PRELIMINARY DRAFT. NOT FOR QUOTATION

Third-Market Effects of Exchange Rates: A Study of the Renminbi[†]

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Abstract

This paper estimates the effects of China's exchange rate changes on exports of competitor countries in third markets. We derive an econometric specification which includes product and destination-specific indices of competition between China and its developing country competitors. Our empirical strategy allows us to exploit the variation--afforded by disaggregated trade data--across exporters, importers, product, and time to estimate the "third-market effect". We find robust evidence for a statistically and quantitatively significant effect of China's exchange rate on competitor country exports. In particular, a country's exports of products that compete more closely with China tend to increase significantly more when the Chinese exchange rate appreciates. Our estimates suggest that a 10 percent appreciation of China's real exchange rate can boost on average a developing country's exports of a typical 4-digit HS product category to third markets by 1-2 percent. The magnitude of the third-market effect is consistent with the underlying theoretical model.

Keywords: exchange rates, trade, China

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I. Introduction

Exchange rates are a perennial source of discussion and analysis, and one of the oldest subjects in international macroeconomics. But the vanes to taste do veer, and do so cyclically in terms of which aspects of exchange rates elicit attention and scrutiny. In the 1930s, under conditions of idle resources and weak demand, the competitive consequences of exchange rates were prominent, especially as many advanced countries successively went off the gold standard. In the 1970s and 1980s, as high inflation became one of the central issues in macroeconomic policy making, exchange rates were increasingly used as anchors for inflation. Periodic financial crises, however, highlighted the role of fixed exchange rates in contributing to such crises particularly in the context of free capital mobility; with many countries starting to move towards flexible exchange rates. In the 2000s, the cycle seems complete with the competitive consequences of exchange rates back in the limelight.

For example, since the Asian financial crisis of the late 1990s, a number of emerging market countries have used exchange rates to self-insure against financial crises and to promote economic growth. Mercantilism, based on undervalued exchange rates, has come back into vogue, described by some as the hallmark of the new era of Bretton Woods II (Dooley et. al.; 2003). Simultaneously, contributions emerged about the possible long run effects of undervalued exchange rates, notably Rodrik (2010) and Johnson et al. (2010).[1] But these and other

[1] Note that the recent contributions on the growth effects of mercantilism have a historical counterpart in the experience of the 1930s described in Robinson (1947). But the difference is that the 1930s experience related to "macroeconomic mercantilism" — the short-run use of exchange rate during periods of slack resources—whereas the more recent contributions stress the medium-run benefits of undervalued exchange rates.

contributions have largely focused on the impacts of exchange rate policies on the countries themselves.[2]

There appears to be less evidence and quantification of the effect of exchange rates on the exports of *other* countries, the spillover effect that is sometimes called the "beggar-thy-neighbor" effect. In this paper, we take a first step toward estimating this spillover effect. We focus on the impact of movements in China's exchange rate on other developing countries.

The case of China presents an excellent opportunity to study this question. China, by virtue of being the world's largest exporter of goods, is guaranteed to have quantitatively more significant competitive consequences for other countries than nearly any other exporter. This is reinforced by the fact that China is also a highly diversified exporter so that it potentially competes with a broad range of countries and across the product spectrum.[3]

In part, reflecting China's dominant size and encompassing scope, its exchange rate policy has been one of the most controversial aspects of international macroeconomics during the 2000s. Ever since the "global savings glut" hypothesis (Bernanke 2005) gained credence as an explanation of global imbalances and as a contributor to the global financial crisis that began in 2008, China's exchange rate policy is being seen as one of the drivers of the global savings glut.[4]

[2] This is generally true of the older, voluminous literature on the trade consequences of exchange rates (Goldstein and Khan (1985) provides a survey and other contributions include Deardorff (1984); Hooper, Johnson and Marquez (2000); Thursby and Thursby (1987)). It is also true of the more recent micro-literature (Dekle and Royoo (2002); Das, Roberts and Tybout (2001); Forbes (2002); Berman, Martin and Mayer (2011)).

[3] So diversified is China's export basket that one might even say it is the only country that has comparative advantage in all products.

[4] The Global Saving Glut and the U.S. Current Account Deficit, Federalreserve.gov. March 10, 2005, Sandridge Lecture, Virginia Association of Economists, Richmond, Virginia,http://www.federalreserve.gov/boarddocs/speeches/2005/200503102/.

Also, over the last two years, with considerable slack in industrial countries, reflected in high unemployment rates and low capacity utilization, the Chinese exchange rate has been criticized for aggravating the demand shortfall in these countries. One estimate, for example, by the Economic Policy Institute, which has been cited by Paul Krugman among others, suggests that if the renminbi were revalued to its equilibrium level, U.S. gross domestic product would increase by nearly 2 per cent, creating up to 2.25 million U.S. jobs (Scott, 2011).

Viewing China's exchange rate policy solely through the prism of global imbalances or industrial country difficulties has obscured an important issue, namely whether it has an effect on other developing countries which compete with China. The trade consequences of China's exchange rate policy is likely to be greater for developing countries than for industrial ones because they compete more closely with China than the United States and Europe, whose areas of comparative advantage are very different from China's.[5]

But while there is a burgeoning literature on China's trade and exchange rates, there is very little evidence on the effect of China's exchange rate on the exports of other developing countries. The existing literature has mostly used a gravity framework augmented with China's exports (e.g. Eichengreen, Ree and Tong (2004), and Ahearne et. al. (2003)) and finds some evidence that Chinese exports crowd out other Asian exports. Recently, Eichengreen and Tong (2011) have estimated the effect of renminbi revaluation on stock market valuations of foreign firms. They

[5] As we show below in Section IV, on average, if a developing country exports a particular good to a particular destination, there is close to 90 percent probability that China will do the same.

find that renminbi appreciation has positive effects on firms competing with China, which is consistent with the findings in this paper.[6]

Our paper contributes to this literature by quantifying the spillover effects of changes in the renminbi on other developing countries. To be more specific: if China's exchange rate depreciates, it affects another country, say Brazil in its own market, in China's market and in the market of third countries to which both Brazil and China export. First, a depreciation of the renminbi will *increase* Chinese exports to Brazil because it is akin to a subsidy to Chinese exporters. Brazil's consumers might benefit from cheaper Chinese goods but Brazilian producers of goods that compete with China will lose (effect on Brazilian producers *in their own market*). Second, a renminbi depreciation will *reduce* Brazilian exports to China because the renminbi depreciation will serve as an import tariff in the Chinese market shielding Chinese producers from Brazilian goods (effect on Brazilian producers *in China's markets*).[7] Finally, a renminbi depreciation will increase Chinese exports to third markets, displacing Brazilian exports, because a depreciation offers a subsidy to Chinese exporters which advantages them vis-à-vis Brazilian exporters (effect on Brazilian producers *in third markets*). We call this latter the "third-market effect" and it is this effect of exchange rate movements on which this paper focuses.

We estimate this third-market effect using disaggregated trade data at the 6-digit level spanning 124 developing country exporters and 57 large importers over the period 2000-2008, that allows us to exploit variation across importers, exporters, products, and time. Our empirical approach is

[6] Eichengreen and Tong (2011) also find that the renminbi appreciation has positive effect on firms exporting to China, negative effect on firms providing inputs for China's processing exports and negative effects for firms importing Chinese products.
[7] Brazilian exports of intermediate goods might possibly benefit if greater Chinese final good production increases demand for imported intermediates.

motivated by an analytical framework based on Feenstra, Obstfeld, and Russ (2011). We develop an identification strategy that relies on the following reasoning: the more a country competes with China in a third market, the more a given depreciation of the renminbi is likely to hurt its exports in that market. We develop indices of competition with China at the exporter-importer-product level to implement this strategy. The empirical specification with a battery of fixed effects helps us overcome to a large extent the problems of endogeneity and omitted variables that plague estimation of trade-exchange rate equations using aggregated data.[8]

We find robust evidence for the existence of a statistically and economically significant third-market effect. In particular, exports to third markets of countries with a greater degree of competition with China tend to rise/fall significantly more as the renminbi appreciates/depreciates. Overall our estimates suggest that a 10 percent appreciation of the renminbi increases a developing country's exports at the product-level on average by 1-2 percent. For high indices of competition, we find that the increase could be as large as 5 percent. The magnitude of the estimates is consistent with the predictions from the analytical framework. The results imply that going forward, if the renminbi were to appreciate, this could provide a substantial boost to developing country exports.

The rest of the paper is organized as follows. In Section II, we set out the analytical framework. Section III elaborates the estimation strategy and Section IV describes the data. The results are presented in Section V and Section VI concludes.

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[8] See Engel (2009), who argues how hard it is econometrically to separate out the effect of exchange rates on trade.

II. Analytical Framework

As discussed above, the third-market effect that we seek to estimate is conceptually straightforward. Take three countries: China as the exporter, the US as importer, and Brazil as a competitor to China in the US market. If the Chinese exchange rate depreciates relative to the dollar, its exports will ceteris paribus become more competitive in the US market (because Chinese exporters will now charge a lower dollar price in the US). As a result, US consumers substitute away from Brazilian products towards Chinese ones, resulting in reduced Brazilian exports to the US. We are interested in the size of this effect.

In order to develop an analytical framework for our empirical exercise, we use the model in Feenstra, Obstfeld and Russ (2011). The setting is as follows. There are J countries, H different goods. Each country produces a range of distinct varieties of each good. There is a constant elasticity of substitution (η) consumption index for the representative consumer in country j. Goods are differentiated not only by their characteristics, also by their country of origin (Armington assumption), with a constant elasticity of substitution between domestically produced and foreign varieties of good g (ω_g), and a constant elasticity of substitution between different varieties of good g originating in different exporters (σ_g). The same elasticity applies to different varieties of good g produced domestically.

Feenstra, Obstfeld and Russ (2011) show that we can express country j's imports from country i of a particular good g, defined at the HS 6-digit level, V_g^{ij}, as follows (equation 11 in their paper).

$$(1)\quad V_g^{ij} = \left[\kappa_g^{ij}\left(\frac{P_g^{ij}}{P_g^{Fj}}\right)^{1-\sigma_g}\right] * \left[\left(1-\beta_g^j\right) * \left(\frac{P_g^{Fj}}{P_g^j}\right)^{1-\omega_g}\right] * \left[\alpha_g^j\left(\frac{P_g^j}{P^j}\right)^{1-\eta}\right] P_j C_j$$

That is, the proportion import demand (V_g^{ij}) of total consumption in , $P_j C_j$, depends on three sets of components:

- the preference weight consumers in j attach to imports of good g from country i, κ_g^{ij}; the price of g imports by j from i, P_g^{ij}, relative to the price index of all g imports, P_g^{Fj} ; and the elasticity of substitution between imported varieties of g, σ_g;

- the preference weight consumers in j attach to domestically produced units of good g, β_g^j; the price index of all g imports by j, P_g^{Fj}, relative to the domestic price of good g, P_g^j; and the elasticity of substitution between the home and foreign varieties of good g, ω_g;

- the preference weight consumers in j attach to consumption of the g good, α_g^j; the price index of the g good, P_g^j, relative to the price index of all goods in g, P^j; and the elasticity of substitution between different goods, η.

We first establish the effect of a change in China's exchange rate changes vis-a-vis country j, E^{cj}, on country j's imports of a particular good g from country i, V_g^{ij}. We can write this effect as a chain effect, consisting of the effects of: the change in the Chinese exchange rate on the price of the Chinese good, the change in the price of the Chinese good on the foreign price index, and the change in the foreign price index on demand for good g from country i:

$$\frac{\partial \ln V_g^{ij}}{\partial \ln E^{cj}} = \frac{\partial \ln P_g^{cj}}{\partial E^{cj}} * \frac{\partial \ln P_g^{Fj}}{\partial \ln P_g^{cj}} * \frac{\partial \ln V_g^{ij}}{\partial \ln P_g^{Fj}} \qquad (2)$$

Now consider each term in the chain starting from the third term. Taking logs of Equation (1) and differentiating with respect to P_g^{Fj} under the assumption that a change in the price index of imported good g has a negligible effect on the aggregate US price index for good g, we get:[9]

$$\frac{\partial \ln V_g^{ij}}{\partial \ln P_g^{Fj}} = \sigma_g - \omega_g \qquad (3)$$

This implies that the elasticity of demand for imports of good g from country i with respect to the foreign price index is simply the difference between the elasticity of substitution between imported varieties of g, σ_g, and the elasticity of substitution between home and foreign varieties, ω_g.[10]

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[9] This is an innocuous assumption from the empirical perspective because any additional terms—for example aggregate destination-specific prices — will be absorbed in the very general fixed effects.

[10] Note that in Broda and Weinstein (2006), $\sigma_g = \omega_g$, i.e. the elasticities of substitution between imported varieties equals the elasticity of substitution between home and foreign varieties. In our framework, if $\sigma_g = \omega_g$, if the renminbi depreciates, consumers in country j reduce their demand for varieties of good g produced at home and hence there is no third-market effect.

From Feenstra, Obstfeld and Russ (2011), we have the price index for imported goods, P_g^{Fj}, (their equation 5):

$$(4) \qquad P_g^{Fj} = \left[\sum_{\substack{i=1 \\ i \neq j}}^{J} \kappa_g^{ij} \left(P_g^{ij}\right)^{1-\sigma_g}\right]^{\frac{1}{1-\sigma_g}}$$

Taking logs, differentiating with respect to the price of the Chinese good g in the j market, P_g^{cj}, and simplifying, we get:

$$(5) \qquad \frac{\partial \ln P_g^{Fj}}{\partial \ln P_g^{cj}} = \frac{\kappa^{cj}\left(P^{cj}\right)^{1-\sigma_g}}{\sum_{\substack{i=1 \\ i \neq j}}^{J} \kappa_g^{ij}\left(P_g^{ij}\right)^{1-\sigma_g}} = s_g^{cj}$$

This implies, as expected, that the elasticity of the foreign price index for good g with respect to the price of the Chinese good g is equal to the expenditure on the Chinese good as a share of expenditure on all imports of g, s_g^{cj}.

We assume that the price of the Chinese good in the US market, P_g^{cj}, depends on the price in China, P_g^c, the exchange rate, E^{cj} (defined in renminbi/importer currency), and an exponent which captures the extent of product-specific exchange rate pass-through from China to j, μ_g^{cj}.

$$(6) \qquad P_g^{cj} = P_g^c \left(1/E^{cj}\right)^{\mu_g^{cj}}$$

Differentiating with respect to the exchange rate, E^{cj}, we have:

$$\frac{\partial \ln P_g^{cj}}{\partial \ln E^{cj}} = -\mu_g^{cj} \tag{7}$$

Substituting from Equations (3), (5) and (7) in Equation (2), we get:

$$\frac{\partial \ln V_g^{ij}}{\partial \ln E^{cj}} = -(\sigma_g - \omega_g) s_g^{cj} \mu_g^{cj} \tag{8}$$

Equation (8) implies that a change in the Chinese exchange rate will have a non-zero effect on import demand for good g only if (i) elasticities of substitution across imported varieties is different from that between imported and domestic varieties, (ii) Chinese share in total imports of that good is strictly positive, and (iii) the exchange rate pass-through is non-zero.

Given our assumption regarding the symmetric elasticity of substitution between imported varieties, σ_g, the effect of a change in China's exchange rate changes vis-a-vis country j, E^{cj}, on country j's imports of a good g from country i, V_g^{ij}, does not depend on any exporter attribute. This makes Equation (8) less amenable to empirical analysis. For example, if in order to test the prediction in Equation (8), we were to regress the import demand at the exporter-importer-product level on the share of China in imports at the importer-product level, the effect of latter would not be estimated precisely as it would be absorbed by importer-product fixed effects.

In order to introduce meaningful variation in the impact of China's exchange rate across exporter countries, so as to make it amenable to econometric analysis, we consider country j's imports, V_p^{ij}, from country i of a particular bundle of goods p, defined at a higher level of aggregation. In our empirical analysis, we use trade data at the Harmonized System (HS) 6-digit. Therefore g is defined at the HS 6-digit level. Country j's imports of p (at say the HS 4-digit level) can be expressed as:

(9) $$V_p^{ij} = \sum_{g=1}^{G} V_g^{ij}$$

G are the number of HS 6-digit lines in the product category p. Taking logs and differentiating with respect to the exchange rate, E^{cj}, we get

(10) $$\frac{\partial \, ln \, V_p^{ij}}{\partial \, ln \, E^{cj}} = -\sum_{g=1}^{G} \left(\frac{V_g^{ij}}{\sum_g V_g^{ij}}\right) s_g^{cj} \mu_g^{cj} (\sigma_g - \omega_g)$$

This equation is intuitive: the elasticity of say Brazil's exports to j at the HS 4-digit category with respect to China's exchange rate vis-à-vis j is related to the weighted average of China's share in total imports in each constituent 6 digit category which Brazil exports, where the weights are Brazil's exports in the corresponding 6 digit category as a share of its total exports in the 4 digit category. Thus, at this higher level of aggregation, the effect of China's exchange rate on exports of a particular country i to another country j depends on the interplay between the relative importance of specific 6-digit product lines, g, in i's exports and the relative importance of China as a source of imports by j of those 6-digit product lines.

Further, we also assume that the elasticities of substitution and the pass-through are constant for all 6-digit lines within the relevant four digit category. i.e. $\mu_g^{Cj} = \mu_p^{Cj}$, $\sigma_g - \omega_g = \sigma_p - \omega_p$. Then Equation (10) can be rewritten as

$$(11) \qquad \frac{\partial \ln V_p^{ij}}{\partial \ln E^{cj}} = I_{ijp}^V * [-\mu_p^{Cj} * (\sigma_p - \omega_p)]$$

where $I_{ijp}^V = \sum_{g=1}^{G} [(\frac{V_g^{ij}}{V_p^{ij}}) * s_g^{Cj}]$ is what we call the "value-based index of competition" with China for good g exported from i to j. For example, if the HS 4-digit category, shirts, consisted of only two items, cotton shirts and non-cotton shirts, then our measure is simply the share of China in country j's imports of each type of shirt, weighted by the importance of each type of shirt in country i's shirt exports to j. $\frac{\partial \ln V_p^{ij}}{\partial \ln E^{cj}}$ is what we define as "the third-market effect".

Equation (11) provides the basis for the first specification we estimate. Under some additional symmetry assumptions, we can also estimate an alternative specification where we rely on the overlap between China's exports and those of country i, at the extensive margin rather than measures of competition at the intensive margin, as in Equation (11) above.

We first assume that for each 6 digit category that i exports to j within a 4-digit category, it exports the same amount. If i exports N_p^{ij} 6-digit categories in the relevant 4 digit category to j, then the first term in Equation (10) simplifies to $1/N_p^{ij}$. Next assume that in each 6 digit category within the relevant 4-digit category where i exports to j, China exports either a fixed share, s_p^{Cj} or nothing. $s_g^{Cj} = s_p^{Cj}$ for $N_{p,Ch}^{ij}$ lines or zero otherwise. Then summing the second ratio over the relevant 6 digit lines gives us $s_p^{Cj} * N_{p,Ch}^{ij}$. As above, we also assume that the elasticities of substitution and the pass-through are constant for all 6-digit lines within the relevant four digit category. i.e. $\mu_g^{Cj} = \mu_p^{Cj}$, $\sigma_g - \omega_g = \sigma_p - \omega_p$.

So that in this special case, Equation (11) can be written as:

$$(12) \qquad \frac{\partial \ln V_p^{ij}}{\partial \ln E^{cj}} = I_{ijp}^{C} * [-s_p^{Cj} * \mu_p^{Cj} * (\sigma_p - \omega_p)]$$

where $I_{ijp}^{C} = \frac{N_{p,Ch}^{ij}}{N_p^{ij}}$ is what we call the "count-based" index of competition. This equation forms the basis for our alternative empirical specification. In this specification the elasticity of i's exports to j with respect to China's exchange rate vis-à-vis j for any HS 4-digit category is related, first of all, to the number of HS 6-digit categories within the 4-digit category that both i and China export, $N_{p,Ch}^{ij}$, divided by the number of 6-digit categories i exports to j within the relevant 4-digit category, N_p^{ij}. Secondly, it is related to China's assumed constant share in each 6 digit line with the relevant 4-digit, s_p^{Cj}, which becomes part of the estimated coefficient in this specification - along with the difference in the two elasticities of substitution, $\sigma_p - \omega_p$, and the extent of pass-through, μ_p^{cj}.

III. Estimation Strategy

The analytical model above is useful in two important respects. First, it provides an intuitive basis for capturing the competition between an exporter and the country changing its exchange rate in third markets. Second, it allows us to identify clearly the key determinants of third-market effects. In particular, it gives us three predictions, relating to the sign and magnitude of the third-market effect that we can take to the data.

Specifically, Equations (11) and (12) would suggest the following:[11]

(i) The value of exports from country i to country j is negatively related to China's exchange rate vis-à-vis the importer currency (measured in renminbi/importer currency); i.e.

$$\frac{\partial\, ln\, V_p^{ij}}{\partial\, ln\, E^{cj}} < 0$$

(ii) The magnitude of the third-market effect depends on the index of competition with China; i.e.

$$\frac{\partial\, ln\, V_p^{ij}}{\partial\, ln\, E^{cj}} = f(I_{ijp})$$

where $f'(I_{ijp}) < 0$

[11] We assume that the equilibrium value of bilateral trade is determined by import demand, which would certainly be true in the extreme case of an infinitely elastic supply curve, but is also likely to be true with less strong assumptions.

In other words, greater is the degree of competition with China, higher is the magnitude of the third-market effect.

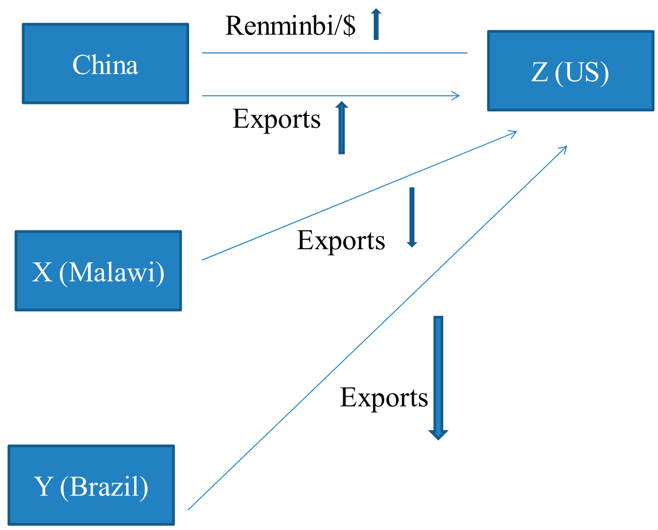
(iii) The magnitude of the third-market is higher, higher the elasticity of substitution between different imported varieties (σ_p), the lower the elasticity of substitution between domestic and imported varieties (ω_p) and higher the exchange rate pass-through (μ_p^{Cj}).[12]

It is not, however, straightforward to take prediction (i) above to the data. The basic problem relates to the fact that the exchange rate (the explanatory variable) and imports (the dependent variable) have different dimensionality. Imports vary by importer, exporter, product and time. China's exchange rate on the other hand varies only by importer and time. To identify the exchange rate effect would entail having to ignore a number of importer-time varying factors that might be correlated with exchange rates and also affect imports. In other words, in a correctly specified estimating equation, China's exchange rate would be absorbed by importer-time fixed effects.

To overcome this problem, we exploit prediction (ii) to develop an identification strategy. The idea underlying our strategy is as follows. Take two countries, Malawi and Brazil. Assume that Brazil faces a greater degree of competition with China in the US market. When the renminbi depreciates vis-à-vis the US$, exports from Brazil to the US will fall more relative than exports from Malawi to the US (Figure 1).

[12] In the case of the count-based index, the magnitude of the third-market effect also depends on the share of China in the imports (s_p^{Cj}).

Figure1. Identification Strategy



Translating the same logic to the country-product-level, and focusing on variation within a country and product, we posit that a particular country's exports of a particular product category p to a destination country j will be more affected by a change in China's exchange rate vis-à-vis country j, the more in competition that country's exports of product category p are with Chinese goods in that destination market. For example, if China's exchange rate depreciates against the dollar, we posit that country i 's (Brazil's) exports of a particular product category p to a destination country j (United States) will be more affected than Malawi's, the more in competition Brazil's exports of product category p are with Chinese goods in US market.

To this end, we create an index of competition (I_{ijp}) between Chinese exports and those of its competitors as described in the analytical section. Note that the index does not have a time sub-script which we explain below.

With this index, we can define our estimating equation:

$$\ln V_{ijpt} = \beta I_{ijp} * \ln E_{jt} + v_{jpt} + s_{ipt} + \gamma_{ijt} + \theta_{ijp} + \epsilon_{ijpt} \quad (13)$$

where V_{ijpt} is the value of exports of HS 4-digit product p from country i to country j. E_{jt} is the Chinese exchange rate vis-à-vis j measured in renminbi per unit of j's currency. This equation is similar to the "difference-in-difference" approach due to the interaction term on the right hand side. The interaction term combines the exchange rate between China and the importing country (say the renminbi-dollar exchange rate) and the index of competition between the exporter and China in the importing country. We expect that the coefficient β in the equation will be negative: an increase in E_{jt} (a depreciation) will reduce i's exports more, the larger is the index of competition.

Econometrically, an advantage of this formulation is that we can control for a wide range of other effects on exports through a set of very general fixed effects. In fact, in our core estimations, we employ all three-way combinations of importer, exporter, product and time fixed effects. For example, v_{jpt} and s_{ipt} capture respectively any importer and exporter country-product and time varying characteristics (e.g. country and product specific technological change or demand or policy shock). Note that these fixed effects also encompass all country-time shocks both on the importer and exporter side such as the state of the business cycle in both countries. γ_{ijt} captures any bilateral time-varying determinants of exports (e.g. preferential arrangements, currency unions etc.). The existence of product-specific preferential tariffs will not confound our identification because they will be absorbed in the θ_{ijp} fixed effects. The only factors that might not be controlled for are policies of importing country that vary by source country and product and time (for example, changes over time in product-specific preferential tariffs).

Another virtue of this specification is that whereas the left hand side variable is importer-product- and destination-specific, the exchange rate is an aggregate variable which is neither product--nor destination-specific, and so there is less concern about reverse-causality flowing from exports to the exchange rates. In other words, while exports can affect exchange rates, it is less likely that exports to certain destinations and of certain products affects the aggregate exchange rates. Moreover, note that unlike most existing macro and micro studies, we are not looking at the effect of a country's exchange rate on its *own* trade. The fact that we are trying to estimate cross-effects of Chinese exchange rates on exports of *other* countries by itself lessens concerns about endogeneity of the exchange rate. For example, it is less likely for the Chinese exchange rate policy to be influenced by exports of specific products to particular destinations.

In sum, our specification minimizes the omitted variables problem through a rich inclusion of fixed effects, while also addressing the endogeneity from trade to exchange rates. We believe that our specification makes a significant advance over the prior literature in disentangling the effects of exchange rates. Thus, one way of interpreting our specification is that we exploit a reasonably exogenous macroeconomic shock—exchange rate changes—to identify the effect of exports of competitor countries through the variation afforded by the index of competition.

The analytical section suggests that there are two ways of measuring the index of competition. The value-based index (VBI) discussed above is defined as:

$$(14) \qquad I_{ijp}^{V} = \sum_{g=1}^{G} \left(\frac{V_g^{ij}}{\sum_g V_g^{ij}}\right) s_g^{cj}$$

p is defined at the 4-digit as in our baseline specifications above and g denotes all the 6-digit categories within the 4-digit. As discussed above, this index is simply the weighted average of China's share in total imports in each constituent 6 digit category which country i exports, where the weights are country i's exports in the corresponding 6 digit categories as a share of its total exports in the 4 digit category.

A count-based index (CBI) is the second way of measuring the index of competition. This can be expressed relatively simply as:

$$(15) \qquad I_{ijp}^{C} = \frac{N_{p,C}^{ij}}{N_{p}^{ij}}$$

This index is simply the number of 6-digit lines in which China's exports overlap with country i's exports in market j divided by the total number of 6-digit lines that country i exports in the relevant 4-digit category in market j.

The VBI is potentially vulnerable to the endogeneity problem because it is expressed in values, like the dependent variable. The CBI, while derived from theory under symmetry assumptions, has the empirical virtue of not being measured in value terms and hence being less related to the left hand side variable. In a sense, the count index is a measure of competition on the extensive margin whereas the dependent variable relates more to the intensive margin. To minimize the endogeneity problems we compute both indices based on the initial period observations (i.e. for the year 2000).

IV. Data

We focus on the period 2000-2008, during which concerns about China's exchange rate policy have been most debated. For this period, we compile disaggregated data on bilateral exports from the UN Comtrade database. The data are for roughly 6000 non-oil HS 6-digit lines covering 900 4-digit products. We cover the 57 major importing countries (making sure that we include all countries that together accounted for over 95 percent of total exports of developing countries) and 124 developing country exporters which are potentially in competition with China (summary statistics are provided in Appendix Table 1 and the list of importing and exporting countries covered in Appendix Table 2).

Trade data are deflated by the US CPI. We recognize that ideally we would use different price indices to deflate trade between different country pairs but this is not currently feasible. However, the presence of the very general fixed effects has the consequence also of implicitly deflating the trade data. The data are implicitly deflated by prices that vary by importer, product and time, by importer, product and exporter and by exporter, product and time. They are not deflated by prices that vary along all four dimensions (importer, exporter, product, and time). So, in some ways the left hand side variable is a hybrid, somewhere in between a pure quantity variable and a value variable. Exchange rate data are from the IMF's International Financial Statistics (IFS) database. Consistent with Equation (6), the bilateral exchange rate is deflated by China's CPI.

Before we present the econometric results, it is worth looking at some basic data. Figure 2 plots China's average index of competition (where the average is over all exporters and products). The index is measured in two ways consistent with the discussion in the analytical section. Both the VBI and the CBI rise over time, consistent with China becoming a bigger and more diverse exporter. The CBI shows in particular that China occupies nearly all the product space of all other developing country exporters. Figures 3a and 3b plot the same indices but disaggregated by region. These charts show that China's overlap with all regions has risen steadily over time, with the level of the overlap greatest with other exporters in Asia (over 95 percent in 2008 for the CBI) and least with Europe and Central Asia.

V. Results

Main Findings

All results are presented for both variations of our competition index. In Table 1, we present the baseline results. Our core sample has nearly 3.6 million observations. Columns [1]-[4] use the value-based index (VBI) while columns [5]-[8] use the count-based index (CBI). In both cases, the specifications progressively increase the number of fixed effects, with a comprehensive set of fixed effects in columns [4] and [8], making the specification a very demanding one. These will constitute our core specifications. All regressions are clustered at the importer-exporter-product level.

We find that the coefficient on the interaction term between the Chinese exchange rate and the index of competition is consistently negative and significant at the 1 percent confidence level. In other words, the more say Brazil is in competition with China in a particular product, a depreciation of the Chinese exchange rate vis-à-vis say the dollar is associated with a greater reduction in Brazil's exports of that product to the United States.

We subject this core specification to a series of robustness checks in Tables 2-6. In Table 2, column [1], we drop outliers, defined as the top and bottom 1 percentile of observations. The key coefficient is negative and statistically significant with the magnitudes close to those for the larger, core sample. In columns [2]-[4], we cluster the standard errors at the exporter-importer-year, exporter-product-year and importer-product year levels, and the statistical significance of the coefficients remain unchanged.

Our core specification uses annual data. To test whether the results hold for the medium run, we use a long difference approach suggested by Acemoglu and Johnson (2007). Thus, in column [5], we use observations only for 2000 and 2008 and find that the results remain similar to the baseline, with the magnitude of the interaction coefficient increasing by a little. In columns [6] and [7], to make sure that the results are not driven by the choice of year for measuring the index of competition, we measure the index for the years 2001 and 2002, respectively.[13] In column [8], we use an alternative measure of competition—the export similarity index due to Finger and Kreinin.[14] Thus, for a wide range of robustness tests, the core results remain unaltered, both in the sense that the coefficients are stable and consistently significant at the 1 percent confidence level.

In Table 3, we test for robustness to alternative measures of the exchange rate variable. In our analytical framework, we assumed that the price of Chinese goods in the importing country market is determined by a simple relationship between domestic price in China and an exchange rate pass-through. Based on the framework, in our core specifications, we deflate the nominal

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[13] The estimated coefficient on the interaction between the index and exchange rate continues to be negative and statistically significant if we use a contemporaneous index of competition, which would of course raise serious concerns about endogeneity.

[14] The Finger-Kreinin index can be expressed as: $FK_{ijpt} = \sum_g \min\left[\frac{X_{ijgt}}{\sum_g X_{ijgt}}, \frac{X_{Cjgt}}{\sum_g X_{Cjgt}}\right]$ where

$$\frac{X_{ijgt}}{\sum_g X_{ijgt}} = \text{Share of product } g \text{ in total exports from } i \text{ to } j \text{ at the 4-digit level}$$

$$\frac{X_{Cjgt}}{\sum_g X_{Cjgt}} = \text{Share of product } g \text{ in total exports from China to } j \text{ at the 4-digit level.}$$

The results are also robust to using the alternative formulation of the Finger-Kreinin Index defined as

$$FK_{ijpt} = 1 - \frac{1}{2}\sum_g \left| \frac{X_{ijgt}}{\sum_g X_{ijgt}} - \frac{X_{Cjgt}}{\sum_g X_{Cjgt}} \right|$$

and the weighted Finger-Krenin Index defined as

$$WFK_{ijpt} = \sum_g \frac{X_{ijgt}}{\sum_k X_{ijgt}} * [1 - \frac{X_{ijgt} - X_{Cjgt}}{X_{ijgt} + X_{Cjgt}}]$$

.

bilateral (between China and the importing country) exchange rate by Chinese prices. The implicit assumption here is that Chinese producers take account of changes in the bilateral exchange rate and average domestic inflation to determine export prices. However, there could be alternative ways Chinese producers and exporters determine their destination-specific export prices. Chinese producers could be influenced just by the nominal bilateral exchange rate (E_{jt}) or by the real bilateral exchange rate ($E_{jt} * P_{jt}/P_t^C$), with P_{jt} and P_t^C denoting prices in importing country and China respectively. The specifications corresponding to these two ways of measuring the exchange rate are in columns [1] and [2] (for the VBI) and columns [5] and [6] (for the CBI). In both cases, the results are robust although the magnitudes decline relative to the core specification.

Yet other models of pricing behavior could involve Chinese producers looking at changes in their multilateral competitiveness in determining destination-specific export prices. In this case, the relevant exchange rate is not destination specific but a multilateral one that is identical across all importers (ME_t) where ME stands for China's multilateral exchange rate and hence without a j subscript).[15] We re-estimate the core regression to cater to these possibilities by using the IMF's effective exchange rate as the relevant measure with the nominal rate in columns [3] and [7], and the real rate in columns [4] and [8]. Again, the coefficients are correctly signed and significant at the 1 percent confidence level. Interestingly, these coefficients are substantially greater than for the core specification.

[15] Note that in this case, the exchange rate varies across time and the index varies across importer, exporter, and product so that the interaction term exploits the variation across all four dimensions.

In Tables 4 and 5, we test for robustness across exporters, defined in geographic terms (Table 4) and in terms of income levels (Table 5). The results are robust in both cases. The results are also consistent between the two tables. For example, the coefficients are lowest for African exporters and in Table 5, the coefficients are lowest for low income countries and greatest for upper middle income countries.[16]

In Table 6, we check if the results are robust to the degree of product disaggregation. In the core specification, the data are at the HS 4-digit level. In Table 6, we use data at the HS 2-digit level. The indices of competition are measured by aggregating across 6-digit lines within the 2-digit category. The sample size shrinks from over 3.6 million to about 860,000 observations. But the interaction term remains negative and significant.

Overall, the results in Table 1-6 confirm the predictions from the analytical framework. The elasticity of developing country exports with respect to Chinese exchange rate depends significantly on the index of competition with China. Further, higher the index of competition, a given depreciation of the renminbi is associated with a bigger reduction in developing country exports.

Discussion of Magnitudes

[16] We also tested for robustness across importers, defined in terms of advanced and other countries, and the results hold for each category of importers.

How can we interpret the magnitude of the estimated coefficients on the interaction between the exchange rate and the index of competition? Evaluated at the average value of the indices, the results from our core specification (columns [4] and [8] of Table 1) yield a "third-market effect" of -0.14 [i.e. (0.4)*(0.352)] and -0.20 [i.e. (0.9)*(0.22)] for the value and count-based indices respectively. The estimates imply that a 10 percent depreciation/appreciation of the renminbi is associated with a reduction/increase in developing country exports at the product level on average by 1-2 percent. If we use the range of coefficients from Tables 1-3, the effects are in the range of 1-4 percent. Importantly, for high indices of competition (in the 90th percentile), the effect can be as high as 5 percent.

It is important to recognize that our estimates do not measure the overall effect of the exchange rate movements but rather a difference-in-difference estimate. Recall that the third-market effect we estimate in equation (13) is given by:

$$\frac{\partial \ln V_{ijpt}}{\partial \ln E_{jt}} = I_{ijp} * \beta \tag{18}$$

Our estimations identify β which we multiply by the relevant value of the index of competition to obtain the average third-market effect. This estimate is akin to a "difference-in-difference" or marginal estimate which is to be distinguished from the overall exchange rate effect. From Equation (13), the estimated overall effect would be given by:

(19) $$\frac{\partial \ln V_p^{ij}}{\partial \ln E^{Cj}} = I_{ijp} * \beta + \theta$$

Where θ is that component of the effect of the exchange rate on exports which we cannot identify because it is absorbed in the fixed effects.

One way of interpreting the difference-in-difference estimate is to compare two countries, say Vietnam and Russia that vary in their average index of competition with China. The two countries' value-based indices are 0.5 and 0.3, respectively. In this case, using the estimates from Column [4] in Table 1 suggests that a 10 percent depreciation of the Chinese exchange rate will reduce Vietnam's exports of a typical HS 4-digit category to third markets by 0.7 [i.e. (0.5-0.3)*0.352)] percent more than Russia's.

What does our analytical framework predict about the magnitude of the third-market effect? Recall from Equations (11) and (12) that the third-market effect predicted by theory based on the value and count-based indices are the following, respectively:

(16) $$\frac{\partial \ln V_p^{ij}}{\partial \ln E^{Cj}} = I_{ijp}^{V} * \left[- \mu_p^{Cj} * \left(\sigma_p - \omega_p\right)\right]$$

$$= I_{ijp}^{V} * \beta^{Theory\ Value}$$

(17) $$\frac{\partial \ln V_p^{ij}}{\partial \ln E^{Cj}} = I_{ijp}^{C} * \left[- s_p^{Cj} * \mu_p^{Cj} * (\sigma_p - \omega_p)\right]$$

$$= I_{ijp}^{C} * \beta^{Theory\ Count}$$

From the existing literature, we can obtain estimated values for each of the parameters. Of course, there is wide variation in each of these, but some ball-park estimates are the following: $\sigma = 3,\ \omega = 1,\ \mu = 0.4$ and $s = 0.4$. The estimates of σ (the elasticity of substitution between imported goods, or the micro-Armington elasticity) and ω (the elasticity of substitution between domestic and imported goods, or the macro-Armington elasticity) are based on Feenstra, Obstfeld and Russ (2011). The pass-through coefficient (μ) is an average of the estimates from Campa and Goldberg (2006) for industrial countries and the estimates of Gopinath et. al. (2011) for the United States. s refers to the average share of China in the markets of each of the importing countries which we obtain from our data.[17]

Combining these estimates with the average value of the index of competition for the value (I_{ijp}^{V}) and count-based (I_{ijp}^{C}) indices from our data (of 0.4 and 0.9, respectively), yield a

[17] Xing (2010) looks specifically at pass-through of Chinese exchange rates to import prices in US and Japan, and estimates pass-through coefficients of 0.23 and 0.56 for the US and Japan respectively.

magnitude of the third-market effect of -0.32 [i.e. (0.4)*{(0.4)*(3-1)}] for the value-based index and -0.29 [i.e. (0.9)*{(0.4)*(0.4)*(3-1)) for the count-based index.

However, the values of the elasticity of substitution that we use to derive the theoretical prediction are based on Feenstra et. al. (2011), who estimate the elasticity for goods at a level of disaggregation close to the HS 10-digit level.[18] Our data on the other hand are at HS 4-digit so that the relevant elasticity for our purpose could be well below the value of 3 that we use here.[19] Thus, third-market effect of 0.3 must be viewed as the upper bound predicted from theory. Therefore based on theory, we should expect that a 10 percent depreciation of the renminbi against the dollar would lead at most to an average reduction of exports of competitor countries of 3 percent.

How do our estimates compare with those predicted from theory? Importantly, our estimated third-market effects of 1-2 percent from the baseline results are not far from the upper bounds suggested by theory. We should, however, be careful in comparing the estimates predicted from theory and those based on our empirical specification since while the former measures the "total" third- market effect, the latter measures only the "marginal" effect. The main thrust (and virtue) of our estimation procedure is to show that the channel of transmission from exchange rates to competitor country exports can be detected in the data. The cost of being able to show this

[18] Feenstra et al. (2011) actually use a unique data source called Current Industrial Reports (CIR) which is published by the US Bureau of the Census. Their dataset covers 191 goods, of which 80 are based on a single 10-digit HS commodity, and another 42 are based on two or three 10-digit HS commodities. So the majority of the dataset is at a highly disaggregate level.

[19] Broda and Weinstein (2006) argue that with more disaggregated data, one is likely to find higher estimates of the elasticity of substitution.

transmission mechanism precisely (by exploiting all the rich sources of variation in the data) is the difficulty in pinning down the magnitude of the overall effect of exchange rates.

In order to get an idea of the magnitude of the overall third-market effect, we estimate an alternative regression which is specified as follows:

$$\ln V_{ijt} = \beta I_{ij} * \ln E_{jt} + \theta \ln E_{jt} + s_{it} + \gamma_{ij} + \epsilon_{ijt} \tag{20}$$

Note the three differences relative to our core specification in Equation [13]. First, we have collapsed the data from four dimensions (importer, exporter, product, and time) to three dimensions, eliminating the product-specific variation. The second difference relative to the core is that we have the exchange rate term on its own in addition to the interaction term (the latter being also a feature of the core specification).[20] Now, we can measure the total effect of an exchange rate change which is given by: $\frac{\partial \ln V^{ij}}{\partial \ln E^{Cj}} = I_{ij} * \beta + \theta$. The specification thus allows us to identify both β and θ . The third change is that because we have an exchange rate term on its own which varies by time and importing country, we cannot include a fixed effect that varies along these two dimensions. Thus our ability to estimate the overall exchange rate effect comes at the price of sacrificing both product-specific variation and key fixed effects, which is why we regard this specification as inferior to our core specification.

[20] Note that the index of competition is now defined for a country relative to China in the importing market but averaged across all products.

The results from estimating Equation [20] are shown in columns [1] and [3] of Table 7 for the two indices. A slightly richer version that includes some controls that vary by importer, exporter and time are presented in columns [2] and [4]. Because of the severe reduction in the variation in the data (the sample is about 13 percent of that in the core specification), the coefficients are less precisely estimated. The exchange rate term is consistently negative and significant.

Taking the most general specification reported in column [2], we can ascertain the magnitude of the overall third-market effect. At the median value of the index of competition of 0.4, this overall effect is about -0.17. That is, a 10 percent depreciation in the Chinese exchange rate relative to the dollar results in a nearly 2 percent reduction in the average exports of a competitor country in the US market. This overall effect is very close to the more precisely estimated difference-in-difference magnitude from the core specification both of which are close to and consistent with the theoretical predictions.

Overall, the estimates in this paper suggest that a 10 percent depreciation/appreciation in the renminbi exchange rate vis-à-vis an importing country decreases/increases on average developing country exports by 1-2 percent. Given the 30 percent *appreciation* of China's real exchange rate over 2000-2008 (Figure 4), our findings suggest that this could have been associated with about a 2-6 percent increase in the typical developing country's exports to third markets.

Finally, we evaluate the third theoretical prediction discussed above which relates the magnitude of the exchange rate effect to the type of good. Recall that equations [16] and [17] suggests that, the magnitude of the third-market effect is higher, higher the elasticity of substitution between different imported varieties (σ_p) and the lower the elasticity of substitution between domestic and imported varieties (ω_p), and higher the exchange rate pass-through (μ_p^{Cj}). Note that we do not have information on σ_p, ω_p and μ_p^{Cj} at the product-level to take the theoretical predictions literally to the data.

However, in order to make a first pass, we partition the data into homogenous versus differentiated products based on Rauch (1999) classification.[21] As shown in Table 8, columns [1], [2], [6] and [7], we find that the coefficients on the interaction between the index of competition and exchange rates are higher in magnitude for homogenous products vis-à-vis differentiated ones. However, we not find a large difference in magnitude of the estimated coefficients. There could be two possible explanations for this. First, although possibilities for substitution across imported varieties are likely to be higher for homogeneous products, the substitution between home and imported varieties is also likely to be higher for these products; dampening the third-market effect. Second, the pass-through coefficient is also likely to be lower for homogenous products. For example, Yang (1997) shows both theoretically and empirically

[21] Note that Rauch's classification is available at the SITC 4-digit; we concord it to HS 6-digit level using standard concordance tables, and then partition the data into homogenous and differentiated using Rauch's liberal classification (reference priced goods are included in the homogenous category). We then aggregate the data to the HS 4-digit level.

that the degree of exchange rate pass-through is negatively related to the degree of substitution (or positively related to the degree of product differentiation). [22]

We also empirically explore whether the magnitude of the third-market effect varies by splitting the products along other dimensions likely to be correlated with the degree of product differentiation. Specifically, we look at variations by skill-intensity of the product – low, medium and high-skill intensive. The classification of products by skill intensity is due to Peneder (2001).[23] Based on our product classification, the proportion of differentiated goods increases with skill-intensity (whereby more than 95 percent of high-skill intensive are also differentiated by Rauch's definition). The results shown in Table 8, columns [3]-[5] and [8]-[10] suggest that our finding of a negative and statistically significant coefficient on the interaction between the index of competition and exchange rate continues to hold across different splits by product-type. Consistent with the predictions from our analytical framework, the magnitude of estimated coefficients on the interaction term declines with skill-intensity, with the magnitude of the effect being the highest for low-skill intensive products.[24]

[22] When products are highly substitutable, a price increase is more likely to lead consumers to switch to other variants. Thus, foreign firms are more likely to keep their prices in line with the domestic price and absorb exchange rate shocks rather than passing them on to prices. On the other hand, when products are highly differentiated (so that they are less substitutable), firms are less worried about losing customers in case of a price increase and will be able to pass cost shocks to prices.

[23] The classification of products into skill-intensity is at the ISIC 2-digit level. The classification is matched to the HS classification using concordance tables from the UN Statistics department.

[24] We look at split by end-use of the product: consumer versus capital and intermediate. Information on product types is taken from the UN's Broad Economic Classification (Pula, Gabor, and Peltonen, 2009). We did not find the interaction coefficient to differ significantly between these product categories.

VI. Conclusion

To our knowledge, our paper is the first attempt to quantify the effect of exchange rate changes on the exports of competitor countries to third markets that both exploits the rich variation afforded by disaggregated trade data and does so in a manner that is motivated by and consistent with theory. We find that China's exchange rate changes can have significant and robust effects on developing countries that compete with China in third markets.

These results have obvious implications for discussions on China's exchange rate policy. This paper has not addressed the question of whether China's exchange rate is undervalued or overvalued. But if estimates of some analysts are correct (Cline and Williamson, 2011), then any further revaluation of the renminbi—quite apart from the effects on global imbalances--could impart a substantial export and possibly growth boost to the prospects of other developing and emerging market countries. So, for example, another 20 percent appreciation of the renminbi in real terms could boost competitor country exports by about 2-4 percent.

References

Acemoglu, Daron and Simon Johnson, 2007. "Disease and Development: The Effect of Life Expectancy on Economic Growth," *Journal of Political Economy*, vol. 115(6), pages 925-985.

Ahearne, Alan, John Fernald, Prakash Lougani, and John Schindler, 2003. "China and Emerging Asia: Comrades or Competitors?" *International Finance Discussion Paper* No. 789, (Washington, D.C.: Federal Reserve Board)

Berman, Nicolas, Philippe Martin and Thierry Mayer, 2009. "How do different exporters react to exchange rate changes? Theory, empirics and aggregate implications," *CEPR Discussion Papers* 7493

Bernanke, Ben S., 2005. "The Global Savings Glut and the U.S. Current Account Deficit," speech delivered at the Sandridge Lecture, Virginia Association of Economics, Richmond, Va., March 10.

Broda, Christian and David E. Weinstein. 2006. *Quarterly Journal of Economics* 121(2): 541-585.

Campa, Jose Manuel and Linda S. Goldberg. 2006. "Pass Through of Exchange Rates to Consumption Prices: What has Changed and Why?," NBER Working Papers No. 12547.

Das, S., Roberts, M., and J. Tybout, 2001. "Market Entry costs, Producer Heterogeneity, and Export Dynamics", *NBER Working Paper* No. 8629

Deardorff, A., 2004. "Testing Trade Theories and Predicting Trade Flows," in *Handbook of International Economics*, R.W. Jones and P.B. Kenen, eds. Amsterdam: North-Holland.

Dekle, Robert and Heajin H. Ryoo, 2007. "Exchange rate fluctuations, financing constraints, hedging, and exports: Evidence from firm level data.", *Journal of International Financial Markets, Institutions and Money* 17, 437–451

Dooley, Michael P., David Folkerts-Landau, and Peter Garber, 2003. "An Essay on the Revived Bretton Woods System", *NBER Working Paper* No. 9971

Eichengreen, B., Y. Rhee and H. Tong (2004). "The Impact of China on the Exports of Other Asian Countries," *NBER Working Paper* no.10768

Eichengreen, Barry and Hui Tong, 2011. "The External Impact of China's Exchange Rate Policy: Evidence from Firm Level Data", *IMF Working Paper*, 155

Engel, Charles, 2009. Exchange Rate Policies*, Federal Reserve Bank of Dallas Staff Paper*.

Feenstra, Robert C., Maurice Obstfeld, and Katheryn N. Russ, 2011. "In Search of the Armington Elasticity.", *mimeo*, UC Berkeley and UC Davis.

Forbes, K., 2002. "How Do Large Depreciations Affect Firm Performance", *NBER Working Paper* No. 9095

Gabor Pula and Tuomas A. Peltonen, 2009. "Has emerging Asia decoupled? An analysis of production and trade linkages using the Asian international input-output table," *European Central Bank Working Paper Series* 993.

Goldstein, Morris and M. S. Khan, 1985. "Income and Price Effects in Foreign Trade", *Handbook of International Economics,* vol. 2. R.W. Jones and P.B. Kenen, eds. Amsterdam: North-Holland.

Gopinath, Gita, Oleg Itskhoki, and Roberto Rigobon. 2011. "Currency Choice and Exchange Rate Pass-Through.", *American Economic Review*, vol. 100(1), pages 304-36
Hooper, P., K. Johnson, and J. Marquez, 2000. "Trade Elasticities for G-7 Countries", *Princeton Studies in International Economics* No. 87.

Johnson, Simon H., Jonathan Ostry, and Arvind Subramanian, 2007. "The Prospects for Sustained Growth in Africa: Benchmarking the Constraints," March, *IMF Working Paper* No. 07/52

Michael Peneder, 2011. "Intangible Investment and Human Resources. The New WIFO Taxonomy of Manufacturing Industries," *WIFO Working Papers* 114, WIFO

Rauch, J.E., 1999. Networks versus Markets in International Trade. *Journal of International Economics* 48, 7–35

Robinson, Joan. 1947. *Essays in the Theory of Employment*, 2nd edition, Oxford: Basil Blackwell. First published in 1937.

Rodrik, Dani, 2008. "The Real Exchange Rate and Economic Growth," *Brookings Papers on Economic Activity*, 2, pp. 365–412.

Scott, Robert E., 2010. "Unfair China Trade Costs Local Jobs*," Economic Policy Institute Policy Brief* No. 260 (March).

Thursby J.G., and M.C. Thursby, 1987. "Bilateral Trade Flows, the Linder Hypothesis, and Exchange Risk", *The Review of Economics and Statistics* 69, 488-495

Yang, Jaiwen. 1997. "Exchange Rate Pass-Through into U.S. Manufacturing Industries" Review of Economics and Statistics. vol. 79, pp. 95-104.

Xing, Yuqing, 2010. The Yuan's Exchange Rates and Pass-through Effects on the Prices of Japanese and the US Imports, Comparative Economic Studies (2010) 52, 531–548.

Table 1. Exports from Developing Countries and Chinese Exchange Rates: Product-Level Evidence

Dependent variable = log(exports) at (exporter,importer,4-digit product, year) level

	Value-based index of competition				Count-based index of competition			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Index of competition with China*log(exchange rate of importer with respect to China)	-0.178***	-0.227***	-0.128***	-0.352***	-0.250***	-0.234***	-0.158***	-0.222***
	[0.002]	[0.001]	[0.001]	[0.004]	[0.001]	[0.001]	[0.001]	[0.002]
N	3,586,936	3,586,936	3,586,936	3,586,936	3,586,936	3,586,936	3,586,936	3,586,936
Fixed effects								
exporter*importer*product	N	N	N	Y	N	N	N	Y
exporter*importer*time	N	N	Y	Y	N	N	Y	Y
exporter*product*time	N	Y	Y	Y	N	Y	Y	Y
importer*product*time	N	Y	Y	Y	N	Y	Y	Y

Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. The index of competition in columns [1]-[4] is defined as the summation over all 6-digit products within the 4-digit category of the following: share of China in overall imports of a 6 digit product multiplied by the share of the 6-digit product in total 4-digit exports from the exporter to the importer. The index of competition with China in columns [5]-[8], is defined at the 4-digit product level, and is equal to the share of 6-digit products within a 4-digit category that i exports to j, that China also exports to j. The index of competition in all the columns is measured in the year 2000. The regression sample includes years from 2000-2008. Standard errors denoted in parentheses are clustered at the importer*exporter*product level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 2. Robustness

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Dependent variable = log(exports) at (exporter,importer, 4-digit product, year) level								
	drop outliers	cluster exp*imp*year	cluster exp*prod* year	cluster imp*prod* year	long-difference (2000, 2008)	index of competition -- 2001	index of competition -- 2002	Finger-Krenin Index
Value-based index of competition								
Index of competition with China*log(exchange rate of importer with respect to China)	-0.370***	-0.352***	-0.352***	-0.352***	-0.416***	-0.326***	-0.311***	-0.385***
	[0.005]	[0.001]	[0.003]	[0.003]	[0.038]	[0.004]	[0.004]	[0.003]
Count-based index of competition								
Index of competition with China*log(exchange rate of importer with respect to China)	-0.192***	-0.222***	-0.222***	-0.222***	-0.208***	-0.387***	-0.417***	
	[0.002]	[0.001]	[0.001]	[0.001]	[0.017]	[0.002]	[0.003]	
N	3,479,214	3,586,936	3,586,936	3,586,936	788,775	3,586,936	3,586,936	3,586,936

See notes to Table 1 for definitions of the value-based and count-based index of competition. Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. In column [1], the top and bottom fifth percentile of the observations are dropped. In columns [2]-[4], we make alternative assumptions on clustering the standard errors. In column [5], we retsrict the sample to two years -- 2000 and 2008. In columns [6] and [7], the index of competition is measured in 2001 and 2002 respectively. In Column [8], we use the Finger-Krenin index of export similarity. The index of competition except in columns [6] and [7] is measured in the year 2000. The regression sample (except column [5]) includes years from 2000-2008. All regressions include exporter*importer*time, exporter*product*time, importer*product time, and exporter*importer*product fixed effects. Standard errors denoted in parentheses are clustered at the importer*exporter*product level (except in columns [3]-[5]) . ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 3. Alternative Exchange Rate Measures

Dependent variable = log(exports) at (exporter,importer, 4-digit product, year) level

	Value-based index of competition				Count-based index of competition			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	Nominal exchange rate	Real exchange rate (deflated by relative prices)	Nominal effective exchange rate	Real effective exchange rate	Nominal exchange rate	Real exchange rate (deflated by relative prices)	Nominal effective exchange rate	Real effective exchange rate
Index of competition with China*log(exchange rate of importer with respect to China)	-0.150***	-0.245***	0.576***	0.545***	-0.133***	-0.214***	0.346***	0.356***
	[0.009]	[0.009]	[0.006]	[0.006]	[0.004]	[0.004]	[0.003]	[0.002]
N	3,586,936	3,586,936	3,602,228	3,602,228	3,586,936	3,586,936	3,602,228	3,602,228

See notes to Table 1 for definitions of the value-based and count-based index of competition. In columns [1] and [5], nominal exchange rate of importer wrt China is measured as renminbi/importer currency. In columns [2] and [6], real exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI relative to importer CPI. In columns [3] and [7], nominal effective exchange rate of China (2005=100) from the IMF is used. In columns [4] and [8], real effective exchange rate of China (2005=100) from the IMF is used. Note that an increase in the real and nominal effective exchange rates denotes an appreciation. The regression sample in all regressions includes years from 2000-2008. All regressions include exporter*importer*time, exporter*product*time, importer*product time, and exporter*importer*product fixed effects. Standard errors denoted in parentheses are clustered at the importer*exporter*product level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 4. Exports from Developing Countries and Chinese Exchange Rates: Product-Level Evidence By Region of Exporter

Dependent variable = log(exports) at (exporter,importer,4-digit product, year) level								
	Value-based index				Count-based index			
	Asia	Europe	LAC	MENA+SSA	Asia	Europe	LAC	MENA+SSA
Index of competition with China*log(exchange rate of importer with respect to China)	-0.467***	-0.433***	-0.297***	-0.116***	-0.288***	-0.258***	-0.192***	-0.139***
	[0.008]	[0.011]	[0.012]	[0.015]	[0.004]	[0.005]	[0.005]	[0.007]
N	1,234,019	997,174	750,565	436,403	1,234,019	997,174	750,565	436,403

The region of the exporter are defined based on the World Bank country classification. See notes to Table 1 for definitions of the valuey-based and count-based index of competition. Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. The index of competition in all the columns is measured in the year 2000. The regression sample includes years from 2000-2008. LAC denotes Latin America and the Caribbean; MENA denotes the Middle East and North Africa; SSA denotes Sub-Saharan Africa. All regressions include exporter*importer*time, exporter*product*time, importer*product time, and exporter*importer*product fixed effects. Standard errors denoted in parentheses are clustered at the importer*exporter*product level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 5. Exports from Developing Countries and Chinese Exchange Rates: Product-Level Evidence By Income Group of Exporter

Dependent variable = log(exports) at (exporter,importer,4-digit product, year) level

	Value-based index of competition			Count-based index of competition		
	[1]	[2]	[3]	[4]	[5]	[6]
	Low-income	Lower-middle-income	Upper-middle-income	Low-income	Lower-middle-income	Upper-middle-income
Index of competition with China*log(exchange rate of importer with respect to China)	-0.231***	-0.331***	-0.383***	-0.226***	-0.209***	-0.222***
	[0.016]	[0.007]	[0.007]	[0.008]	[0.003]	[0.003]
N	334,533	1,410,064	1,708,740	334,533	1,410,064	1,708,740

The income groups of the exporter are defined based on the World Bank country classification. See notes to Table 1 for definitions of the value-based and count-based index of competition. Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. The index of competition in all the columns is measured in the year 2000. The regression sample includes years from 2000-2008. All regressions include exporter*importer*time, exporter*product*time, importer*product time, and exporter*importer*product fixed effects. Standard errors denoted in parentheses are clustered at the importer*exporter*product level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 6. Exports from Developing Countries and Chinese Exchange Rates: Product-Level Evidence - 2 digit

Dependent variable = log(exports) at (exporter,importer,2-digit product, year) level

	Value-based index				Value-based index			
	[1]	[3]	[4]	[5]	[1]	[3]	[4]	[5]
Index of competition with China*log(exchange rate of importer with respect to China)	-0.131***	-0.084***	-0.009***	-0.306***	-0.293***	-0.206***	-0.113***	-0.268***
	[0.002]	[0.002]	[0.002]	[0.006]	[0.001]	[0.001]	[0.001]	[0.003]
N	861,487	861,487	861,487	861,487	861,487	861,487	861,487	861,487
Fixed effects								
exporter*importer*product	N	N	N	Y	N	N	N	Y
exporter*importer*time	N	N	Y	Y	N	N	Y	Y
exporter*product*time	N	Y	Y	Y	N	Y	Y	Y
importer*product*time	N	Y	Y	Y	N	Y	Y	Y

Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. The index of competition in columns [1]-[4] is defined as the summation over all 6-digit products within the 2-digit category of the following: share of China in overall imports of a 6 digit product multiplied by the share of the 6-digit product in total 2-digit exports from the exporter to the importer. The index of competition with China in columns [5]-[8], is defined at the 2-digit product level, and is equal to the share of 6-digit products within a 2-digit category that i exports to j, that China also exports to j. The index of competition in all the columns is measured in the year 2000. The regression sample includes years from 2000-2008. Standard errors denoted in parentheses are clustered at the importer*exporter*product level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 7. Exports from Developing Countries and Chinese Exchange Rates: Identifying the Total Effect of Exchange Rate Changes

Dependent variable = log(exports) at (exporter,importer, year) level

	Value-based index of competition		Count-based index of competition	
	[1]	[2]	[3]	[4]
Index of competition with China*log(exchange rate of importer with respect to China)	-0.066	-0.063	0.240	0.243
	[0.219]	[0.219]	[0.192]	[0.194]
log(exchange rate of importer with respect to China)	-0.143**	-0.144**	-0.320**	-0.331**
	[0.066]	[0.066]	[0.154]	[0.156]
N	34,960	34,258	35,792	35,024
Fixed effects				
exporter*time	Y	Y	Y	Y
importer*time	N	N	N	N
exporter*importer	Y	Y	Y	Y
Additional exporter*importer*time controls	N	Y	N	Y

Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. The index of competition in columns [1] and [2] is defined as the summation over all 6-digit products at the exporter-importer-year level of the following: share of China in overall imports of a 6 digit product multiplied by the share of the 6-digit product in total exports from the exporter to the importer. The index of competition with China in columns [3]and [4], is defined at the exporter-importer level, and is equal to the share of 6-digit products that i exports to j, that China also exports to j. The index of competition in all the columns is measured in the year 2000. The regression sample includes years from 2000-2008. The additional exporter-importer-time varying controls in columns [2] and [4] include dummies for whether the countries belong to an free-trade area, currency union; and whether one or both countries are WTO members. Standard errors denoted in parentheses are clustered at the importer*exporter level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

Table 8. Exports from Developing Countries and Chinese Exchange Rates: Product Types

Dependent variable = log(exports) at (exporter,importer, 4-digit product, year) level

	Value-based index					Count-based index				
	Homogenous	Differentiated	Low-skill	Medium skill	High skill	Homogenous	Differentiated	Low-skill	Medium skill	High skill
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Index of competition with China*log(exchange rate of importer with respect to China)	-0.339***	-0.312***	-0.320***	-0.295***	-0.202***	-0.240***	-0.205***	-0.238***	-0.198***	-0.131***
	[0.010]	[0.004]	[0.006]	[0.005]	[0.011]	[0.004]	[0.002]	[0.003]	[0.002]	[0.005]
N	981,310	2,679,680	1,326,035	1,810,629	465,852	981,310	2,679,680	1,326,035	1,810,629	465,852

Goods are classified into homogeneous or differentiated according to Rauch's liberal classification at 6-digit level. Goods are classified by skill-intensity based on Peneder (2001). See notes to Table 1 for definitions of the value-based and count-based index of competition. Exchange rate of importer wrt China is measured as renminbi/importer currency, deflated by the Chinese CPI. The index of competition in all the columns is measured in the year 2000. The regression sample includes years from 2000-2008. All regressions include exporter*importer*time, exporter*product*time, importer*product time, and exporter*importer*product fixed effects. Standard errors denoted in parentheses are clustered at the importer*exporter*product level. ***, ** and * denote statistical significance at the 1, 5 and 10 percent respectively.

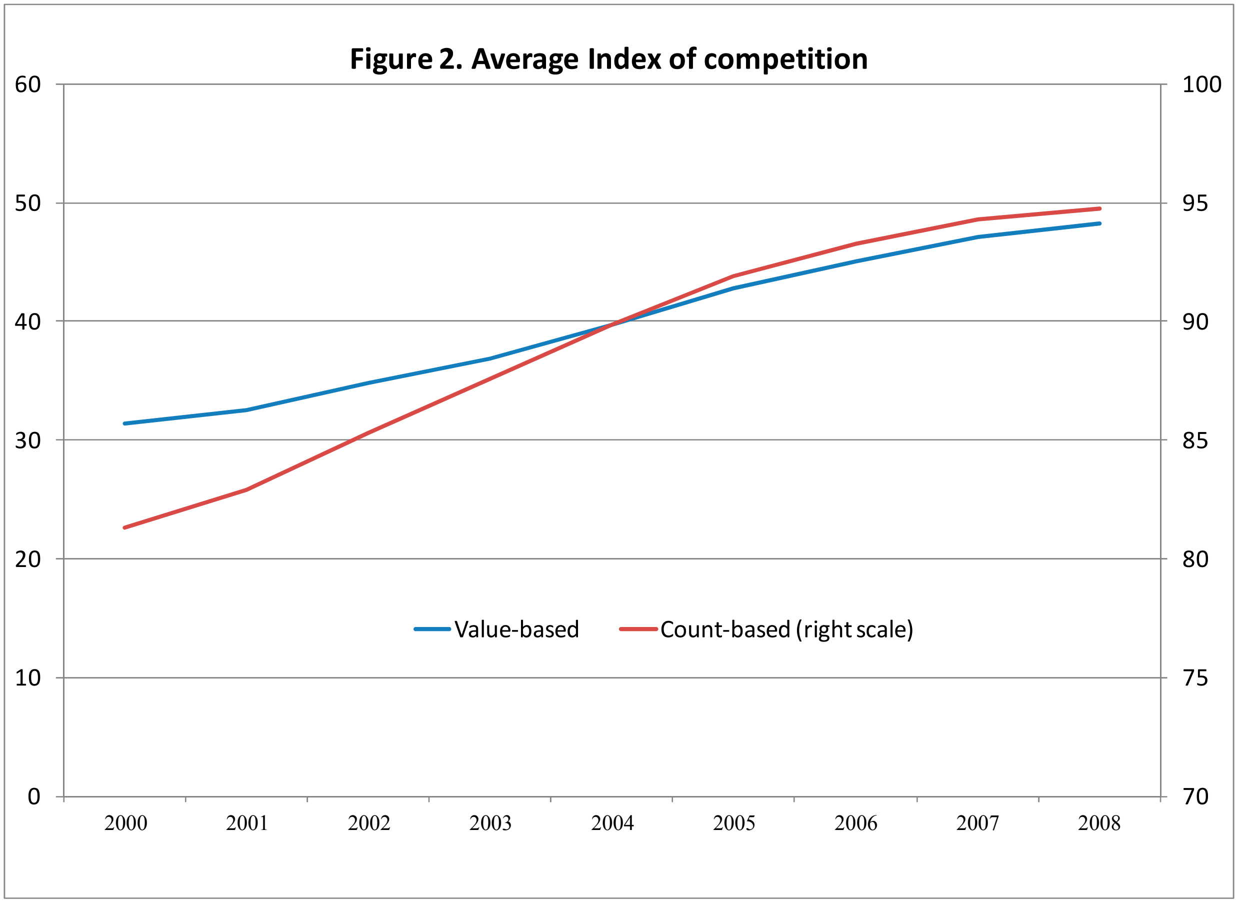


Figure 2. Average Index of competition
60
50
40
30
20
10
0
100
95
90
85
80
75
70
2000
2001
2002
2003
2004
2005
2006
2007
2008
Value-based
Count-based (right scale)

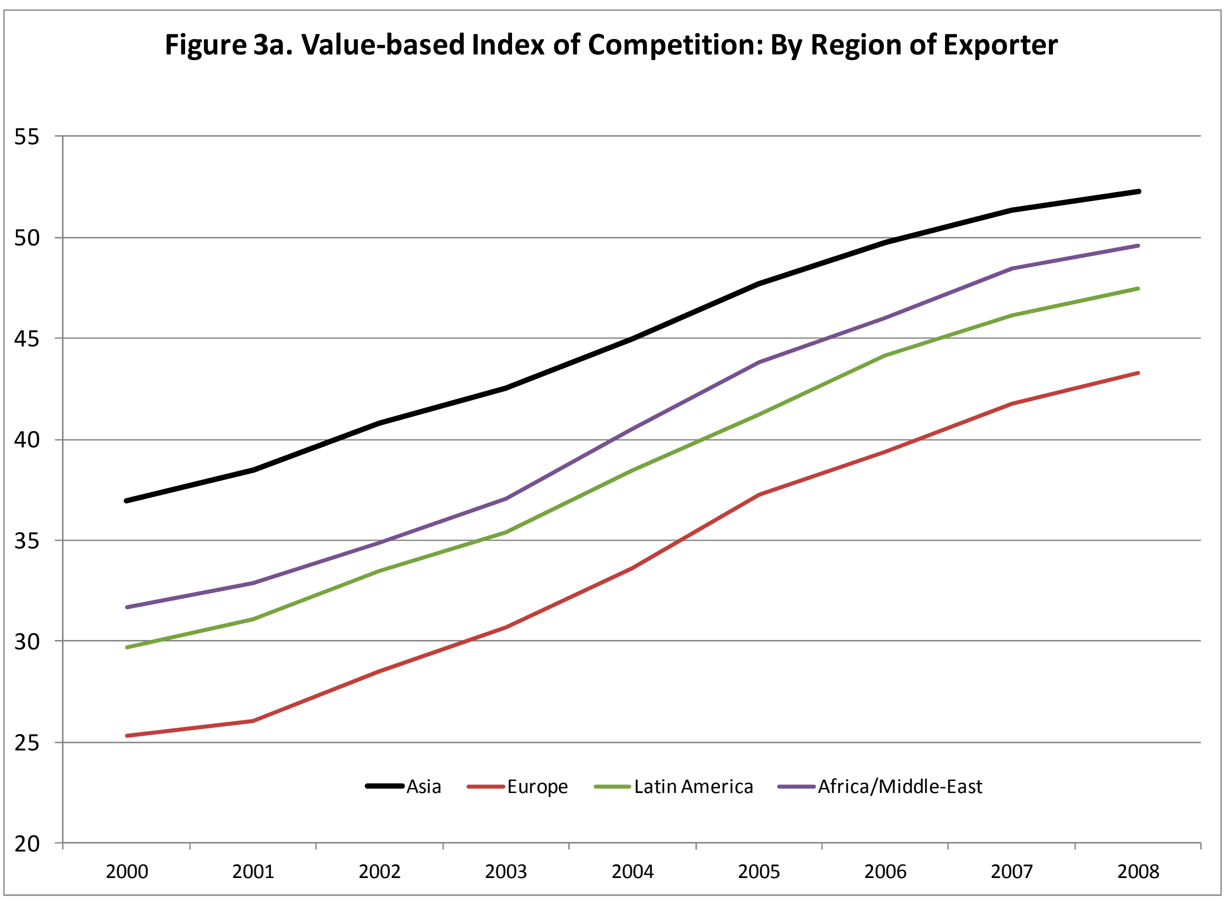


Figure 3a. Value-based Index of Competition: By Region of Exporter
55
50
45
40
35
30
25
20
2000
2001
2002
2003
2004
2005
2006
2007
2008
Asia
Europe
Latin America
Africa/Middle-East

Figure 3b. Count-based Index of Competition: By Region of Exporter

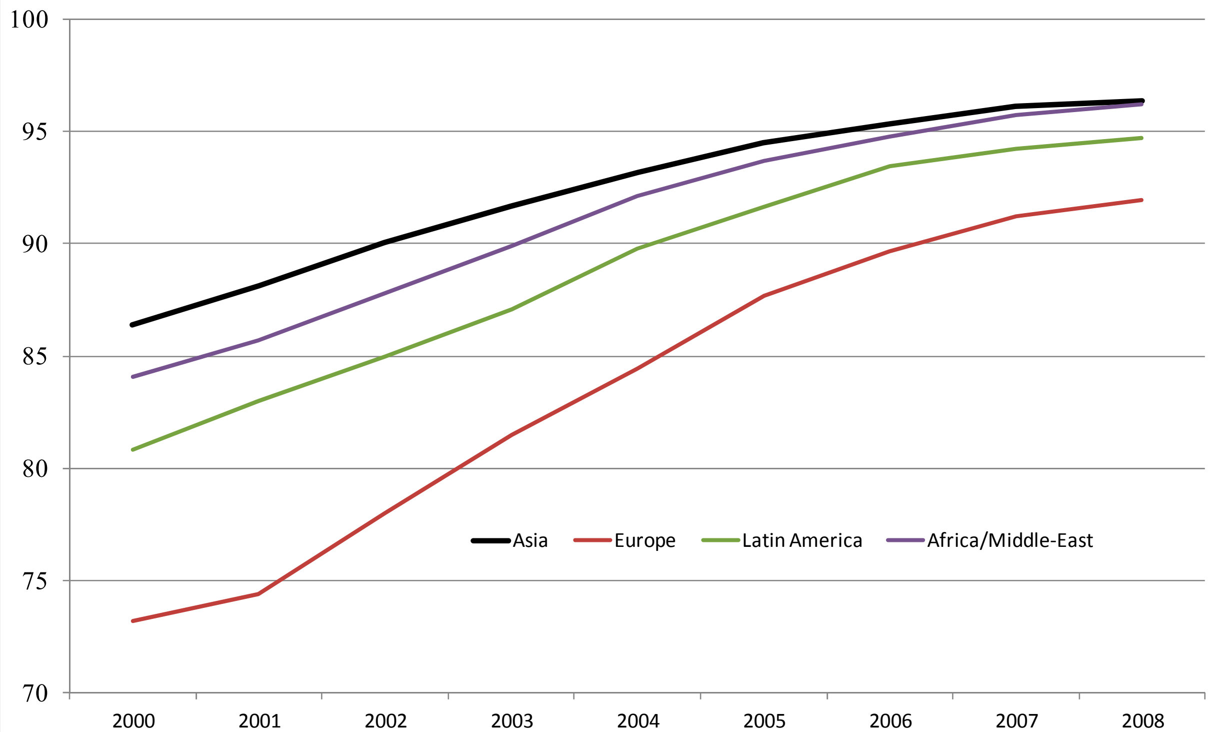
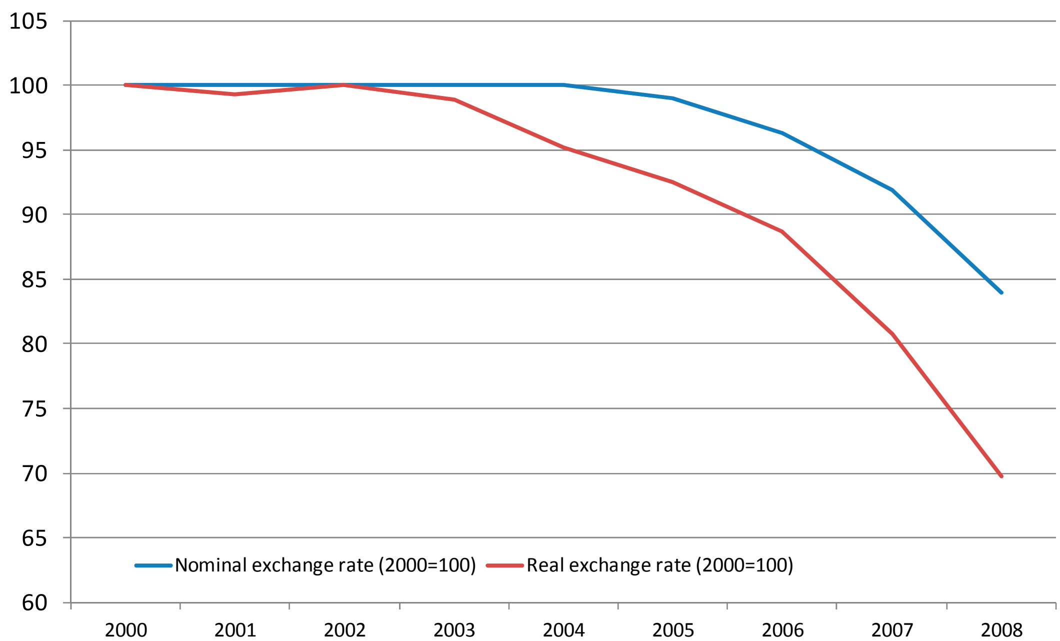


Figure 4.
Nominal and Real Exchanges: China



Source. International Financial Statistics, IMF. Nominal exchange rate is measured in renminbi/US$.
Real exchange is obtained by deflating nominal exchange rate by Chinese CPI.

Table A1. Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Nominal Exports ('000 USD)	3,586,936	2009.797	39531.450	0.001	1.590E+07
Log (real exports, deflated by US CPI)	3,586,936	-1.485	3.134	-11.611	12.100
Index of competition with China (structural measure)	3,586,936	0.408	0.325	0.000	1.000
Index of competition with China (count-based measure)	3,586,936	0.898	0.282	0.000	1.000
Nominal exchange rate (renminbi / importer currency)	3,586,936	2.614	3.332	0.000	15.222
Log (renminbi/importer currency exchange rate, deflated by Chinese CPI)	3,586,936	-5.892	2.426	-13.247	-2.632

Table A2. List of countries

Exporting countries		Importing countries
Afghanistan	Macedonia, FYR	Algeria
Albania	Madagascar	Argentina
American Samoa	Malawi	Australia
Argentina	Malaysia	Austria
Armenia	Maldives	Belarus
Bangladesh	Mali	Belgium
Belarus	Marshall Islands	Brazil
Belize	Mauritania	Canada
Benin	Mauritius	Chile
Bhutan	Mexico	Colombia
Bolivia	Micronesia, Fed. Sts.	Czech Republic
Bosnia and Herzegovina	Moldova	Denmark
Botswana	Mongolia	Egypt, Arab Rep.
Brazil	Montenegro	Finland
Bulgaria	Morocco	France
Burkina Faso	Mozambique	Germany
Burundi	Myanmar	Greece
Cambodia	Namibia	Hong Kong, China
Cameroon	Nepal	Hungary
Cape Verde	Nicaragua	India
Central African Republic	Niger	Indonesia
Chile	Pakistan	Ireland
Colombia	Palau	Israel
Comoros	Panama	Italy
Congo, Dem. Rep.	Papua New Guinea	Japan
Costa Rica	Paraguay	Kazakhstan
Cote d'Ivoire	Peru	Korea, Rep.
Cuba	Philippines	Malaysia
Djibouti	Poland	Mexico
Dominica	Romania	Morocco
Dominican Republic	Russian Federation	Netherlands
Ecuador	Rwanda	New Zealand
Egypt, Arab Rep.	Samoa	Nigeria
El Salvador	Sao Tome and Principe	Norway
Eritrea	Senegal	Pakistan
Ethiopia(excludes Eritrea)	Seychelles	Philippines
Fiji	Sierra Leone	Poland
Gabon	Solomon Islands	Portugal
Gambia, The	Somalia	Qatar
Georgia	South Africa	Romania
Ghana	Sri Lanka	Russian Federation
Grenada	St. Kitts and Nevis	Saudi Arabia
Guatemala	St. Lucia	Singapore
Guinea	St. Vincent and the Grenadines	Slovak Republic
Guinea-Bissau	Suriname	South Africa
Guyana	Swaziland	Spain
Haiti	Syrian Arab Republic	Sweden
Honduras	Tajikistan	Switzerland
India	Tanzania	Taiwan, China
Indonesia	Thailand	Thailand
Jamaica	Togo	Turkey
Jordan	Tonga	Ukraine
Kazakhstan	Tunisia	United Arab Emirates
Kenya	Turkey	United Kingdom
Kiribati	Uganda	United States
Kyrgyz Republic	Ukraine	Venezuela
Lao PDR	Uruguay	Vietnam
Latvia	Uzbekistan	
Lebanon	Vanuatu	
Lesotho	Vietnam	
Liberia	Zambia	
Lithuania	Zimbabwe	