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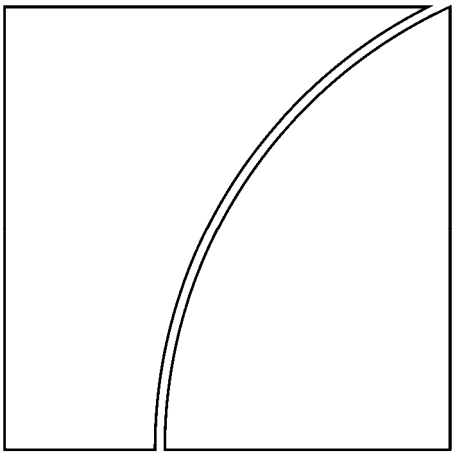

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# China's exchange rate policy and Asian trade

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Keywords: China, trade, exports, real exchange rate.

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# CHINA'S EXCHANGE RATE POLICY AND ASIAN TRADE

Alicia Garcia-Herrero and Tuuli Koivu[1]

## Abstract

This paper shows empirically that China's trade balance is sensitive to fluctuations in the real effective exchange rate of the renminbi. However, the current size of the trade surplus is such that exchange rate policy alone will probably not be able to address the imbalance. The potential reduction in the trade surplus resulting from an increase in the renminbi exchange rate is limited mainly because Chinese imports do not react as expected to a renminbi appreciation – they tend to fall rather than increase. By estimating bilateral import equations for China and its major trade partners, we find that the reaction for imports is generally confirmed for China's trade with Southeast Asian countries. That result might be attributable to Asia's vertical integration, as a large share of Chinese imports from Southeast Asia are re-exported. We also find that total exports from a number of Asian countries react negatively to a renminbi appreciation, which points to a dependence of Asian countries' exports on those of China.

Keywords: China, trade, exports, real exchange rate

JEL classification: F1, F14

## 1. Introduction

China's share in world trade has increased extremely rapidly during the past years. In fact, it is already one of the largest exporters in the world, together with Germany and the United States.

Until recently, China's trade balance was very close to zero. According to China's customs statistics, its trade surplus amounted to mere USD 32 billion (or 1.7% of GDP) in 2004 (Graph 1). However, since 2005 the trade surplus has ballooned: it reached nearly USD 180

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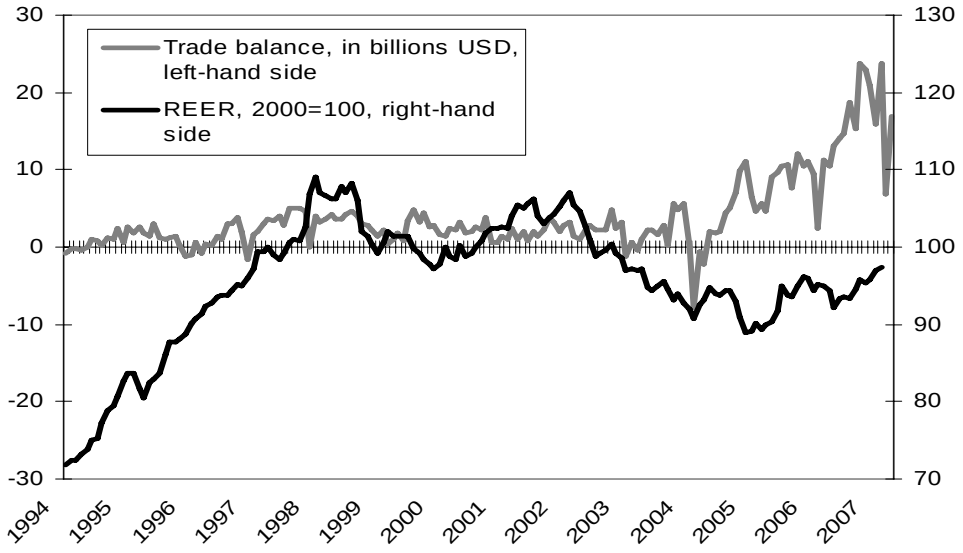
billion in 2006 (close to 7% of GDP) and increased further in 2007, to more than 10% of GDP.[2]

On the one hand, Chinese policymakers appear to be maintaining an artificially low exchange rate for the renminbi so as to profit from external demand and achieve a much needed high growth rate. On the other hand, given that prices may still play only a limited role in supply and demand decisions in China's transitional economy, doubts have been raised that the exchange rate can be an effective tool in reducing the trade surplus.

**Graph 1. China's trade balance and real effective exchange rate, monthly figures**




Source: China's customs statistics, CEIC, IFC.

Linked to the first argument is the fact that China is facing strong pressure from industrial countries to appreciate the renminbi. The real effective exchange rate (REER) of the renminbi rose steeply from 1994 until end-1997 but tended to decline after that until the move to a more flexible exchange rate regime was announced in July 2005. Thereafter the renminbi has appreciated somewhat in real terms. The question is whether – and to what extent – the sharp increase in the trade surplus can be explained by such a real depreciation.

The large size of China's trade surplus makes the issue important not only for China but also for the rest of the world. The existing literature is not conclusive. The lack of appropriate data and sufficiently long time series has discouraged research on the link between the renminbi exchange rate and China's trade. Since the summer of 2003, when discussions on the undervaluation of the renminbi came to the forefront, research on China's exchange rate policy has blossomed, but much of it has focused on estimating the long-run equilibrium exchange rate for China or exploring what kind of exchange rate regime best suits the Chinese economy. While both questions are clearly relevant, the most urgent issue – given the size of global imbalances – is whether China should use currency appreciation as a tool to reduce its huge trade surplus.

[2] China's balance of payments trade statistics generally show slightly larger trade surpluses than the customs statistics. According to the balance of payments data, the trade surplus in 2006 amounted to USD 218 billion, or more than 8% of GDP.

Our paper analyzes this question empirically using cointegration analysis. According to our results, a real appreciation of the renminbi would reduce China's trade surplus in the long run, but the effect would be limited. The relatively small impact – compared with the size of the imbalance – is mainly explained by the peculiar price elasticity we find for imports: namely, Chinese imports are negatively affected by the renminbi's real appreciation. By estimating bilateral import equations, we find that imports from Asian countries tend to fall but not those from other countries. This apparently counterintuitive result might well be explained by the vertical integration that characterises intraregional trade in Asia: Chinese imports from the rest of Southeast Asia are mostly geared towards re-export. In addition, we show evidence that the Southeast Asian countries do not seem able to compensate for the reduction in their exports to China by increasing exports to other countries, as their total exports are generally negatively affected by the renminbi's appreciation. In other words, exports from Southeast Asian countries seem to be a complement to exports from China rather than a substitute for them.

The rest of the paper is organized as follows. Section 2 reviews the existing literature. Section 3 describes the methodology and the data used. Section 4 presents the results on how China's exports and imports react to changes in the exchange rate and demand. In Section 5, we dig deeper into the issue of why Chinese imports do not get a boost from the renminbi's appreciation; to do so, we estimate bilateral trade equations with China's main trade partners and then analyse the export equations of selected Asian countries. Section 6 concludes.

## 2. Literature review

The literature on the impact of a real renminbi appreciation on China's trade balance may be divided into two groups according to the results. The first group – and clearly the largest – shows evidence that a real appreciation reduces the trade surplus through exports or imports or both. Only a couple of papers find a positive impact on the trade surplus or one. Table 1 summarizes the literature and the methodologies used.

Among the first studies on this topic, Cerra and Dayal-Gulati (1999) estimate the price elasticities of China's exports and imports for the period 1983–97 with an error correction model and find them to be negative and significant for exports (–0.3) and positive and significant for imports (0.7). In addition, they show that both elasticities increase over time. Dees (2001) improves on the previous analysis by separating China's exports and imports into two categories, those processed (eg imports of components for assembly) and ordinary ones. He finds that, in the long term, currency appreciation decreases exports. He also reports that ordinary exports are more price sensitive than processing exports, and processing imports slightly increase in the case of a renminbi appreciation. Bénassy-Quéré and Lahrèche-Révil (2003) simulate the impact of a 10% real renminbi depreciation and report an increase in China's exports to the OECD countries and a reduction of China's imports from emerging Asia if their exchange rates remained unchanged. Kamada and Takagawa (2005) do some model simulations to calculate the effects of China's exchange rate reform. They show that a 10% appreciation would boost Chinese imports slightly, while the impact on China's exports would be minuscule. These four papers that use data prior to China's WTO membership thus find exports to be affected negatively and imports positively by a renminbi appreciation.

A few more papers using the data mainly prior to the WTO membership study only Chinese exports. Yue and Hua (2002) and Eckaus (2004) both confirm the earlier result that a real appreciation reduces China's exports. As does Cerra and Dayal-Guyati, but with more recent data, Yue and Hua show that Chinese exports are becoming more price sensitive. Voon et al (2006) use sectoral data for 1978–98 and incorporate the degree of overvaluation of the

renminbi when estimating China's export equations; they also find a negative link between appreciation and China's exports.

The papers using more recent data support the earlier results on exports' negative exchange rate elasticity but challenge the result that a renminbi appreciation would increase imports to China. Lau et al (2004) estimate China's exports to, and imports from, the G-3 using quarterly data. In the long run, an increase of the real effective exchange rate is found to be significant in lowering exports. However, neither ordinary imports nor imports for processing seem to be affected by the REER. In any event, the results are difficult to interpret since it is not clear how they discount exports and imports, and the number of observations is small. Thorbecke (2006) uses a gravity model to study the effect of exchange rate changes on triangular trading patterns in Asia. To that end, he disaggregates exports into intermediate, capital and final goods. His results indicate that a 10% renminbi appreciation reduces Chinese final exports by nearly 13%. However, the appreciation would not significantly affect Chinese imports from the United States. Finally, Shu and Yip (2006) estimate the impact of exchange rate movements on the Chinese economy as a whole and find that an appreciation can reduce exports through an expenditure-switching effect that causes a moderate contraction in aggregate demand.

Although the earlier papers conclude that a renminbi appreciation would lead to a decline in China's trade surplus mainly via its negative impact on Chinese exports, some other papers offer a somewhat different view. For example, Jin (2003) estimates the relationship among real interest rates, real exchange rates and China's balance of payments and concludes that a real appreciation tends actually to increase the surplus in the balance of payments. Cerra and Saxena (2003) use sectoral data to study the behaviour of Chinese exporters and find that higher export prices have increased the supply of exports, particularly in recent years. The impact of the nominal exchange rate (NEER) on exports is not robust. In any event, their results – as any other with sectoral data – should be interpreted with care since only about half of Chinese exports are covered in the sectoral data, and no quality adjustment is reported in the unit price series.

One of the most recent attempts to estimate Chinese import and export equations is that of Marquez and Schindler (2006). They use shares of world total trade instead of import and export volumes to avoid employing proxies for China's export and import prices. According to their results, the real appreciation of the renminbi negatively affects not only China's export share but also its import share, at least for ordinary trade. The results are interesting, but estimated impacts are on import and export shares so that no inference can be made about the trade account. In addition, no cointegration techniques are used so that only short-run elasticities can be estimated.

In brief, a clear majority of earlier studies have found that a real appreciation of the renminbi reduces Chinese exports. The result is robust to changes in research method, time period and data coverage. However, the results on the exchange rate elasticity of Chinese imports are much more ambiguous: the earlier studies found that an appreciation would increase Chinese imports, and the more recent studies reached a very different finding. Overall, no clear conclusions about the impacts of a real appreciation of the renminbi on China's trade balance can be made on the basis of earlier studies.

In this paper we use more-recent data to look at the impact of the real exchange rate on China's trade. In addition, we use cointegration techniques to focus on longer-term structural developments. We also expand the analysis from aggregate import and export equations to bilateral ones so as to investigate whether large differences exist among China's trade partners. This approach is particularly important for the rest of Asia, as we shall show.

## Table 1. Earlier literature

| Authors | Data | Methodology | Impact of REER on exports/imports | Estimated price elasticities | Impact of demand | Other control variables |
|---|---|---|---|---|---|---|
| Bénassy-Quéré and Lahrèche-Révil, 2003 | Yearly 1984–2001 | Gravity model | A renminbi real depreciation increases China's exports to the OECD and reduces Asian exports to China. | –1.2 (exports) | - | - |
| Cerra and Dayal-Gulati, 1999 | Quarterly, 1983–97 | Error Correction Model | No effect on exports/imports for 1983–97.<br>For 1988 to 1997, negative and significant impact on exports and positive and significant on imports. | –0.3 (exports)<br>0.7 (imports) | Significant and positive for 1988–97 period | FDI, industrial production, output gap |
| Cerra and Saxena, 2003 | Quarterly sectoral data, 1985–2001 | Dynamic OLS | Price elasticity of exports increases towards end of period. NEER does not have a robust significant impact and industry-level results mixed. | 1985–2001: –1.0<br>1994–2001: 3.8 (export supply) | - | Domestic credit |
| Dees, 2001 | Monthly, 1994–99 | Error Correction Model | Appreciation decreases exports. Effect stronger on ordinary exports than on processed ones. No significant effect on ordinary imports but appreciation slightly increases processed imports. | –0.3 (exports)<br>0.2 (imports for processing) | Positive and significant for exports and imports. | Simulation of a shock to the economy gives the same results. |
| Eckaus, 2004 | Yearly, 1985–2002 | OLS | Negative and significant effect on exports to the U.S. and China's share of U.S. imports. | –0.3 (exports to the US) | Positive and significant effect | |
| Kamada and Takagawa, 2005 | Monthly, 1994–2000 | Theoretical model and OLS estimation | Revaluation causes a one-time import boost in the model but OLS shows no significant effect. | - | - | - |
| Lau et al, 2004 | Quarterly, 1995–2003 | Dynamic OLS | Negative and significant effect on exports and imports for processing. No significant effect on ordinary imports. | –1.47 (exports)<br>–1.28 (imports for processing) | Positive effect on exports. | FDI, VAT tax rebates and exports |
| Marquez and Schindler, 2006 | Monthly, 1/1997–2/2004 | OLS, studies effect on China's market share in world exports and imports | An appreciation lowers ordinary imports but for processed imports effect not robust. Effect on exports also not robust. | 10% appreciation reduces China’s export share by 0.5% and the import share by 0.1% | Positive for imports but not robust for exports. | FDI |
| Shu and Yip, 2006 | Quarterly, 1995–2006 | Error Correction Model | Appreciation reduces exports. | –1.3 (exports) | Positive and significant | Market share |
| Thorbecke, 2006 | Annual, 1982–2003 | Gravity model, Error Correction Model, OLS | In gravity model, an appreciation decreases China's exports. In VEC and OLS, exports to the U.S. decrease in the case of appreciation. No significant coefficient for imports. When studying US-China trade in a gravity model, no clear outcome. | –1.3 (exports) | Positive and significant for exports. Income elasticity for imports no robust. | Distances and common language in gravity models |
| Voon et al, 2006 | Annual, sectoral data 1978–98 | OLS | Negative impact of an appreciation on exports. | - | Positive and significant for exports. | Exchange rate volatility and misalignment |
| Yue and Hua, 2002 | Annual, provincial 1980–2000 | OLS, TSLS and fixed effect panel | Depreciation increases exports. Exchange rate sensitivity increases in the 1990s. | From –0.97 to –0.16 (exports) | Not significant. | Domestic production capacity |

## 3. Methodology and data

To assess the sensitivity of Chinese exports and imports to changes in the real exchange rate of the renminbi, we estimate standard export and import equations. We use cointegration techniques because we are interested in the long-run relationships. In addition, we use reduced-form export and import equations to avoid simultaneous equation bias, which would result from estimating supply and demand functions alone. However, to avoid potential problems with omitted variables, we include supply and demand determinants in the reduced-form equation.[3]

The two estimating equations are as follows:

$$X_t = \alpha_0 + \alpha_1 REER_t + \alpha_2 Y_t^* + \sum_{i=3}^{n} \alpha_i controls_t + \varepsilon_t$$

$$M_t = \beta_0 + \beta_1 REER_t + \beta_2 Y_t + \sum_{i=3}^{n} \beta_i controls_t + \varepsilon_t$$

where $X_t$ is the volume of exports from China, $M_t$ is the volume of imports into China, $REER_t$ is the real effective exchange rate of the renminbi, $Y_t^*$ is foreign demand and $Y_t$ is China's domestic demand. The estimated parameters are as follows: $\alpha_1$ exchange rate elasticity of exports, $\alpha_2$ income elasticity of exports, $\beta_1$ exchange rate elasticity of imports and $\beta_2$ income elasticity of imports.

Given the importance of the processing sector for the Chinese economy, we estimate separate equations for processed and ordinary exports. In the same way, we differentiate between imports for processing and ordinary imports.[4] Graphs A1 and A2 in the appendix show the trends in ordinary and processed exports and imports: both grew much faster from 2001 onwards in conjunction with China's 2001 entry into the WTO.

A noticeable difficulty in working with the Chinese trade data is that, because no export and import price indices exist at the aggregate level, values and volumes cannot be easily disentangled. We therefore need to use proxies for the price data. As a proxy for export prices, we use China's consumer price index (CPI). We use that measure because China's National Bureau of Statistics does not provide data for a producer price index, and the whole a sales price index does not exist for our whole sample.[5] For import prices we calculate a weighted index of China's 25 most important trade partners' export prices and deflate China's imports with this index (data sources are in Table A1 in the Appendix). As a robustness test, we used export prices for Hong Kong SAR as a proxy for China's export prices; the results were maintained.[6]

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[3] See Goldstein and Khan (1985) for a critique of the prevailing assumption in export equations that supply is infinitely elastic.

[4] Imports for processing comprise imports of parts and components that are used in the processing sector as inputs to manufacture exports. Processed exports include components exported from China for assembly in other countries and exports of goods that are assembled using imported components. Ordinary trade, in turn, refers to goods that are not subject to further processing and are not assembled from imported components.

[5] We also prefer the CPI to other external deflators, such as a weighted average of China's partners' import prices, because China has rapidly increased its market share, and it already is a major world exporter; thus, it is hard to argue that it is a pure price taker.

[6] The underlying assumption is that most Hong Kong SAR exports are originally produced in mainland China and that Hong Kong SAR's mark-up of these goods remains relatively constant.

The REER is drawn from the IMF's international financial statistics and is constructed as follows:

$$REER = \prod_{i=1}^{N} (rer_i)^{w_i}$$

where $N$ is the number of currencies included in the index, $w_i$ is the weight of the $i_{th}$ currency and $rer_{i,t}$ is the bilateral real exchange rate against each of China's trade partners.[7] We also used the REER constructed by the BIS as a robustness test; the results did not change.

We expect the exchange rate elasticity for exports to be negative, as Chinese products compete in the world market. The expected sign for the exchange rate elasticity of imports is less clear in the Chinese case. A real appreciation should foster imports if the gained purchasing power is stronger than the reduced demand following the associated fall in exports. The reaction will very much depend also on the import structure. If imports are mainly substitutes for domestic production, price elasticity should be positive, ie an appreciation should increase imports. However, if imports are basically components and investment goods directed to the export industry, which is very large in China's case, they may be affected negatively by an appreciation.

Foreign demand for Chinese exports is measured by world imports (excluding imports to China) and deflated by the global import price index. Obviously, some production-based measure could have also been used, but monthly data do not exist. Furthermore, that kind of data may have even more serious difficulties in capturing the fast growth in world trade in the past few years – clearly faster than GDP growth – that has been due to the opening up of emerging economies.

For China's domestic demand for ordinary imports, we use the volume of industrial production. GDP would, of course, be a broader measure of economic output, but in the wake of the major statistical reform in 2005, China's authorities have yet to publish quarterly GDP statistics for 1994–2005. For imports for processing, we use processed exports as a demand factor in the long run. The expected sign for income elasticity is positive both for exports and imports.

Additional controls are included in the export and import equations on the basis of their relevance in the trade literature as well as for the Chinese case. For exports, we test for the relevance of rebates of the value-added tax (VAT) that are used in China as a policy tool either to encourage or discourage exports, depending on the business cycle. The expected sign on VAT rebates is obviously positive.[8] To introduce supply considerations in our reduced-form equation, we use a measure of capacity utilization. The a priori is that high capacity utilization should point to potential supply constraints, which could hinder export growth. Capacity utilization is defined as the difference between industrial production and its trend, the latter being calculated using a Hodrick-Prescott filter.

The final control variable in the export equation is the real stock of inward foreign direct investment (FDI). While the relation between trade and exports is well established in the literature, it could be particularly relevant for China given the large amount of FDI directed to the export sector. Although in general one would expect that an increase in the stock of FDI should foster China's exports, the complicated structures of production chains, in which components and unfinished products may travel via several countries before reaching the final market, may complicate such an a priori.[9]

Moving to the import equation, import tariffs clearly need to be included since they have been substantially reduced, particularly since China's entry into the WTO. The second control is

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[7] For more details, see Bayoumi et al (2005).

[8] Data for VAT rebates start only in 1995 and end in 2004.

[9] Chinese monthly data on FDI exist only as of 1997.

again the FDI stock. We would, in principle, expect to find a positive coefficient on the FDI stock insofar as foreign companies are more likely to use imported machinery, components and parts in their production than are Chinese companies. However, as foreign companies start to gear their whole production chain to China, the need for imports could actually be reduced along with an increase in the FDI stock.

Finally, a deterministic trend is included in both export and import equations when it is statistically significant. The trend variable should help to capture productivity improvements and the ongoing reforms in the Chinese economy, which we cannot easily measure otherwise.

All other variables except VAT rebates and import tariffs, which are measured as a share of the value of exports and imports, are in logarithms. As Chinese data may not follow the standard seasonal pattern, we prefer to use unadjusted series while introducing dummies for the Chinese New Year and December.[10]

We use monthly data for the period 1994–2005. Starting the analysis prior to 1994 would have made little sense since a breakthrough in China's market reforms occurred in that year. Some of the reforms are especially relevant to the question we pose, in that the two exchange rate systems were unified, mandatory planning for imports was eliminated and licensing requirements and quotas were reduced. Also price reform[11] was pushed forward, the renminbi started to be convertible on the current account and private sector development benefited from the new company law.

## 4. Results for China's import and export equations

As a preliminary step, we test for the order of integration of the variables included in our analysis. We use the augmented Dickey-Fuller (ADF) tests for the existence of a unit root. Nearly all variables are found to be non-stationary in levels but stationary in first differences.[12] We then test for the existence of cointegration vectors using the Johansen procedure. We find at least one cointegrating vector for each variable group. As proposed by Phillips and Loretan (1991),[13] the presence of the cointegrating vectors allows us to estimate a regression of the lagged determinants and their differences through a non-linear least squares approach. Such an approach will yield unbiased and consistent estimates of the long-run and short-run parameters.[14]

Besides regressions on export and import equations for our full sample (1994–2005), we also ran such regressions for a shorter period (2000–05) that concentrates on the period of WTO influence.[15] In both cases, we consider it important to distinguish between processed and

[10] The final regression includes the dummies only when statistically significant.

[11] According to OECD (2005), the share of transactions conducted at market prices among producer goods increased to 78% in 1995, from 46% in 1991.

[12] There are only two exceptions: capacity utilization, which appears to be I(0), and the FDI stock, which is not stationary even in first differences. The latter result seems to be due to the relatively large number of lags suggested by the Akaike information criteria. If we use only one lag, as suggested by the Schwarz criterion, we can reject the unit root even at the 1% level.

[13] This approach tackles the simultaneity problem by including lagged values of the stationary deviation from the cointegrating relationship.

[14] The results of unit root and cointegration tests are available on request from the authors.

[15] Its continuous move towards a market economy allowed China to enter the WTO in December 2001. Because of the lengthy preparation for China's accession and the agreed transition period thereafter, it is very difficult to estimate when its WTO membership started to influence China's trade and by how much. Factual information points to 2000 as the point at which the effects of China's prospective WTO entry became clear. Statistical techniques also support the choice of 2000 to break our sample, as we find a structural break in the beginning of 2000 through a Chow test.

ordinary trade and, therefore, run separate equations for each of them in the case of both exports and imports. The maximum number of short-term lags introduced in the equations was three, and we ultimately included only those that were statistically significant.

The full results for the export equations can be found in Table A2 in the Appendix.[16] As expected, long-run exchange rate elasticities of China's exports – both processed and ordinary – are negative and significant in our full sample and also after WTO entry. When appropriately transformed (see Table 2), the estimated long-run impact of the real exchange rate is around –1.3 for processed exports for both periods. For ordinary exports, it drops from –2.3 measured for the whole period to –1.6 for the more recent period. Our results are very close to those found by other authors using cointegration analysis (–1.5 for total exports in Lau et al (2004) and –1.3 in Shu and Yip (2006)). They are also similar to the estimated export price elasticities for major industrial countries (–1.5 and –1.6 for the United States and the United Kingdom, respectively, according to Hooper et al (1998)).

For both ordinary and processed exports, the long-run positive effect of world demand on Chinese exports is very small and not statistically significant in our full sample, but it does become significant after WTO membership. That result is in line with the idea that China was facing considerable barriers to profiting from other countries' growth before its WTO entry. In addition, for the most recent sample, the income elasticity of Chinese exports is very close to 1, as expected.

**Table 2. Long-run exchange rate and demand elasticities**

| | | Ordinary exports | Processed exports * | Ordinary imports | Imports for processing |
|---|---|---|---|---|---|
| **Exchange rate elasticity** | 1994–2005 | -2.3 | -1.3 | -1.0 | -0.8 |
| | 2000–05 | -1.6 | -1.4 | -0.4 | (-0.3) |
| **Demand elasticity** | 1994–2005 | (0.5) | (0.2) | -0.3 | (0.2) |
| | 2000–05 | 1.0 | 0.8 | 0.3 | 0.4 |

Note: Values in parentheses are not statistically significant.

As for the control variables, capacity utilization has a significant impact on exports only contemporaneously or with a one-month delay. The sign of capacity utilisation is negative, in line with the idea that a larger share of production stays in the domestic market in high-growth periods. The VAT rebates are not statistically significant in any of the specifications; we thus exclude them from the final estimations, as their inclusion would shorten the estimation period due to data constraints.[17] As mentioned above, the data on the FDI stock start in 1997, and the stock is thus introduced as an explanatory variable only during the more recent subperiod. Somewhat surprisingly, however, the FDI stock does not affect Chinese exports to a statistically significant extent. The trend is positive and significant for all equations, while exports seem to decrease during the Chinese New Year and increase in December. If we exclude the trend from estimations, the coefficients on both world demand and the FDI stock would become strongly positive and significant. However, our results on the exchange rate elasticity would remain essentially unchanged.

The estimated coefficients of the import equations are shown in Table A3 in the Appendix. Demand factors seem to play a relatively moderate role in explaining past imports.[18] In the

[16] All the reported results pass the serial correlation test on residuals.

[17] VAT rebates could not be included as a short-run variable because we had only annual data on tariffs, and thus changes were rare throughout the sample.

[18] In the case of ordinary imports, income elasticity becomes positive and significant for 1994–2005 if we exclude the trend variable from the regression.

later subsample, imports for processing do react positively to external demand, measured by processed exports, and domestic industrial output increases ordinary imports, as expected.

As one would expect, the FDI stock appears to have a positive effect in the long run both on ordinary imports and on imports for processing. Finally, a reduction in import tariffs seems to foster imports for processing in the long run.[19] As for exports, dummies for the Chinese New Year as well as for December were significant in most cases.

Finally, the exchange rate elasticity of imports is always negative and generally significant. The only exception is imports for processing in the latter subperiod, for which the negative coefficient on the exchange rate is significant only at the 15% level. The exchange rate has not only a direct link to imports for processing but also an indirect link via processed exports. In other words, a renminbi real appreciation tends to reduce imports rather than to increase them. Although counterintuitive at first sight, such negative elasticity has already been reported in some of the most recent literature, such as Marquez and Schindler (2006). The finding basically implies that imports – even ordinary ones – are more sensitive to the lowering of exports induced by the renminbi real appreciation than to a rise in purchasing power.

## 5. Looking at the reasons behind the negative exchange rate elasticity

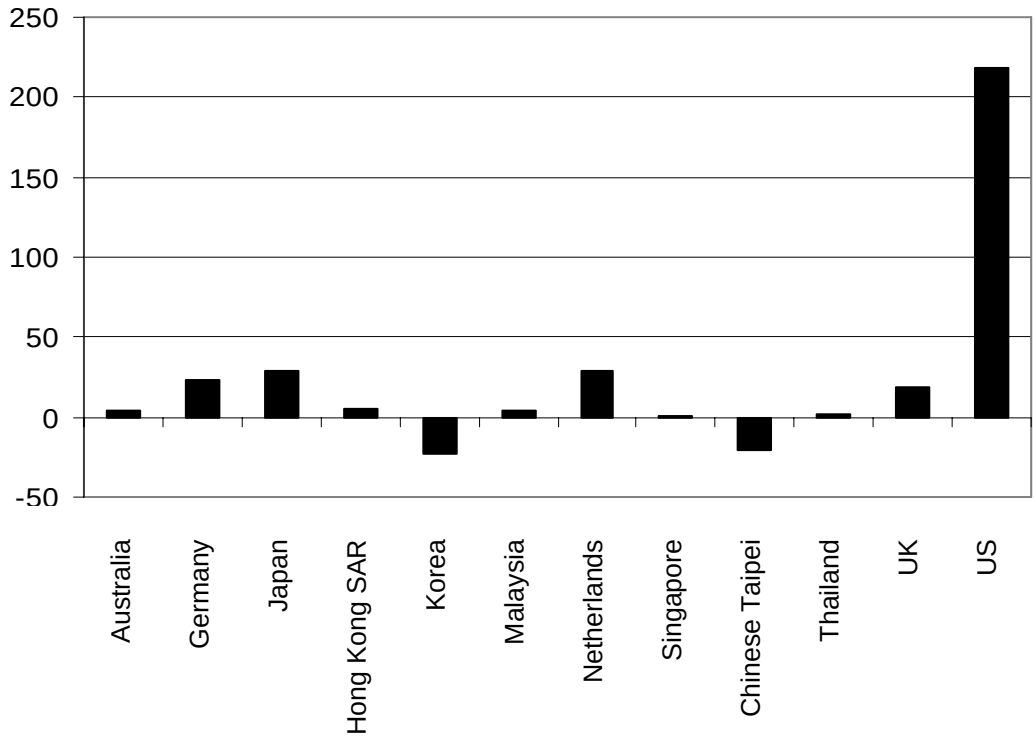
The finding that a renminbi real appreciation has a negative impact on imports requires careful analysis, especially given its implications for China's trade surplus in the event of a real renminbi appreciation. Our a priori hypothesis is that the finding is related to the special characteristics of China's trade as illustrated by the large differences in China's bilateral trade balances across countries (Graphs 2 and 3).

China imports a large amount of intermediate goods from the rest of Asia for processing and re-exporting. As a result, the high degree of vertical integration among Asian exporting industries makes their imports to China more a complement to Chinese goods than a substitute for them. This implies that a real appreciation of the renminbi could lead to a decrease not only in Chinese exports but also in imports.

Vertical integration applies more to processing industries, but many ordinary imports, such as investment goods and raw materials, also function as inputs to the export sector. Overall, because the share of non-high quality consumption goods in China's imports is relatively small, it seems that only a small share of import products compete with Chinese domestic production. Some import products only follow foreign direct investment.

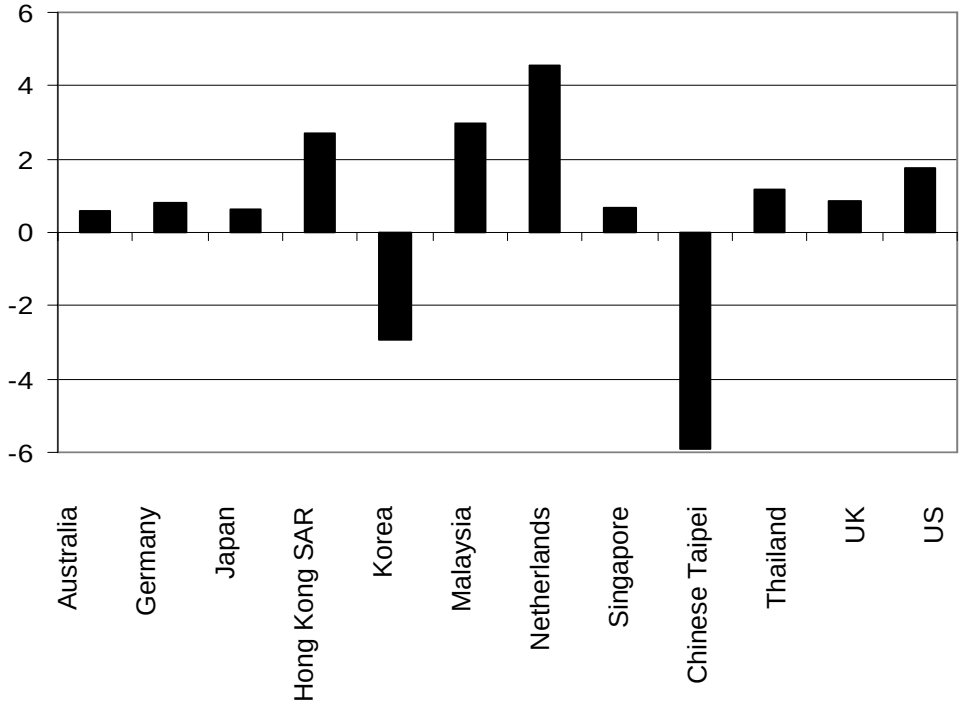
[19] Import tariffs could not be included as a short-run variable because we had only annual data on tariffs, and thus changes were rare throughout the sample.

**Graph 2. China's bilateral trade balances with selected countries in 2005, in billions of USD**




Source: IMF Direction of Trade; the data for Chinese Taipei are from the Bureau of Foreign Trade.
Note: Data are from the partners' side.

**Graph 3. China's bilateral trade balances with selected countries in 2005, in per cent of each country's GDP**




Source: IMF Direction of Trade; the data for Chinese Taipei are from the Bureau of Foreign Trade.
Note: Data are from the partners' side.

To explore the issue further with readily available date, we ran bilateral regressions for China's 10 largest trade partners to assess whether a renminbi real appreciation would impact those partners differently. Our a priori is that imports from Southeast Asian countries, being mainly intermediary products for China to assemble and re-export, should respond negatively to a renminbi appreciation. In turn, imports from other countries are expected to react variably to renminbi appreciation, depending on their export structure. The estimated bilateral equations take the following format:

$$X_{tj} = \alpha_{0j} + \alpha_{1j} RER_{tj} + \alpha_{2j} Y_{tj}^{*} + \sum_{i=3}^{n} \alpha_{ij} controls_{tj} + \varepsilon_{tj}$$

$$M_{tj} = \beta_{0j} + \beta_{1j} RER_{tj} + \beta_{2j} Y_{t} + \sum_{i=3}^{n} \beta_{ij} controls_{tj} + \varepsilon_{tj}$$

where Chinese exports and imports to/from country j ($X_{tj}$ and $M_{tj}$, respectively) are explained by the bilateral real exchange rate ($RER_{jt}$), external and domestic demand ($Y_{tj}$* and $Y_t$) and other control variables. Unfortunately, we cannot separate exports and imports for ordinary and processing products, as no such data exist. As in the previous exercise, the CPI is used as a deflator for Chinese exports, and imports to China are converted to volumes with the export price index of each trade partner.[20] The bilateral real exchange rate between the renminbi and the currency of each of China's export and import partners is measured in CPI terms. The demand for China's exports is proxied by the real GDP of each of its export partners, while China's domestic demand is again captured by industrial production. We also introduce the stock of bilateral FDI in both export and import equations. As before, we introduce capacity utilisation for China's export equations. Finally, a trend was introduced when statistically significant.[21] Data sources are reported in Table A1 in the Appendix.

We estimate the bilateral trade equations for 2000–05 because, for some countries, data did not exist for the whole period. That practise allows us to compare results between countries and also with those for aggregate export and import equations. Following the same procedure as before, we conduct unit root tests for all bilateral variables. Virtually all of them are I(1) and at least one cointegration vector was found for each bilateral import and export equation.[22]

The results for the bilateral export equations are very similar to our aggregate estimations and also across countries (see Table A4 in the Appendix).[23] The bilateral appreciation of the renminbi against the currency of each of China's major trade partners reduces Chinese exports, although for the United States and Chinese Taipei the link is not statistically significant. The only exception is Hong Kong SAR, for which the coefficient is positive but not statistically significant. The result for Hong Kong SAR is not surprising given the difficulties in interpreting the data on trade between it and the mainland. After transformation (see Table 3),

[20] When we formulate the bilateral equations, we use data from China's trading partners rather than from China's statistics to avoid China's incorrect accounting of its trade with Hong Kong SAR. China's statistics show a large amount of exports to Hong Kong SAR that in fact only pass through on the way to other countries. In any event, the data we use have other well-known caveats. For example, because of some tax considerations and its large ports, the Netherlands is often indicated as a final destination for goods that are actually only passing through to other European countries, which explains why the Netherlands appears in the data as one of China's major trade partners and also why it appears to have a large trade deficit with China. In reality, the bilateral equation on trade between China and the Netherlands reflects the dynamics of trade between China and Europe more generally.

[21] The number of short-term lags included in the final estimations is again based on their statistical significance. We seasonally adjust the data with the CensusX12 programme to avoid seasonal fluctuations in China's trade partners' data. If statistically significant, we introduce dummies for Chinese New Year and December.

[22] Capacity utilisation was again I(0). The results of unit root and cointegration tests are available on request from the authors.

[23] We do not report the equation on China's exports to Japan as it does not pass the standard misspecification tests. All reported results have passed the LM test on residuals' serial correlation.

the exchange rate elasticity is highest for exports to Singapore if we ignore the insignificant coefficient on exports to the United States.

We also find that economic activity in China's trade partners increases Chinese exports, as one would expect. Bilateral income elasticities are highly significant for all countries except Germany. For some countries, particularly in Europe and the United States, such elasticities are very large. That might be due to the relatively short time since China's entered the WTO, an event marking a major structural change in world trade. In addition, the large elasticities point to the importance of demand factors in explaining the large trade imbalance between China and the United States and the EU countries.

In some cases, our measure of productivity gains, the trend variable, is also positive and significant. For Korea and Chinese Taipei, however, the trend is negative. As for FDI, an increase of FDI from Korea or Chinese Taipei into China raises Chinese exports to these countries, but for Germany and Italy, the impact is the opposite. The differential effect might be due to the differing behaviour of Asian and European multinationals when dealing with the Chinese market. As mentioned above, a negative link could reflect a transfer of the entire manufacturing process to China. For example, in the past, some semi-finished products may have been first exported from China to Germany and after some modification shipped to the final destination, whereas now the entire manufacturing process has probably been moved to China and there is no longer the need to ship the product first to Germany. Nonetheless, the result should be interpreted with caution as it warrants deeper analysis.

The results for the bilateral import equations are much less homogeneous, as shown in Table A5 in the Appendix.[24] First, our estimated long-run price elasticities show that a renminbi real appreciation reduces imports from all Asian countries to China. The coefficient is significant for Korea and Thailand. For high-income countries – the United States, Germany and Japan – the coefficient is negative but not statistically significant. The coefficient is positive for only Russia and Australia, but it is not statistically significant.

**Table 3. Bilateral long-run exchange rate and demand elasticities**

| | Export equation | | | Import equation | |
|---|---|---|---|---|---|
| | Bilateral RER | Demand | | Bilateral RER | Demand |
| **US** | (-2.0) | 5.9 | **Japan** | (-0.4) | (-0.7) |
| **Hong Kong SAR** | (0.2) | 1.5 | **Korea** | -0.8 | 2.7 |
| **Japan*** | - | - | **US** | (-3.1) | 1.2 |
| **Germany** | -0.6 | (2.0) | **Chinese Taipei** | (-1.1) | 6.8 |
| **Korea** | -0.6 | 2.8 | **Germany** | (-0.5) | (0.0) |
| **Netherlands** | -1.1 | 7.0 | **Singapore*** | - | - |
| **UK** | -0.6 | 8.2 | **Russia** | (1.2) | (-0.5) |
| **Singapore** | -1.6 | 1.8 | **Australia** | (0.1) | 1.3 |
| **Italy** | -1.3 | 3.6 | **Malaysia** | (-0.3) | (0.2) |
| **Chinese Taipei** | (-0.4) | 5.6 | **Thailand** | -1.0 | (0.5) |

* Equations for China's exports to Japan and imports from Singapore did not pass the misspecification tests.
Note: Values in parentheses are not statistically significant.

[24] Of China's 10 most important import destinations, we drop Singapore because of econometric problems. All reported results have passed the LM test on residuals' serial correlation.

As for the income elasticities, they are generally positive although rather low and not always statistically significant. China's imports from Japan, Chinese Taipei, Germany, Russia, Malaysia and Thailand increase with FDI from these countries. Again, Korea is somewhat exceptional, with negative and significant long-run coefficient on FDI. Table 3 summarises the transformed long-run price and income elasticities for China's bilateral export and import equations.

**Table 4. Structure of imports to China from major partners as a share of total imports in 2005**

| | Agricultural products | Mineral products | Chemicals | Textiles | Base metals | Machinery | Electronics | Vehicles | Optical instruments |
|---|---|---|---|---|---|---|---|---|---|
| Australia | 4.5 | **52.8** | 10.2 | 8.2 | **12.7** | 1.9 | 0.8 | 1 | 0.4 |
| Germany | 0.2 | 0.2 | 6.9 | 0.6 | 7.8 | **35.9** | **13.1** | **11.9** | 6 |
| Japan | 0.2 | 1.5 | 8.8 | 3.7 | **11.4** | **21.5** | **30.0** | 4.5 | 8.7 |
| Korea | 0.6 | 4.7 | 10.2 | 3.8 | 9.7 | 9.5 | **33.6** | 2.8 | **14.8** |
| Malaysia | 6.4 | 2.6 | 4.1 | 0.7 | 1.8 | 8.6 | **63.0** | 0.1 | 1.3 |
| Russia | 5.0 | **48.4** | 13.9 | 0.0 | **16.2** | 0.5 | 0.4 | 1.2 | 0.0 |
| Taiwan | 0.1 | 0.9 | 7.4 | 4.5 | 10 | 9.7 | **38.7** | 0.5 | 16.1 |
| Thailand | 6.1 | 5.9 | 4.4 | 2.6 | 2.9 | **27.5** | **26.5** | 0.3 | 1.3 |
| US | 8.6 | 2 | **11.3** | 4.3 | 6.7 | **17.1** | **17.5** | 8.9 | 7.8 |

Source: CEIC.

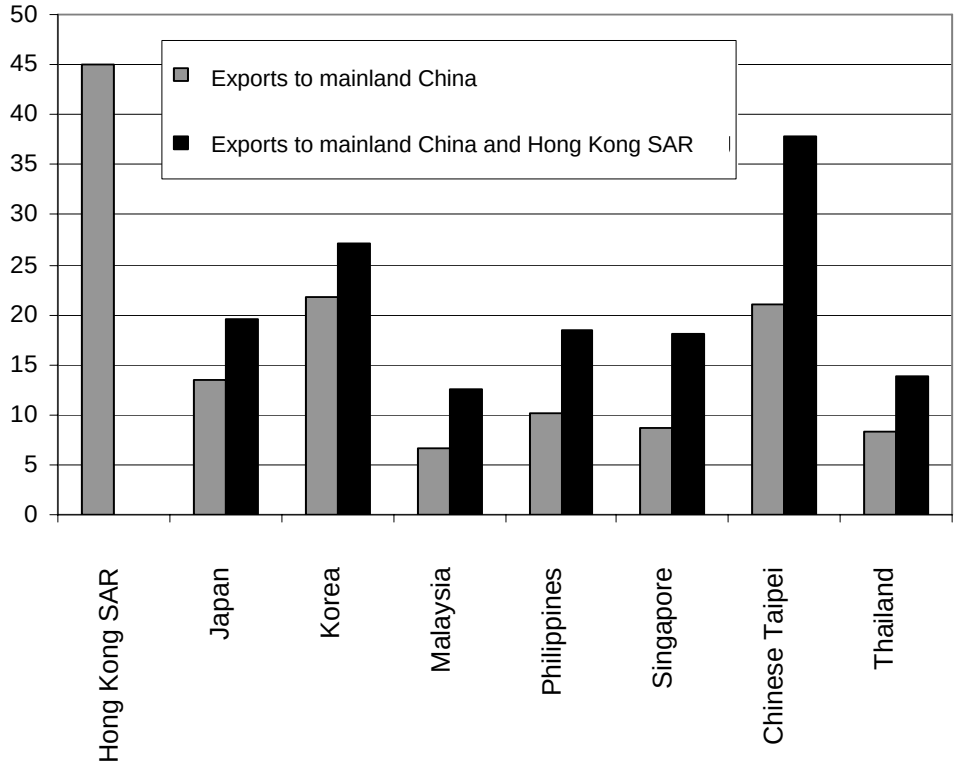
To better understand the diverse results found for the exchange rate elasticity of Chinese imports, we examine the composition of China's imports from each of its major trade partners (Table 4). Australia and Russia basically export energy and raw materials to China, which might explain the weak reactions of Chinese imports from these countries to changes in the bilateral real exchange rate. Somewhat surprisingly, an increase in China's economic activity does not have a significant positive impact on imports from Russia (actually, the link is negative but far from being statistically significant). The lack of connection could be explained by the underdeveloped transport connections between Russia and China: if railway use is at capacity, more oil cannot be transported to China even with an increase in demand. In contrast, Australian imports do increase with China's industrial value-added.

A second group of countries that can be identified in the results are those with high income level. Exports from Germany, Japan and the United States are not sensitive to changes in the bilateral real exchange rate. Exports from Germany and Japan to China are clearly driven by FDI, but US exports to China seem to benefit more from overall economic development in China. Those results are natural when considering the structure of exports from these countries. About half of German and Japanese exports to China are machinery and electronics, products that are often used in the export oriented (and largely foreign owned) industries. The imports from the United States, however, are much more widely varied, including soybeans, airplanes and high-tech chips. Although many of the products from the United States are directed to the domestic sector, there are no subsidies or Chinese competition for them, which largely explains the low and even negative exchange rate elasticity.

The third group of countries consists of emerging Asian countries whose exports to China are negatively affected by a renminbi appreciation. They mainly export products, parts and components to Chinese export industries, and their exports to China are thus negatively linked to renminbi appreciation.

As shown in Graph 4, a number of Asian countries have a very large share of their exports going to mainland China. If we assume that a part of the exports to Hong Kong SAR also end up in mainland China, the shares become even larger. For example, exports to mainland China and Hong Kong SAR constitute close to 40% of all exports from Chinese Taipei.

**Graph 4: Share of exports going to the mainland China and Hong Kong SAR for selected Asian countries in 2005, in per cent**




Source: IMF Direction of Trade; the data for Chinese Taipei are from the Bureau of Foreign Trade.

Therefore, our results, which point to a renminbi appreciation reducing exports from the rest of Asia to China, should be a concern for many Asian countries, especially if they are not able to compensate for this effect by increasing exports to other destinations. The threat from a renminbi appreciation largely depends upon the degree of complementarity among Asian exports and also upon the reactions of the Asian supply chains. Although testing for this hypothesis would require a detailed sectoral analysis that is beyond the scope of this paper, we attempt to give a preliminary assessment by estimating export equations for China's main trade partners in Asia.

The form of the export equation is the same as above for China, so we explain exports by the country's own real effective exchange rate and world demand. In addition, the equation includes China's real effective exchange rate as an additional explanatory variable. The data on exchange rates are again CPI-based, and world demand is measured by world total imports. The trend is included when it is found to be statistically significant.

We estimate the export equations for China's main Asian trade partners for the period 2000–05 and seasonally adjust the data with the CensusX12 programme.[25] We find our variables are again integrated of degree 1, and at least one cointegrating vector exists among each group of variables.[26]

[25] We dropped Indonesia from the sample because of a lack of data.

[26] The results of unit root and cointegration tests are available on request from the authors.

**Table 5. Export equations for China's major regional trade partners**

| | China's REER | REER | Foreign demand |
|---|---|---|---|
| **Hong Kong SAR** | (-0.4) | (-0.5) | 1.0 |
| **Japan*** | - | - | - |
| **Korea** | -0.6 | -0.3 | 1.2 |
| **Malaysia** | 1.4 | -2.4 | 1.1 |
| **Philippines** | (-0.3) | 1.2 | (0.3) |
| **Singapore** | (-0.1) | -1.1 | 1.9 |
| **Taiwan** | -2.0 | 0.8 | 0.8 |
| **Thailand** | -0.5 | (0.5) | (0.2) |

* Equation for Japan did not pass the misspecification tests.
Note: Values in parentheses are not statistically significant..

The detailed results from the export equations for the selected Asian countries are reported in Table A6 in the Appendix.[27] When transforming the obtained long-run coefficients (Table 5), we can see that exports from most Asian countries are negatively affected by China's real currency appreciation. For Korea, Chinese Taipei and Thailand, the negative impact of the renminbi appreciation is statistically significant. The only exception is Malaysia, whose exports would benefit from renminbi real appreciation. Thus, the country-based indicate that exports from many other Asian countries do not seem to be redirected fully to other countries when China's demand for imports shrinks. As expected, income elasticities are always positive, although they are not statistically significant in the case of the Philippines and Thailand. Our results are thus very much in line with those of Ahearne et al (2006) and Cutler et al (2004), who found that common factors, like world demand, drive exports both from China and the other Asian economies.

## 6. Conclusions

During the past few years, there has been growing discussion both in China and in international forums on the desirability of a renminbi appreciation. Many have argued that exchange rate policy would not serve the purpose of reducing China's large trade surplus. This paper shows empirically that China's trade balance is sensitive to fluctuations in the real effective exchange rate. In fact, estimating long-run elasticities of Chinese exports and imports to changes in the renminbi's real effective exchange rate for the period from 1994 to end-2005, we find strong evidence that a real appreciation reduces exports substantially in the long run. The result holds both for processed exports (i.e. transformed and re-exported goods) and ordinary exports. However, real currency appreciation also reduces imports to China, which limits the net impact of exchange rate policy on the trade surplus.

On the basis of our estimated elasticities for the period beginning at the point (2000) that WTO entry for China was known, a 5% real appreciation of the effective exchange value of the renminbi – other things given – would have led to about a 7% reduction in export volume. When we take into account the direct link from the exchange rate to imports as well as the indirect link (from a decrease in processed exports to imports for processing), the total volume of imports would have decreased by about 4%. Based on these estimates, the trade surplus would have shrunk almost by one fourth in 2005, from about USD 100 billion to less than USD 80 billion. However, these figures have to be treated with extreme care as they represent only very rough calculations that do not take into account, for example, the pass-through effects of the exchange rate on export and import prices and thus on the trade surplus. It is likely that our

[27] All the reported results pass the LM misspecification test.

figures overestimate the reduction in the trade surplus because, in the case of an appreciation, the export prices denominated in foreign currency would probably increase so that the actual impact on the export value would actually be smaller. On the other hand, fluctuations in the renminbi exchange rate may not influence all import prices, eg the world market price for oil, so that the pass-through effect on Chinese import prices could be much smaller. Unfortunately, pass-through effects in China are difficult to estimate because of a lack of time series data on export and import prices.

Although it is not completely new, our finding that China's imports decrease as a result of an appreciation of its currency prompted a deeper investigation. We explored the issue further by estimating bilateral equations for China's trade with its major trade partners. It seems that the renminbi bilateral real appreciation against the currency of a trade partner generally reduces China's imports, particularly from other Asian countries. The result for Chinese imports from Asia is probably explained by the high degree of vertical integration of the exporting sectors of Asian countries. Such Asian production networks make products from other Asian countries more of a complement to China's exports than a substitute for them. This hypothesis is supported by our results showing that total exports from Asian countries – and not only exports to China – are negatively affected by a renminbi real appreciation.

These findings raise concerns in terms of Asia's reaction to a sudden appreciation of the renminbi, particularly if other Asian currencies also appreciate. Although this study concentrates on only the volumes of imports and exports – so the conclusions cannot be comprehensive – it does underscore the importance of investigating further potential effects from a renminbi real appreciation and different combinations of exchange rate policies in Asia. A number of papers on this issue have already been published, but studies using fresh data are needed.

Finally, although Chinese exports have clearly benefited from fast economic growth in advanced economies, we found the income elasticity of Chinese imports to be rather low. It seems that exports to China are more dependent on foreign direct investment than economic activity in China. However, this characteristic can change in the near future if the composition of Chinese imports starts shifting from raw materials, parts and components and investment goods towards goods for domestic consumption.

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# Appendix

**Table A1. Data sources**

**China's export and import equations**

| Variable | Explanation | Frequency | Source | Method |
|---|---|---|---|---|
| processed exports | The volume of China's processed exports | Monthly | CEIC | Original data in US dollars. Converted to renminbi and deflated by China's CPI. In logs. |
| ordinary exports | The volume of China's ordinary exports | Monthly | CEIC | Original data in US dollars. Converted to renminbi and deflated by China's CPI. In logs. |
| imports for processing | The volume of China's imports for processing | Monthly | CEIC | Original data in US dollars. Converted to renminbi and deflated by China's import price index. In logs. |
| ordinary imports | The volume of China's ordinary imports | Monthly | CEIC | Original data in US dollars. Converted to renminbi and deflated by China's import price index. In logs. |
| | China's import price index | Monthly | IFS, own calculations | Index was calculated by taking weighted average of China's 25 most important trade partners' export price indices. |
| demand for exports | The volume of world total imports excl. imports to China | Monthly | IFS | In US dollars, converted into volumes by world import price index (IFS), in logs. |
| demand for imports | The volume of industrial production in China | Monthly | CEIC | Index constructed by using real growth rates, in logs. |
| reer | China's real effective exchange rate | Monthly | IFS | CPI based measure |
| capacity utilization | Estimate for output gap | Monthly | CEIC, own calculations | Business cycles estimated by using Hodrick-Prescott filter on industrial production data (CEIC) |
| import tariffs | Weighted average import tariffs as a share of total imports | Annual | IMF Occasional Paper, WTO | The authors calculated the weighted average for 2001-2005 with help of WTO tariff data. Data for 1999-2000 were interpolated as they were not available. |
| VAT rebates | Value-added tax rebates on exports as a share of total exports | Annual | WTO | The amount of value-added tax returned to the exporters as a share of total exports |
| FDI | Accumulation of foreign direct investment into China | Monthly | CEIC | Original data in US dollars. Converted to renminbi and deflated by China's CPI. In logs. |
| | China's CPI | Monthly | CEIC | |

**China's bilateral export and import equations**

| Variable | Explanation | Frequency | Source | Method |
|---|---|---|---|---|
| exports | The volume of China's bilateral exports | Monthly | Direction of trade, except data for Chinese Taipei from CEIC | Data from China's trade partners' side. Original data in US dollars. Converted to renminbi and deflated by China's CPI. Seasonally adjusted. In logs. |
| imports | The volume of China's bilateral imports | Monthly | Direction of trade, except data for Chinese Taipei from CEIC | Data from China's trade partners' side. Original data in US dollars. Deflated by trade partners' export prices. Seasonally adjusted. In logs. |
| | Trade partners' export prices | Monthly | IFS, except data for Chinese Taipei from CEIC | Unit price index, not available for Malaysia and Chinese Taipei, for which we used CGPI data. For Russia we used IFS export price index for oil-exporting countries. |
| demand for exports | Real GDP in each trade partner | Quarterly | Bloomberg | The quarterly data on real GDP were interpolated into a monthly series. Seasonally adjusted. In logs. |
| demand for imports | The volume of industrial production in China | Monthly | CEIC | Index constructed by using real growth rates. In logs. |
| rer | Bilateral real exchange rate | Monthly | Own calculations | Based on nominal exchange rate and CPI data. For Australia, monthly CPI data were not available and export price data were used. |
| | Bilateral nominal exchange rate | Monthly | IFS, except data for Germany, Netherlands and Italy from BIS and for Russia and Chinese Taipei from Bloomberg | |
| | Consumer price index | Monthly | BIS, except data for Chinese Taipei from Bloomberg | |
| bilateral FDI | Accumulation of bilateral direct investment into China | Monthly | CEIC | Original data in US dollars. Converted to renminbi and deflated by China's CPI. Seasonally adjusted. In logs. |

**Export equations for selected Asian countries**

| Variable | Explanation | Frequency | Source | Method |
|---|---|---|---|---|
| exports | The volume of each Asian country's total exports | Monthly | IFS, except data for Chinese Taipei from CEIC | Original data in US dollars. Deflated by each country's export price index. For Malaysia, Philippines and Chinese Taipei, export price data were not available and CPI was used. Seasonally adjusted. In logs. |
| | Each Asian country's export prices | Monthly | IFS, except data for Chinese Taipei from Bloomberg | Unit price index. |
| demand for exports | The volume of world total imports | Monthly | IFS | Original data in US dollars. Deflated by the world import price index (IFS). Seasonally adjusted. In logs. |
| China's reer | China's real effective exchange rate | Monthly | IFS | CPI based measure. |
| reer | Each Asian country's real effective exchange rate | Monthly | BIS | |

## Table A2. China's export equations

| | Dependent variable | | | |
|---|---|---|---|---|
| | Full sample | | From WTO onwards | |
| | **D_ordinary exports** | **D_processed exports** | **D_ordinary exports** | **D_processed exports** |
| **Long-run coefficients** | | | | |
| C | 6.358*** | 4.966** | 5.578 | 4.789 |
| | (2.092) | (1.424) | (5.965) | (6.094) |
| world imports$_{t-1}$ | 0.256 | 0.110 | 1.006*** | 0.598* |
| | (.243) | (.176) | (.326) | (.360) |
| reer$_{t-1}$ | -1.190*** | -0.649*** | -1.604*** | -0.996*** |
| | (.191) | (.108) | (.246) | (.209) |
| ordinary exports$_{t-1}$ | -0.519*** | | -1.005*** | |
| | (.066) | | (.095) | |
| processed exports$_{t-1}$ | | -0.485*** | | -0.719*** |
| | | (.055) | | (.104) |
| fdi$_{t-1}$ | | | -0.099 | -0.107 |
| | | | (.399) | (.391) |
| Trend | 0.006*** | 0.006*** | 0.011*** | 0.010** |
| | (.002) | (.001) | (.004) | (.004) |
| Chinese New Year dummy | -0.265*** | -0.257*** | -0.269*** | -0.252*** |
| | (.030) | (.022) | (.029) | (.029) |
| December dummy | 0.161*** | 0.104*** | | |
| | (.032) | (.023) | | |
| **Short-run coefficients** | | | | |
| D_world imports$_t$ | 0.381* | 0.406*** | -0.055 | 0.209 |
| | (.209) | (.149) | (.216) | (.203) |
| D_world imports$_{t-1}$ | | | -0.976*** | -0.398* |
| | | | (.229) | (.203) |
| D_world imports$_{t-2}$ | | | -0.752*** | -0.523*** |
| | | | (.167) | (.141) |
| D_world imports$_{t-3}$ | | | | |
| D_reer$_t$ | -0.673 | -0.214 | -1.494** | -1.160** |
| | (.730) | (.539) | (.617) | (.537) |
| D_reer$_{t-1}$ | 0.928 | 1.022* | 1.518** | 0.951* |
| | (.750) | (.537) | (.647) | (.565) |
| D_reer$_{t-2}$ | -0.023 | -0.522 | | |
| | (.740) | (.529) | | |
| D_reer$_{t-3}$ | 1.485** | 1.059** | | |
| | (.734) | (.526) | | |
| D_capacity utilization$_t$ | | -0.607** | -0.591* | -1.213*** |
| | | (.256) | (.315) | (.294) |
| D_capacity utilization$_{t-1}$ | | | -0.709** | -0.626* |
| | | | (.341) | (.321) |
| D_capacity utilization$_{t-2}$ | | | | |
| D_capacity utilization$_{t-3}$ | | | | |
| D_fdi$_t$ | | | | |
| D_fdi$_{t-1}$ | | | | |
| D_fdi$_{t-2}$ | | | | |
| D_fdi$_{t-3}$ | | | | |
| D_ordinary exports$_{t-1}$ | -0.167*** | | 0.238*** | |
| | (.060) | | (.078) | |
| D_processed exports$_{t-1}$ | | -0.099* | | -0.056 |
| | | (.055) | | (.085) |
| Sample period | 5/1994-12/2005 | 5/1994-12/2005 | 1/2000-12/2005 | 1/2000-12/2005 |
| Number of obs. | 140 | 140 | 72 | 72 |
| $R^2$ adjusted | .70 | .78 | .83 | .85 |

Standard errors in parentheses. * Indicates significance at 10% level, ** at 5% level and *** at 1% level.

## Table A3. China's import equations

| | Dependent variable | | | |
|---|---|---|---|---|
| | Full sample | | From WTO onwards | |
| | D_ordinary imports | D_imports for processing | D_ordinary imports | D_imports for processing |
| **Long-run coefficients** | | | | |
| c | 2.483*** | 6.465*** | -0.962* | -2.520 |
| | (.302) | (.866) | (.489) | (2.052) |
| domestic demand$_{t-1}$ | -0.099** | | 0.095*** | |
| | (.042) | | (.033) | |
| processed exports $_{t-1}$ | | 0.134 | | 0.448*** |
| | | (.118) | | (.152) |
| reer$_{t-1}$ | -0.343*** | -0.700*** | -0.155** | -0.365 |
| | (.059) | (.119) | (.059) | (.247) |
| import tariffs$_{t-1}$ | | -0.329*** | | -0.339*** |
| | | (.076) | | (.120) |
| fdi$_{t-1}$ | | | 0.102** | 0.685*** |
| | | | (.050) | (.212) |
| ordinary imports$_{t-1}$ | -0.327*** | | -0.355** | |
| | (.122) | | (.166) | |
| imports for processing$_{t-1}$ | | -0.879*** | | -1.132*** |
| | | (.140) | | (.176) |
| trend | 0.005*** | 0.007*** | | |
| | (.000) | (.001) | | |
| Chinese New Year dummy | -0.054*** | 0.239*** | -0.014* | -0.220*** |
| | (.008) | (.020) | (.008) | (.022) |
| December dummy | 0.074*** | 0.117*** | | |
| | (.010) | (.025) | | |
| **Short-run coefficients** | | | | |
| D_domestic demand$_t$ | | 1.079*** | 0.140*** | 2.027*** |
| | | (.280) | (.043) | (.306) |
| D_domestic demand$_t$ | | | -0.105** | 1.150*** |
| | | | (.040) | (.346) |
| D_domestic demand$_t$ | | | -0.189*** | |
| | | | (.030) | |
| D_domestic demand$_t$ | | | | |
| D_reer$_t$ | 0.207 | 0.303 | -0.445*** | -0.998* |
| | (.237) | (.582) | (.148) | (.609) |
| D_reer$_{t-1}$ | 0.030 | 1.338** | 0.520*** | 2.286*** |
| | (.238) | (.579) | (.157) | (.606) |
| D_reer$_{t-2}$ | -0.002 | -0.566 | | |
| | (.245) | (.571) | | |
| D_reer$_{t-3}$ | 0.492** | 1.535*** | | |
| | (.236) | (.560) | | |
| D_fdi$_t$ | | | 0.043 | -1.231 |
| | | | (.253) | (.943) |
| D_fdi$_{t-1}$ | | | 0.933*** | 0.452 |
| | | | (.248) | (.883) |
| D_fdi$_{t-2}$ | | | 0.153 | -2.725*** |
| | | | (.241) | (.779) |
| D_fdi$_{t-3}$ | | | -0.551*** | |
| | | | (.206) | |
| D_ordinary imports$_{t-1}$ | 1.526*** | | 2.155** | |
| | (.504) | | (.840) | |
| D_imports for processing$_{t-1}$ | | 0.045 | | -0.096 |
| | | (.058) | | (.077) |
| Sample period | 5/1994-12/2005 | 5/1994-12/2005 | 1/2000-12/2005 | 1/2000-12/2005 |
| Number of obs. | 140 | 140 | 72 | 72 |
| $R^2$ adjusted | .95 | .77 | .97 | .83 |

Standard errors in parentheses. * Indicates significance at 10% level, ** at 5% level and *** at 1% level.

## Table A4. China's bilateral export equations

| | US | HK | Germany | Korea | Netherlands | UK | Singapore | Italy | Chinese Taipei |
|---|---|---|---|---|---|---|---|---|---|
| | Dependent variable: D_exports from China to country i | | | | | | | | |
| **Long-run coefficients** | | | | | | | | | |
| c | -19.128*** | -8.191*** | -8.784 | -34.200*** | -20.457** | -60.640*** | -5.625 | -23.138 | -42.16*** |
| | (6.164) | (2.153) | (26.864) | (10.334) | (8.290) | (14.000) | (5.366) | (19.809) | (9.550) |
| $GDP^i_{t-1}$ | 3.426*** | 1.020*** | 2.340 | 2.821*** | 2.947*** | 5.811*** | 1.664*** | 4.659** | 5.224*** |
| | (.906) | (.339) | (2.332) | (.881) | (1.055) | (1.328) | (.429) | (1.907) | (1.179) |
| $rer^i_{t-1}$ | -1.173 | 0.108 | -0.727*** | -0.629*** | -0.442** | -0.456*** | -1.473*** | -1.649*** | -0.334 |
| | (1.157) | (.749) | (.199) | (.179) | (.173) | (.122) | (.495) | (.249) | (.493) |
| $FDI^i_{t-1}$ | 0.082 | 0.014 | -2.233*** | 1.448*** | 0.076 | -0.075 | -0.086 | -4.178*** | 1.658*** |
| | (.196) | (.183) | (.363) | (.325) | (.103) | (.144) | (.142) | (.762) | (.480) |
| $exports^i_{t-1}$ | -0.058 | -0.112 | -1.194*** | -1.130*** | -0.419*** | -0.707*** | -0.924*** | -1.295*** | -0.940*** |
| | (.105) | (.110) | (.176) | (.158) | (.117) | (.135) | (.185) | (.163) | (.181) |
| trend | | | 0.040*** | -0.019* | | | 0.011** | 0.046*** | -0.007* |
| | | | (.006) | (0.007) | | | (.005) | (.007) | (.004) |
| Chinese New Year dummy | | | | -0.019*** | | | | | |
| | | | | (.009) | | | | | |
| **Short-run coefficients** | | | | | | | | | |
| $D\_GDP^i_t$ | | | -3.412 | | -2.574* | | 1.230** | | 0.418 |
| | | | (2.884) | | (4.030) | | (.575) | | (1.214) |
| $D\_GDP^i_{t-1}$ | | | -2.156 | | -4.532 | | | | -1.547 |
| | | | (3.036) | | (3.945) | | | | (1.433) |
| $D\_GDP^i_{t-2}$ | | | -1.772 | | 3.978 | | | | -1.685 |
| | | | (2.960) | | (3.867) | | | | (1.377) |
| $D\_GDP^i_{t-3}$ | | | -8.127*** | | -10.298*** | | | | -3.041** |
| | | | (2.633) | | (3.617) | | | | (1.217) |
| $D\_rer^i_t$ | | | -0.562** | | -0.340 | -1.143*** | -1.319** | -0.922*** | -2.093*** |
| | | | (.275) | | (.371) | (.244) | (.608) | (.339) | (.715) |
| $D\_rer^i_{t-1}$ | | | | | 0.646* | -0.024 | 0.944 | 0.716** | -0.389 |
| | | | | | (.396) | (.275) | (.584) | (.329) | (.777) |
| $D\_rer^i_{t-2}$ | | | | | | 0.754*** | 0.619 | 0.757** | -1.781** |
| | | | | | | (.255) | (.588) | (.338) | (.771) |
| $D\_rer^i_{t-3}$ | | | | | | | 1.352** | 0.864** | |
| | | | | | | | (.578) | (.330) | |
| $D\_FDI^i_t$ | | | | | -2.003* | -0.193 | | -3.449** | 3.471 |
| | | | | | (1.095) | (.916) | | (1.370) | (2.315 |
| $D\_FDI^i_{t-1}$ | | | | | 1.944* | -1.096 | | 2.468** | 0.528 |
| | | | | | | (.845) | | (1.222) | (2.167) |
| $D\_FDI^i_{t-2}$ | | | | | | 2.821*** | | 3.530** | -4.231* |
| | | | | | | (.848) | | (1.214) | (2.180) |
| $D\_FDI^i_{t-3}$ | | | | | | | | | |
| $D\_Cutilization_t$ | 0.197 | -1.047*** | | -0.794** | -0.311 | | | | -0.967*** |
| | (.284) | (.221) | | (.282) | (.459) | | | | (.341) |
| $D\_Cutilization_{t-1}$ | -0.989*** | | | | -0.155 | | | | |
| | (.284) | | | | (.632) | | | | |
| $D\_Cutilization_{t-2}$ | | | | | 0.497 | | | | |
| | | | | | (.643) | | | | |
| $D\_Cutilization_{t-3}$ | | | | | 1.040** | | | | |
| | | | | | (.463) | | | | |
| $D\_exports^i_{t-1}$ | -0.058 | -0.112 | 0.108 | 0.010 | -0.088 | -0.123 | -0.070 | .152 | -0.002 |
| | (.105) | (.110) | (.131) | (.106) | (.129) | (.111) | (.129) | (.112) | (.124) |
| Sample period | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 |
| Number of obs. | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| $R^2$ adjusted | .53 | .59 | .55 | .64 | .38 | .60 | .47 | .57 | .56 |

Standard errors in parentheses. * indicates significance at 10% level, ** at 5% level and *** at 1% level.

## Table A5. China's bilateral import equations

| | Japan | Korea | US | Chinese Taipei | Germany | Russia | Australia | Malaysia | Thailand |
|---|---|---|---|---|---|---|---|---|---|
| | Dependent variable: D_imports from country i to China | | | | | | | | |
| **Long-run coefficients** | | | | | | | | | |
| c | -3.501*** | 2.626** | 5.902 | -33.69*** | -1.464 | -0.787 | -7.564*** | -3.289 | -0.249 |
| | (.963) | (3.003) | (10.123) | (10.706) | (1.294) | (6.754) | (1.838) | (3.825) | (1.125) |
| China's demand$_{t-1}$ | -0.248 | 1.888*** | 0.643*** | 2.657** | 0.018 | -0.250 | 1.562*** | 0.119 | 0.272 |
| | (.197) | (.621) | (.224) | (1.149) | (.175) | (.626) | (.394) | (.472) | (.193) |
| rer$^{i}_{t-1}$ | -0.134 | -0.588*** | -1.630 | -0.441 | -0.248 | 0.555 | 0.161 | -0.188 | -0.582** |
| | (.136) | (.201) | (1.781) | (.487) | (.174) | (.858) | (.132) | (.854) | (.236) |
| FDI$^{i}_{t-1}$ | 0.884*** | -1.022*** | -0.073 | 3.469*** | 0.598*** | 0.314* | -0.106 | 1.159** | 0.924*** |
| | (.299) | (.380) | (.390) | (.889) | (.220) | (.172) | (.190) | (.566) | (.309) |
| China's imports$^{i}_{t-1}$ | -0.360*** | -0.711*** | -0.529*** | -0.394*** | -0.536*** | -0.118 | -1.169*** | -0.585*** | -0.574*** |
| | (.104) | (.131) | (.128) | (.113) | (.136) | (.125) | (.158) | (.139) | (.112) |
| trend | | 0.011** | | -0.039** | | | | | |
| | | (.006) | | (.015) | | | | | |
| Chinese New Year dummy | 0.049** | | | | | | | | |
| | (.019) | | | | | | | | |
| **Short-run coefficients** | | | | | | | | | |
| D_ China's demand$_{t}$ | | 2.218*** | | 2.530*** | | | 1.064** | | |
| | | (.377) | | (.688) | | | (.441) | | |
| D_China's demand$_{-1}$ | | | | | | | | | |
| D_China's demand$_{-2}$ | | | | | | | | | |
| D_China's demand$_{-3}$ | | | | | | | | | |
| D_rer$^{i}_{t}$ | | -0.928** | | | | | | | -0.467 |
| | | (.392) | | | | | | | (.635) |
| D_rer$^{i}_{t-1}$ | | | | | | | | | 1.547** |
| | | | | | | | | | (.602) |
| D_rer$^{i}_{t-2}$ | | | | | | | | | |
| D_rer$^{i}_{t-3}$ | | | | | | | | | |
| D_FDI$^{i}_{t}$ | -1.023 | 3.749* | | 8.455*** | | | -0.371 | | -0.755 |
| | (1.504) | (1.977) | | (3.145) | | | (.884) | | (2.423) |
| D_FDI$^{i}_{t-1}$ | -4.306*** | 1.075 | | -2.108 | | | -0.513 | | -5.238** |
| | (1.444) | (2.101) | | (3.083) | | | (.953) | | (2.448) |
| D_FDI$^{i}_{t-2}$ | | -1.398 | | -5.730** | | | -1.998** | | |
| | | (2.071) | | (2.854) | | | (.951) | | |
| D_FDI$^{i}_{t-3}$ | | 5.271*** | | | | | | | |
| | | (1.822) | | | | | | | |
| D_China's imports$^{i}_{t-1}$ | -0.347** | -0.095 | -0.193* | -0.328*** | -0.239** | -0.118 | 0.112 | -0.077 | -0.050 |
| | (.118) | (.098) | (.115) | (.107) | (.116) | (.125) | (.111) | (.122) | (.108) |
| Sample period | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 |
| Number of obs. | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| $R^2$ adjusted | .37 | .73 | .33 | .48 | .35 | .22 | .52 | .27 | .36 |

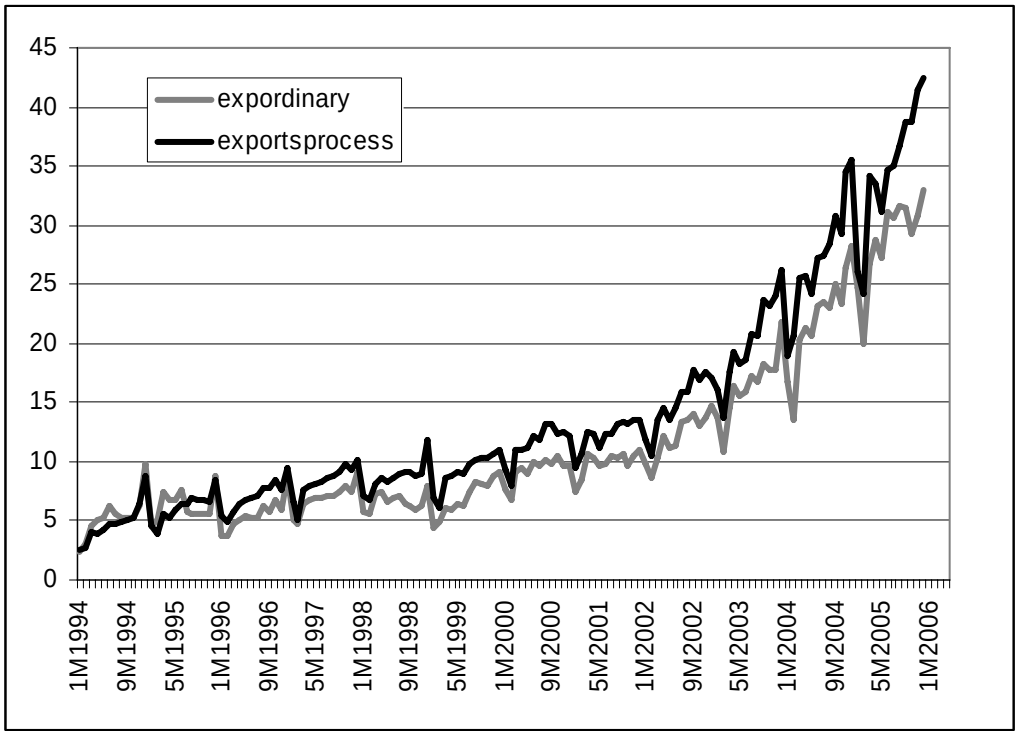
Standard errors in parentheses. * indicates significance at 10% level, ** at 5% level and *** at 1% level.

## Table A6. Export equations for selected Asian countries

| | Hong Kong SAR | Korea | Malaysia | Philippines | Singapore | Chinese Taipei | Thailand |
|---|---|---|---|---|---|---|---|
| | Dependent variable: D_Total exports from Asian country i | | | | | | |
| **Long-run coefficients** | | | | | | | |
| c | 0.875 | -1.019 | -0.335 | -0.827 | -4.598* | 1.805 | 1.276 |
| | (2.086) | (1.104) | (1.274) | (1.973) | (2.318) | (2.423) | (2.356) |
| world imports$_{t-1}$ | 0.962*** | 0.841*** | 0.644*** | 0.075 | 1.422*** | 0.465** | 0.149 |
| | (.235) | (.211) | (.160) | (.112) | (.169) | (.214) | (.187) |
| China's reer$_{t-1}$ | -0.383 | -0.443*** | 0.817** | -0.087 | -0.087 | -1.105*** | -0.317* |
| | (.304) | (.130) | (.374) | (.233) | (.202) | (.360) | (.190) |
| reer$^{i}_{t-1}$ | -0.483 | -0.182** | -1.394*** | 0.320** | -0.774*** | 0.426* | 0.328 |
| | (.309) | (.087) | (.465) | (.150) | (.453) | (.214) | (.255) |
| exports$^{i}_{t-1}$ | -1.004*** | -0.719*** | -0.582*** | -0.268*** | -0.734*** | -0.558*** | -0.679*** |
| | (.167) | (.141) | (.134) | (.080) | (.146) | (.142) | (.133) |
| trend | | | | | -0.002** | | 0.002* |
| | | | | | (.001) | | (.001) |
| **Short-run coefficients** | | | | | | | |
| D_world imports$_{t}$ | 0.545*** | 1.174*** | 0.726*** | 0.787*** | 1.449*** | 0.919** | 0.447 |
| | (.184) | (.138) | (.213) | (.291) | (.169) | (.379) | (.275) |
| D_world imports$_{t-1}$ | | 0.262 | 0.658** | 0.507 | | 0.455 | 0.406 |
| | | (.209) | (.254) | (.346) | | (.399) | (.333) |
| D_World imports$_{t-2}$ | | 0.302** | 0.443* | 0.519* | | 1.154*** | 0.492* |
| | | (.135) | (.259) | (.277) | | (.334) | (.262) |
| D_world imports$_{t-3}$ | | | 0.459** | | | | |
| | | | (.201) | | | | |
| D_China's reer$_{t}$ | -0.596 | | -0.590* | -0.275** | | | -1.652*** |
| | (.396) | | (.352) | (.122) | | | (.441) |
| D_China's reer$_{t-1}$ | 0.446 | | | | | | 1.384*** |
| | (.426) | | | | | | (.482) |
| D_China's reer$_{t-2}$ | -0.448 | | | | | | |
| | (.397) | | | | | | |
| D_China's reer$_{t-3}$ | 0.864** | | | | | | |
| | (.410) | | | | | | |
| D_reer$^{i}_{t}$ | | | | 0.213 | | -0.891 | 1.008* |
| | | | | (.333) | | (.583) | (.569) |
| D_reer$^{i}_{t-1}$ | | | | -0.518 | | 0.689 | -1.067* |
| | | | | (.320) | | (.583) | (.586) |
| D_reer$^{i}_{t-2}$ | | | | -0.238* | | -1.074* | |
| | | | | (.327) | | (.599) | |
| D_reer$^{i}_{t-3}$ | | | | | | | |
| D_ exports$^{i}_{t-1}$ | -0.002 | -0.049 | -0.324*** | -0.275** | -0.235*** | -0.325*** | 0.148 |
| | (.114) | (.112) | (.100) | (.122) | (.081) | (.112) | (.115) |
| Sample period | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 | 1/00-12/05 |
| Number of obs. | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| $R^2$ adjusted | .53 | .70 | .65 | .28 | .70 | .55 | .46 |

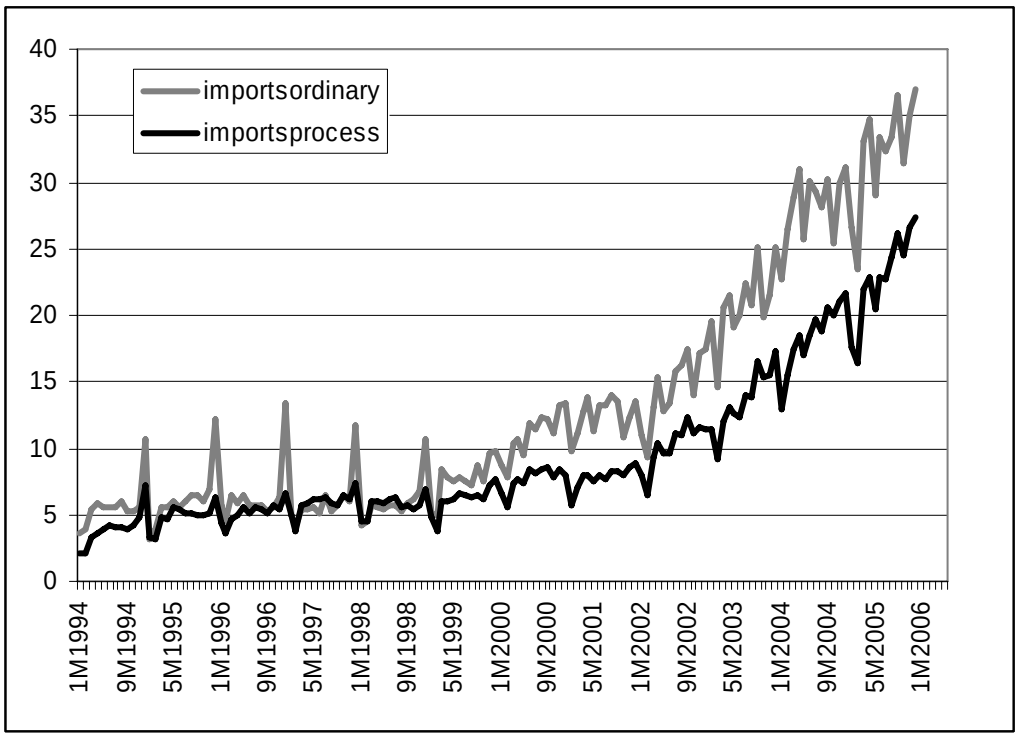
Standard errors in parentheses. * indicates significance at 10% level, ** at 5% level and *** at 1% level;

**Graph A1. Ordinary and processed exports, billions of USD**




Source: CEIC.

**Graph A2. Ordinary and processed imports, billions of USD**




Source: CEIC.