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TRADE, EXCHANGE RATES, AND MACROECONOMIC DYNAMICS IN EAST ASIA: WHY THE ELECTRONICS CYCLE MATTERS[*]

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Abstract

Against the background of increasing regional trade and investment, there is growing interest in monetary and macroeconomic policy coordination in East Asia. Although there is a sizable literature on macroeconomic linkages among East Asian countries and the potential merit of policy coordination in the region, the existing studies tend to examine these issues exclusively in terms of macroeconomic variables and do not consider how these aggregate variables are influenced by one prominent feature of a number of East Asian economies: their heavy dependence on the electronics industry. Although active engagement in the global electronics industry has been a powerful growth engine for the Asian countries, it has also left their economies vulnerable to cyclical fluctuations in the world electronics market. As the cycle of the global electronics industry exerts profound impacts on the medium-term dynamics of the Asian economies, it is imperative to take an explicit account of its influence when studying the way in which the regional economies are linked to one another and how this relationship can be altered by a specific policy initiative. We illustrate the importance of this point by examining recent studies on: (1) trade competition between China and other Asian countries and the role of the Chinese renminbi therein; and (2) the effect of fluctuations in the yen/dollar exchange rate on the regional economies.

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1. INTRODUCTION

Against the backdrop of the 1997 Asian crisis and increasing regional trade and investment flows, there has been growing interest in monetary and macroeconomic policy coordination in East Asia. According to some authors, monetary policy coordination and joint exchange rate management would help East Asian countries not only to manage their own economies but also to adjust their collective relationship with the rest of the world (Williamson 2005). In recent years, for example, the Asian countries have collectively been incurring a massive trade surplus with the United States while intervening heavily in foreign exchange markets to stave off their currencies' appreciation. According to some observers, the Asian monetary authorities' extensive exchange market intervention reflects not so much their desire to keep their currencies pegged to the dollar as their fear of losing export competitiveness to other Asian countries, notably China (Persaud and Spratt 2004). Other authors argue that the uncoordinated exchange rate policies of East Asian countries keep their economies vulnerable to fluctuations in the exchange rates among the world's major currencies. It is widely perceived, in particular, that large medium-term swings in the yen/dollar exchange rate changes Japan's export competitiveness vis-à-vis other East Asian economies and generate unnecessary export and macroeconomic fluctuations among the latter (Ogawa and Ito 2002). In the eyes of some authors, these issued can be best dealt with by introducing an explicit regional monetary arrangement and coordinating the interests of individual countries (McKinnon 2005).

The foregoing issues -- trade competitiveness between China and other East Asian economies, the effect of a renminbi (RMB) revaluation on regional trade flows, the relationship between the yen/dollar exchange rate and emerging Asian economies, the role of trade and exchange rates in regional business cycle transmission – have all been studied extensively in recent years. The existing studies, however, tend to approach these issues exclusively from a macroeconomic perspective, often adopting an analytical framework developed to study macroeconomic interaction among major industrial countries. In consequence, these studies tend to play down structural differences between the emerging East Asian economies and mature industrial economies and their implications for the issues under investigation.

One prominent feature shared by a number of East Asian economies is their heavy dependence on the electronics industry. Whilst the Asian countries' active participation in global electronics production networks has helped their rapid industrialization and economic growth, it has also left their economies vulnerable to cyclical fluctuations in the world electronics market. Although the burst of the dotcom bubble in the United States in 2000 and the subsequent global electronics recession have highlighted their structural weakness, the sensitivity of the Asian economies to the world electronics cycle is in fact of much longer standing. Thus any empirical research on the medium-term dynamics of the East Asian economies and their regional repercussions must recognize this point explicitly. We will illustrate the importance of this point by examining a sample of recent studies on: (1) trade competitiveness between China and other East Asian countries and its implication for China's exchange rate policy; and (2) the relationship between yen/dollar exchange rate fluctuations and the business cycles of emerging Asian countries. As we will see, many of the apparently strong results in these studies are turned upside down once an explicit account has been taken of the electronics cycle.

The rest of this paper is organized as follows. In the next section, we first provide a broad review of the world electronics industry and its relationship with the East Asian economies. Section 3 looks at recent debate on the competitive relationship between the exports of China and other East Asian countries and factors underlying their medium-term export performance. In Section 4, we examine recent literature on the relationship between the yen/dollar exchange rate and the business cycles of the Asian economies. Section 5 summarizes the findings of the paper and comments on what needs to be explored further to improve our understanding of the macroeconomic interaction among the Asian countries and its relationship with the world electronics market. In Appendix A, we follow up Section 3 by looking more closely at China's trade statistics and the implication of the recent change in the country's exchange rate policy. Appendix B complements Section 4 by providing an additional analysis of the historical relations among the electronics cycle, the export performance of the Asian countries and the external value of their currencies. Appendix C details the data and variables used in our econometric investigation.

2. THE GLOBAL ELECTRONICS CYCLE AND EAST ASIAN ECONOMIES

The electronics industry is loosely defined as the industry that produces semiconductor and other electronic devices, as well as industrial, consumer and other end-user equipment that depends heavily on such devices. During the past three decades, the electronics industry is one of the fastest growing segments of the world economy. Table 1 shows the global output of major electronic products in 1987 and 2002. Not surprisingly, "Electronics Data Processing" (mostly PCs and peripherals) and "Radio Communications and Radar" (increasingly dominated by mobile telephones and related products) represent the two largest end-user markets. "Components" also constitutes a sizable sub-category, reflecting the fact that producers of parts and components are a major industry player in their own right and trade with myriads of down- as well as up-stream producers. Researchers and industry analysts frequently refer to the "global electronics industry", stressing the fact that producers based in any specific country are typically connected through various production sharing arrangements with their foreign subsidiaries and other firms around the world (Ernst 2004).

As is widely documented, East Asian countries' active participation in the global electronics industry has been an important catalyst for their industrialization and integration into the world economy. Figure 1 illustrates how the shares of the United States and ten East Asian countries in the global production and consumption of electronics have evolved over the past two decades. In this figure and throughout the rest of this paper, "ANIES4" refer to Hong Kong, Korea, Singapore and Taiwan while "ASEAN4" denote Indonesia, Malaysia, the Philippines and Thailand. We find that the United States has remained the largest producer-cum-consumer throughout the past twenty years, although its consumption far exceeds its production. In contrast, most East Asian countries are net exporters of electronics goods. Among the latter, the net export share has been on a clear declining trend in Japan whereas the converse has been the case in China. As a group, the other eight East Asian countries (ANIES4 + ASEAN4) accounted for 9.1 percent of global output in 1987-89 and 19.3 percent in 2001-03; their corresponding consumption share was much smaller 3.9 and 6.7 percent, respectively.

Table 2 shows the shares of electronics goods in the exports and imports of individual East Asian countries. Although Japan has long been the world's largest electronics exporter in value terms,[1] the share of electronics in its total exports in 2001-03 was in fact among the lowest in East Asia. In relatively small economies such as Malaysia, the Philippines and Singapore, electronics account for more than half of their total export earnings, and the increase in their shares during the past two decades has been truly phenomenal. However, most regional economies also import substantial amounts of electronics, of which the bulk is accounted for by parts and components. The simultaneous expansions of exports and imports attest to the Asian countries' successful participation in the global electronics industry but also underscore their vulnerability to the vicissitude of the world electronics market.

The international market for electronics is indeed prone to sizable medium-term fluctuations that are only partly attributable to the cycle of the world economy. At the core of the global web of electronics production networks is the semiconductor industry, which is well-known for its salient boom/bust cycle. Figure 2 plots the annual growth rate of world trade in semiconductor devices (measured in nominal US dollars), together with its breakdown into price and volume changes. We find that the world semiconductor market has undergone four major cycles during the past 20 years, each one involving massive gyrations in both price and quantity traded. Figure 2 is also annotated with major events widely recognized as proximate causes of individual cycles. As we can see, each cycle is an outcome of complex interaction among technical progress in the semiconductor industry itself, demand fluctuations and changes in the leading products in the end-used electronics market, and the demand condition of major consumer countries.[2]

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[1] This position has been replaced by China in 2003.

[2] In general, the prices of mid-stream electronic components and end-user products are more stable than those of semiconductors, and the extent of price fluctuations also varies considerably across semiconductor products. Nevertheless, as semiconductors typically account for a sizable part of the total operating costs of mid- and down-stream producers, the cyclicality of the semiconductor market tends to affect their profitability and pricing decision as well.

As we can see in Figure 3, the cyclical fluctuations in the global electronics market are substantially larger than those of the world economy at large. This figure compares the real GDP growth rates of the US and world economies with those of total new orders for electronic goods in the United States and the global shipment of semiconductor chips (the latter two are deflated by the US and global GDP deflators, respectively). Whereas the first two series are clearly correlated with the other two series, their correlations have not been perfect, particularly during the years before the mid-1990s. Although it appears that their relationship has strengthened recently, this is in part due to the unusually large IT boom/bust cycle during 1999-2002 and its impact on major industrial economies.[3]

Given the heavy dependence of the East Asian countries on the electronics industry and substantial medium-term fluctuations in the world electronics market, it is not surprising that the latter affect the economies of these countries. As an illustration, Figure 4 plots the price/quantity movements of world trade in semiconductor and other electronic components, together with those of the aggregate imports and exports of six Asian countries.[4] As semiconductors account for a sizable portion of international trade in electronic parts and components, it is natural that the dynamics of the latter follows those of the former closely. More interesting is that their movements also seem to be reflected in the price/volume dynamics of the Asian countries' aggregate trade. Although the plots in the lower panels may not look very similar to those of the upper panels, this is partly because the import and export prices of many countries collapsed in the wake of the Asian crisis. On closer examination, we find that the Asian countries' import and export prices tended to

[3] In Figure 3, the correlation between the growth rates of the global semiconductor shipment and the world GDP is 0.172 (1985-1994) and 0.662 (1995-2004) while that between the growth rates of the US electronics new orders and the real US GDP was 0.417 (1985-1994) and 0.739 (1995-2004). For 20 years between 1985 and 2004, the standard deviations of the annual growth rates of world chips shipments and US electronics orders were 17.6 and 9.7 percent,whereas those for the world and US GDP were 0.9 and 1.3 percent, respectively.

[4] These countries include Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand. Indonesia, the Philippines and China are excluded due to the lack of appropriate official data (see Section 3). Data for Malaysia are lacking for some years.

make a upward excursion in years when there was a major hike in the world semiconductor price (e.g. 1987 and 1995) whereas the converse was the case when the latter fell sharply (e.g. 1985, 1996, 1998 and 2001). We also note that the import and export prices of the Asian countries tend to commove closely, reflecting their sensitivity to the cyclicality of the world electronics market and perhaps also indicating that most countries are price takers in both of the import and export markets. In what follows, we refer to these medium-term fluctuations in the electronics market as the *global electronics cycle* (GEC) and investigate its relationship with the East Asian economies more closely.

3. TRADE COMPETITIVENESS BETWEEN CHINA AND OTHER ASIAN COUNTRIES

In recent years, there has been lively debate about China's increasing presence in regional and world trade and its implication for other East Asian countries. According to Fernald and Loungani (2004), there are at present two opposing views on this issue. In one view, China and other Asian countries as "comrades", that is, China's phenomenal export growth in recent years is largely or entirely benign to other Asian countries. Those who subscribe to this view point out that substantial parts f China's exports are accounted for by foreign multinationals' processing trade while the country's growing economy provides a much-needed new market for its neighbors (Kwan 2002; Weis 2004). The other view, in contrast, regards China and the other Asian countries primarily as competitors. Those who support this view typically stress increasing similarity of their export goods and China's rising export share in third-country markets, as well as its rising share in world inward foreign direct investment (Schott 2004; Kumakura 2005a). Not surprisingly, those who take the former view tend to be skeptical about the ability of exchange rates to adjust China's external balance, whereas those who subscribe to the latter are often less so.

Those who question the view that China and other Asian countries are engaged in a fierce trade war often point out the fact that their exports tend to comove closely. Following Fernald and Loungani (2004), we plotted in Figure 5 the yearly growth rates of exports from China and eight East Asian countries (ANIES4 + ASEAN4, henceforth abbreviated as EA8).[5]

[5] As a large portion of China's exports is mediated by Hong Kong, we also show the growth rate of

Although China's exports have recently grown much faster than those of EA8, we see that they do indeed tend to move in tandem.

Ahearne, Fernald, Loungani and Schindler (2003) note that the preceding visual impression can yet be deceptive, since the relationship between the exports of China and EA8 may be negative once their proximate determinants have been controlled for. To investigate this possibility, Ahearne et al. estimate the following regression model for the eight East Asian countries i = 1, 2, .., 8:

$$\Delta x_{i,t} = \alpha + \sum\nolimits_{j=0} \beta_j \Delta f_{i,t-j} + \sum\nolimits_{k=0} \gamma_k \Delta s_{i,t-k} + \sum\nolimits_{l=0} \delta_l \Delta x_{CHN,t-l} + ... + \varepsilon_{i,t} \quad (1)$$

where $x_{i,t}$ denotes country i's real exports in period t, $f_{i,t}$ is the foreign income, $s_{i,t}$ is the real effective value of the currency of country i, $x_{CHN,t}$ is the real exports of China (all in natural logarithm), and $\varepsilon_{i,t}$ is the error term. In this and the next section, we write the rate of change in the real effective value of country i's currency in each period as

$$\Delta s_{i,t} \equiv \sum\nolimits_j \omega_{j,t} \Delta s_{i/j,t} \equiv \sum\nolimits_j \omega_{j,t} \left(\Delta e_{i/j,t} + \Delta p_{j,t} - \Delta p_{i,t} \right) \quad (2)$$

where $e_{i/j,t}$ is the log of the price of one unit of country j's currency in i's currency), $p_{i,t}$ is the price level in country i, and $\omega_{j,t}$ is the share of currency j in the effective exchange rate index. Thus a positive value of $\Delta s_{i,t}$ indicates currency i's real depreciation.

Ahearne et al.'s estimation results are reproduced in Table 3. They obtained these results by pooling the data for ANIES4, ASEAN4 and EA8 and estimated eq. (1) with the fixed effect model.[6] We observe that the coefficient on the contemporaneous Chinese export growth is positive in all cases and statistically significant at the 10 percent level for ASEAN4. Ahearne et al. note that these results are "inconsistent with most stories of severe, cutthroat competition between China and the rest of Asia" (Ahearne et al. 2003, pp.7). More recently, a team of economists at the Hong Kong Monetary Authorities have re-estimated eq. (1) with

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aggregate exports from China and Hong Kong (excluding their mutual trade), together with that of EA8 other than Hong Kong.

[6] As the original article defines a rise in the real exchange rate as an appreciation of the home currency, we have changed the sign of its coefficients so that it matches our definition in eq. (2).

updated data and using a few alternative estimation methods (Cutler, Chow, Chan and Li 2004). In their results, too, the estimates of δ_l are generally positive and often statistically significant (Cutler et al. 2004, pp. 22).[7]

The result in Table 3, however, contains a few puzzles. First, while the exports of China and other Asian countries may indeed be more complementary than commonly believed, the coefficients on $\Delta x_{CHN,t}$ are much larger for lower-income ASEAN4 that presumably compete more directly with China in export markets, than for higher-income ANIES4. In addition, the estimated coefficients on the foreign income $\Delta f_{i,t}$ are all extremely large, suggesting that the exports of the Asian countries have the income elasticity of 3.0-5.2. Although Cutler et al.'s estimates of its coefficient are slightly smaller, they still range between 1.6 and 3.13.

As far as we can see, there are two problems in the foregoing estimation, and both of these problems are related closely to the global electronics cycle (GEC). The first and relatively straightforward problem is that eq. (1) does not take into account the effect of GEC on the exports of the Asian countries. As we saw in Section 2, electronics constitute the bulk of their exports, and the cycle of the global electronics industry has historically been correlated only partially with the world business cycle. Although Ahearne et al. (2003) do not explain how they computed $\Delta f_{i,t}$, Cutler et al. (2004) define this variable as the growth rate of the world real GDP excluding that of country *i*. Thus it seems likely that much of the impact of the GEC on the Asian countries' exports is missed out in their estimation.

The second and slightly more subtle problem concerns the way in which Ahearne et al. and Cutler et al. compute $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$. Both authors merely state that these variables are the growth rates of each country's "real" exports and do not explain how the nominal export values are deflated. If we interpret eq. (1) as an export demand function, the most suitable deflator is the export price index, preferably one constructed directly from customs data. As far as we know, however, the Chinese authorities provide no official export price index, and those for some other countries are missing as well. Our suspicion is that Ahearne et al. and Cutler et al. compute $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ either by deflating the nominal

[7] Cutler et al. estimate eq. (1) by pooling data for EA8 and Japan.

local-currency export values by the local-currency CPI (or perhaps the GDP deflator), or by deflating the nominal US-dollar exports by the US CPI. Although such deflation methods are quite common in cross-country regressions, there are at least two reasons to suspect that they are problematic in our present setting. First, as many Asian countries' exports are concentrated on electronics, the commodity composition of their exports must be very different from the commodity basket of their domestic price indices. Second, we saw in Figure 4 that the aggregate export price of the East Asian countries was correlated with the GEC. This points to the possibility that not only do $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ in Ahearne et al. and Cutler et al. fail to track the actual export volume accurately but also suffer a systematic bias arising from the GEC.[8]

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[8] Partly motivated by the result of Ahearne et al. (2003), Eichengreen, Rhee and Tong (2004) also investigate export complementarity between China and other Asian countries. Rather than measuring the correlation between their aggregate exports, Eichengreen et al. estimate the following (modified) gravity model using annual bilateral trade data for 1990-2002

$$x_{i,j,t} \equiv a + b * x_{CHN,j,t} + c * Z_{i,j,t} + e_{i,j,t}$$

where $x_{i,j,t}$ and $x_{CHN,j,t}$ are the real exports of, respectively, Asian country *i* and China to third country *j*, and $Z_{i,j,t}$ is a vector of standard gravity-equation arguments. To control for unobserved factors that simultaneously influence $x_{i,j,t}$ and $x_{CHN,j,t}$, Eichengreen et al. estimate this equation with two-stage least squares (2SLS), first estimating an independent gravity equation for $x_{CHN,j,t}$ and then using its predicted value as an instrument for the foregoing regression model. In their baseline estimation, the estimated value of *b* is -0.18 with the standard error of 0.02.

As the above regression refers only to the exports to third countries, the estimated value of *b* is not directly comparable to δ_I in Ahearne et al. As China's export share in major third markets has recently risen sharply, the positive correlation between the aggregate exports of China and other countries found by Ahearne et al. almost certainly reflects the growing imports of China from the latter countries. And as China's import growth should be driven at least partly by its rising income level, and as its income is in turn correlated strongly with its exports, one cannot get the full picture unless one obtains the quantitative relationship among these three variables. Eichengreen et al. thus estimate yet another gravity equation for Chinese *imports* and, by combining the estimated income elasticity of its imports with the preceding result, calculate the net impact of China's 10 percent income growth on the exports of the other Asian countries. The computed full effect is positive for a few high-income countries (e.g. Korea) but mildly negative for other East Asian countries (and more significantly so for most South Asian countries).

Thus the end result of Eichengreen et al. is less optimistic than those of Ahearne et al. and

Before investigating how much the results in Table 3 are influenced by these two problems, we first reestimate eq. (1) by making only minimum modifications to the relevant variables. First, we generate the time series of $\Delta f_{i,t}$ by taking a weighted average of the real GDP growth rates of 26 foreign countries, where the weight is the (time-varying) share of each foreign country in country *i*'s exports. As the Asian countries' trade relations are not homogeneous and have changed substantially over time, the series of $\Delta f_{i,t}$ computed in this way should capture more closely the external demand for each country's exports. Second, although Ahearne et al. and Cutler et al. seem to use a CPI-deflated real exchange rate index for $\Delta s_{i,t}$, it is unlikely that CPI-based effective exchange rates provide a good measure of each country's export competitiveness (Kumakura 2005a). We thus create for each country an original effective exchange rate index based on the PPI for the manufacturing or industrial sector, assuming that this index does a better job of tracking the local exporters' production costs.[9] And lastly, we compute $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ by deflating nominal local-currency export values with the manufacturing PPI rather than the CPI, as the former's volume weights should be closer to those of exports. See Appendix C for the data source and details on the construction of individual variables.

We estimate eq. (1) using updated annual data for 1985-2004, taking into account the fact that China's integration to the world economy in earlier years had been rather tenuous.[10] As we shall discuss later, our series of $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ in fact still fail to track properly changes in the genuine export volumes. In many countries affected badly by the Asian crisis, for example, the computed values of $\Delta x_{i,t}$ in 1998 tend to be implausibly large, most certainly reflecting the fact that their domestic PPI responded more slowly and by

Cutler et al. One reason why the result we will find below is closer to that of Eichengreen et al. is that their 2SLS estimation controls (perhaps inadvertently) for the simultaneous impact of the GEC on the exports by China and the other countries. Eichengreen et al., however, compute $x_{i,j,t}$ and $x_{CHN,j,t}$ by deflating nominal US dollar export values by the US CPI, a method unlikely to provide an accurate proxy for the actual export volumes; see below.

[9] For countries where a suitable PPI was unavailable, we used the WPI for export and domestically-sold products.

[10] Extending the sample to 1981, however, does not materially change the results that follow.

smaller amounts to the collapse of the home currency than did their export prices.[11] We thus remove 1998 from our sample by adding a year dummy variable to eq. (1). We also eliminate the lagged dependent variable from the set of regressors, since lagged regressands can cause a serious estimation bias in panel regression, particularly when the time dimension of the data set is not very long (Judson and Owen 1999).

The result of our estimation is shown in Table 4. Despite the fact that we retained Ahearne et al.'s basic specification, our result differs substantially from theirs. First, the coefficient on China's export growth is positive for ANIES4 but negative for ASEAN4, quite opposite to their result. Second, although the coefficient on $\Delta s_{i,t}$ remains positive and statistically significant, their values are twice to three time larger than what we saw in Table 3. These observations suggest that the results reported by Ahearne et al./Cutler et al. are sensitive to the choice of the price index with which to compute export volume and real exchange rates. As we will see later, for many Asian countries even the PPI-based effective exchange rate is in fact not a good measure of external competitiveness; we should not thus put much trust in the large coefficients on $\Delta s_{i,t}$ are in Table 4.

Let us now examine the first of the two problems noted above. To test if the GEC really has an independent explanatory power for the export performance of the Asian countries, we modify Ahearne et al.'s regression model as follows:

$$\Delta x_{i,t} = \alpha + \sum_{j=0} \beta_j \Delta f_{i,t-j} + \sum_{k=0} \gamma_k \Delta s_{i,t-k} + \sum_{m=0} \phi_m \Delta elc_{t-m} + \ldots + \varepsilon_{i,t} \qquad (3)$$

where Δelc_{t-m} is a variable that reflects the state of the world electronics market. While there are a number of candidates for this variable, we saw in Section 2 that the cycle of the global electronics industry was typically accompanied by changes in *both* the prices and the volumes of relevant products, with no mechanical relationship between the two. This suggests that we will miss much of the dynamics of the electronics industry if we let $\Delta elc_{i,t}$ be represented solely by a price or quantity variable. By taking this point into account, we first consider the following indicator of the GEC:

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[11] For example, the values of $\Delta x_{i,\,1998}$ for Indonesia and Korea are 1.526 and 0.322 (i.e. increases in 152.6 and 32.2 percent); if we use CPI-deflated exports, their values are even larger 1.751 and 0.370.

$$\begin{aligned}\Delta elc_{1,t} \equiv\ & \Delta \ln\left(\text{Global sales of semiconductor devices in nominal US dollars}\right)_t \\ & - \Delta \ln\left(\text{World GDP in nominal US dollars}\right)_t\end{aligned} \tag{4}$$

where the global sales of semiconductors include both those shipped within individual countries and traded between two countries. While it is possible to interpret this variable as a "real" growth rate of the world semiconductor market, we consider it as representing the part of the cyclical fluctuations in the global electronics market that are not attributable to the world business cycle.[12] If we let $\Delta p_{elc,t}$ and Δp_t denote the rate of change in the price of semiconductors and the world inflation rate (both measured in US dollars), and $\Delta y_{elc,t}$ and Δy_t the real growth rates of the volume of global semiconductor shipment and the world GDP, $\Delta elc_{1,t}$ can be written as

$$\Delta elc_{1,t} = \left(\Delta p_{elc,t} + \Delta y_{elc,t}\right) - \left(\Delta p_t + \Delta y_t\right) = \left(\Delta p_{elc,t} - \Delta p_t\right) + \left(\Delta y_{elc,t} - \Delta y_t\right) \tag{5}$$

In general, therefore, our measure of GEC departs from 0 whenever the dynamics of the global semiconductor market deviates from those of the world economy on either or both of the price and the quantity margins. The series of $\Delta elc_{1,t}$ computed as above still turned out to be quite volatile over time. Thus we add the square of this variable to eq. (3) so as to allow for the possibility that its effect on the regressand is non-linear.

The result of our estimation is in Table 5. This table omits the results for specifications that include lagged explanatory variables (other than $\Delta x_{CHN,t-1}$) as most of their coefficients were either statistically insignificant or had the unexpected sign. The term representing the

[12] Note that a downturn in the world electronics market can depress the exports of each Asian country not only directly by reducing the amount of electronic goods it can sell in the international market but also indirectly by slowing down the economies of its export-destination countries and depressing their import demand for other products. When eq. (3) is estimated with $\Delta elc_{1,t}$, most of this latter effect should appear in the coefficient on $\Delta f_{i,t}$, even if its fundamental cause is a change in $\Delta elc_{1,t}$. Thus, if the coefficient on $\Delta elc_{1,t}$ still turns out to be statistically significant, that would suggest that GEC has an explanatory power for the exports of the Asian countries over and above its indirect effect through foreign income.

GEC is highly significant in all specifications, with some indication of nonlinearity.[13] We also notice that the estimated coefficients on $\Delta f_{i,t}$ are substantially smaller than what we found in Table 4, suggesting that our previous estimation confounded the effect of foreign income with that of the GEC. In regressions for ANIES4, the coefficients on $\Delta x_{CHN,t}$ are still positive but no longer statistically significant; in regressions for ASEAN4, its coefficient remains significant and even more negative than in Table 4. In general, our result seems to indicate that the GEC is an important determinant of the Asian countries' exports.

In a few East Asian countries, however, semiconductors constitute a leading export product. Although we are here interpreting $\Delta elc_{1,t}$ not literally as the growth rate of world semiconductor sales but an indicator of the cyclical condition of the wider electronics market, its value is in practice determined jointly with $\Delta x_{i,t}$. To the extent that this is the case, there is legitimate concern about estimation bias due to the endogeneity between the regressand and our GEC variable. As a check on this possibility, we consider an alternative indicator of the GEC and see how using this variable affects the preceding result. Here we consider the following variable

$$\begin{aligned}\Delta elc_{2,t} \equiv \Delta \ln\left(\text{New orders for electronic goods in the USA in nominal US dollars}\right)_t \\ - \Delta \ln\left(\text{USA GDP in nominal US dollars}\right)_t\end{aligned} \qquad (6)$$

As the share of the United States in the world electronics consumption is very large, the growth rate of the new orders for electronic goods in the country is widely used as an indicator of the state of the world electronics market (see, for example, Ping et al. 2004). As the US new orders only concern those received by local manufacturers, estimating eq. (3) with this variable should help alleviate the potential endogeneity problem.

The result is shown in Table 6. As the square of $\Delta elc_{2,t}$ was not statistically significant,[14] this table shows the results for specifications that include only the linear terms.

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[13] Although the estimated coefficients on $\Delta elc_{1,t}$ are small compared to the coefficients on $\Delta f_{i,t}$, the standard deviation of $\Delta elc_{1,t}$ during the sample period is 0.173 while those of $\Delta f_{i,t}$ ranges between 0.012 and 0.014.

[14] This evidently reflects the fact that $\Delta elc_{2,t}$ is less volatile than $\Delta elc_{1,t}$ (see Figure 3).

In general, the estimated coefficients of $\Delta elc_{2,t}$ are large and statistically significant, and the overall fit of the equation is comparable to Table 5. Although the coefficient on $\Delta elc_{2,t}$ is only marginally significant for ANIES4, this is apparently due to fairly strong correlations between $\Delta elc_{2,t}$ with $\Delta f_{i,t}$.[15] This multicollinearity problem is reflected in the coefficients on $\Delta f_{i,t}$, whose estimates are larger than the corresponding values in Table 5. Otherwise the results are similar to Table 5, including the sign and the value of the coefficient on $\Delta x_{CHN,t}$.[16]

Let us now consider the second of the two problems mentioned earlier. As noted previously, China reports no official export price index while those for Indonesia, Malaysia and the Philippines are either unavailable or available for only a limited period.[17] We thus first limit our attention to the five countries for which official unit export value indices are available (Hong Kong, Korea, Singapore, Taiwan and Thailand) and generate for each of these countries an alternative series of $\Delta x_{i,t}$ by taking the difference between the growth rates of its export values and unit value index. We then pool the data for the five countries and estimate eq. (3), using alternatively the previous and the new series of $\Delta x_{i,t}$ as the dependent variable. As there is no new series for Chinese exports, we do not include $\Delta x_{CHN,t}$ in this round of estimation.

The result is shown in Table 7. As is immediately clear, the two sets of regressions generate *very* different results. First, when the dependent variable is the "proper" volume growth rate, the coefficients on the contemporaneous real exchange rate variable are invariably small and are not estimated precisely. Second, although $\Delta elc_{1,t}$ and $\Delta elc_{2,t}$

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[15] $\Delta elc_{2,t}$ has been correlated fairly tightly with the US business cycle in recent years whereas some of ANIES4 (e.g. Korea and Taiwan) depend particularly heavily on the Untied States as their export market. In these countries, therefore, $\Delta elc_{2,t}$ is inevitably correlated with $\Delta f_{i,t}$.

[16] As yet another check on the potential simultaneity bias, we estimated eq. (3) using the values of $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ that are computed by excluding semiconductors (SITC 776) from each country's total exports. The electronics variable still tuned out to be highly significant, suggesting that the impact of the GEC on the exports of the Asian countries extends well beyond the semiconductor sector itself.

[17] Although Indonesia reports import and export price indices, these are based on survey data at the wholesale level.

remain highly significant in both sets of regressions, the estimated coefficients are generally larger when the dependent variable is the volume growth rate. While the coefficients on the lagged electronics variables have the unexpected sign in all regressions, this appears to reflect high collinearity among the explanatory variables. All in all, Table 7 is a sobering reminder that at least for the countries under consideration, deflating nominal exports with domestic price indices is not a reliable way of approximating the actual export volume.

Strictly speaking, the unit export value indices used above are not comparable across the countries, since they are not compiled with the same formula and not all of them are based exclusively on customs statistics. Moreover, as many of these indices are a Laspeyres index with only periodic adjustments of the quantity weights, there may be some bias due to changes in the composition of export commodities.[18] Recently, a team of economists at the Japanese Institute of Developing Economies (IDE) has compiled annual unit import and export value indices for a number of industrial and emerging Asian countries (Noda 2005). The IDE indices are based on detailed customs data gathered from either the UN COMTRADE or national sources and were subjected to extensive consistency tests, although the institute still continues its efforts to improve their reliability. The current versions of the indices are available in a number of alternative formats, including a chain-linked Fischer index (CLFI) that is least likely to suffer from large measurement errors.[19] As a further check on our previous result, we recompute $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ using this IDE-CLFI and repeat the previous estimation for EA8. As our new series of $\Delta x_{i,t}$ and $\Delta x_{CHN,t}$ exhibit no obvious anomalies during the Asian crisis, we drop this time the year dummy for 1997. The sample period is 1986-2003 due to the availability of the IDE price index for China.[20]

[18] The Laspeyres export price index is prone to a bias when the same volume weights are used for a prolonged period. Barth and Dinmore (1999) provide a related discussion in the context of the Asian countries.

[19] When a volume index is derived by dividing nominal values by a chain-linked Fischer price index, the former also becomes a chain-linked Fischer index.

[20] The original IDE unit export value index for Hong Kong was compiled for the country's total exports including re-exports. We thus requested the IDE staff to compile a new index for its domestic

The result of this last set of regressions is shown in Table 8. The coefficients on $\Delta f_{i,t}$ now range between 0.5 and 1.2, which look more plausible than what we saw previously. The coefficients on $\Delta s_{i,t}$ are of the expected sign but, as in the right columns of Table 7, numerically small and only marginally significant. The coefficients on $\Delta elc_{1,t}$ are generally significant and large, as are those on its square term. Lastly, the coefficients on $\Delta x_{CHN,t}$ are positive for ANIES4 but negative for ASEAN4 --- again similar to the previous regressions --- although they are now statistically insignificant in most cases. In the end, therefore, the *only* variable that remained unambiguously significant throughout this section was those pertaining to the electronics cycle.

Why, then, did using the export volume variable generate the regression results that are so different from those based on the PPI-deflated "real" exports? To shed light on this question, we computed for each of EA8 and China the difference between the annual inflation rates of the domestic price indices (CPI or PPI) and the rate of nominal depreciation of the home currency against the dollar, for each year during our estimation period. If the local-currency prices of export goods are synchronized closely with the general domestic price level, the calculated values should be a good proxy for the rate of change in the aggregate export price measured in US dollars. Figure 6 compares the time series of the computed values with the corresponding rate of change in the IDE-CLFI, which is also measured in US dollars and should represent the actual export price movement with reasonable accuracy.[21] As we can see in the upper panel, however, the dollar-converted CPI and PPI do not track the IDE index well, even excluding the period of the Asian crisis when the former completely undershot the latter. On closer examination, we also notice that the years in which the inflation rate of the IDE-CLFI is visibly higher than those of the other two series --- 1987, 1889, 1995 2000, and 2003 --- all correspond to years when the price of

exports, from which the country's volume growth rate was computed.

[21] All plots in the upper panel are computed by taking the weighted average of the corresponding values for the eight Asian countries, where the weight is the share of each country in their aggregate exports measured in US dollars.

semiconductors shot up in the international market (see Figure 2).[22]

The foregoing observation suggests that if we compute $\Delta x_{i,t}$ not from an explicit export volume index but in terms of CPI- or PPI-deflated "real" exports, its value is systematically biased upward when the international prices of electronic goods are rising faster than the domestic price level, which typically coincide with upturns in the electronics cycle. As we saw before, $\Delta f_{i,t}$ also tends to have a higher value when the world electronics market is booming, as the latter is often boosted by a strong US economic growth and in turn tends to push up the growth rates of the Asian economies (see Section 4). Then if we regress the CPI- or PPI-based "real" export growth rate on an equation like (1), we are bound to find a large coefficient on $\Delta f_{i,t}$ not only because this variable will inevitably pick up some of the effects attributable to the GEC but also because of its artificially inflated correlation with the dependent variable. This indeed seems to be one reason why we found puzzlingly large values for the coefficients on $\Delta f_{i,t}$ in Tables 3 through 7.

The preceding analysis also points to the possibility that our measure of $\Delta s_{i,t}$ does not accurately represent each country's export competitiveness. As we saw in Figure 3, the GEC seems to exert significant influence on both the export and import prices of the East Asian countries. As the electronics industries of many Asian countries rely heavily on imported components, a large increase in the international prices of the latter should add measurably to their production cost, of which only part is likely to be passed onto their export prices. To the extent that this is the case, a real exchange rate index computed with

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[22] In China, however, the GEC does not seem to have a systematic effect on the discrepancies between the IDE unit value index and the two dollar-converted domestic price indices (Figure 6, lower panel). We can think of a few reasons why this is the case. First, although electronics now constitute a sizable part of China's exports, the share of electronic goods in its total exports started to surge only in mid-1990s (Table 2). Second, China maintained until 1993 a dual exchange rate regime and a system of foreign exchange retention quotas, which should have driven a wedge between the exporters' nominal sales and their effective revenues (Mehran et al. 1996). Third, China's domestic prices have been liberalized in steps during the 1980s and 90s -- often engendering a bout of price hikes -- and should have been influenced heavily by factors unrelated to external development (Feyzioğlu 2004). At least during the last few years, however, the discrepancies between China's export price index and two domestic price indices have been very similar to those for EA8.

the domestic CPI or PPI can deviate from the external competitiveness of home producers not merely because a large exchange rate movement tends to drive a wedge between the domestic price level and the prices of traded goods, but also because it misses an important part of the systematic impact of the GEC on the profitability of the domestic electronics producers.[23] We will revisit this issue in the next section.

As it should to take time for China's economic and export growth to have their full effect felt on its neighbors, whether China and the other emerging Asian countries are comrades or competitors is clearly a medium- to long-term question. To the extent that this is the case, one ought to be cautious about drawing an answer to this question from time-series regressions like eqs. (1) and (3). Moreover, since these regressions address the cyclical determinants of Chinese exports only indirectly, we are still unsure about the relative importance of the GEC and other factors as determinants of its trade dynamics. In Appendix A, we look more closely on China's recent trade statistics and argue that it is not quite accurate to consider the country simply as an assembly house for foreign multinationals.

4. YEN-DOLLAR EXCHANGE RATE AND BUSINESS CYCLES OF EAST ASIAN COUNTRIES

Another issue that recurs in the literature on macroeconomic dynamics and monetary coordination in East Asia is the relationship between the yen/dollar exchange rate and the economies of Japan and other countries in the region. While the relative economic position of Japan, China and other Asian countries has changed dramatically during the past few decades, Japan still remains a major player in regional trade and an important provider of foreign direct investment (FDI). A number of authors argue, in particular, that recurrent swings in the yen/dollar exchange rate have been an important source of macroeconomic instability, not only in Japan but also among other Asian countries (McKinnon 2005).

[23] One complicating factor is that the electronics industries of a few (though not all) Asian countries are dominated by foreign multinationals, which tend to engage in extensive intra-firm trade in production materials and components. Thus the impact of the GEC on the profitability of local operations is likely to differ across the countries.

Although one can conceive of a number of channels through which a large swing in the yen/dollar exchange rate might affect the emerging Asian economies, what is most stressed in the literature is its effect on their export performance. For example, Ito, Ogawa and Sasaki (1999) note that the export growth rates of emerging Asian countries are correlated negatively with the real exchange rates between their currencies and the yen, suggesting that the latter is responsible for the former. Similarly, McKinnon and Schnabl (2003) point out that the business cycles of these countries are correlated strongly with one another, and claim that their synchronized output cycles are generated principally by medium-term fluctuations in the yen/dollar exchange rate. Corsetti et al. (1999) and Doraisami (2004) note the fact that the yen depreciated sharply vis-à-vis the dollar since mid-1995 through 1998, during which the growth rates of most Asian countries' export earnings have either decelerated markedly or ground to a halt. In their view, the post-1995 yen depreciation was an important causal factor behind the subsequent Asian crises.

As one can see, the preceding views all rest on the assumption that most East Asian currencies are either pegged or kept stable vis-à-vis the US dollar, for otherwise there is little reason for nominal yen/dollar fluctuations to immediately change the relative export competitiveness between Japan and other Asian countries. And this is indeed the dominant view in the literature. The pre-crisis exchange rate regimes of most Asian countries are widely described as de facto dollar pegs while some authors even argue that many crisis-affected countries have recently revived their dollar peg policies (Fukuda 2002; McKinnon 2005). As these authors all recommend some kind of regional exchange rate arrangement as a means to enhancing macroeconomic stability in East Asia, the relationship between the yen/dollar exchange rate and the regional economies has implications for a number of policy issues.

The existing literature provides several econometric "evidence" in support of the view that yen/dollar fluctuations constitute the principal macroeconomic destabilizer in East Asia. For example, Kwan (2001) and McKinnon and Schnabl (2003) test this hypothesis by estimating the following simple OLS model:

$$\Delta y_{EA,t} = \alpha + \beta \Delta y_{USA,t} + \gamma_0 \Delta e_{¥/\$,t} + \gamma_1 \Delta e_{¥/\$,t-1} + \varepsilon_t \quad (7)$$

where $\Delta y_{EA,t}$ denotes a weighted average of the yearly real GDP growth rates of the nine East Asian countries (EA8 and China),[24] $\Delta y_{USA,t}$ is the real growth rate of the United States (a proxy for the export demand), and $\Delta e_{¥/\$,t}$ is the rate of nominal depreciation of the yen vis-à-vis the dollar. Their results are reproduced in Table 9 as reference for our succeeding discussion. As one can see, the estimated coefficients on $\Delta e_{¥/\$,t}$ and $\Delta e_{¥/\$,t-1}$ are all negative and statistically significant at standard levels, whereas the US growth rate indicates little bearing on the dependent variable. Similarly, Ito et al. (1999) regress the export growth rates of six Asian countries on the GDP growth rates of the Unites States and Japan and the real exchange rate of their currencies vis-à-vis the dollar and the yen, and find for most countries that a depreciation of the home currency against the yen has a positive and statistically significant effect on the dependent variable. Doraisami (2004) also investigates the factors behind Malaysia's export slowdown during the lead-up to the Asian crisis, employing a more sophisticated error correction model and using the nominal yen/dollar exchange rate as a proxy for the Malaysian Ringgit's misalignment. She finds that the yen/dollar rate is relevant to both the long- and short-run export performance of Malaysia, with the yen's fall vis-à-vis the dollar systematically depressing its export earnings. At first look, these results appear to corroborate the view that a large yen depreciation depresses the exports of emerging Asia and causes its economic slowdown.

In our view, however, these studies entail a few important problems, which are – as in the last section – related to the presence of the GEC. In the remainder of this section, we will discuss these issues and show that the case for the "destabilizing yen" becomes considerably murky once these issues have been taken into account. While we develop our discussion in terms of the preceding Kwan/McKinnon/Schnabl model (henceforth KMS), at least some of the issues discussed below are relevant to Ito et al. (1998), Doraisami (2004) and a number of other studies that employ more advanced econometric techniques.

The first and most obvious problem of eq. (7) is that it ignores the possibility that the GEC affects the growth performance of the East Asian economies. Table 10 shows the

[24] The weight is the share of each country in their aggregate GDP measured in US dollars.

coefficients of correlation for the real GDP growth rates of the East Asian and other countries, together with their correlations with the two GCE indicators developed in Section 3. In the upper panel, we find that the growth rate of each of EA8 is indeed correlated strongly with those of the other seven countries but not with that of China. This suggests that what McKinnon and Schnabl refer to as the "synchronizes business cycles in East Asia" is essentially a phenomenon for EA8. The upper table also indicates that the correlations between their business cycles and those of major industrial countries – which collectively constitute the bulk of their export markets – are surprisingly low, although Japan appears to be a marginal exception in this regard.

The lower panel of Table 10 shows the correlation of the GDP growth rates of individual countries among EA8, together with the correlations of each country's growth rate with our measures of the GEC. We observe that the pair-wise GDP correlations are generally high but not uniformly so – for example, the growth rate of the Philippines is correlated relatively weakly with those of the other countries. The pair-wise correlations are particularly high when the pair includes either Malaysia or Singapore. In the right two columns, we also observe that the growth rates of *all* eight countries are correlated positively with our GEC indicators. Moreover, their correlations are particularly strong in Malaysia and Singapore – precisely the countries that seem to be serving as the glue for the regional output synchronization.

Another important issue concerning eq. (7) is the meaning of the coefficients on $\Delta e_{¥/\$,t}$ and $\Delta e_{¥/\$,t-1}$. Although KMS regard these variables largely as proxies for the relative export competitiveness of Japan and other Asian countries, there are questions about the accuracy of this interpretation. In Figure 7, we plotted the annual growth rate of EA8's aggregate real GDP, the growth rates of the export earnings of EA8 and Japan (measured in US dollars), the rate of change in the nominal yen/dollar exchange rate,[25] together with one of our measures of the GEC, $\Delta elc_{1,t}$. As we can see, EA8's export growth rate is correlated very tightly with its GDP growth rate, suggesting that the former is indeed

[25] For ease of visual inspection, this figure plots the yen/dollar exchange rate so that a positive value indicates a yen appreciation.

an important determinant of the latter. In Figure 7, however, we notice that Japan's export growth rate also fluctuates essentially in tandem with that of EA8. This observation looks rather odd in light of the "destabilizing yen" hypothesis since, if this hypothesis were correct, we would expect the exports of Japan and EA8 to move in the opposite directions in times of major yen/dollar fluctuations.[26] We also find that the yen/dollar exchange rate looks correlated with $\Delta elc_{1,t}$, raising further questions about what is really represented by the coefficients on $\Delta e_{¥/\$,t}$ and $\Delta e_{¥/\$,t-1}$. Indeed, at least on visual inspection the exports of *both* Japan and other Asian countries are correlated more closely with our GEC indicator than with the yen/dollar exchange rate.

Apart from the preceding issue, we note that two quite stringent conditions need to be satisfied for the nominal yen/dollar exchange rate to be a good proxy for the relative export competitiveness of Japan and other Asian countries. One condition is, as noted above, that the latter countries keep their currencies pegged to the dollar sufficiently tightly that the exchange rates between their currencies and the yen always move in unison with the nominal yen/dollar exchange rate. However, this assumption is not as self evident as it may first look, except perhaps for a brief period before the Asian crisis (Kumakura 2005b). At least in some countries, moreover, there is evidence that the monetary authorities were not ignorant of external developments, including major changes in the demand for their exports and the exchange rates among third currencies (see Appendix B).

The second condition is that the relative cost competitiveness of Japan and other Asian countries remains reasonably stable as long as nominal exchange rates are stable, so that one does not have to make a distinction between the nominal and real exchange rates. This is, however, difficult to believe. As we saw in Figure 3, the aggregate export and import

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[26] As we noted before, a number of observers argue that the large and rapid yen depreciation after mid-1995 was a major causal factor behind the subsequent slowdown of the emerging Asian countries' export earnings and the regional currency crisis. As we can see in Figure 7, however, the growth rate of Japan's exports in fact fell even more sharply in 1996. In Figure 4, we also observe that the deceleration of the Asian countries' export earnings in 1996 was due largely to the fall in their export prices and not in their volume. Notice further in Figure 2 that this was the year in which the price of memory chips collapsed in the international market, a point emphasized by World Bank (2000) as a factor behind the pre-crisis regional export deceleration.

prices of emerging Asian countries tend to comove closely, partly reflecting large shares of electronics in their imports and exports, and perhaps also because most countries are price takers in export markets. This is not the case for Japan, however. The Japanese electronics industry depends substantially less on imported components, while evidence suggests that Japanese exporters possess more price-setting power than those of the other Asian countries.[27] To the extent that this is the case, large swings in the international prices of electronic goods should have asymmetric effects on the profitabilities of the Japanese and other Asian producers, even if there is no change in nominal exchange rates.[28]

We now examine more fully the empirical importance of the preceding issues. To investigate the relationship between the GEC and the economic growth of the emerging Asian countries, we first reestimate eq. (7) using data for 1985-2004[29] and see what will happen if we replace $\Delta e_{¥/\$.t}$ and $\Delta e_{¥/\$,t-1}$ with our GEC variables. Although KMS use for the dependent variable the average real growth rates of EA8 and China, we exclude China from the following analysis by considering what we saw in Table 10. In addition, while KMS use the US growth rate as the proxy for the export demand, we also consider a more general proxy computed analogously to $\Delta f_{i,t}$ in Section 3. And Lastly, we add a year dummy for 1998 to the set of regressors as the output collapse in this year was clearly an abnormal event. See Appendix C for details about individual variables.

The result of our estimation is shown in Table 11. The specifications in the left columns retain the basic structure of the KMS model, and the results are quite similar to what we saw in Table 10. The regressions in the right columns replace $\Delta e_{¥/i,t}$ and $\Delta e_{¥/i,t-1}$. with the GEC variables. The coefficients on $\Delta elc_{1,t}$ and $(\Delta elc_{1,t})^2$ are all highly significant,

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27 In the short run, however, there are such complications as foreign-currency pricing and pricing to market, which tend to make the yen prices of Japanese exports sensitive to exchange rate movements. See, for example, Athukorala and Menon (1994) and Sato (1999).

28 For 1985-2003, the correlation between the aggregate import and export prices measured by the IDE-CLFI is 0.555 for EA8 and 0.329 for Japan. If we exclude 1998, the correlation is 0.540 for EA8 and only 0.255 for Japan. The values for EA8 are the simple arithmetic average for the eight countries.

29 We have chosen this sample period to maintain continuity with Section 3. Most results shown below do not change materially even if we use the same sample period as those of KMS.

and the specifications in the right column clearly outperform those in the left columns. This observation seems consistent with our hypothesis that the GEC is more important than the yen/dollar exchange rate for EA8's business cycles.

Nevertheless, as these regressions are all based on a single-equation OLS, there are some concerns about their robustness. In particular, the average growth rate of EA8 remained quite high in most of our sample period, with 1985, 1998 and 2001 being the only years in which the rate dropped significantly (Figure 8). As we excluded 1998 with the dummy variable, the results in Table 11 should depend largely on the data for 1985 and 2001. As we saw in Table 10, however, the business cycles of individual countries are less homogeneous and tend to be more variable over time, suggesting that panel regression of the kind used in Section 3 might allow us to conduct more reliable estimation.[30] In addition, to compare our hypothesis more directly with that of KMS, we would like to consider specifications that include the exchange rate variables and the GEC variables simultaneously. However, as $\Delta e_{Y/\$,t}$ and $\Delta elc_{1,t}$ are correlated fairly strongly (Figure 8), merely throwing in both variables is unlikely to produce an efficient result. More importantly, it is wise to pause for a moment and consider *why* the two series are correlated.[31]

One possibility is that the correlation simply reflects a valuation effect from yen/dollar fluctuations. Recall that $\Delta elc_{1,t}$ is the difference between the growth rates of world semiconductor sales and the world GDP, both measured in nominal US dollars. As Japan is a major producer of semiconductor devices, a large swing in the nominal yen/dollar

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[30] Although McKinnon and Schnabl (2003) also conduct estimation for individual countries, they estimate two independent OLS equations for each country, by regressing its growth rate alternatively on the growth rates of foreign countries or on the yen/dollar exchange rate.

[31] We note, however, that at least part of their empirical correlation may have been a mere coincidence. For example, although both the yen/dollar rate and our GEC variable moved upward in 1986-1988, the yen appreciation during this period is generally considered as a result of a correction of its previous depreciation and an aggressive G3 intervention, whereas the accelerated sales of semiconductors during this period are typically attributed to the first major PC boom in the United States and other industrial countries. In 1985 and 2000, there was a large swing in our GEC indicator but little movement in the yen/dollar exchange rate.

exchange rate is likely to affect the global sales of semiconductor chips *measured in dollars* even if their *volume* remains unchanged, as long as products sold or purchased by Japanese firms are priced in yen. To alleviate this valuation effect, we now modify the definition of $\Delta elc_{1,t}$ slightly:

$$\begin{aligned}\Delta elc_{1,t}^{*} \equiv \Delta\big(&\text{Global semiconductor sales except for those shipped from/within/to Japan},\\ &\text{all measured in nominal US dollars}\big)_t \\ -\,\Delta\ln\big(&\text{World GDP} - \text{Japan's GDP, both measured in US dollars}\big)_t\end{aligned} \tag{8}$$

The first term removes all semiconductor devices exported to and from Japan, as well as those produced and purchased within Japan, from the global shipment values; the second term is the total GDP of all countries other than Japan. As both terms systematically exclude components related to Japan, this modified GEC indicator should alleviate its spurious correlation with the yen/dollar exchange rate. Our alternative measure of the GEC, $\Delta elc_{2,t}$, is unlikely to suffer from this variation problem since it is computed solely to values related to economic activity within the United States.

There is also a possibility of the causality running from the electronics cycle to the yen/dollar exchange rate. As we saw in Figure 4, Japan's trade balance in electronic goods has consistently been in large surplus while the United States is the world's largest electronics importer. It is not necessarily surprising, therefore, that a major downturn in the global electronics industry puts a downward pressure on the yen by reducing Japan's trade surplus with the United States.[32] In Table 12, we present the result of a standard Granger causality test for the yen/dollar exchange rate and our measures of the electronics cycle.[33] Although the Granger test has its well-known limitations, our result is (mildly) in favor of the causality running from the GEC to the yen/dollar rate whereas the opposite causality is

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32 Moreover, if a sharp contraction of the global electronics sales depresses the income of EA8 (as we posit here), the resulting fall in EA8's import demand can put a further pressure on the yen as these countries constitute an increasingly important export market for Japan.

33 We used the data for 1981-2004 for the test considering our relatively small sample. The lag length is one for all tests, as lags beyond one year were deemed not relevant.

not supported. Table 12 also shows that the yen/dollar exchange rate is substantially less correlated with $\Delta elc^{*}_{1,t}$ and $\Delta elc_{2,t}$ than with $\Delta elc_{1,t}$, suggesting that using the first two variables helps us isolate the effects of exchange-rate and electronics shocks on the Asian economies when estimating equations that include both variables.

As noted previously, however, there are reasons to suspect that the nominal yen/dollar exchange rate is not a good proxy for the relative export competitiveness of Japan and EA8. We thus create an index of the real bilateral exchange rate between the yen and each of the currencies of EA8, and use this variable as an indicator of the relative competitiveness of each country and Japan. In the first instance, we compute (the growth rate of) this real exchange rate analogously as in Section 3

$$\Delta s_{¥/i,t} \equiv \Delta e_{¥/i,t} + \Delta p_{i,t} - \Delta p_{JPN,t} \tag{9}$$

where $\Delta p_{JPN,t}$ and $\Delta p_{i,t}$ are the PPI inflation rate of Japan and country *i*. Thus a positive value of $\Delta s_{¥/i,t}$ indicates the yen's real depreciation vis-à-vis the currency of country *i*.[34]

We tried a series of panel regressions by employing the same fixed effect model as in Section 3. A sample of our estimation results are shown in Tables 13 and 14. In Table 13, the coefficients on $\Delta elc^{*}_{i,t}$ and $(\Delta elc^{*}_{1,t})^2$ are generally highly significant and have values roughly similar to those on $\Delta elc_{1,t}$ and $(\Delta elc_{1,t})^2$ in Table 11. In Table 14, the coefficients on $\Delta elc_{2,t}$ is mostly significant when the external demand is represented by $\Delta y_{USA,t}$ but

[34] KMS also argue that a weak yen also depresses the emerging Asian economies by slowing down Japan's FDI into these economies. If the coefficients on $\Delta e_{¥/\$,t}$ and $\Delta e_{¥/\$,t-1}$ reflect this effect, replacing these variables with $\Delta s_{¥/i,t}$ and $\Delta s_{¥/i,t-1}$ may not be a good idea. However, this seems implausible for several reasons. First, although a large yen appreciation has indeed often led to a surge in Japan's outward FDI, the latter typically did not occur contemporaneously but with some time lag. Second, while it is true that the yen/dollar exchange rate is correlated fairly strongly Japan's outward FDI, its correlation with EA8's *total* inward FDI is not strong. Third, and related to the preceding point, Japan is by no means a dominant source of FDI in emerging Asia. For example, Japan's share in the total inward FDI in EA8 was 31.6 percent for 1981-1990 and only 12.7 percent for 1991-2000 (Hayase 2002). Moreover, the two largest economies among EA8, Korea and Taiwan, have been net exporters of direct investment capital in most of KMS's sample periods. In Indonesia (the third largest), the investment from ANIES4 far exceeded that from Japan in both the 1980s and 1990s.

insignificant when the latter is proxied by $\Delta f_{i,t}$. The latter observation parallels what we saw in Section 3 and seems to reflect a relatively high collinearity between $\Delta f_{i,t}$ and $\Delta elc_{2,t}$.[35] Lastly, the coefficients on $\Delta s_{Y/i}$ are positive in both Tables 13 and 14 and statistically significant in many cases. Contrary to KMS's hypothesis, therefore, the yen's real depreciation vis-à-vis EA8's currencies is associated *positively* with their real growth rates.

While exchange rates may indeed not be an important determinant of EA8's business cycles, the positive coefficients on $\Delta s_{Y/i}$ still look counterintuitive. We can think of at least two reasons why our estimation generated such a "perverse" result. First, and as we discuss more fully in Appendix B, there is evidence that some of the Asian currencies tend to depreciate (or be devalued) when the home country's export performance deteriorates in the wake of a serious downturn in the world electronics market. Thus the positive coefficients on $\Delta s_{Y/i}$ in Tables 13 and 14 may not really mean that the yen's depreciation stimulates the economies of EA8, but indicate instead that a major electronics recession depresses the exports and the income of EA8 and tend to cause their currencies to depreciate, either through natural market pressure or by the monetary authorities' deliberate adjustment.

The second possibility is that our real exchange rate index is not an accurate measure of export competitiveness. As we noted before, the standard real exchange rate index in the form of eq. (9) may not be suitable for many East Asian countries whose export and import prices are sensitive to the GEC. To the extent that this is the case, our real exchange rate index may not simply fail to track properly the relative profitability of the export sectors of Japan and EA8 but its departure from the latter may also (at least to some extent) be induced by the GEC. This last possibility is worrisome, since if it were true the coefficients on $\Delta elc^{*}_{1,t}$ and $\Delta elc_{2,t}$ reported in Tables 13 and 14 would also become suspect.

To investigate the latter possibility, we modify the real exchange rate index in eq. (9) and see if using this modified variable has any measurable effect on the estimation result.

[35] However, the overall fit of the regressions in Table 14 is broadly comparable to those of Table 13, suggesting that $\Delta elc_{2,t}$ does contribute significantly to the model's explanatory power.

As an experiment, we consider the following index

$$\Delta\hat{s}_{\text{Y}/i,t} \equiv \Delta e_{\text{Y}/i,t} + \Delta\hat{p}_{i,t} - \Delta\hat{p}_{JPN,t} \tag{10}$$

where $\Delta\hat{p}_{i,t}$ and $\Delta\hat{p}_{JPN,t}$ represent the period-to-period changes in the overall profitabilities of the export sectors of Japan and country *i*. The profitability of each country's exporters should depend primarily on their sales values and production costs, of which the latter include the costs of imported materials and locally-sourced production factors (e.g. labor and utilities). We posit here that $\Delta\hat{p}_{i,t}$ and $\Delta\hat{p}_{JPN,t}$ are determined by the following simple linear functions

$$\begin{aligned} \Delta\hat{p}_{i,t} &\equiv \left[\alpha\Delta p^{m}_{i,t} + (1-\alpha)\Delta p_{i,t}\right] - \Delta p^{x}_{i,t} \\ \Delta\hat{p}_{JPN,t} &\equiv \left[\beta\Delta p^{m}_{JPN,t} + (1-\beta)\Delta p_{JPN,t}\right] - \Delta p^{x}_{JPN,t} \end{aligned} \tag{11}$$

where $\Delta p^{m}_{i,t}$ and $\Delta p^{m}_{JPN,t}$ denote the rates of change in the prices of the imported materials in each country, $\Delta p^{x}_{i,t}$ and $\Delta p^{x}_{JPN,t}$ are the rates of change in the prices of export goods, $\Delta p_{i,t}$ and $\Delta p_{JPN,t}$ are the rates of change in the costs of the locally employed production factors, all in terms of their own currencies. α and β represent the shares of the imported materials in the total production cost.

Although the actual values of α and β should vary across countries and over time, we impose the values of $\alpha = \beta = 0.5$ here to simplify our computation. With this additional condition, we can rewrite eq. (10) as

$$\Delta\hat{s}_{\text{Y}/i,t} = \frac{1}{2}\Delta s_{\text{Y}/i,t} + \frac{1}{2}\left[\Delta p^{m}_{i,t}(\$) - \Delta p^{m}_{JPN,t}(\$)\right] - \left[\Delta p^{x}_{i,t}(\$) - \Delta p^{x}_{JPN,t}(\$)\right] \tag{12}$$

where $\Delta p^{m}_{i,t}(\$)$, $\Delta p^{x}_{i,t}(\$)$, $\Delta p^{m}_{JPN,t}(\$)$ and $\Delta p^{x}_{JPN,t}(\$)$ are the rates of changes in the prices of each country's imported materials and export goods *in US dollars*.[36] Eq. (12) shows that our modified real exchange rate index is a weighted average of the standard real exchange rate and the rates of change in the relative import and export prices in the two

[36] For example, $\Delta p^{m}_{i,t}(\$)$ corresponds to $\Delta p^{m}_{i,t} - \Delta e_{i/\$}$.

countries. Here we proxy $\Delta p^m_{i,t}$, $\Delta p^m_{JPN,t}$, $\Delta p^x_{i,t}$ and $\Delta p^x_{JPN,t}$ with the corresponding IDE-CLFI discussed in Section 3 while approximating $\Delta p_{i,t}$ and $\Delta p_{JPN,t}$ with each country's PPI.

Table 15 shows the result of regressions with the modified real exchange rate index. As we can see, although the coefficients on $\Delta \hat{s}_{\text{Y}/i,t}$ and $\Delta \hat{s}_{\text{Y}/i,t-1}$ are still positive, most of them are estimated very imprecisely and no longer statistically significant. Although this result is open to a number of interpretations, it does seem to corroborate our suspicion that our previous standard real exchange rate index was contaminated by the effect of GEC. The results in Table 15 are otherwise quite similar to those in Table 13, including the estimated coefficients on $\Delta elc^*_{1,t}$ and $(\Delta elc^*_{1,t})^2$. On balance, therefore, what we have seen in this section suggest that the GEC is more important than the nominal yen/dollar exchange rate as a factor behind EA8's business cycles.[37]

5. CONCLUSIONS AND ADDITIONAL THOUGHTS

Although there is a sizable literature on the macroeconomic linkages among the East Asian countries and the potential merits of regional macroeconomic policy coordination, most authors address these issues by examining the behavior of standard macroeconomic variables and do not pay sufficient attention to what the industrial structures of the East Asian economies have to say about these issues. For a number of East Asian economies, however, the GEC is not a mere industry shock but a macroeconomic shock *par excellence*, exerting considerable effects on the empirical behavior of a number of key aggregate variables. Therefore, one cannot assess properly the way in which the regional economies

[37] Duttagupta and Spilimbergo (2004) estimate the export demand and supply functions for five Asian countries, with the purpose of identifying the determinants of their export performance before and after the Asian crisis. They also estimate the export demand and supply equations for specific industries, including vehicles (SITC78), clothing (84) and semiconductors (776). Because of data limitation, however, the nominal export values for these product groups are often deflated using a more aggregated export price index, such as one covering the entire machinery sector (SITC7). Moreover, the cost of production – a crucial argument in the export supply function – is proxied by either wage rates or the WPI, with no regard to the cost of imported inputs.

interact with one another and how this relationship can be altered by a specific policy initiative, without first gaining an accurate understanding of the way in which the GEC affects relevant macro variables. In this last section, we comment briefly on what has been left out in this paper, what need to be explored further to deepen our understanding of the relationship between the GEC and the Asian economies, and how this relationship might change in the future.

First, although this paper treated the GEC as largely exogenous to the East Asian economies for analytical expediency, this is not quite true in reality, not least because the region now commands a sizable share of global electronics output.[38] Nor did we attempt to distinguish the direct impact of GEC on specific countries and its transmission to other countries through trade and other channels, although the relative importance of these two effects should vary considerably across the countries. While a number of authors examine the role of trade and financial linkages in the propagation of economic shocks in Asia, the existing studies pay relatively little attention to the nature and the origin of such shocks.[39] Distinguishing the GEC and other types of demand and supply shocks explicitly may help us assess the relative importance of these shocks and the way in which these shocks are transmitted across countries through alternative propagation channels.

Second, while our econometric investigation relied mostly on pooled OLS with fixed country effects to highlight the problems of the existing studies, this estimation method masks the potentially diverse relationships between the GEC and individual Asian economies. As we saw in Section 2, some of the smallest economies in the region, such as Malaysia and Singapore, depend particularly heavily on electronics and should be most vulnerable to the cycle of the world electronics market. One the other hand, the electronics industry is much less prominent in such countries as Indonesia, where most impact of GEC should be felt indirectly through their linkages with other regional economies. These differences matter, not only for individual countries to formulate the most effective policy

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[38] When studying each economy in the region, however, it would still make sense to treat the GEC as an exogenous shock, at least as a first approximation.

[39] See, for example, Crosby (2003) and Abeysinghe and Forbes (2005).

for safeguarding their economies but also for assessing the potential cost and benefit of regional policy coordination.

Third, although we developed our GEC indicators by using statistics that are monitored closely by industry analysts, these indices are all very simple and leave room for improvement. Moreover, whilst electronics now constitute the leading exports goods in most East Asian countries, the electronic industries in these countries differ along a number of dimensions, including the relative share of local firms and foreign multinationals in output and employment, the linkage between the electronics industry and other domestic industries and the composition of goods produced and exported. It may thus be interesting to consider country-specific indicators of the GEC, by focusing on the aspects of global electronics activity that are particularly relevant to each country. Recently, the Monetary Authority of Singapore (MAS) has developed its own Electronics Leading Indices (ELIs), which aim to improve its ability to forecast turning points in global electronics demand and to assess its likely impact on the domestic economy (Ping et al. 2004).[40]

Fourth, what we have seen in this paper highlights the importance of using reliable price and volume indices when studying the dynamics of imports and exports. Although the existing literature often relies on "real" import and export values based on domestic CPI or PPI, this seemingly innocuous expediency can cause a substantial bias in empirical work. In recent years, disputes about China's exchange rate policy have spawned a torrent of papers on the extent of the RMB's misalignment and the expected impact of changes in its external value on the country's balance of trade. As there are no readily available statistics for China's trade volumes, however, most authors examine these issues using quasi-volume indices obtained by deflating the country's nominal import and export values with the CPI of China or its trading partners.[41] Given so much hype going on about China's trade and

[40] The Federal Reserve Bank of New York also updates regularly its "Tech-Pulse Index" -- a sophisticated coincident index of the US ICT sector – to monitor its changing relationship with the broader US economy (Hobijin et al. 2003).

[41] It is reported, however, that the People's Bank of China compiles import and export price indices for its internal use. China's monthly PPI data became available in October 1996.

exchange rate policies, this state of affairs is quite distressing and needs to be corrected. While the IDE unit value indices used in this paper are an important contribution in this respect, these indices are available only at the annual frequency, and the UN trade statistics on which most of their indices draw are known to have their own shortcomings. The quality and reliability of empirical research would be enhanced substantially by developing and making available to the public consistent and internationally comparative indices of trade price and volume, preferably at the monthly or quarterly frequencies.

Fifth, what we have seen in this paper suggests that the standard real exchange rate indices are not suitable as a measure of the external competitiveness of the East Asian countries. There is strong evidence that the sales prices and the production costs of the region's manufacturing firms are not only sensitive to nominal exchange rate movements but also influenced heavily by the condition of the international electronics market. Therefore, in order to monitor the external competitiveness of the export industries in each country, one needs to look beyond the domestic price indices and to develop an alternative measure of the real exchange rate that takes an explicit account of this latter effect.[42] What we have done at the end of the last section is only an elementary step toward this direction and needs to be refined further by paying a closer attention to cross-country differences in industrial structure.

Lastly, let us consider briefly how the nature of the GEC and its relationship with the East Asian economies might change in the future. First, the salient boom-bust cycle of the semiconductor industry – which has often constituted an important driver of the GEC in the past – is unlikely to disappear in the near future because of this industry's distinctive characteristics, including extremely fast progress in wafer fabrication technology, the rising costs of production facilities, and the unusually large rewards for early market entry due to steep learning curves (Leachman and Leachman 2003). In recent years, however, the world

[42] The discussion in this paragraph concerns the competitiveness of the domestic tradables sector vis-à-vis those of foreign countries. When the real exchange rate is used to measure the tradable sector's internal competitiveness -- i.e. the relative price incentive within a country for producing tradable as opposed to nontradable goods – one normally needs an entirely different empirical index (Hinkle and Montiel 1999).

chips market has been undergoing a number of structural changes, of which the most salient is the shift of the leading growth areas from high-volume memory devices to logic chips and other microprocessors that are less susceptive to extreme price gyrations. The structural shift in the semiconductor market mirrors similar structural shift in the downstream electronics market, notably from the once-dominant fixed computing devices to network-related applications and consumer multimedia (Linden, Brown and Appleyard 2003). As the main engine of the end-user market shifts from volatile corporate investment to household consumption, the extreme market instability of the type witnessed at the beginning of this decade may become less frequent in the future.

Since most East Asian countries have already been integrated firmly into the global production networks for electronics, their sensitivity to the GEC will remain at least in the near future.[43] As their economies grow and their income levels rise, however, GEC may gradually become more synchronized with the condition of the end-user markets within the region. In this connection, it is interesting to consider how China's economic growth might change the relationship between GEC and the Asian economies. As a rise in disposable income is typically accompanied by an even faster increase in electronics consumption, China's rapid economic growth should help shift the center of global electronics consumption from the United States and other traditional markets to the emerging Asian region. In addition, whereas the business cycles of China and other regional economies have been largely independent until the 1990s, recent statistics suggest that this situation is changing rapidly, particularly in such countries as Hong Kong and Taiwan. The business cycles of China and other Asian countries may become more synchronized in the future, not only because China constitutes an increasingly critical export market for the latter but also because its domestic demand might emerge as an important determinant of the dynamics of the global electronics industry. If this turns out to be the case, the East Asian economies may retain their close relationship with the GEC, albeit under a slightly different mechanism

[43] The severe market downturn in 2000-2001 was nonetheless a major wake-up call for the region's policy-makers. Although many countries have since launched a number of initiatives to ease their economies' vulnerability to the electronics cycle, such efforts are likely to bear fruit only slowly; see MAS (2004) and Ernst (2004) for recent policy initiatives in Singapore and Malaysia.

than in the past.

APPENDIX A: RECENT TRADE DYNAMICS IN CHINA

In Section 3, we examined the view that the exports of China and other emerging Asian countries are more complementary than competitive. The empirical analysis in Section 3 was, however, based on data that span the last two decades, during which China's external trade relationship has changed enormously. Moreover, the empirical framework of Ahearne et al. (2003) and Cutler et al. (2004), with which we conducted most of our investigation on the subject, treats the exports of China and other countries asymmetrically and does not address the determinants of the former directly. In this Appendix, therefore, we look more closely at China's recent trade statistics and consider the role of the GEC in its trade dynamics; we also comment briefly on how the recent change in China's exchange rate policy might imply for its external balance in the future.

As we discussed in Section 3, a number of authors claim that the recent explosion of China's exports are largely benign to other Asian countries since much of its trade is accounted for by foreign multinationals' processing trade in which the share of domestic value added is limited. These authors also argue that exchange rate adjustment is likely to have little effect on China's external balance, since much of the total production cost for its final export goods is incurred outside the country and unrelated to the RMB's external value (Liu 2005). Whilst assembly operations by foreign multinationals have no doubt played a crucial role in China's rapid integration into the world economy, a closer look at recent statistics suggests that the factors underlying the country's trade dynamics are more nuanced.

In Figure A1, we first plot the growth rates of China's import and export values relative to the same quarter in the previous year. The top panel also shows the corresponding growth rate of worldwide semiconductor sales, whereas the middle and bottom panels compare the growth rates of China's exports and imports with those of foreign and China's income. As we can see in the top panel, at least since the late 1990s, both of China's exports and imports have been correlated strongly with the world semiconductor shipment, suggesting that GEC is an increasingly important determinant of the medium-term dynamics of Chinese trade.[44] Of course, GEC is *not* the only driver of China's trade – the other two panels suggest that its imports and exports are also affected (though more mildly) by the general demand conditions of the foreign and domestic economies. As is clear in Figure A1, however, the medium-term fluctuations in China's trade and the world semiconductor sales are an order of magnitude lager than those of the foreign and domestic GDP, suggesting that one should take an explicit account of GEC when investigating factors behind the country's trade dynamics.

A corollary of the preceding observation is that the degree of synchronization between China's imports and exports is not time-invariant but depends critically on the state of the world electronics market. As in 1999-2002, when the world electronics market is being turned upside down, gyrations of processing trade tend to dominate the dynamics of the country's aggregate imports and exports and obscure the effect of other factors. When the world electronics market is relatively tranquil, however, the effect of the other factors can become more noticeable. In the top panel, we observe that China's exports grew much more robustly than its imports during 1996-1998 and also since mid-2004 till today. During the former period, the exports grew strongly despite the unfolding of the Asian crisis mainly because the U.S. economy continued to grow strongly, whereas the simultaneous slowdown of the Chinese economy prevented its imports from expanding equally rapidly. In the latter period, exports have remained relatively brisk but the growth of its imports has fallen sharply, apparently reflecting the combination of (mildly) slowing domestic consumer demand and rapidly rising local excess capacity (Anderson 2005). This observation suggests that once the distinct impact of GEC has been taken into account China's trade follows the normal rule of economics after all -- its imports and exports respond to their respective demands in the theoretically predicted manner and thus do not necessarily move together.

In Figures A2 and A3, the growth rates of aggregate imports and exports are broken down in terms of contributions from different types of trade. As we can see in Figure A2, imports and exports related to assembly operations ("processing trade") have increased

[44] In 2004, the share of electronics in China's exports was 31.6 percent.

consistently throughout the last decade, and their contributions to the growth rates of aggregate imports and exports have risen measurably in recent years. Similarly, Figure A3 indicates that a substantial part of the growth in aggregate imports and exports are accounted for by foreign invested enterprises, attesting to the view that processing trade by foreign multinationals – of which the bulk is related to electronics and other machinery – has been the engine of the rapid growth of China's trade.

In Figure A2, however, we also observe that the medium-term dynamics of imports and exports are also influenced significantly by non-processing ("ordinary") trade. We also find that the growth rates of ordinary imports and exports are much more weakly correlated with each other than those of processing imports and exports. In Figure A3, moreover, although state-owned enterprises and other domestic firms[45] have contributed very little to the growth of aggregate exports since 2001, the influence of these firms remain relatively significant on the import side. For example, the recent slowdown of aggregate import growth is largely accounted for by a sharp fall in non-processing imports, much of which is conducted by state-owned and other domestic enterprises.

It should also be noted that ordinary trade still remains sizable in terms of the share in the country's total import and export *values*, as does trade conducted by state-owned and other domestic firms. In 2004, for example, non-processing trade accounted for 60.5 and 44.7 percent of China's total imports and exports whereas trade by domestic enterprises constituted 43.3 and 42.7 percent of its aggregate imports and exports. As imports of local firms are more geared toward domestic investment and consumption than are those of foreign-owed enterprises, the former is unlikely to remain unaltered when the local economic condition deteriorates. Similarly, as domestic exporters generally depend less on imported materials and tend to compete with their foreign firms more on the basis of cheap domestic labor, their export performance is unlikely to remain independent of the external value of the RMB. In the absence of major fluctuations in the global electronics market, therefore, the medium-term dynamics of China's aggregate trade balance should respond to the foreign and domestic economic conditions in a theoretically consistent manner, and this

[45] The latter includes collective enterprises and other private firms.

tendency may become more palpable in the future. Moreover, when China's business cycle goes seriously out of step with those of its trade partners, the RMB exchange rate may prove to be a more effective policy tool in managing the country's external balance than is often claimed to be the case.[46]

APPENDIX B: EXCHANGE RATES AND EXPORTS OF EAST ASIAN COUNTRIES

In Section 4, we argued that the negative coefficients on the nominal yen/dollar exchange rates in the KMS regressions should not be read as evidence for the negative impact of a yen deprecation on the income of the Asian countries, since not all of their currencies have been pegged to the dollar sufficiently tightly to justify this interpretation. We also argued -- contrary to what is widely claimed in the existing literature – that at least some of these currencies have been fairly responsive to the external environment of their economies, including the exchange rates among major foreign currencies and the demand for their exports. This Appendix illustrates these points in terms of a simple counterfactual.[47]

A fundamental premise of the KMS regression is that the monetary authorities of EA8 have *routinely* pegged their currencies to the dollar throughout their estimation period, with little or no regard to the dollar's movements vis-à-vis other currencies. To investigate the validity of this assumption, we consider how much each currency would have adjusted against the dollar in each year during the past two decades if the monetary authorities had neutralized systematically the effect of exchange rate movements among third currencies – i.e., had the monetary authorities fixed the home currency's nominal effective exchange rate (NEER). If the preceding assumption were correct, the actual past movement of each

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[46] Cerran and Saxena (2000) are one of the few studies that estimate China's export demand and supply equations using price and volume indices compiled directly from its customs statistics. According to their result, the price elasticity of the country's export supply has increased significantly during the 1990s.

[47] We note that the aim of this Appendix is not to identify rigorously the exchange rate regimes of individual countries but merely to examine if their currencies have been kept sufficiently stable vis-à-vis the dollar as to justify KMS's interpretation. In our view, the former question is much more subtle and requires a more detailed analysis; see Kumakura (2005b, c) for related discussions.

currency should have little resemblance to its movement under this hypothetical NEER targeting regime.

To this end, let us first define (the rate of change in) the NEER of currency i as

$$\Delta e_{i,t} \equiv \sum_{j} \omega_{j,t} \Delta e_{i/j,t} \tag{13}$$

where i = 1, 2, .., 8 correspond to each of EA8. By separating out the bilateral exchange rate between the home currency and the US dollar, we obtain

$$\Delta e_{i,t} = \omega_{\$,t} \Delta e_{i/\$,t} + \sum_{j \neq \$} \omega_{j,t} \Delta e_{i/j,t} \tag{14}$$

where $\omega_{\$,t}$ is the weight of the dollar in our NEER index.

If the monetary authorities fixes the home currency's NEER, $\Delta e_{i,t}$ is always equal to 0. Equating the right hand side of eq. (14) to 0 and rearranging, we obtain

$$\omega_{\$,t} \Delta e_{i/\$,t} = \sum_{j \neq \$} \omega_{j,t} \Delta e_{j/i,t} \tag{15}$$

By adding $\left(1-\omega_{\$,t}\right)\Delta e_{i/\$,t}$ on both sides of eq. (15), we find

$$\Delta e_{i/\$,t} = \sum_{j \neq \$} \omega_{j,t} \Delta e_{j/i,t} + \left(1-\omega_{\$,t}\right)\Delta e_{i/\$,t} = \sum_{j \neq \$} \omega_{j,t} \left(\Delta e_{j/i,t} + \Delta e_{i/\$,t}\right) \tag{16}$$

and hence

$$\Delta e_{i/\$,t} = \sum_{j \neq \$} \omega_{j,t} \Delta e_{j/\$,t} \tag{17}$$

In eq. (17), the value on the left hand side (LHS) is the rate of change in the home currency's nominal exchange rate with the dollar, whereas those on the right hand side (RHS) are the rates of change in the bilateral exchange rates between the dollar and other foreign currencies, including the yen. Thus eq. (17) can be read as the monetary authorities' reaction function under our hypothetical NEER targeting regime. As the past values of the RHS variables are all readily available, it is straightforward to compute the corresponding LHS value once the currency weights $\omega_{j,t}$ have been determined.[48] We compute the

[48] For simplicity, this Appendix uses for $\omega_{j,t}$ the same time-varying trade weights as in Section 2.

time-series of this hypothetical exchange rate movement for the eight Asian currencies during the past twenty years and compare their movements with their actual movements.

The result of this exercise is shown in Figure B1. For reference, the figure also plots the growth rate of each country's export values measured in dollars. While the result varies from one country to another, the figure exhibits a few interesting general features. First, even if we disregard the period of the Asian crisis, there is in fact no country -- with the sole exception of Hong Kong – whose currency has been kept unambiguously more stabile vis-à-vis the dollar throughout the whole period than would have been the case under our hypothetical NEER targeting regime. For example, the actual path of the exchange rate between the Philippine peso and the US dollar has consistently been more volatile than the simulated path, except for a brief period before the Asian crisis.[49]

Second, at least for a few countries such as Singapore and Taiwan, the actual and counterfactual exchange rate movements look sufficiently correlated with each other that it looks difficult to believe that these countries have pursued a dollar peg with no regard to other currencies.[50] Even in Korea – by far the largest economy among EA8 – the actual won-dollar exchange rate adjusted in the way that neutralized the yen's large swing vis-à-vis the dollar during the few years prior to the Asian crisis. This observation casts doubt over the view that the post-1995 yen depreciation was the central cause of the crisis.

Lastly, the actual exchange rate movements in many countries do not seem to have

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Using more complicated weights -- for example, ones that take account of export competition in third countries -- does not materially change the results shown below.

[49] Of course, this does not necessarily imply that the central bank of the Philippines was happy about the observed movement of the peso. This was indeed almost certainly not the case, since the country experienced a number of macroeconomic difficulties during the 1980s and early 1990s which ultimately made its old central bank insolvent in 1993 (Kongsamut and Vamvakidis 2000).

[50] While the counterfactuals in Figure 8 are based on the NEER targeting regime, we can also reconstruct the past movement of each currency that would have occurred under more complicated exchange rate regimes. In fact, if one computes their movement necessary to stabilize the real effective exchange rate defined in eq. (2), the computed series is even more closely aligned to the actual movement in such countries as Singapore and Taiwan.

been independent of the growth rates of their exports. The exports of most countries increased rapidly during 1986-1988, 1993-1995 and 2000 but decelerated markedly in 1985, 1989-1992, 1996-1998 and 2001-2002. These years roughly correspond to the peaks and troughs of GEC, as befits our hypothesis that cyclical fluctuations of world electronics transactions are the primary determinant of most countries' export performance. On further examination, we also notice that the currencies of some countries had the tendency of strengthening vis-à-vis the dollar during the years when their exports were booming, whereas the opposite was the case when their export performance deteriorated sharply. This tendency was most salient in 2001, when both the world electronics demand and the exports of the Asian countries contracted sharply in the wake of the burst of the US IT bubble and simultaneous recessions in major industrial countries. In countries like Korea and the Philippines, however, earlier episodes of poor export performance (e.g. 1985 and 1989-1991) also coincided with periods of the home currency's sharp depreciation vis-à-vis the dollar. Of course, one cannot tell from Figure 8 how much of the observed exchange rate movements were the result of the monetary authorities' deliberate adjustment policy and how much was due to their loss of control on private foreign exchange markets. This observation nonetheless raises further doubt about the view that the external value of the currencies of the Asian countries has been kept delinked with their economic fundamentals.

Given what we have seen in this Appendix, it should now be clear why a regression model like eq. (7) is not suitable for assessing the effect of the yen/dollar exchange rate on the Asian economies. Suppose, as per our hypothesis in Section 4, that the correct causal effects are from an electronics recession to a deterioration of the export performance (and perhaps an associated drop in domestic investment) of EA8 to their domestic recession. Eq. (7), however, includes variables representing yen/dollar movements but no GEC variable. As we saw in Section 4, the nominal yen/dollar exchange rate has historically been correlated negatively with the GEC, partly for the reasons discussed there and perhaps also because of sheer coincidence. Then one is bound to find large and negative coefficients on the yen/dollar terms, not because these variables are a fundamental determinant of the regressand but because of their correlation with the missing variable. And this seems to be one reason why replacing the nominal yen/dollar exchange rate with the real exchange rates between the yen and the other Asian currencies -- which are substantially less correlated with the GEC – changed the regression results so dramatically in Section 4.

APPENDIX C: DATA SOURCE AND THE CONSTRUTION OF VARIABLES

Total export values in nominal US dollars

IMF International Financial Statistics (IFS) except for Hong Kong and Singapore. The values for these countries are obtained from the CEIC Asia database and exclude re-exports.

Export/import values of electronic goods

UN COMTRADE. Data for the Philippines are adjusted for SITC9310 using data obtained from *Foreign Trade Statistics of the Philippine*.

Global and country semiconductor shipments

US Semiconductor Industry Association homepage.

New orders for electronic goods in the United States

US Bureau of Census homepage. The growth rate is computed for 19887SIC-M3 35H + 36M - SX2 - 36D (-1993) and 1997NAICS-M3 34S (1994-). The latter excludes semiconductors.

Nominal and real GDP

IMF IFS and World Economic Outlook. EA8's composite real growth rate is computed as

$$\Delta y_{EA,t} \equiv \sum_{i=1}^{8} \frac{Y_{i,t-1}}{\sum_{j=1}^{8} Y_{j,t-1}} \Delta y_{i,t} \tag{18}$$

where $Y_{i,t-1}$ denotes country *i*'s GDP in nominal US dollars in year $t-1$; $\Delta y_{i,t}$ is the growth rate of its real GDP between $t-1$ and t.

Manufacturing PPI/ WPI

IMF IFS except for China, Germany, Hong Kong, and Taiwan. Data for Germany are obtained from the CEIC Non-Asia Database and apply to Former West Germany until 1990. Data for other countries are from the CEIC Asian Database. Pre-1990 data for Hong Kong are estimated using data for the GDP deflator and import and export unit price indices.

Import and export price indices

Official statistics for Korea and Thailand are obtained from IMF IFS. Official statistics for Hong Kong, Malaysia, Singapore and Taiwan are from the CEIC Asia Database. Hong Kong's export price index refers to domestic exports only. The IDE-CLFI is provided electronically by the IDE. Details on the construction of this index, as well as their values for up to one decimal point, can be found in Noda (2005).

Nominal exchange rates with the US dollar

IMF IFS except for China and Taiwan. Taiwan's data are obtained from the CEIC Asia Database. The official exchange rate between the RMB and the dollar is taken from IFS. For 1988-1994, the rate of change in the RMB/dollar exchange rate was computed by weighting the official exchange rate and the floating exchange rate at the Foreign Exchange Adjustment Centers ("the swap rate") with the ratio of 1: 4. Data on the swap rate are gathered from *Almanac of China's Finance and Banking* and *China Economic News*.

Currency weights for effective exchange rates

The currency weights for the effective exchange rate indices used in Section 2 and Appendix B are computed as follows:

$$\omega_{j,t} \equiv (3/6)\omega^*_{j,t-1} + (2/6)\omega^*_{j,t-2} + (1/6)\omega^*_{j,t-3} \quad (19)$$

$$\omega^*_{j,t} \equiv \frac{X_{ij,t} + X_{ji,t}}{\sum_j \left(X_{ij,t} + X_{ji,t} \right)} \quad (20)$$

where $X_{ij,t}$ stand for the export values from country *i* to *j* in year *t*, measured in terms of nominal US dollars. The set of foreign countries *j* is fixed for all *i* = 1, 2, ..., 8 and includes the following 26 countries: Australia, Austria, Belgium+Luxembourg, Canada, China, France, Germany, Hong Kong, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Philippines, Singapore, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States. See Kumakura (2005a) for the criteria for country selection. Data on bilateral imports and exports are obtained from Statistics Canada's *World Trade Database*..

Foreign import demand

The rate of change in the demand for country *i*'s exports, $\Delta f_{i,t}$, is defined as follows:

$$\Delta f_{i,t} \equiv \sum_j v_{j,t} \Delta y_{j,t} \tag{21}$$

where $\Delta y_{j,t}$ denotes the real GDP growth rate of foreign country *j* and $v_{j,t}$ is the weight attached to country *j*. The latter is computed as

$$v_{j,t} \equiv (3/6) v^*_{j,t-1} + (2/6) v^*_{j,t-2} + (1/6) v^*_{j,t-3} \tag{22}$$

$$v^*_{j,t} \equiv \frac{X_{ij,t}}{\sum_j X_{ij,t}} \tag{23}$$

The foreign demand variable for EA8 as a whole, used in the early part of Section 4, is computed as

$$\Delta f_t \equiv \sum_k \eta_{k,t} \Delta y_{k,t} \tag{24}$$

where *k* is each foreign country outside EA8. *i* = 1, 2, .., 8 is each of EA8, and $\eta_{k,t}$ is the weight of country *k* computed as

$$\eta_{k,t} \equiv (3/6) \eta^*_{k,t-1} + (2/6) \eta^*_{k,t-2} + (1/6) \eta^*_{k,t-3} \tag{25}$$

$$\eta^*_{k,t} \equiv \frac{\sum_i X_{ik,t}}{\sum_k \sum_i X_{ik,t}} \tag{26}$$

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Table 1. Output of world electronics industry

Major product categories	1987		2002	
	Value (U$M)	Share (%)	Value (U$M)	Share (%)
Electronic data processing	140,093	25.1	311,568	28.8
Office equipment	16,323	2.9	12,486	1.2
Control and Instrumentation	49,922	8.9	78,867	7.3
Medical and Industrial equipment	18,393	3.3	45,568	4.2
Radio communications and Radar	75,195	13.4	155,776	14.4
Telecommunications	57,064	10.2	77,975	7.2
Consumer audiovisual and personal	67,428	12.1	98,936	9.1
Components	134,674	24.1	300,302	27.8
Total	559,092	100.0	1,081,478	100.0

(Source) Reed Electronics Research, Yearbook of World Electronics Data.

Table 2. Shares of electronics in trade of East Asian countries

Country	1985-87		1993-95		2001-03	
	Exports	Imports	Exports	Imports	Exports	Imports
China	0.030[1]	0.087[1]	0.102	0.120	0.259	0.259
	(0.006)[1]	(0.041)[1]	(0.045)	(0.078)	(0.115)	(0.211)
Hong Kong	0.156	0.130	0.225	0.253	0.138	0.290
	(0.087)	(0.081)	(0.198)	(0.175)	(0.123)	(0.171)
Indonesia	0.002	0.052	0.046	0.070	0.116	0.039
	(0.002)	(0.034)	(0.011)	(0.048)	(0.058)	(0.017)
Japan	0.241	0.036	0.272	0.099	0.231	0.164
	(0.084)	(0.021)	(0.158)	(0.058)	(0.154)	(0.094)
Korea	0.166	0.118	0.258	0.137	0.330	0.207
	(0.067)	(0.092)	(0.160)	(0.105)	(0.183)	(0.165)
Malaysia	0.194	0.235	0.437	0.315	0.532	0.450
	(0.166)	(0.208)	(0.281)	(0.290)	(0.344)	(0.410)
Philippines	0.206	0.158	0.349	0.192	0.667	0.424
	(0.192)	(0.153)	(0.255)	(0.181)	(0.484)	(0.416)
Singapore	0.274	0.196	0.505	0.360	0.527	0.415
	(0.149)	(0.143)	(0.256)	(0.256)	(0.361)	(0.330)
Taiwan	0.222[2]	0.146[2]	0.292	0.187	0.406	0.295
	(0.104)[2]	(0.111)[2]	(0.184)	(0.157)	(0.277)	(0.224)
Thailand	0.064	0.113	0.216	0.170	0.280	0.240
	(0.063)	(0.091)	(0.125)	(0.137)	(0.196)	(0.187)

(Notes) Values in parentheses are the shares of parts and components. Electronic goods are defined as the sum of SITC (Rev.2) 75, 76, 771, 772, 774 and 776. Share of parts and components are computed for 759, 7649, 771, 772 and 776. Export shares for Hong Kong and the Philippines refer to domestic exports only. Import shares for Hong Kong are computed for retained imports. Values for the Philippines are adjusted for goods shipped to/from export processing zones and recorded on SITC 9310. (1) Value for 1987. (2) Value for 1989.
(Source) Author's calculation with data from UN COMTRADE, Foreign Trade Statistics of the Philippines and Monthly Statistics of Exports and Imports in Taiwan Area, R.O.C.

Table 3. Panel regression for East Asian exports (Ahearne et al. 2003)

Explanatory variable	ANIES4 (1)	ANIES4 (2)	ASEAN4 (1)	ASEAN4 (2)	EA8 (1)	EA8 (2)
∆f	3.16	3.87	2.97	5.22	3.13	4.13
	(0.63)	(0.93)	(0.69)	(1.23)	(0.47)	(0.83)
Lag 1		-1.60		-0.04		-1.06
		(0.73)		(0.12)		(0.62)
Lag 2		1.16		0.03		0.58
		(0.54)		(0.81)		(0.55)
∆s	0.38	0.37	0.32	0.29	0.33	0.37
	(0.13)	(0.10)	(0.12)	(0.06)	(0.10)	(0.08)
Lag 1		0.37		-0.30		-0.15
		(0.12)		(0.08)		(0.10)
Lag 2		0.09		-0.11		0.05
		(0.14)		(0.08)		(0.07)
∆x (China)	0.03	0.08	0.22	0.11	0.11	0.13
	(0.10)	(0.10)	(0.13)	(0.13)	(0.08)	(0.09)
Lag 1		0.09		0.22		0.09
		(0.14)		(0.17)		(0.11)
Lag 2		-0.03		0.17		-0.01
		(0.13)		(0.19)		(0.13)
Lagged dependent variable	0.14	0.14	-0.05	-0.02	0.02	0.12
	(0.10)	(0.10)	(0.09)	(0.13)	(0.07)	(0.09)
R^2 (adj.)	0.34	0.44	0.41	0.49	0.39	0.39

(Notes) Estimation with the fixed effect model. Values in parentheses are standard errors of coefficients. Constants and country fixed effects are not reported in the original article
(Source) Ahearne et al. (2003, pp.25).

Table 4. Panel regression for East Asian exports (1985-2004)

Explanatory variable	ANIES4 (1)	ANIES4 (2)	ASEAN4 (1)	ASEAN4 (2)	EA8 (1)	EA8 (2)
∆f	3.794***	3.682***	3.611***	4.026***	3.865***	4.020***
	(0.692)	(0.713)	(0.812)	(0.811)	(0.545)	(0.567)
Lag 1		0.178		-1.427*		-0.545
		(0.638)		(0.811)		(0.539)
∆s	0.764***	0.759***	0.906***	0.893***	0.918***	0.912***
	(0.147)	(0.149)	(0.066)	(0.064)	(0.051)	(0.052)
Lag 1		0.210		-0.131**		-0.068
		(0.150)		(0.056)		(0.049)
∆x (China)	0.123*	0.111	-0.218**	-0.264**	-0.055	-0.064
	(0.067)	(0.075)	(0.093)	(0.106)	(0.059)	(0.068)
Lag 1		0.034		-0.160		-0.061
		(0.076)		(0.097)		(0.065)
D (1998)	0.114***	0.108***	0.158**	0.193***	0.134***	0.147***
	(0.038)	(0.039)	(0.064)	(0.062)	(0.037)	(0.037)
D. W.	1.740	1.731	1.469	1.553	1.429	1.427
R^2 (adj.)	0.539	0.536	0.804	0.826	0.748	0.750

(Notes) Pooled estimation with country fixed effects. Constants and country fixed effects are not reported. (*), (**) and (***) denote statistical significance at 10, 5 and 1 percent. Dependent variable is the growth rate of PPI-deflated exports in local currencies. Exports of Hong Kong and the Philippines exclude re-exports.

Table 5. Panel regression for East Asian exports (1985-2004)

Explanatory variable	ANIES4				ASEAN4				EA8			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Δf	2.916***	2.665***	2.482***	2.436***	2.314**	2.151**	1.766*	1.771*	2.600***	2.393***	2.371***	2.374***
	(0.857)	(0.842)	(0.841)	(0.836)	(0.973)	(0.999)	(0.951)	(0.924)	(0.648)	(0.652)	(0.649)	(0.648)
Δs	0.779***	0.758***	0.716***	0.691***	0.880***	0.880***	0.913***	0.920***	0.907***	0.906***	0.916***	0.919***
	(0.144)	(0.141)	(0.142)	(0.142)	(0.065)	(0.065)	(0.062)	(0.061)	(0.049)	(0.049)	(0.049)	(0.049)
Δelc1	0.115**	0.160***	0.154***	0.161***	0.174**	0.199**	0.253***	0.240***	0.146***	0.180***	0.194***	0.190***
	(0.054)	(0.056)	(0.055)	(0.055)	(0.072)	(0.079)	(0.077)	(0.075)	(0.045)	(0.049)	(0.049)	(0.049)
$[\Delta elc1]^2$		-0.443**	-0.400**	-0.480**		-0.227	-0.389	-0.214		-0.328*	-0.375**	-0.320*
		(0.198)	(0.198)	(0.204)		(0.297)	(0.285)	(0.288)		(0.178)	(0.179)	(0.186)
Δx (China)			0.102	0.073			-0.284***	-0.217*			-0.095*	-0.074
			(0.064)	(0.068)			(0.091)	(0.093)			(0.057)	(0.060)
Lag 1				0.094				-0210**				-0.065
				(0.067)				(0.092)				(0.061)
D (1998)	0.088**	0.075**	0.085**	0.075**	0.181***	0.172***	0.111*	0.130**	0.125***	0.115***	0.100***	0.106***
	(0.038)	(0.038)	(0.038)	(0.038)	(0.062)	(0.064)	(0.063)	(0.062)	(0.035)	(0.035)	(0.036)	(0.037)
D. W.	1.506	1.569	1.563	1.570	1.349	1.343	1.638	1.661	1.346	1.349	1.404	1.408
R^2 (adj.)	0.546	0.570	0.579	0.585	0.805	0.804	0.825	0.835	0.763	0.767	0.770	0.770

(Notes) See Table 4.

Table 6. Panel regression for East Asian exports (1985-2004)

Explanatory variable	ANIES4			ASEAN4			EA8		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Δf	3.213***	2.967***	2.801***	2.448**	2.202**	2.305**	2.768***	2.770***	2.824***
	(0.894)	(0.891)	(0.901)	(0.966)	(0.924)	(0.910)	(0.655)	(0.653)	(0.657)
Δs	0.789***	0.737***	0.713***	0.884***	0.916***	0.921***	0.911***	0.919***	0.922***
	(0.147)	(0.147)	(0.148)	(0.065)	(0.063)	(0.062)	(0.050)	(0.050)	(0.050)
Δelc2	0.155	0.151	0.179*	0.302**	0.367***	0.324**	0.237***	0.250***	0.235***
	(0.106)	(0.104)	(0.107)	(0.135)	(0.131)	(0.131)	(0.086)	(0.086)	(0.088)
Δx (China)		0.121*	0.099		-0.261***	-0.207**		-0.074	-0.058
		(0.066)	(0.069)		(0.091)	(0.093)		(0.058)	(0.060)
Lag 1			0.078			-0.175*			-0.055
			(0.069)			(0.093)			(0.061)
D (1998)	0.083**	0.093**	0.083**	0.164**	0.109	0.124*	0.114***	0.102***	0.108***
	(0.041)	(0.040)	(0.041)	(0.064)	(0.064)	(0.063)	(0.036)	(0.037)	(0.038)
D. W.	1.647	1.654	1.638	1.334	1.557	1.591	1.380	1.415	1.425
R^2 (adj.)	0.531	0.546	0.547	0.803	0.821	0.827	0.759	0.760	0.759

(Notes) See Table 4.

Table 7. Panel regression for East Asian exports (1985-2004)

Explanatory variable	Dependent variable = Δ ln[PPI-deflated exports] (1)	(2)	(3)	(4)	(5)	Dependent variable = Δ ln[exports volume] (1)	(2)	(3)	(4)	(5)
Δf	2.755***	2.515***	2.429***	3.257***	3.226***	2.208***	1.964**	2.137**	3.370***	3.770***
	(0.694)	(0.684)	(0.688)	(0.732)	(0.748)	(0.814)	(0.809)	(0.825)	(0.891)	(0.894)
Lag 1			2.176***		1.378**			1.753**		0.978
			(0.593)		(0.594)			(0.711)		(0.710)
Δs	0.755***	0.749***	0.683***	0.755***	0.732***	0.194	0.188	0.128	0.205	0.190
	(0.123)	(0.120)	(0.115)	(0.127)	(0.123)	(0.144)	(0.142)	(0.137)	(0.154)	(0.146)
Lag 1			0.235**		0.207*			0.319**		0.297**
			(0.114)		(0.122)			(0.137)		(0.146)
Δelc1	0.125***	0.166***	0.135***			0.204***	0.246***	0.195***		
	(0.045)	(0.047)	(0.045)			(0.053)	(0.056)	(0.054)		
Lag 1			-0.156***					-0.156***		
			(0.040)					(0.048)		
$[\Delta elc1]^2$		-0.406**					-0.412**			
		(0.169)					(0.200)			
Lag 1										
Δelc2				0.128	0.217**				0.143	0.206*
				(0.089)	(0.094)				(0.108)	(0.113)
Lag 1					-0.252***					-0.332***
					(0.090)					(0.108)
D (1998)	0.085**	0.072**	0.057*	0.084**	0.093**	0.029	0.016	0.008	0.037	0.065
	(0.032)	(0.032)	(0.031)	(0.035)	(0.035)	(0.038)	(0.038)	(0.037)	(0.042)	(0.042)
D. W.	1.521	1.593	1.678	1.707	1.739	1.403	1.405	1.622	1.621	1.727
R^2 (adj.)	0.577	0.598	0.640	0.551	0.585	0.510	0.527	0.565	0.440	0.500

(Notes) Pooled regression for Hong Kong, Korea, Indonesia, Singapore, Taiwan and Thailand. Export volumes are derived from nominal export values and unit export price indices. Country fixed effects are not reported.

Table 8. Panel export regression for East Asian countries (1986-2003)

Explanatory variable	ANIES4 (1)	(2)	(3)	(4)	ASEAN4 (1)	(2)	(3)	(4)	EA8 (1)	(2)	(3)	(4)
Δf	1.186	0.980	0.785	0.478	1.111	0.711	0.739	0.782	1.000	0.695	0.656	0.548
	(1.398)	(1.392)	(1.397)	(1.326)	(0.805)	(0.788)	(0.793)	(0.801)	(0.749)	(0.740)	(0.744)	(0.729)
Δs	0.393	0.368	0.367	0.213	0.094*	0.080	0.081	0.072	0.112*	0.099*	0.099*	0.075
	(0.260)	(0.258)	(0.257)	(0.278)	(0.050)	(0.048)	(0.048)	(0.049)	(0.058)	(0.057)	(0.057)	(0.056)
Δelc1	0.196*	0.261**	0.239**	0.181*	0.186**	0.274***	0.284***	0.281***	0.194***	0.272***	0.264***	0.233***
	(0.104)	(0.112)	(0.113)	(0.107)	(0.070)	(0.075)	(0.078)	(0.079)	(0.061)	(0.066)	(0.068)	(0.067)
$[\Delta elc1]^2$		-0.539	-0.444	-0.565		-0.661**	-0.696**	-0.505*		-0.608***	-0.579**	-0.543**
		(0.365)	(0.372)	(0.375)		(0.258)	(0.266)	(0.288)		(0.222)	(0.227)	(0.240)
Δx (China)			0.097	0.161**			-0.035	-0.029			0.030	0.067
			(0.081)	(0.079)			(0.057)	(0.059)			(0.049)	(0.050)
Lag 1				0.201**				-0.056				0.076
				(0.084)				(0.063)				(0.053)
D. W.	2.089	2.202	2.277	2.514	1.954	1.916	1.894	1.897	2.043	2.126	2.149	2.305
R^2 (adj.)	0.218	0.232	0.237	0.321	0.207	0.269	0.262	0.244	0.245	0.280	0.277	0.301

(Notes) Dependent variable is the growth rate of export volume derived from Noda (2005). Hong Kong's volume index is recompiled by excluding re-exports at the request of the author.

Table 9. Business cycle regression for East Asian countries

Explanatory variable	Kwan (2001) Sample period: 1982-1997 (1)	(2)	(3)	McKinnon and Schnabl (2003) Sample period: 1982-2001 (1)	(2)	(3)
Δy (USA)	0.39	0.33	0.32	0.31	0.18	0.19
	(2.42)	(2.60)	(2.71)	(1.25)	(0.83)	(1.01)
Δe (Y/$)		-0.069	-0.059		-0.10	-0.08
		(-3.15)	(-2.82)		(-2.70)	(-2.38)
Lag 1						-0.08
						(-2.23)
D. W.	1.576	1.822	1.691	1.12	1.40	1.43
R^2 (adj.)	0.245	0.539	0.606	0.03	0.28	0.41

(Notes) Values in parentheses are t-values. Dependent variable is an weighted average of the real GDP growth rates of nine East Asian countries (EA8 + China).

Table 10. Correlation of country business cycles and the global electronics cycle (1985-2004)

	EA8	China	Japan	United States	EU15
Hong Kong	0.741 (0.573)	0.273 (0.239)	0.349 (0.174)	0.113 (0.278)	0.108 (0.245)
Indonesia	0.797 (0.479)	0.145 (0.047)	0.439 (0.245)	-0.275 (-0.245)	-0.194 (-0.127)
Korea	0.814 (0.553)	0.104 (-0.013)	0.528 (0.407)	-0.146 (0.018)	0.183 (0.535)
Malaysia	0.816 (0.612)	0.085 (-0.013)	0.351 (0.135)	-0.102 (0.042)	-0.075 (0.045)
Philippines	0.416 (0.347)	-0.320 (-0.374)	0.088 (-0.015)	0.184 (0.250)	0.184 (0.237)
Singapore	0.724 (0.764)	0.101 (0.053)	0.310 (0.194)	0.164 (0.262)	0.125 (0.202)
Taiwan	0.480 (0.665)	0.244 (0.228)	0.415 (0.392)	0.286 (0.324)	0.231 (0.261)
Thailand	0.828 (0.585)	0.100 (-0.005)	0.617 (0.544)	-0.210 (-0.100)	0.029 (0.224)
China	0.132 (0.039)		-0.096 (-0.162)	0.188 (0.221)	-0.411 (-0.398)
Japan	0.521 (0.392)			0.070 (0.157)	0.505 (0.618)
United States	-0.083 (0.117)				0.381 (0.362)
EU15	0.088 (0.352)				

	Indonesia	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand	Δelc1	Δelc2
Hong Kong	0.581 (0.169)	0.706 (0.501)	0.533 (0.233)	0.410 (0.324)	0.585 (0.483)	0.690 (0.745)	0.536 (0.193)	0.563 (0.562)	0.317 (0.347)
Indonesia		0.769 (0.130)	0.823 (0.658)	0.369 (0.312)	0.545 (0.517)	0.269 (0.321)	0.838 (0.563)	0.279 (0.252)	0.156 (0.247)
Korea			0.637 (0.190)	0.248 (0.053)	0.513 (0.376)	0.505 (0.660)	0.791 (0.471)	0.359 (0.351)	0.157 (0.186)
Malaysia				0.532 (0.497)	0.849 (0.874)	0.306 (0.281)	0.757 (0.503)	0.571 (0.614)	0.482 (0.609)
Philippines					0.573 (0.528)	0.183 (0.150)	0.329 (0.200)	0.465 (0.437)	0.274 (0.268)
Singapore						0.528 (0.514)	0.587 (0.491)	0.714 (0.706)	0.564 (0.586)
Taiwan							0.382 (0.412)	0.463 (0.447)	0.446 (0.442)
Thailand								0.357 (0.326)	0.186 (0.214)

(Notes) Values in parentheses are computed excluding the period of the Asian crisis (1997-1998). Values larger than 0.5 are highlighted. In the upper panel, the correlation of the growth rates of each of EA8 and EA8 denotes the correlation coefficient for the growth rates of each country and the weighted average for the other seven countries.
(Source) Author's calculation with data from IMF WEO.

Table 11. Business cycle regression for East Asian countries (1985-2004)

Explanatory variable	Regression with yen/dollar exchange rate (1)	(2)	(3)	(4)	Regression with electronics cycle variable (1)	(2)	(3)	(4)
∆y (USA)	0.093	-0.013			-0.277	-0.451		
	(0.360)	(0.340)			(0.311)	(0.349)		
∆f			0.363	-0.042			-0.275	-0.718
			(0.631)	(0.634)			(0.570)	(0.688)
∆elc					0.098***	0.113***	0.094***	0.110**
					(0.024)	(0.037)	(0.025)	(0.039)
Lag 1						0.040		0.043
						(0.028)		(0.030)
$[\Delta elc]^2$					-0.180**	-0.302*	-0.161	-0.274*
					(0.103)	(0.148)	(0.103)	(0.146)
Lag 1						-0.039		-0.046
						(0.109)		(0.111)
∆e (Y/$)	-0.085*	-0.070*	-0.085*	-0.070*				
	(0.042)	(-0.041)	(0.041)	(0.039)				
Lag 1		-0.076*		-0.076*				
		(0.041)		(0.043)				
D (1998)	-0.105***	-0.095***	-0.103***	-0.095***	-0.102***	-0.101***	-0.106***	-0.108***
	(0.021)	(0.020)	(0.020)	(0.020)	(0.017)	(0.018)	(0.017)	(0.018)
D. W.	1.100	1.294	1.084	1.299	1.102	1.348	1.124	1.478
R^2 (adj.)	0.648	0.695	0.654	0.695	0.771	0.773	0.763	0.763

(Notes) Standard errors in parentheses. Dependent variable is the weighted average of the real GDP growth rates of EA8, where the weight is the share of each country in their collective GDP meausured in nominal US dollars.

Table 12. Causality test for the yen/dollar exchange rate and the electronics cycle (1981-2004)

Null hypothesis			F-stat.	(Prob.)	Null hypothesis			F-stat.	(Prob.)
∆e (Y/$)	does not cause	∆elc1	0.818	(0.458)	∆elc1	does not cause	∆e (Y/$)	4.281	(0.031)**
∆e (Y/$)	does not cause	∆elc1*	0.849	(0.445)	∆elc1*	does not cause	∆e (Y/$)	3.401	(0.057)*
∆e (Y/$)	does not cause	∆elc2	0.298	(0.746)	∆elc2	does not cause	∆e (Y/$)	1.109	(0.353)

Variable		Correlation with ∆e (Y/$)
∆elc1 :	∆ln (world semiconductor sales) - ∆ln (world GDP)	-0.498
∆elc1* :	∆ln (world semiconductor sales ex. those shipped in/to/from Japan) - ∆ln (world GDP ex. Japan)	-0.363
∆elc2 :	∆ln (USA electronics new orders) - ∆ln (USA GDP)	-0.290

(Note) (*) and (**) indicate rejection of null hypothesis at 10 and 5 percent.

Table 13. Business cycle regression for East Asian countries (1985-2004)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
△y (USA)	-0.163	-0.272	0.331	-0.160	-0.222					
	(0.212)	(0.222)	(0.228)	(0.212)	(0.225)					
△f						0.819***	0.754***	1.368***	0.785***	0.790***
						(0.245)	(0.270)	(0.210)	(0.245)	(0.269)
△elc1*	0.099***	0.105***		0.105***	0.104***	0.062***	0.057**		0.070***	0.056**
	(0.015)	(0.021)		(0.015)	(0.021)	(0.017)	(0.023)		(0.017)	(0.023)
Lag 1		0.040**		-0.206***	0.030*		0.014		-0.140**	0.003
		(0.018)		(0.060)	(0.018)		(0.018)		(0.060)	(0.019)
$[\triangle elc1^*]^2$	-0.202***	-0.297***			-0.260***	-0.135**	-0.141			-0.103
	(0.061)	(0.089)			(0.090)	(0.060)	(0.092)			(0.092)
Lag 1		-0.058			-0.066		-0.066			-0.075
		(0.066)			(0.066)		(0.064)			(0.063)
△s (Y/i)			0.027	0.041**	0.036**			0.028*	0.038**	0.039**
			(0.018)	(0.016)	(0.016)			(0.015)	(0.015)	(0.016)
Lag 1			-0.005	-0.004	-0.002			0.006	0.004	0.005
			(0.017)	(0.015)	(0.015)			(0.015)	(0.014)	(0.014)
D (1998)	-0.103***	-0.108***	-0.107***	-0.091***	-0.097***	-0.081***	-0.087***	-0.060***	-0.071***	-0.073***
	(0.012)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)	(0.014)	(0.017)	(0.013)	(0.015)
D. W.	1.147	1.169	1.144	1.120	1.143	1.169	1.188	1.162	1.174	1.179
R^2 (adj.)	0.503	0.514	0.369	0.519	0.523	0.536	0.534	0.503	0.549	0.547

(Notes) Panel regression for EA8 with the fixed effect model. Dependent variable is the growth rate of each country's real GDP.

Table 14. Business cycle regression for East Asian countries (1985-2004)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
△y (USA)	-0.362	-0.440*	-0.368	-0.397	-0.235					
	(0.246)	(0.256)	(0.242)	(0.246)	(0.253)					
△f						1.061***	1.129***	1.003***	1.014***	1.122***
						(0.272)	(0.291)	(0.270)	(0.275)	(0.264)
△elc2	0.077*	0.061	0.077*	0.075*	0.152***	0.020	0.024	0.021	0.022	0.054
	(0.042)	(0.044)	(0.041)	(0.031)	(0.034)	(0.040)	(0.042)	(0.040)	(0.040)	(0.034)
Lag 1		0.024			0.006		-0.037			-0.033
		(0.042)			(0.031)		(0.041)			(0.029)
$[\triangle elc2]^2$	-0.538***	-0.606***	-0.601***	-0.614***		-0.204	-0.162	-0.271	-0.266	
	(0.202)	(0.209)	(0.200)	(0.201)		(0.201)	(0.213)	(0.201)	(0.203)	
Lag 1		-0.094					-0.115			
		(0.196)					(0.188)			
△s (Y/i)			0.041**	0.040**	0.033*			0.034**	0.034**	0.033**
			(0.017)	(0.017)	(0.017)			(0.016)	(0.016)	(0.016)
Lag 1				-0.010	-0.005				0.004	0.005
				(0.016)	(0.016)				(0.015)	(0.015)
D (1998)	-0.109***	-0.111***	-0.098***	-0.098***	-0.096***	-0.078***	-0.074***	-0.071***	-0.071***	-0.060***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.014)	(0.016)	(0.015)	(0.015)	(0.015)
D. W.	1.127	1.143	1.148	1.159	1.202	1.136	1.163	1.170	1.170	1.183
R^2 (adj.)	0.458	0.457	0.476	0.473	0.440	0.501	0.497	0.513	0.510	0.508

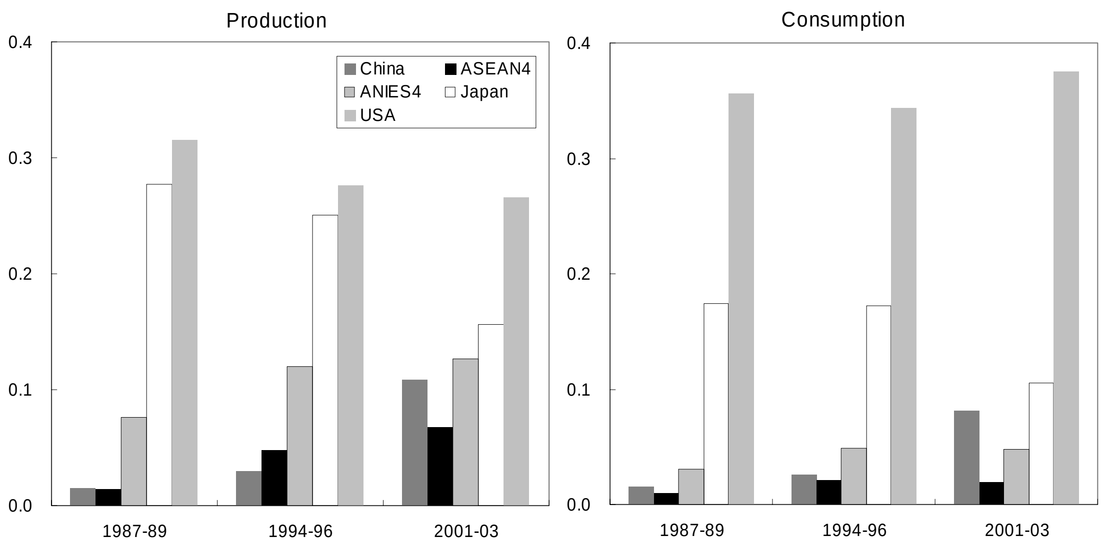
(Notes) See Table 13.

Table 15. Business cycle regression for East Asian countries (1984-2003)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
∆y (USA)	-0.125	-0.119	-0.201	0.333				
	(0.222)	(0.222)	(0.233)	(0.235)				
∆f					0.926***	0.924***	0.870***	1.416***
					(0.253)	(0.253)	(0.276)	(0.215)
∆elc1*	0.100***	0.098***	0.098***		0.060***	0.059***	0.047**	
	(0.016)	(0.016)	(0.022)		(0.017)	(0.017)	(0.024)	
Lag 1			0.044**				0.017	
			(0.019)				(0.019)	
$[\Delta elc1^*]^2$	-0.203***	-0.196***	-0.282***		-0.133**	-0.127**	-0.119	
	(0.062)	(0.062)	(0.092)		(0.061)	(0.061)	(0.093)	
Lag 1			-0.089				-0.103	
			(0.070)				(0.067)	
$\Delta \hat{s}$ (Y/i)	0.013	0.018	0.035	0.028	0.026	0.031	0.041	0.039
	(0.025)	(0.025)	(0.026)	(0.028)	(0.024)	(0.024)	(0.025)	(0.025)
Lag 1		0.028	0.025	0.045		0.027	0.029	0.035
		(0.025)	(0.025)	(0.028)		(0.024)	(0.024)	(0.024)
D (1998)	-0.103***	-0.101***	-0.106***	-0.110***	-0.076***	-0.075***	-0.080***	-0.061***
	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.014)	(0.015)	(0.013)
D. W.	1.126	1.108	1.122	1.062	1.167	1.141	1.159	1.073
R^2 (adj.)	0.505	0.506	0.521	0.376	0.548	0.549	0.551	0.517

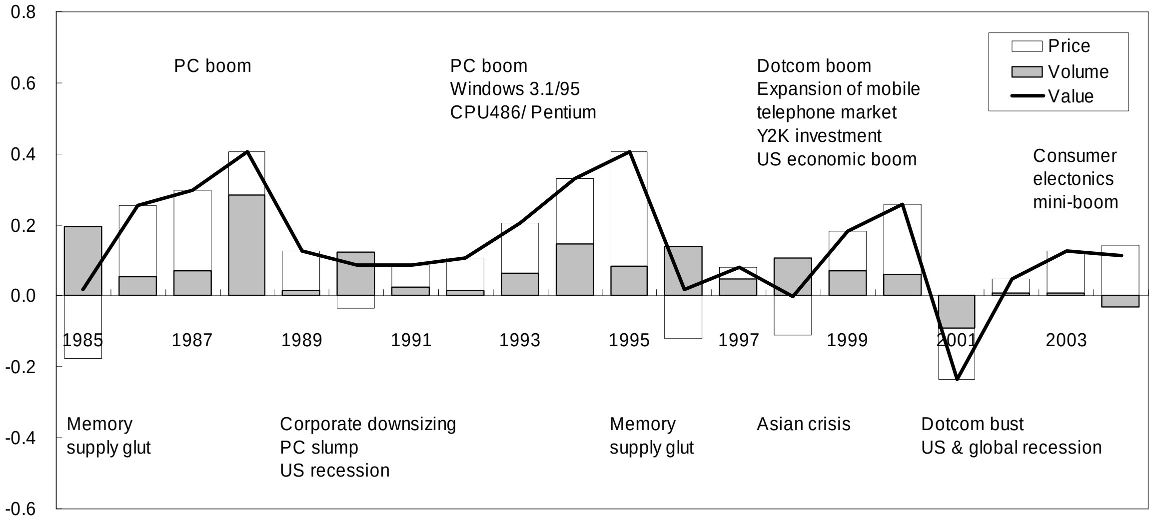
(Notes) See Table 13. See eqs. (10)-(12) for definition of $\Delta \hat{s}$ (Y/i).

Figure 1. Share of East Asian countries in world electronics production and consumption



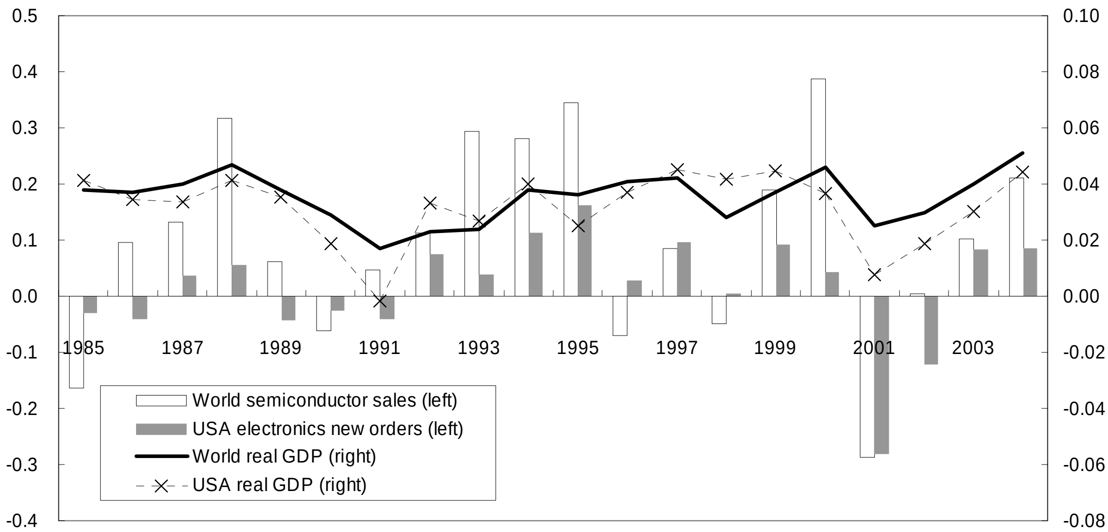
(Note) Consumption shares are computed by excluding parts and components.
(Source) Reed Electronics Research Yearbook of World Electronics Data.

Figure 2. Price and Volume decomposition of semiconductor trade cycle (1985-2004)



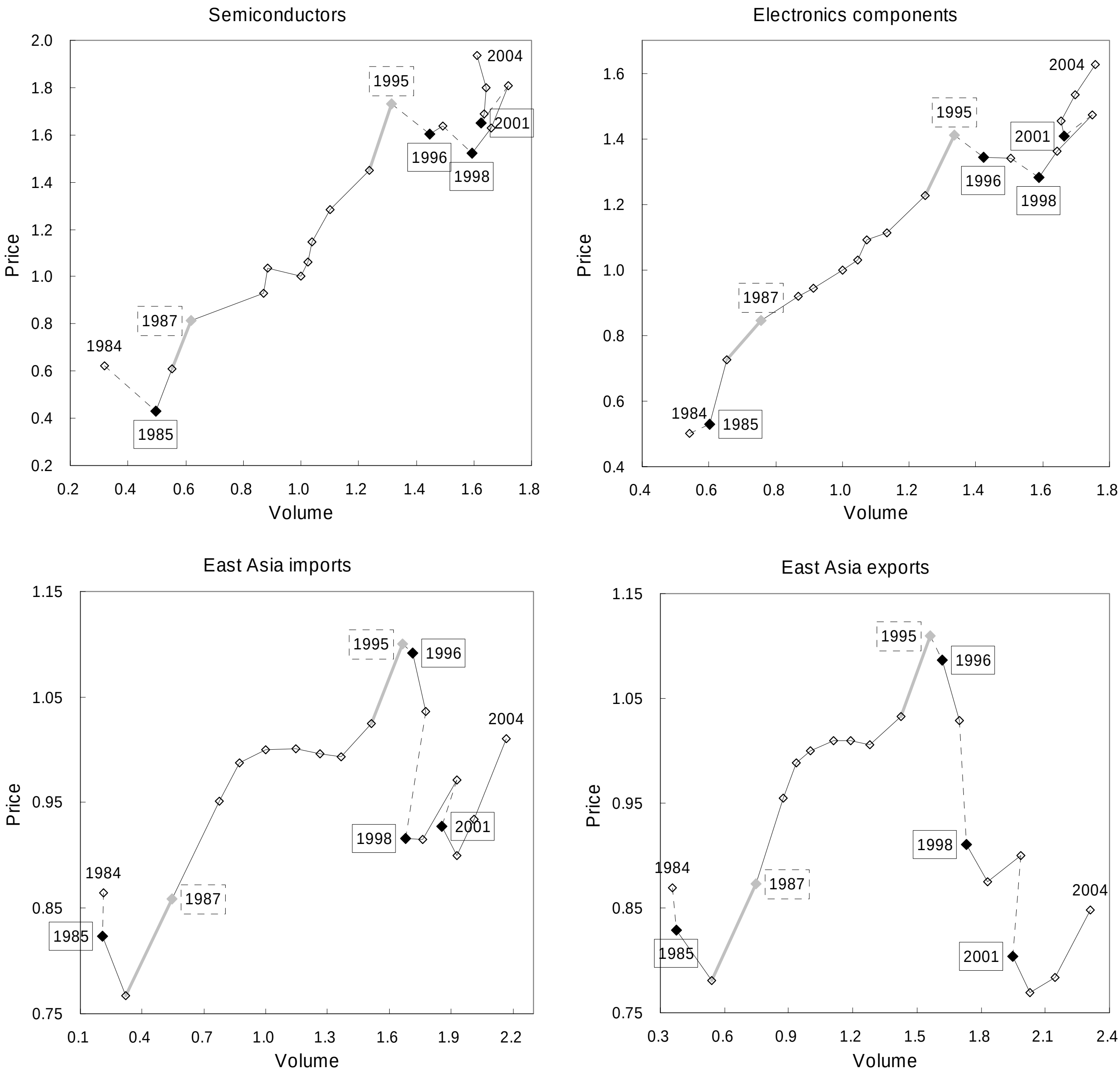
(Notes) Measured for SITC (Rev.2) 776 in terms of the growth rate over previous year. Growth rates of value and volume are computed with data for 29 major exporter countries; the rate of change in the price is imputed from the value and volume growth rates. Value and price are measured in nominal US dollars.
(Source) Original data are from UNCOMTRADE, Foreign Trade Statistics of the Philippines and Monthly Statistics of Exports and Imports in Taiwan.

Figure 3. Cycles of the world economy and the global electronics market (1985-2004)



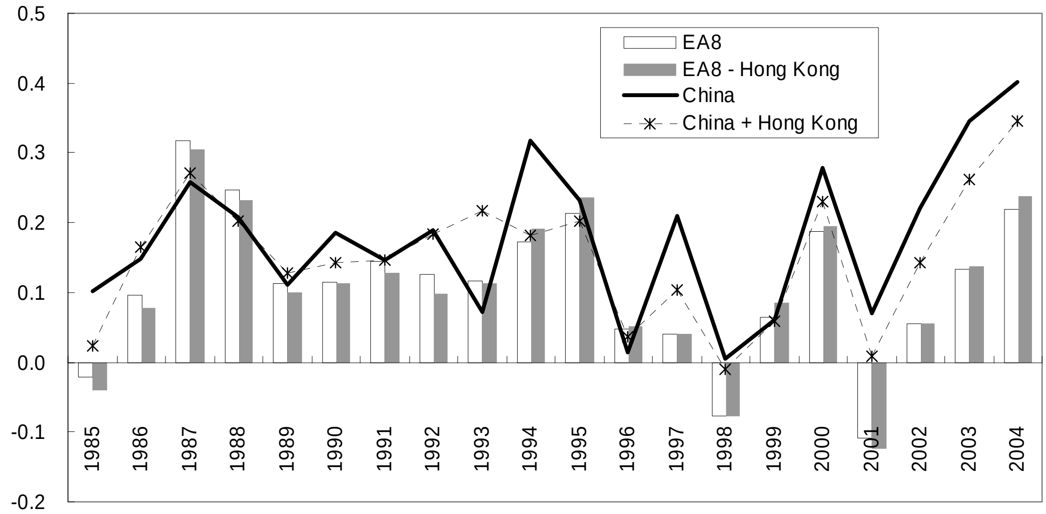
(Notes) All values are the rate of change over the previous year. World semiconductor sales are measured in US dollars and deflated by the world GDP deflator; US electronics new orders are measured in terms of SIC-based M3 series 35H + 36M - SX2 - 36D (1985-1993) and NAIC-based M3 Series 34S (1994-2005) and deflated by the US GDP deflator.
(Source) IMF WEO, US Semiconductor Industry Association, and US Bureau of Census.

Figure 4. Price and volume dynamics of global electronics trade and East Asia's trade



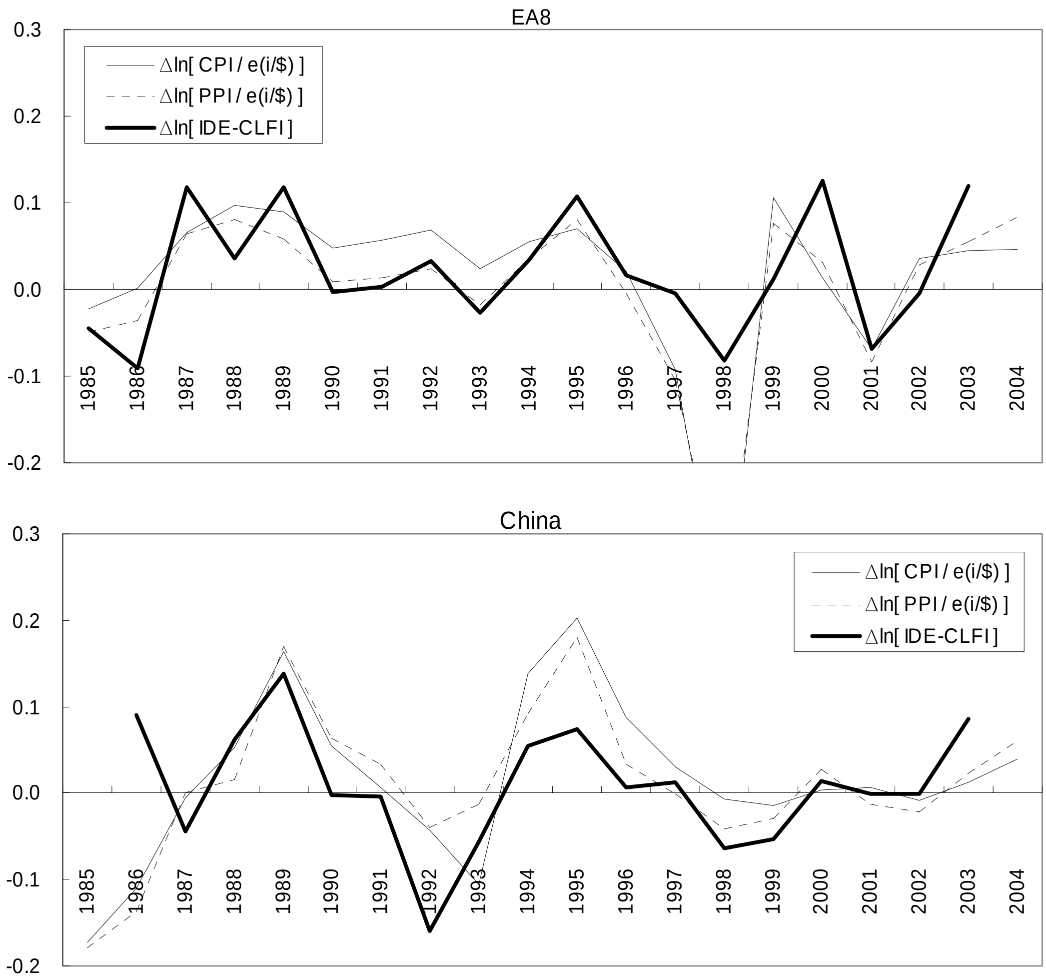
(Notes) All values are in natural logarithm (1990 = 1). All prices are measured in nominal US dollars. Prices and volumes of EA imports and exports are the weighted average for Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand, where the weight is each country's share in all countries' imports or exports. Date for Malaysia are unavailable for some years. 1985, 1996, 1998, 2001 are years in which the rate of change in the semiconductor price fell below the average for 1985-2004 minus one standard deviation (= -5.8 percent); 1987 and 1995 are years in which the price rose by more than the period average plus one standard deviation (= 21.0 percent).
(Source) IMF IFS, CEIC Asia Database, UN COMTRADE, Monthly Statistics of Exports and Imports R.O.C..

Figure 5. Growth rates of exports of China and other East Asian countries



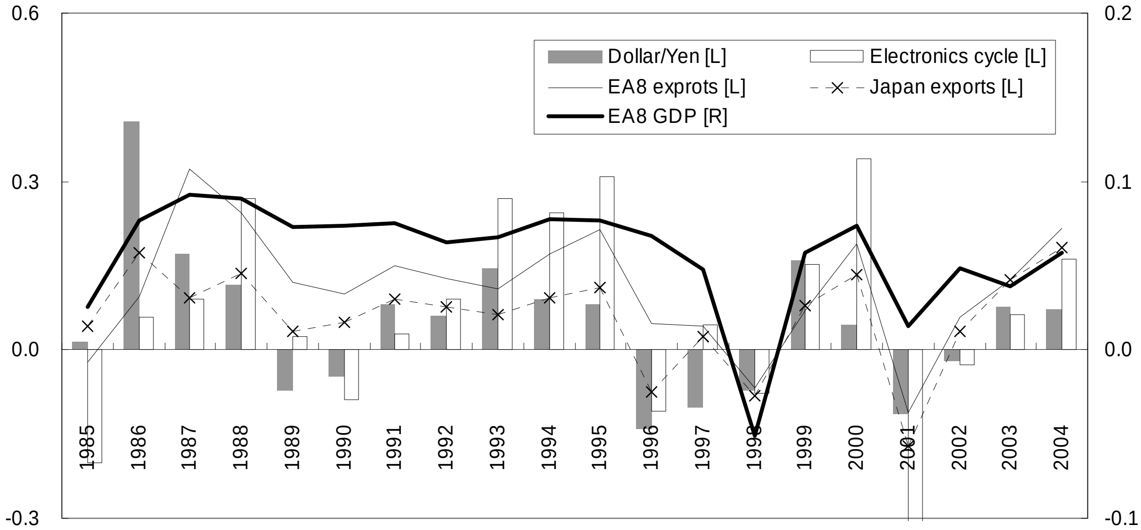
(Notes) Export values are measured in terms of nominal US dollars.
(Source) IMF DOTS and CEIC Asia Database.

Figure 6. Implicit and explicit indices of aggregate export price (y/o/y rate of change)



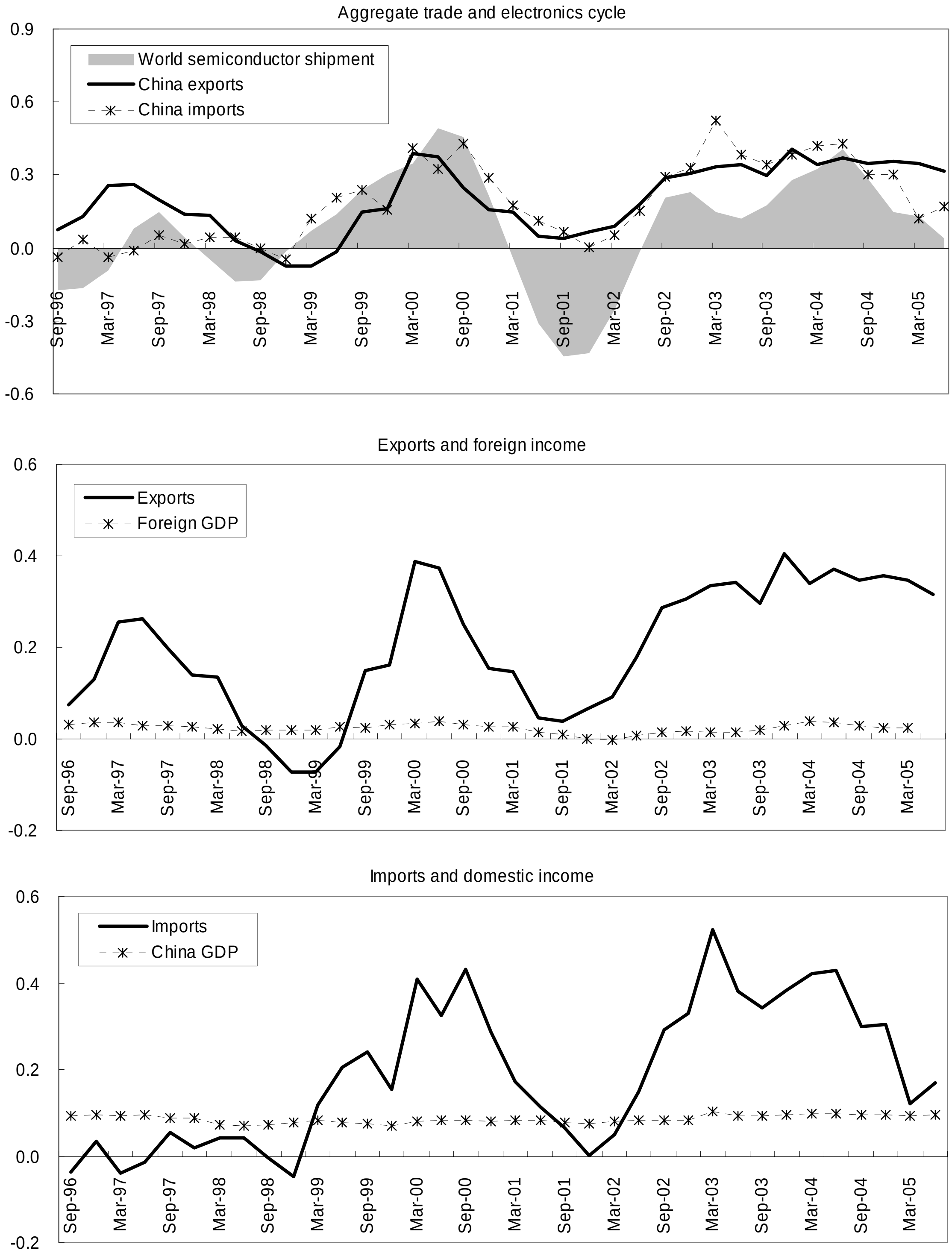
(Source) IMF IFS, CEIC Asia Database, and Noda (2005)

Figure 7. Trade and business cycles of East Asian countries (annual rates of change)



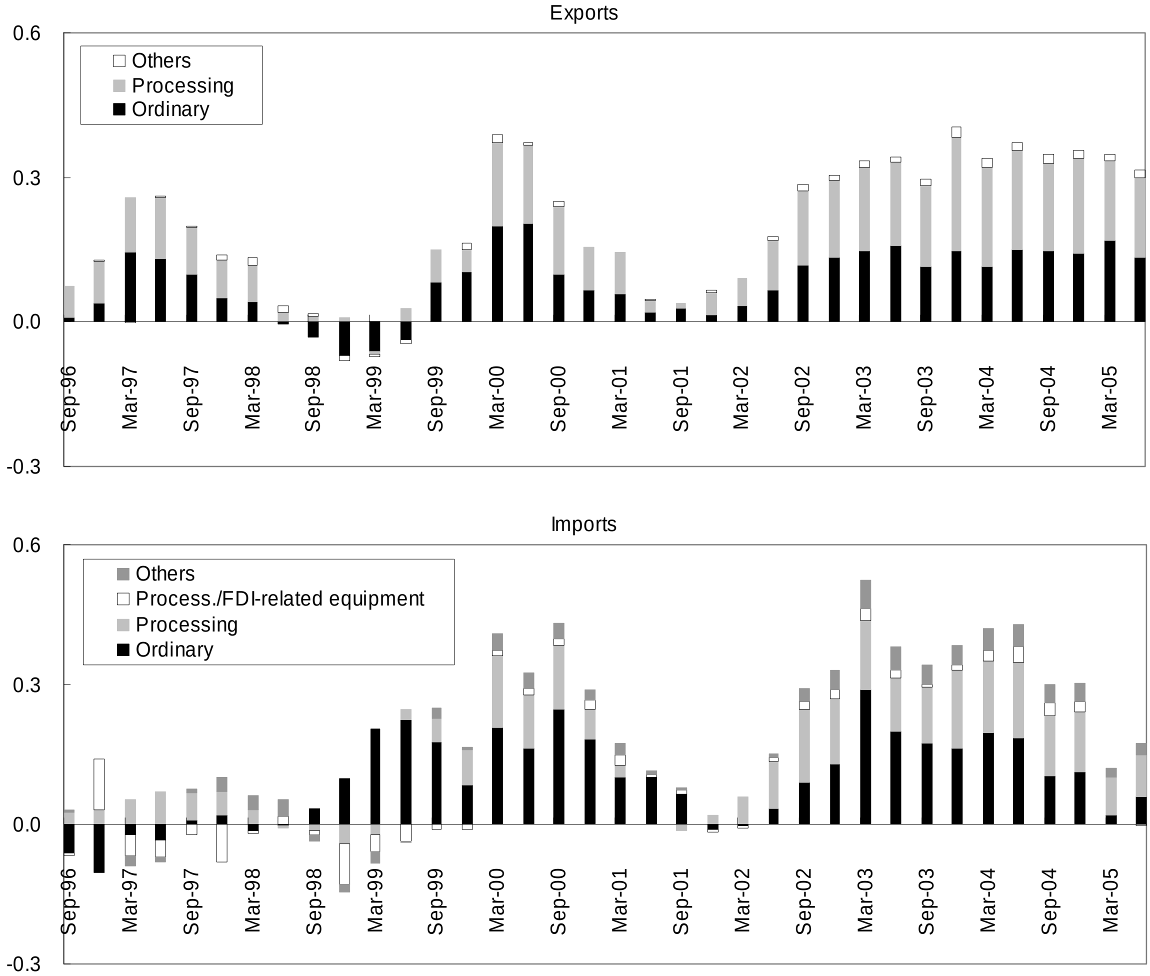
(Note) EA8's GDP growth rate is the weighted average of the eight countries, where the weight is each country's share in their aggregate GDP. Electronics cycle is measured in terms of $\Delta elc_{1,t}$.
(Source) IMF IFS and WEO, CEIC Database and US SIA.

Figure A1. China's exports and imports (y/o/y rate of growth)



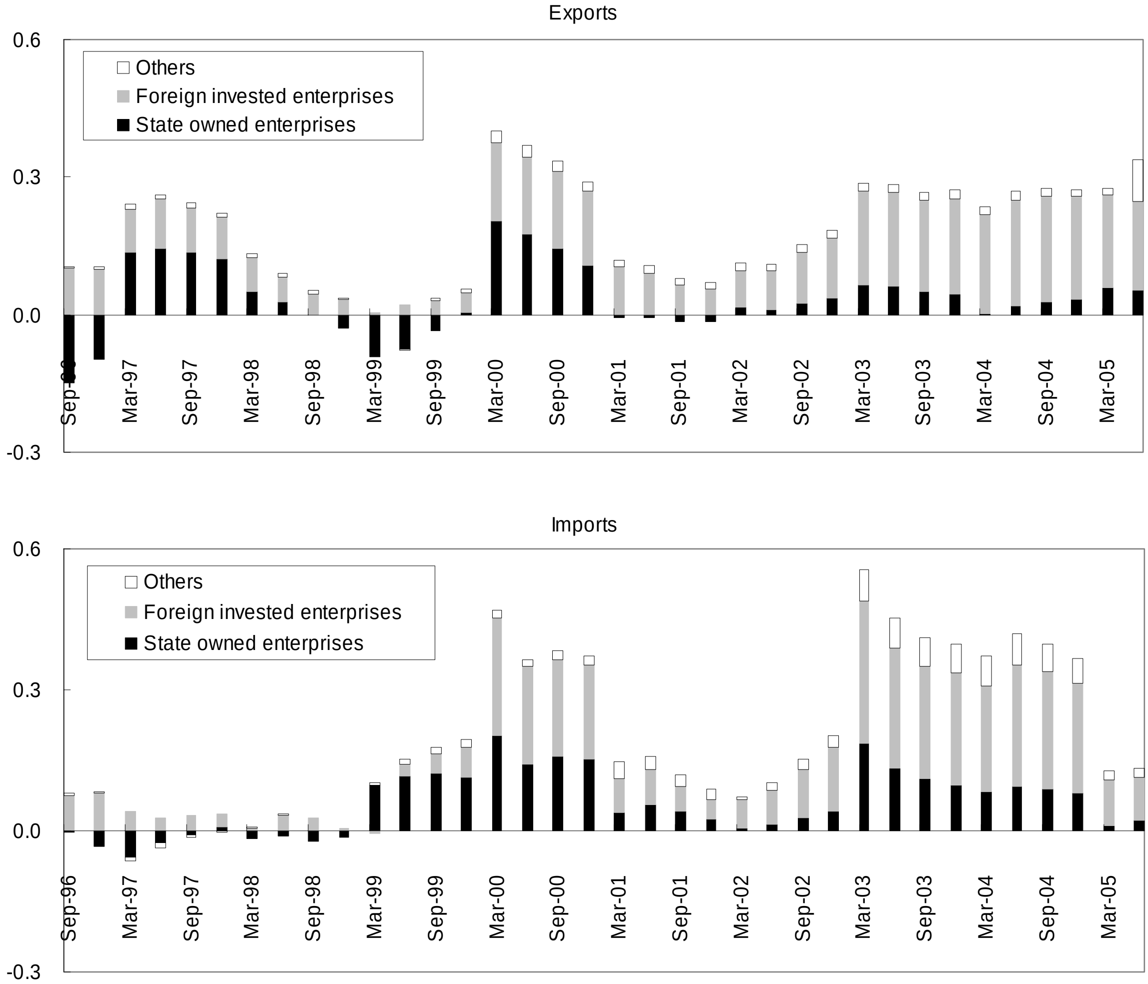
(Notes) World semiconductor shipment is measured in terms of nominal US dollars. The growth rate of foreign GDP is measured as the weighted average for USA, Japan and 12 European countries, where the weights are the share of each country in China's exports.
(Source) CEIC Asia and Non-Asia Database.

Figure A2. China's export and imports by customs regime (y/o/y rate of growth)



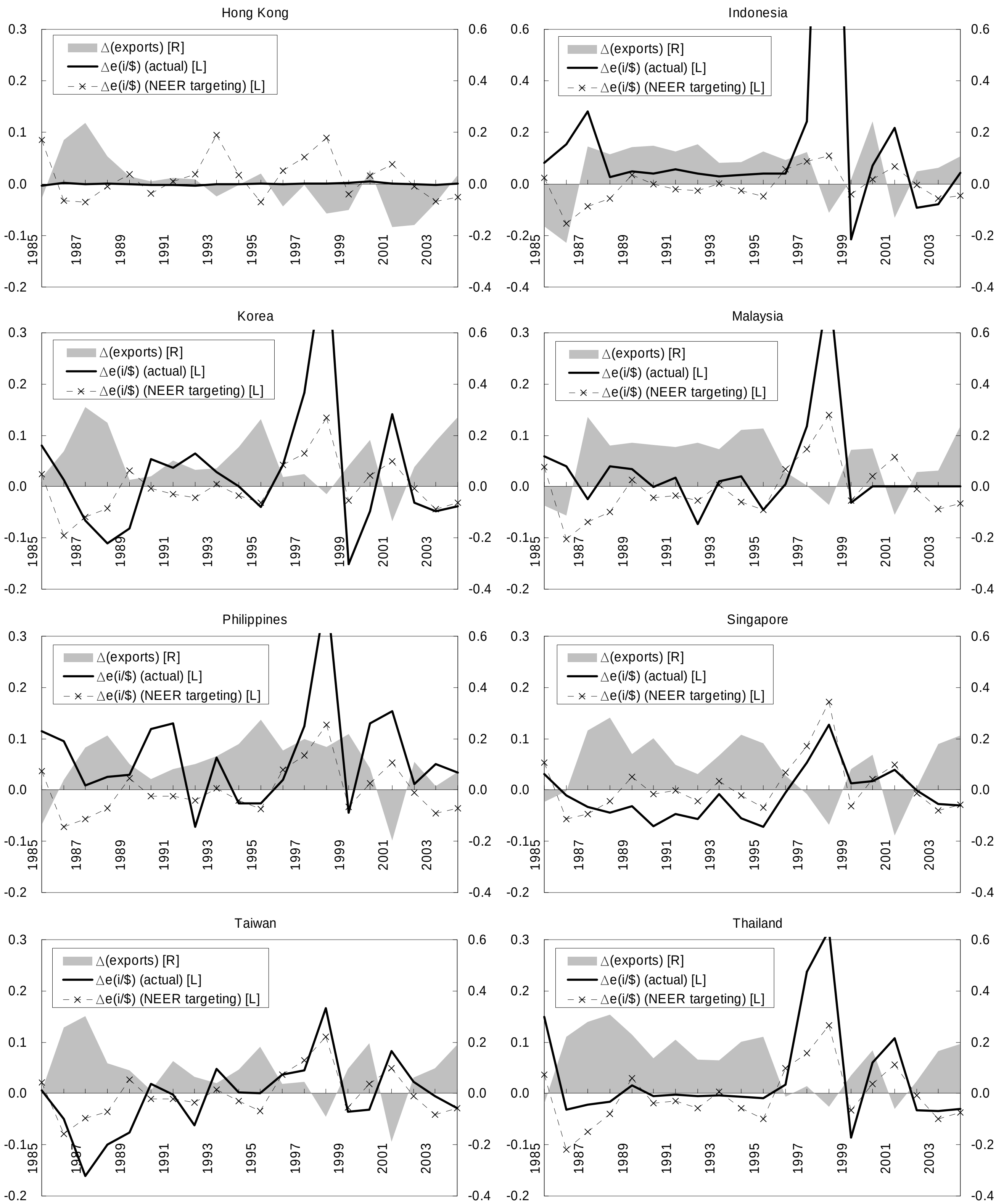
(Notes) "Processing" refers to imports and exports related to domestic assembly operations. "Processing-/ FDI-related equipment" includes equipment imported for processing trade and equipment or materials invested by foreign invested enterprises.
(Source) CEIC Asia Database.

Figure A3. China's export and imports by type of enterprises (y/o/y rate of growth)



(Notes) "Foreign invested enterprises" includes both foreign owned firms and joint ventures of local and foreign enterprises.
(Source) CEIC Asia Database.

Figure B1. Actual and hypothetical movement of nominal exchange rates vis-à-vis the US dollar



(Notes) All values are measured in terms of the y/o/y rate of change. Exports are measured in nominal US dollars. Exports of Hong Kong and Singapore exclude re-exports.
(Source) IMF IFS, CEIC Asian Database, Statistics Canada World Trade Database.