMB per dollar, has kept declining since July 2005. Motivated by these observations, in the next section, I develop a theoretical framework aimed at exploring the relationship between exchange rate movements and bilateral trade.

[Insert Figure 1 Here]

3 Theoretical Gravity Framework

Following Yu (2010), suppose that each country produces unique product varieties; the export of good h in industry k from country i to the importer (*i.e.*, the U.S.) is identical to the consumption of good h in industry k in the U.S. Exporter $i = 1, ..., I$ has K industries. Industry $k \epsilon K$ produces N_{ik} commodities. The U.S. faces an aggregate CES utility function:

$$U = \int_{i=1}^{I} \int_{k=1}^{K} \int_{h=1}^{N_{ik}} (C_{i,us,k}^{h})^{\rho} dhdkdi, (\rho > 0) \tag{1}$$

where $C_{i,us,k}^{h}$ is American consumption of good h in industry k produced by country i. The elasticity of substitution σ is denoted as $\sigma = 1/(1-\rho)$. Following Anderson and van Wincoop (2003), I assume that, given each exporter i, $p_{i,us,k}^{h} = p_{i,us,k}^{h'}$ for all h and h' in $\{1, ..., N_{ik}\}$, *i.e.*, all the goods in industry k imported by the U.S. from country i have the same price $p_{i,us,k}$.[2] In addition, American consumption is identical over the entire line of products within industry k sold by country i, *i.e.*, $C_{i,us,k}^{h} = C_{i,usk}^{h'} = C_{i,us,k}, \forall h \in \{1, ...N_{ik}\}$. Utility function (1) can then be expressed as:

$$U = \int_{i=1}^{I} \int_{k=1}^{K} N_{ik} (C_{i,us,k})^{\rho} dkdi. \tag{2}$$

The representative consumer in the U.S. maximizes her utility (2) subject to the budget constraint:

$$Y^{us} = \int_{i=1}^{I} \int_{k=1}^{K} N_{ik} p_{i,us,k} C_{i,us,k} dkdi, \tag{3}$$

[2] Note that prices of varieties are allowed to differ *across* industries. This assumption is roughly consistent with the reality: the price of a Chrysler-type automobile is close to that of a Ford, but it is very different from the price of a pencil.

where Y^{us} is the U.S. GDP. By solving this maximization problem, I obtain the demand function for each product:

$$C_{i,us,k} = (p_{i,us,k}/P_k)^{\frac{1}{\rho-1}}(Y^{us}/P_k), \tag{4}$$

where the aggregate American price index, P_k, is defined as:

$$P_k \equiv [\int_{i=1}^{I}\int_{k=1}^{K} N_{ik}(p_{i,us,k})^{\frac{\rho}{\rho-1}}dkdi]^{\frac{\rho-1}{\rho}}. \tag{5}$$

Hence, the total value of American imports from China ($i = ch$) is:

$$X_{us,k}^{ch} \equiv \int_{h=1}^{N_k^{ch}} p_{ch,us,k}^{h} C_{ch,us,k}^{h} dh = N_k^{ch} p_{ch,us,k} C_{ch,us,k}, \tag{6}$$

where the first equality follows the definition of export value, and the second one is due to the equal price assumption across varieties of goods. Combining (4), (5), and (6), I obtain the export value of industry k from China to the U.S.:

$$X_{us,k}^{ch} = N_k^{ch} Y_k^{us}(p_{ch,us,k}/P_k)^{\frac{\rho}{1-\rho}}. \tag{7}$$

However, bilateral trade is also affected by the number of varieties in the exporting country, N_k^{ch}, which is unfortunately unobservable. For estimation, I consider the monopolistic competition model presented originally by Krugman (1979), which helps us to eliminate the number of exporting varieties in my gravity equation (7).

As in Krugman (1979), Baier and Bergstrand (2001), and Feenstra (2002), the representative firm in a country maximizes profits. Specifically, the production of goods (y_k^{ch}) incurs a fixed cost (κ_k^{ch}) and a constant marginal cost (ϕ_k^{ch}) given that labor (l_k^{ch}) is the representative firm's unique input in industry k:

$$l_k^{ch} = \kappa_k^{ch} + \phi_k^{ch} y_k^{ch}. \tag{8}$$

The monopolistically competitive equilibrium implies two conditions for the representative firm. First, the marginal revenue should equal marginal cost for the representative firm. Since the elasticity of demand equals the elasticity of substitution, σ, when China's number of goods N_k^{ch} is large, I obtain the first equilibrium condition:

$$\rho p_k^{ch} = \phi_k^{ch} w^{ch}, \tag{9}$$

where the wage in China is denoted as w^{ch}.

Second, the representative firm obtains zero profits due to free entry. Given that the firm's profit function in China is $\pi_k^{ch} = p_k^{ch} y_k^{ch} - w^{ch}(\kappa_k^{ch} + \phi_k^{ch} y_k^{ch})$, I obtain the equilibrium production level, $\bar{y}_k^{ch}$, for such a representative firm in industry k in China:

$$\bar{y}_k^{ch} = \frac{\rho \kappa_k^{ch}}{(1-\rho)\phi_k^{ch}},$$

where $\bar{y}_k^{ch}$ is a constant number given that ρ, κ_k^{ch} and ϕ_k^{ch} are all constant parameters. By denoting the bilateral exchange rate ($\$/RMB$) as e, the GDP in China measured in dollars is $Y^{ch} = \frac{1}{s_k^{ch}} e N_k^{ch} p_k^{ch} \bar{y}_k^{ch}$ where s_k^{ch} is the output share of industry k in China. Substituting this into (7), I have:

$$X_{us,k}^{ch} = \frac{s_k^{ch} Y^{ch} Y_k^{us}}{e p_k^{ch} \bar{y}_k^{ch}} [p_{ch,us,k}/P_k]^{\frac{\rho}{\rho-1}}. \tag{10}$$

Therefore, bilateral trade depends on the bilateral exchange rate as well as the trading countries' GDP, China's industrial output share, the fixed production of China's representative firm, and various price indices. Note that in (10), I use disaggregated industrial output to measure American income but GDP to measure Chinese income. The reason is that I do not have data on disaggregated Chinese industrial data. For convenience, I include the main notation of the model in Appendix Table 1.

4 Empirical Methodology

To estimate the gravity equation (10), I specify the estimating equation by taking logs on both sides:

$$\ln X_{us,k}^{ch} = \ln(Y^{ch}Y_k^{us}) - \ln e - \ln p_k^{ch} + \ln s_k^{ch} + (1-\sigma)\ln p_{ch,us,k} - (1-\sigma)\ln P_k - \ln \bar{y}_k^{ch}. \quad (11)$$

Like tariffs, the bilateral exchange rate serves as a kind of "iceberg" trade cost across borders (Samuelson, 1952). The RMB appreciation would have a partial pass-through effect on the domestic import prices in the U.S. Put another way, like imposing a tariff on the imports of a large country, the movement of the exchange rate lowers the exporter's (China) prices. We shall consider $p_{ch,us,k} = e(p_k^{ch})^\delta$ where $\delta < 1$ to capture this idea.[3] Note that $p_{ch,us,k}$ is the industrial price on a c.i.f.(cost, insurance, freight) basis whereas p_k^{ch} is the industrial price on a f.o.b.(free on board) basis. By taking the log, we have:

$$\ln p_{ch,us,k} = \alpha_k + \ln e + \delta \ln p_k^{ch} + \mu_{k.} \quad (12)$$

Finally, the constant term, α_k , captures any other bilateral "border" effects that are not specified in (12).

Now I obtain the estimating equation for each period by substituting (12) into (11):

$$\ln X_{us,kt}^{ch} = \ln(Y_t^{ch}Y_{kt}^{us}) - \sigma \ln e_t + (\delta(1-\sigma)-1)\ln p_{kt}^{ch}$$

$$+[(1-\sigma)\alpha_k - \ln \bar{y}_k^{ch} + \ln s_{kt}^{ch} + (\sigma-1)\ln P_{kt} + (1-\sigma)\mu_{kt}]. \quad (13)$$

In this specification, the log directional imports to the U.S. from China, an indicator

[3] Different specifications would not change the estimation results in the following section.

of trade openness, mainly depends on the trading countries' GDP, the bilateral exchange rate, and China's f.o.b. price index ($\ln p_k^{ch}$).

However, in (13), in addition to the unspecified border effects (μ_{kt}), and the representative firm's production in China ($\bar{y}_{kt}^{ch}$), China's industrial output share (s_{kt}^{ch}) is unobservable. In addition, although the American aggregate price index, P_{kt}, in the specification (13) is also unobservable since it depends on the unobservable exporter's number of goods, N_k^{ch}, according to (5), it is still worthwhile to use American producer price index (PPI) to serve as a proxy of American aggregate price index. Instead, all the other terms mentioned above are abstracted from the theoretical sense and may not have good empirical counterparts in the reality.[4] As a result, such terms are absorbed into the error term, ϵ_{kt}, which is as follows:

$$\epsilon_{kt} = (1-\sigma)\alpha_k - \ln \bar{y}_k^{ch} + \ln s_{kt}^{ch} + (1-\sigma)\mu_{kt}.$$

Following Feenstra (1989), the expected exchange rate in each quarter is a log-linear function of the current and past three quarters' average spot rates.[5] Accordingly, I have the following specification for the estimations:

$$\ln X_{us,kt}^{ch} = \beta_0 + \beta_1 \ln Y_t^{ch} + \beta_2 \ln Y_{kt}^{us} + \sum_{l=0}^{3} \beta_{3l} \ln e_{t-l} + \beta_4 \ln p_{kt}^{ch} + \beta_5 \ln P_{kt} + \epsilon_{kt}. \quad (14)$$

Note that in this bilateral trade equation (14) I do not restrict the coefficient of trading countries' GDP as a unit. Instead, the coefficients $\beta_1$and β_2 are allowed to absorb the effects of the trading partners' sizes on bilateral trade in a flexible manner, though the two

[4] I thank a referee for suggesting this point.

[5] Choosing different numbers of past quarterly average spot rates does not substantially change the estimation results.

variables are also moved to the LHS as the denominator of the regressand as a robustness check later.

5 Data, Econometrics, and Results

In this section, I first describe the data sets used in the paper, followed by a discussion of the econometric methods. I then address the possible endogeneity problem. Finally, the section concludes with various robustness checks.

5.1 Data

The sample covers seven years (from the first quarter of 2002 to the last quarter of 2008). The reason for choosing this period is that the imports of the U.S. from China and accordingly the Sino-U.S. bilateral trade increased dramatically after China acceded to the WTO in 2001. The regressand of the estimate is the log of industrial imports from China to the U.S. at the SITC two-digit level. These directional imports are consistent with the prediction of the gravity model, which only considers one-way trade flow (Baldwin and Taglioni, 2006). I also use import data to the U.S. rather than Chinese export data to avoid the imprecise measures due to China's re-export (from Hong Kong) situation (Feenstra and Hanson, 2004). Among the independent variables, the spot exchange rate of the RMB against the dollar is measured by using quarterly average rates. The reason for not adopting the spot rate is to avoid its daily random error (Feenstra, 1989).[6]

Turning to the price data, it is most appropriate to use China wholesale unit-values

[6] As pointed out by Meese and Rogoff (1983) and confirmed by Feenstra (1989), using the quarterly forward exchange rate does not change the results.

f.o.b. prices to determine industrial prices in China. Unfortunately, such data are currently inaccessible. Following Baier and Bergstrand (2001), I therefore use China's industrial price index (PPI) to measure the f.o.b. price.[7] All data used in the present paper are publicly available from the CEIC database.[8] Trading partners' GDP and GDP per capita are measured in constant U.S. dollars. Module A of Table 1 offers a concordance between the SITC two-digit categories and the PPI categories in China. Similarly, Module B of Table 1 provides a concordance between the U.S. output data and trade data at each industrial level.

[Insert Table 1 Here]

Panel A of Table 2 presents descriptive statistics for each variable. There are 1,736 quarterly observations in the Sino-U.S. estimations because 62 industries over 2002–2008 are covered.[9]

[Insert Table 2 Here]

5.2 Main Estimates

Table 3 presents the estimated effects of the value of the RMB in terms of the U.S. dollar on trade. Note that the exchange rate is measured in dollars per RMB in all the

[7] Note that data on PPI should be less volatile and have a lower mean than data on the wholesale unit-values f.o.b. price. As a result, using the PPI data may underestimate the economic magnitude of the price variable. However, one does not need to worry much about that since such a variable serves only as a control variable and is not the main particular interest in the paper. I thank a diligent referee for pointing this out.

[8] CEIC Data Company Ltd. ("CEIC") specializes in providing high quality, comprehensive databases, focusing on Asian economic, industrial and financial time series data. Data source: http://www.ceicdata.com.

[9] Note that there are six missing observations of log US imports from China.

estimations. Therefore, an increase in the exchange rate indicates an appreciation of the RMB. The first column reports the benchmark pooled OLS results. The coefficients of the log GDP for both U.S. and China are positive and significant, which is consistent with the theoretical prediction that larger countries trade more. Trade is directly proportional to trading countries' GDP. The coefficient of China's prices is negative and significant at the conventional level, which implies that increased export prices are associated with decreased exports from China.

More importantly, the negative sign of the bilateral exchange rate clearly suggests that a larger appreciation of RMB (*i.e.*, a higher bilateral exchange rate) leads to lower imports to the U.S. from China. In Column (2), following Feenstra (1989), I include the quarterly lags of exchange rates in the regressions because the previous exchange rates might affect their current bilateral directional trade. It turns out that the coefficient of the log exchange rate in the current period remains stable and is broadly consistent with estimates in Column (1). In contrast, the coefficients of exchange rate half a year and three-quarters of a year ago are significantly positive. I suspect that these unexpected terms are due to the lack of the consideration of fixed effects.

From (13), it is understood that bilateral trade is also affected by the representative firm's output in China ($\bar{y}^k_{us}$), which are unobservable. To control for these unobserved and hence omitted factors, I therefore consider a fixed-effects specification as follows:

$$\epsilon_{kt} = \eta_k + \varphi_{yt} + \varphi_{qt} + t + \nu_{kt},$$

where η_k captures the unobserved, industry-specific, time-invariant fixed-effects, whereas

t is the time trend, φ_{yt} is the year-varying fixed effects, and φ_{qt} is the quarter-varying fixed effects that capture the year (quarter)-variant factors such as the global financial crisis in 2008. However, both the year-varying and quarter-varying fixed effects still do not completely capture the time-specific common factors here.[10] Since the objective of the present paper is to explore how the exchange rate variable, which has no cross-sectional variation and thus can be seen as a common time-variant factor for all industries, affects the Sino-U.S. trade, I am not able to use year–quarter-varying dummies to control completely for the time-varying fixed effect.[11] Instead, I have to rely on both the year-varying and quarter-varying fixed effects, in addition to the regular time-trend variable, and allow the exchange rate variable to pick up the residual effect after controlling for such fixed effects.

In addition, denotes other unspecified idiosyncratic effects. Columns (3)–(4) of Table 3 report the fixed-effect estimation results for (14). The estimated coefficient of the log exchange rate in Column (3) is reduced to -1.524, which implies that a 1 percentage point increase in the value of the RMB leads to a 1.524 percentage point decrease in imports to the U.S. from China. The estimate in Column (4) has a very close coefficient on the exchange rate variable. In addition, it suggests that lags of previous periods in the exchange rate have no significant effects on bilateral trade after controlling for the two-way fixed effects.

[Insert Table 3 Here]

[10] Note that the 12 time-varying dummies included in the regressions here include 8 annual dummies to capture year-varying fixed effects and 4 quarterly dummies to capture the quarter-varying fixed effects, which are much fewer than the 28 year–quarter dummies when a quarter is treated as a unit of time.

[11] I thank a referee for insightfully pointing this out.

5.3 Endogeneity Issues

The bilateral exchange rate is not exogenously given but is indeed affected by the volume of imports to the U.S. from China. In reality there may be a variety of channels through which bilateral trade would reversely affect the bilateral exchange rate. One possible channel is that China's higher trade surplus from the U.S. could increase the U.S. political pressure on China to appreciate the RMB. In early 2005, the termination of the Multi-Fiber Agreement led to a surge in textile exports from China into the U.S. As a result, the Sino-U.S. trade imbalance increased dramatically, which in turn caused special interests groups in the U.S. to demand that the domestic textile producers be protected. To avoid possible trade sanctions from the U.S., the Chinese government agreed to appreciate the RMB against the dollar by 2% in July 2005.[12] Moreover, the RMB was no longer pegged to the U.S. dollar alone but to a basket of currencies. Therefore, the volume of imports to the U.S. from China reversely affected the bilateral exchange rate.

To control for the endogeneity of the bilateral exchange rate, IV estimation is a powerful econometric method.[13] To obtain accurate estimates, I chose China's monetary stock (M1) as the instrument variable to perform the two-step general method of moments (GMM) estimation. The main reason for adopting the GMM was that it requires fewer assumptions about the error terms and has the ability to generate heteroskedasticity-robust standard

[12] Though the Chinese officials would be reluctant to admit that the U.S. diplomacy has a key role to play in the development of the RMB. I thank a referee for correctly pointing this out.

[13] The IV approach is a good way to control the endogeneity issues raised by various possible sources: reverse causality (*i.e.*, simultaneity), omitted variables, and measurement errors. Wooldridge (2002, chapter 5) carefully scrutinizes this topic. Therefore, the IV estimates here control for the endogeneity caused by the reverse causality of the bilateral exchange rate as well as the one caused by the omitted variables in (14).

errors as compared with the general least-squares method (Hall, 2004). I report the estimation results of the second-stage GMM in Columns (5)–(6) of Table 3.

The economic rationale for choosing M1 as an instrument for the exchange rate follows that of Bergin and Feenstra (2008): with a tight monetary policy caused by a decreasing money supply, Chinese interest rates increase. As a result, the surging demand for the RMB pushes its exchange rate up.[14] With a stronger RMB, the Chinese exports to the U.S. are expected to decrease. To validate this instrument variable, I performed several statistical tests.

First, the F-statistic test in the first stage shows that the instrument is highly statistically significant. The F-statistics are also definitely high enough to pass the F-test. Secondly, Columns (5)–(6) of Table 3 were checked to see whether such an exclusive instrument was "relevant", that is, whether it is correlated with the endogenous regressor (*i.e.*, the exchange rate). In my econometric model, the error term is assumed to be heteroskedastic: $\epsilon_{ijt} \sim N(0, \sigma^2_{ij})$. Therefore, the usual Anderson (1984) canonical correlation likelihood ratio test is invalid since it only works under the assumption. Instead, I use the Kleibergen and Paap (2006) Wald statistic to check whether the excluded instrument correlates with the endogenous regressors. The null hypothesis that the model is under-identified is rejected at the 1% significance level.

Thirdly, I test whether or not the instrument (*i.e.*, Chinese M1) is weakly correlated

[14] One caveat here is that China currently still, to some extent, has capital control. A possible related concern is that the historical link between the money supply and the exchange rate may be weak. However, the simple correlation between the two variables in my data set is quite sizable ($corr. = 0.47$), hence the concern mentioned above should not be so severe. I thank a referee for suggesting this check.

with the exchange rate. If so, then the estimates will perform poorly in the IV estimate. The Kleibergen and Paap (2006) F-statistics provide strong evidence to reject the null hypothesis that the first stage is weakly identified at a highly significant level.[15] Finally, both the Anderson and Rubin (1949) statistic (which is an LM test) and the Stock and Wright S statistic (which is a GMM distance test) reject the null hypothesis that the coefficient of the endogenous regressor is equal to zero. In short, these statistical tests provide sufficient evidence that the instrument performs well and therefore the specification is well justified.

Columns (5)–(6) of Table 3 report the estimation results using the Chinese M1 as an instrument. Column (5) suggests that the elasticity of the exchange rate on imports to the U.S. from China is -4.748, which is fairly close to its counterpart in Column (1) without controlling for the endogeneity and fixed effects. However, in Column (6), after controlling for the two-way fixed effects, the estimated magnitude of the log of the exchange rate was reduced to 1.640, which is very close to its counterpart in Column (3), -1.524, without controlling for the endogeneity.

5.4 Additional Robustness Checks

To repeat, China's exchange rate against the U.S. dollar changed after July 2005. Therefore, it is reasonable to suspect that the pass-through of the exchange rate and accordingly its impact on the bilateral trade volume are underestimated when data from before the structural change are included in the model. I therefore re-estimate the effects by including

[15] Note that the Cragg and Donald (1993) F-statistic is no longer valid since it only works under the *i.i.d.* assumption.

only the samples after the 2005 change.

[Insert Table 4 Here]

Table 4 reports the Sino-U.S. estimations for the samples during 2005–2008. Briefly, the point elasticity of bilateral trade with respect to the exchange rate in all the specifications has the same statistically significant signs and close magnitudes to their counterparts shown in Table 3. In particular, in Column (6), after controlling for the endogeneity of the exchange rate and the two-way fixed effects, the appreciation of the RMB was found to have a larger effect ($\hat{\beta}_3 = -1.827$) on reducing Sino-U.S. bilateral trade than the result shown in Column (6) of Table 3: $\hat{\beta}_3 = -1.640$. This ascertains that our previous conjecture that the effect of exchange rate movement on the bilateral trade is underestimated once the sample with a time-invariant exchange rate before 2005 is included.

Moreover, Table 5 includes both countries' GDP per capita in the estimations to check if they have significant effects on bilateral trade as these variables are standard in recent gravity models (*e.g.*, see Rose, 2004; Subramanian and Wei, 2007). In all the estimations, China's GDP per capita has a significant and positive sign whereas the U.S. counterparts are insignificant at the conventional statistical level. Nevertheless, the appreciation of the RMB still has a significantly negative effect on the imports to the U.S. from China in all the specifications.

[Insert Table 5 Here]

5.5 Alternative Measures on Trade and Exchange Rate[16]

As mentioned above, the estimations in the present paper are based on the augmented Anderson and van Wincooop (2003) theoretical model in which the regressand of their empirical specifications is measured as trade flows divided by the product of GDPs. The equilibrium condition for the bilateral trade flow (11) also illustrates this point:

$$\ln(X_{us,k}^{ch}/Y^{ch}Y_k^{us}) = \ln s_k^{ch} - \ln e - \ln p_k^{ch} + (1-\sigma)\ln p_{ch,us,k} - (1-\sigma)\ln P_k - \ln \bar{y}_k^{ch}. \quad (15)$$

Therefore, I perform the estimations by using the trade ratio, which is defined as American imports from China divided by the product of GDPs, as the regressand in Table 6. All the estimated coefficients for the exchange rate in Columns (1)–(3) are highly significant at conventional statistical levels. The OLS estimate in Column (1) suggests that the point elasticity of trade ratio with respect to the exchange rate is −2.414. After controlling for the two-way fixed effects, the effect is reduced to 1.532 as shown in Column (2), which is very close to its counterpart in Column (3) of Table 3: −1.524. A further exploration by including the previous exchange rate realizations does not change the estimation results. The magnitude of the current exchange rate equals −1.501 in Column (3), which again is close to that in Column (2): −1.532. All of these findings suggest that the main message that RMB appreciation leads to low American imports from China is robust regardless of different forms of regressand.

[Insert Table 6 Here]

[16] I am most grateful to two anonymous referees for their insightful suggestions on Subsections 5.5–5.7.

Since the inflation rate in China and the U.S. certainly did not track exactly over 2002–2008, it is worthwhile exploring how the real Sino-U.S. exchange rate affects the American imports from China. Following previous works such as Zhang (2001), I proxy the real exchange rate as the product of the nominal exchange rate (e) and a fraction of the American producer price index (PPI_{US}) in the denominator and China's producer price index (PPI_{CH}) in the numerator:$e \times \frac{PPI_{CH}}{PPI_{US}}$. The OLS estimates in Column (4) and the fixed-effects estimates in Column (5) of Table 6 suggest that real exchange rate appreciation leads to low American imports from China. These results are still robust even when the three-quarter lags of real exchange rate realizations are included, as shown in Column (6).

5.6 Additional Estimates with Other Competing Trading Partners

As highlighted by Anderson and van Wincooop (2003), to estimate the gravity model precisely, it is essential for researchers to control for the "multilateral resistance". The basic idea is that the bilateral trade flow is not simply affected by the two trading countries' economic factors but is also affected by factors from all other trading countries. That is, trade volumes are determined by relative export barriers but not by absolute trade barriers. Although the theoretical model above suggests that the American imports from China explicitly depend on the U.S. and Chinese incomes, the Sino-U.S. exchange rate, and the prices of traded goods in China and the U.S., it also implies that the American imports from China are also affected by imports from other countries.[17] In fact, it is

[17]To see this point, note that the American aggregate industrial price index in the derived gravity equation (11) depends on many exporters' numbers of varieties, as shown in (5).

possible that the American imports from China are affected by its imports from some Asian countries that have patterns of exports similar to China.[18] Indeed, the exchange rates in such countries also adjust after the dollar depreciation against the RMB. Therefore, it is worthwhile seeing how the variation of such an American exporters' exchange rate as well as that of the RMB vis-à-vis the US dollar affect the U.S. imports.

To address this concern, I include data of Indonesia, Japan, Korea, Thailand, and Vietnam as well as China in the sample.[19] Their basic statistics are reported in Module B of Table 1. Hence, my cross-country sample increases from 1,730 to 6,305. Column (1) of Table 7 reports the OLS estimation results, which suggest that the RMB appreciation against the U.S. dollar decreases the ratio of American imports from such Asian trading partners (*i.e.*, the U.S. imports over the product of the 2 trading countries' GDPs). The negative sign of the exchange rate variable still remains statistically significant even by including the past exchange rate realizations, as shown in Column (2).

To control effectively for the "multilateral resistance" effect in the gravity estimations, following Baldwin and Taglioni (2006), Column (3) performs the estimates with the *time-varying country-specific* fixed effects as well as the regular industry-specific fixed effects. Since the panel in my sample includes 6 American trading countries with 28 time spans, I generate 168 (*i.e.*, 6×28) dummies for unidirectional trade data (*e.g.*, exports from China to the U.S.) in addition to the regular industy-specific fixed effects. It turns out that a

[18] I thank a referee for insightfully suggesting this point.

[19] Here data of Hong Kong are not included since Hong Kong kept a fixed exchange rate against the U.S. dollar over time and hence it is impossible to explore the effects of the movement of the exchange rate on bilateral trade.

10% appreciation of the exporter's exchange rate is associated with an 11% decrease in the ratio of U.S. imports from such countries. This finding is insensitive once the 3-period past exchange rate realizations are included in the estimations, as shown in Column (4). Finally, Columns (5)–(6) examine the effect of real exchange rate movement on the import ratio of the U.S. from such trading countries. The OLS estimate in Column (5) suggests that real exchange appreciation significantly reduces the U.S. imports from such Asian trading partners.

[Insert Table 7 Here]

5.7 Further Estimates on Sectoral Heterogeneity

In all the estimations above, the exchange rate variable varies over years but does not change across industries. The homogeneity assumption on the exchange rate coefficient may be acceptable if the aggregate trade flow is of interest. However, the exchange rate pass-through, as a function of market (pricing) power, would vary considerably across industries. Hence, it is important for us to study the heterogenous effect of the exchange rate on the industry-level bilateral trade.

The common correlated effects (CCE) approach is a good way to identify such heterogenous effects of the exchange rate across industries. As introduced by Pesaran (2006), the basic idea is to filter the industry-specific regressors by means of cross-section averages. In this way, as the number of industries becomes larger and larger, the differential effects of unobserved common factors converge to zero asymptotically. In particular, the CCE estimator is obtained by two steps following Eberhardt and Teal (2009). First, I perform

62 OLS estimations by each industry i and obtain its coefficients $\hat{\mathbf{b}}_i$. Secondly, the CCE estimators are those averaged across sectors: $\hat{\mathbf{b}}_{CCE} = \sum_i \hat{\mathbf{b}}_i/62$.

Table 8 reports the estimation results by using this common factor approach to spatial heterogeneity. Columns (1)–(3) use the U.S. imports from China as the regressand. The point elasticity of bilateral imports with respect to the exchange rate is -1.148 in Column (1), which is quite close to the fixed-effect estimate in Column (4) of Table 3: -1.483. Such magnitudes do not vary much either when trading partners' per capita GDPs are included or when past exchange rate realizations are taken into account. By way of comparison, Columns (4)–(6) adopt the import ratio divided by the product of trading countries' GDPs as the regressand. It turns out that the CCE estimator of the exchange rate is $-.964$ in Column (4). Its magnitudes increase once the trading partners' per capita GDPs are considered in Column (5) or past exchange rate realizations are included in Column (6). Nevertheless, in any case, all the CCE estimates suggest that the appreciation of the RMB against the dollar significantly reduced the imports to the U.S. from China.

[Insert Table 8 Here]

6 Concluding Remarks

In this paper, I investigate the effect of the RMB appreciation on imports to the U.S. from China using industrial panel data from 2002 to 2008. Differently from other pure reduced-form estimations, my estimations are guided by an augmented theoretical gravity model. Structural parameters based on a theoretical framework will help us to understand the magnitude of RMB revaluation on Sino-U.S. bilateral trade. The estimation results clearly suggest that the RMB appreciation against the dollar significantly reduced imports to the U.S. from China. These findings are robust to different econometric methods and different data periods.

This finding has policy implications. Firstly, if appreciation of the RMB does significantly reduce the Sino-U.S. bilateral trade imbalance, then it would have the beneficial effect of relieving the trade tensions between the two giants. Secondly, RMB appreciation would make it more difficult for Chinese exporters to export to the U.S. *ceteris paribus*, which in turn would require Chinese exporting firms to make every effort to boost their productivity to survive in the global competition.

Several extensions and possible generalizations merit special consideration. One of them is to replace the industrial price index with actual unit-value f.o.b. prices, if the data are available. In this manner, the exchange rate pass-through can be more precisely identified. Another possible extension is to include import tariffs in the model and to examine the symmetry hypothesis between the exchange rate and the tariffs. Due to the data constraint, I am not able to explore these issues here. However, these are the topics that I will pursue in future work.

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Table 1: Concordance of Industries

Module A: Concordance between China's PPI and Trade Sectors

Name for PPI Sectors	Sectoral Code for the Sino-US Trade
Metallurgical	20,42,43,44,45,66
Coal	16,22
Petroleum	23,24
Chemical	19,28,29,30,32,33,34,35,36,38
Machine Manufacturing	46,47,48,49,50,51,52,53,54
Building Materials	55,56
Timber	15,39
Food	1,2,3,4,5,6,7,8,9,10,11,12,14,21,25,26,27,31
Textile	18,41
Tailoring	57,58,59
Leather	13,37
Paper	17,40
Cultural, Educational & Handicrafts Article	60,61

Module B: Concordance between US Industrial Sectors and Trade Sectors

Name of US Industrial Sectors	Sectoral Code for the Sino-US Trade
Agriculture, Forestry, Fishing & Hunting	1,2,3,4,5,6,7,8,9,13,14,16,21
Mining	20
Wood Products	39
Nonmetallic Mineral Products	42
Primary Metals	43,44
Fabricated Metal Products	45,55
Machinery	46,47, 48,49
Computer & Electronic Products	50,51
Electrical Equipment, Appliances	52
Motor Vehicles and Parts	53
Other Transportation Equipment	54
Furniture and Related Products	56
Miscellaneous Manufacturing	60,61,62
Food & Beverage & Tobacco Products	10,11,12,25,26,27
Textile Mills & Textile Product Mills	18,41
Apparel, Leather & Allied Products	37,57,58,59
Paper Products	17,40
Printing & Related Support Activities	30
Petroleum and Coal Products	15,22,23,24
Chemical Products	19,28,29,31,32,33,36
Plastics & Rubber Products	34,35,38

Note: In Module A the power industry is not included here since it is not involved in the Sino-US. bilateral trade.

Table 2: Summary Statistics

Panel A: Basic Statistics for Sino-US Trade (2002-2008)

Variables	Obs.	Mean	Std. Dev.	Min	Max
Log US Imports from China	1,730	1.893	1.255	-2.698	4.187
Log GDP of the USA (million)	1,736	6.495	.047	6.419	6.560
Log GDPPC of the USA	1,736	-1.954	.047	-2.031	-1.893
Log GDP of China	1,736	5.745	.190	5.408	6.132
Log GDPPC of China	1,736	2.652	.150	2.319	2.912
Log China's PPI	1,736	1.992	.120	1.436	2.496
Log PPI of the USA	1,736	2.181	.080	1.929	2.420
Log Exchange Rate ($\$/RMB$)	1,736	-.882	.096	-.917	-.398
1-Lag of Log Exchange Rate ($\$/RMB$)	1,674	-.901	.024	-.917	-.835
2-Lag of Log Exchange Rate ($\$/RMB$)	1,612	-.903	.020	-.917	-.842
3-Lag of Log Exchange Rate ($\$/RMB$)	1,550	-.906	.017	-.917	-.855
Log China's Monetary Base (M1)	1,736	7.008	.128	6.774	7.220
1-Lag of Log China's Monetary Base	1,674	3.992	.125	3.775	4.192
2-Lag of Log China's Monetary Base	1,612	3.985	.121	3.775	4.189
3-Lag of Log China's Monetary Base	1,550	3.977	.116	3.775	4.178
Year	1,736	2005	2.000	2002	2008
Quarter	1,736	2.5	1.118	1	4
Industrial Code for Sino-US Trade	1,736	31.4	17.900	1	62

Panel B: Basic Statistics for US Imports from 7 Asian Countries (2005-2008)

Variables	Obs.	Mean	Std. Dev.	Min	Max
Log US Imports	6,319	1.314	1.386	-3	4.623
Log GDP of the USA (million)	6,720	3.495	.047	3.419	3.560
Log GDPPC of the USA	6,720	4.027	.039	3.963	4.080
Log GDP of Exporters	6,720	2.339	.538	.939	3.132
Log GDPPC of Exporters	6,460	3.557	.463	2.031	3.980
Log PPI of Exporters	6,584	2.019	.057	1.978	2.415
Log PPI of the USA	6,720	2.166	.050	2.095	2.273
Log Exchange Rate ($ per local currency)	6,720	-2.351	.876	-4.229	-.833
1-Lag of Log Exchange Rate	6,652	-2.285	.842	-4.229	-.833
2-Lag of Log Exchange Rate	6,585	-2.299	.847	-4.229	-.833
3-Lag of Log Exchange Rate	6,519	-2.296	.847	-4.229	-.833
Log Exporters' Monetary Base (M1)	6,720	4.143	1.158	2.502	5.680
1-Lag of Log Exporters' Monetary Base	6,549	4.071	1.159	2.502	5.680
2-Lag of Log Exporters' Monetary Base	6,486	4.080	1.164	2.502	5.680
3-Lag of Log Exporters' Monetary Base	6,423	4.080	1.162	2.502	5.680
Year	6,720	2005	2.000	2002	2008
Quarter	6,720	2.5	1.118	1	4
Industrial Code for Sino-US Trade	6,720	31.4	17.900	1	68

Table 3: Effects of RMB Revaluation on the Imports to the U.S. from China (2002-2008)

Imports to the U.S. from China	OLS				IV	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Exchange Rate ($\$/RMB$)	-4.647**	-4.442**	-1.524**	-1.483**	-4.748**	-1.640**
	(-8.03)	(-7.34)	(-9.84)	(-9.37)	(-2.56)	(-2.15)
Log Exchange Rate (1-Lag)		.353		.214	-.678	.510
		(1.19)		(1.17)	(-.16)	(.07)
Log Exchange Rate (2-Lag)		.609**		.204	-.996	.036
		(2.05)		(1.24)	(-.16)	(.04)
Log Exchange Rate (3-Lag)		.719**		.198	-.331	.096
		(2.31)		(1.60)	(-.08)	(.15)
Log China's Price Index	-3.265**	-3.144**	-.321**	-2.71*	-3.344**	-.403
	(-7.03)	(-6.33)	(-2.31)	(-1.95)	(-4.37)	(-.71)
Log US Price Index	-4.580**	-4.789**	.795**	1.103**	-4.719**	1.145**
	(-11.35)	(-11.82)	(4.83)	(5.92)	(-9.50)	(4.22)
Log GDP of U.S.	8.223**	8.363**	2.322	-1.043	17.245	1.838
	(4.35)	(4.28)	(1.34)	(-.29)	(.20)	(.13)
Log GDP of China	.899*	.516	.831	.356	5.015	.778
	(1.84)	(1.01)	(1.06)	(.34)	(.24)	(.23)
Time Trend			-.005	.018	-.635	-.068
			(-.27)	(.66)	(-.22)	(-.15)
Year-specific Fixed Effects	No	No	Yes	Yes	No	Yes
Quarter-specific Fixed Effects	No	No	Yes	Yes	No	Yes
Industry-specific Fixed Effects	No	No	Yes	Yes	No	Yes
First-stage F-statistics					56.28†	21.46†
Kleibergen-Paap rk LM Statistic					38.24†	28.76†
Kleibergen-Paap rk Wald Statistic					46.85†	29.32†
Anderson-Rubin χ^2 Statistic					8.49†	5.27
Stock-Wright LM S Statistic					8.21†	5.25
Prob.>F or Prob.>χ^2	.000	.000	.000	.000	.000	.000
Number of Observations	1,730	1544	1730	1544	1544	1544
R^2	.165	.172	.531	.507	.174	.506

Notes: numbers in parenthesis are t-values. *(**) indicates significance at 1 (5) percent level. ‡ indicates that the p-value of the statistic is less than 0.01.

Table 4: Effects of RMB Revaluation on the Imports to the U.S. from China (2005-2008)

American Imports from China	OLS				IV	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Exchange Rate ($\$/RMB$)	-4.383**	-4.249**	-1.534**	-1.530**	-3.917**	-1.827**
	(-6.18)	(-.601)	(-9.42)	(-8.79)	(-2.62)	(-3.20)
Log Exchange Rate (1-Lag)		.215		.211	-.225	.295
		(.67)		(1.01)	(-.09)	(.81)
Log Exchange Rate (2-Lag)		.426		.177**	-.066	.194
		(1.33)		(2.12)	(-.02)	(.44)
Log Exchange Rate (3-Lag)		.525		.159	.172	.177
		(1.58)		(.97)	(.07)	(.50)
Log China's Price Index	-2.732**	-2.785**	-.313**	-.306**	-2.776**	-.503
	(-4.79)	(-4.82)	(-2.18)	(-2.12)	(-3.50)	(-1.04)
Log US Price Index	-4.235**	-4.304**	1.470**	1.445**	-4.322**	1.373**
	(-9.32)	(-9.58)	(4.71)	(4.53)	(-9.09)	(3.30)
Log GDP of U.S.	10.274**	8.338**	2.052	-2.129	9.713	-3.805
	(3.03)	(2.25)	(.99)	(-.44)	(.18)	(-.50)
Log GDP of China	1.009	.796	1.350	1.052	.185	2.379
	(1.61)	(1.24)	(1.16)	(.45)	(.01)	(.79)
Time Trend			-.17	.002	-.017	-.233
			(-.66)	(.04)	(-.01)	(-.60)
Year-specific Fixed Effects	No	No	Yes	Yes	No	Yes
Quarter-specific Fixed Effects	No	No	Yes	Yes	No	Yes
Industry-specific Fixed Effects	No	No	Yes	Yes	No	Yes
First-stage F-statistics					89.49†	37.46†
Kleibergen-Paap rk LM Statistic					174.99†	52.51†
Kleibergen-Paap rk Wald Statistic					170.37†	55.66†
Anderson-Rubin χ^2 Statistic					8.59†	14.79†
Stock-Wright LM S Statistic					8.17†	14.56†
Prob.>F or Prob.>χ^2	.000	.000	.000	.000	.000	.000
Number of Observations	990	990	990	990	990	990
R^2	.166	.169	.456	.457	.170	.455

Notes: numbers in parenthesis are t-values. *(**) indicates significance at 1 (5) percent level. ‡ indicates that the p-value of the statistic is less than 0.01. Here quarter-specific fixed effects instead of year-specific fixed effects are included.

Table 5: More Robustness Checks for the Imports to the U.S. from China (2002-2008)

Imports to the U.S. from China	OLS		FE		IV
	(1)	(2)	(3)	(4)	(5)
Log Exchange Rate ($\$/RMB$)	-4.832**	-4.508**	-1.687**	-1.657**	-7.200*
	(-7.79)	(-6.98)	(-10.13)	(-9.51)	(-1.89)
Log Exchange Rate (1-Lag)		-.035		.203	
		(-.10)		(1.03)	
Log Exchange Rate (2-Lag)		.274		.191	
		(.74)		(1.15)	
Log Exchange Rate (3-Lag)		.380		.190	
		(1.09)		(1.37)	
Log China's Price Index	-3.522**	-3.245**	-.453**	-.408**	-4.626**
	(-7.15)	(-6.35)	(-3.09)	(-2.77)	(-2.54)
Log US Price Index	-4.630**	-4.781**	.827**	1.125**	-4.371**
	(-11.62)	(-11.83)	(5.02)	(6.05)	(-7.58)
Log GDP of U.S.	2.178	-.030	-1.771	-2.392	33.918
	(.10)	(-.00)	(-.33)	(-.37)	(.62)
Log GDP of China	.364	.198	1.169	.724	1.294
	(.50)	(.26)	(1.47)	(.67)	(.78)
Log GDP per capita of U.S.	-2.829	-.001	3.020	.980	-22.650
	(-.20)	(-.00)	(.76)	(.19)	(-.66)
Log GDP per capita of China	1.915*	1.341	1.249**	1.202**	2.454*
	(1.74)	(1.03)	(2.83)	(2.77)	(1.71)
Time Trend	.030	.037	-.029	-.009	
	(.46)	(.45)	(-1.36)	(-.32)	
Year-specific Fixed Effects	No	No	Yes	Yes	No
Quarter-specific Fixed Effects	No	No	Yes	Yes	No
Industry-specific Fixed Effects	No	No	Yes	Yes	No
First-stage F-statistics					39.10†
Kleibergen-Paap rk LM Statistic					37.35†
Kleibergen-Paap rk Wald Statistic					39.29†
Anderson-Rubin χ^2 Statistic					3.46†
Stock-Wright LM S Statistic					3.43†
Prob.>F or Prob.>χ^2	.000	.000	.000	.000	.000
Number of Observations	1730	1544	1730	1544	1730
R^2	.171	.174	.533	.509	.161

Notes: numbers in parenthesis are t-values. *(**) indicates significance at 1 (5) percent level. ‡ indicates that the p-value of the statistic is less than 0.01.

Table 6: Alternative Measures on Bilateral Trade and Exchange Rate

Regressand: $\log(X_{US}^{CH}/Y_{CH}Y_{US})$	Nominal Exchange Rate			Real Exchange Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Exchange Rate ($\$/RMB$)	-2.414**	-1.532**	-1.501**	–	–	–
	(-126.30)	(-10.17)	(-9.98)			
Log Real Exchange Rate ($\frac{\$}{RMB}\frac{PPI\_CH}{PPI\_US}$)	–	–	–	-.178	-.556**	-.518**
				(-.42)	(-4.23)	(-2.61)
Log (Real) Exchange Rate (1-Lag)			.123			-.308
			(1.37)			(-1.21)
Log (Real) Exchange Rate (2-Lag)			.100			.352
			(1.15)			(1.36)
Log (Real) Exchange Rate (3-Lag)			.132			-.149
			(1.58)			(-.60)
Log China's Price Index	-2.651**	-.323**	-.268*	–	–	–
	(-11.17)	(-2.34)	(-1.93)			
Log US Price Index	-4.623**	.802**	1.107**	–	–	–
	(-11.55)	(4.88)	(5.95)			
Time Trend	-.041**	-.001	-.006**	-.007**	-.003**	-.006**
	(9.21)	(-1.17)	(-2.77)	(-1.99)	(-3.14)	(-4.58)
Year-specific Fixed Effects	No	Yes	Yes	No	Yes	Yes
Quarter-specific Fixed Effects	No	Yes	Yes	No	Yes	Yes
Industry-specific Fixed Effects	No	Yes	Yes	No	Yes	Yes
Prob.>F or Prob.>χ^2	.000	.000	.000	.100	.000	.000
Number of Observations	1,730	1,730	1,544	1,730	1,730	1,730
R^2	.157	.356	.398	.003	.219	.247

Notes: X_{US}^{CH} denotes imports to the U.S. from China. Numbers in parenthesis are t-values. *(**) indicates significance at 1 (5) percent level.

Table 7: Bilateral Estimates with other Asian Countries

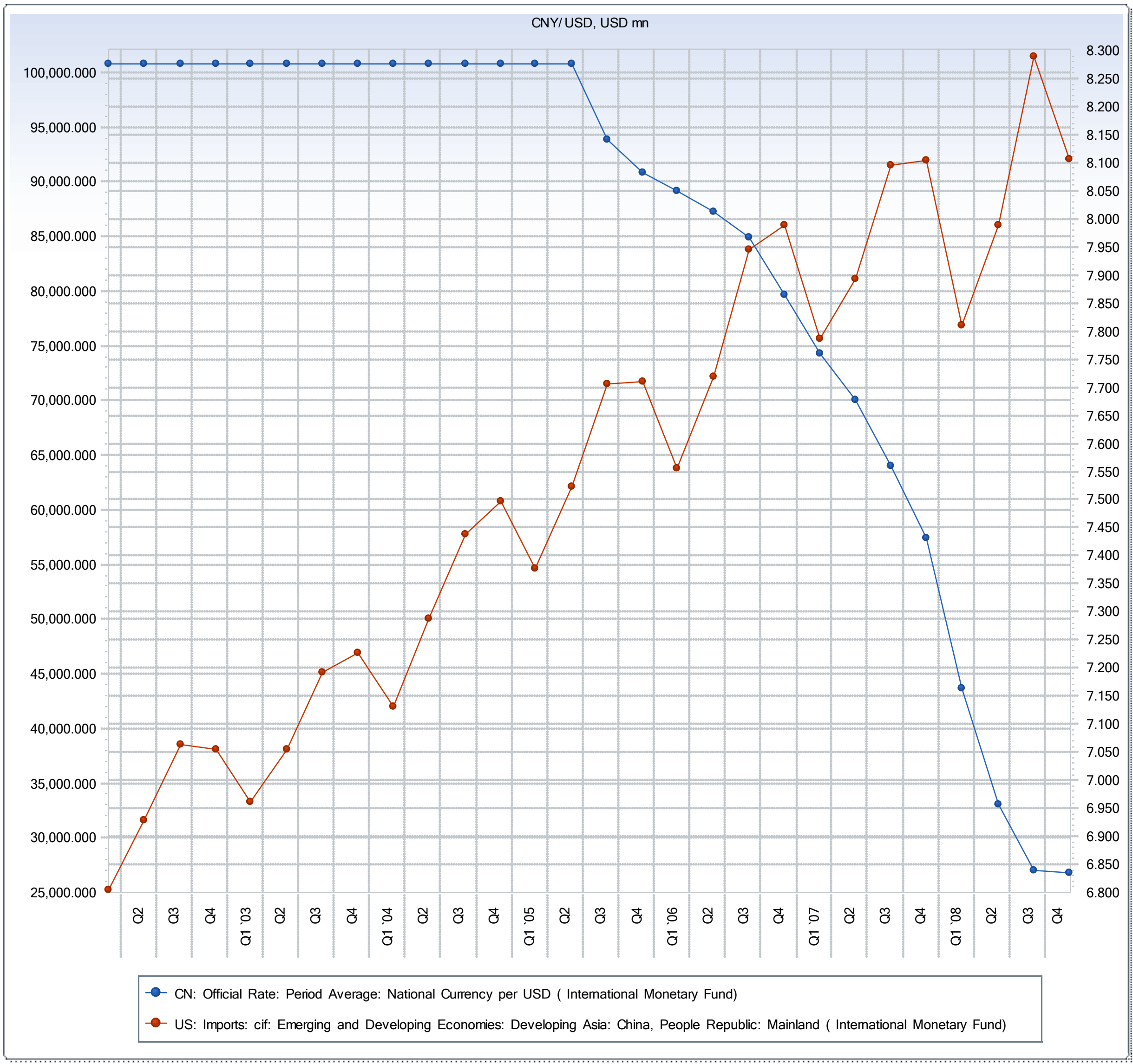
Regressand: $\log(X^i_{US}/Y_iY_{US})$	OLS		FE		OLS
	(1)	(2)	(3)	(4)	(5)
Log Exchange Rate (e_i)	-2.036**	-1.158**	−1.102**	-1.116**	–
	(-70.14)	(-37.71)	(-2.86)	(-2.83)	
Log Real Exchange Rate ($e_i\frac{PPI}{PPI\_US}$)	–	–	–	–	-2.107**
					(-89.58)
Log Exchange Rate (1-Lag)		-.662**		-.001	.064**
		(-22.93)		(-.003)	(2.17)
Log Exchange Rate (2-Lag)		-.673**		-.019	.038
		(-23.90)		(-1.19)	(1.29)
Log Exchange Rate (3-Lag)		-.646**		-.021	-.019
		(-22.37)		(-1.05)	(-.65)
Log Exporter's Price Index	.262	.578*	.745	.641	–
	(.70)	(1.88)	(.39)	(.34)	
Log US Price Index	-3.760*	-2.863*	.614	.477	–
	(-8.62)	(-7.89)	(.43)	(.33)	
Time-varying Country Fixed Effects	No	No	Yes	Yes	No
Industry-specific Fixed Effects	No	No	Yes	Yes	No
Prob.>F or Prob.>χ^2	.000	.000	.000	.000	.000
Number of Observations	6,305	5,986	6,305	5,986	5,902
R^2	.538	.670	.796	.649	.520

Notes: X^i_{US} denotes imports to the U.S. from exporter i. The exporters here include China, Indonesia, Japan, Korea, Thailand, and Vietnam. Numbers in parenthesis are t-values. Here exchange rate (e_i) is defined as dollar per exporter i's currency. There are 168 (*i.e.*, 6*28) time-varying country dummies and 68 industrial dummies in the FE estimations. *(**) indicates significance at 1 (5) percent level.

Table 8: Common Factor Estimations to Spatial Heterogeneity

Regressand:	$\log X_{US}^{CH}$			$\log(X_{US}^{CH}/Y_{CH}Y_{US})$		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Exchange Rate (e)	-1.148**	-1.164	-1.085	-.964**	-3.249**	-3.610**
	(-3.90)	(-1.28)	(-1.12)	(-3.08)	(-5.60)	(-4.68)
Log Exchange Rate (1-Lag)			.069			-.125
			(.44)			(-.90)
Log Exchange Rate (2-Lag)			.359**			.193*
			(2.98)			(1.75)
Log Exchange Rate (3-Lag)			.172**			.045
			(2.21)			(.28)
Log GDP of U.S. (Y_{US})	1.248	1.892	-3.499	–	–	
	(.80)	(.57)	(-.78)			
Log GDP of China (Y_{CH})	.063	.188	.096	–	–	
	(.64)	(.89)	(.43)			
Log China's Price Index	.073	.034	.001	.419	-1.945**	-2.407**
	(.23)	(.04)	(.00)	(1.22)	(-3.56)	(-3.30)
Log US Price Index	1.881**	2.238**	2.299**	1.234*	2.537**	3.293**
	(2.87)	(3.15)	(2.39)	(1.89)	(3.41)	(3.14)
Log US GDP per capita		-1.507	1.213		-.376	-.063
		(-.69)	(.46)		(-.34)	(-.05)
Log China's GDP per capita		.301	-.147		2.055**	2.337**
		(.38)	(-.21)		(4.56)	(6.09)
Time Trend	.011	.003	.028*	-.008**	-.036**	-.040**
	(1.19)	(.24)	(1.81)	(-2.48)	(-4.36)	(-3.51)
Number of Industry	62	62	62	62	62	62
Number of Observations	1,736	1,736	1,736	1,736	1,736	1,736

Notes: X_{US}^{CH} denotes imports to the U.S. from China. Numbers in parenthesis are t-values. *(**) indicates significance at 1 (5) percent level.



Data Source: CEIC Database

Figure 1: The American Imports from China and The RMB Appreciation Trajectory (2002-2008)

Appendix Table 1: Main Notation for the Models

Symbol	Definition
	Panel A: Theoretical Framework
$C^{h}_{i,us,k}$	Amount of goods h of industry k produced in country i and consumed in the U.S.
N_{ik}	Number of goods of industry k produced in country i
σ	Elasticity of substitution, $\sigma > 1$
e	Sino-U.S. Bilateral exchange rate ($\$/RMB$)
Y^{ch}	Level of GDP in China
Y^{us}_{k}	Output level of industry k in the U.S.
$p_{ch,us,k}$	Price of industry k on an American c.i.f. (cost, insurance, freight) basis
$p_{ch,k}$	Price of industry k on a f.o.b. (free on board) basis
$X^{ch}_{us,k}$	Value of exports of industry k from China to the U.S.
P_{k}	American aggregate price index of industry k
w^{ch}	Wages in China
l^{ch}_{k}	Labor input for the representative firm of industry k in China
y^{ch}_{k}	Output of China's representative firm of industry k , which is a fixed number in equilibrium: $y^{ch}_{k} = \bar{y}^{ch}_{k}$
κ^{ch}_{k}	Fixed cost for the representative firm of industry k in China
s^{ch}_{k}	Industry k's output share in China
ϕ^{ch}_{k}	Constant marginal cost for the representative firm of industry k in China
	Panel B: Empirical Specification
α_{k}	Unspecified industrial bilateral border effect
ϵ_{kt}	Error term in Specification (13)
η_{k}	Industry-specific random variable
φ_{yt}	Year-specific random variable
φ_{qt}	Quarter-specific random variable
υ_{kt}	Industrial idiosyncratic random variable