Working Paper

INTERNATIONAL MONETARY FUND

WP/07/266

IMF Working Paper

China's Changing Trade Elasticities

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Asia and Pacific Department

China's Changing Trade Elasticities

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November 2007

Abstract

China's sectoral trade composition, product quality mix, and import content of processing exports have all changed substantially during the past decade. This has rendered trade elasticities estimated using aggregate data highly unstable, with more recent data pointing to significantly higher demand and price elasticities. Sectoral differences in these parameters are also very wide. All this suggests greater caution in using historical data to simulate the response of the China's economy to external shocks and exchange rate changes. Analyses based on models whose estimated coefficients largely reflect the China of the 1980s and 1990s are likely to turn out to be wrong, perhaps even dramatically.

JEL Classification Numbers: F40, F30.

Keywords: Trade, elasticity, exchange rate, trade balance.

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[1] We are grateful to the extensive discussions with Jaewoo Lee on econometric analyses, comments from Steven Dunaway, Christoph Duenwald, Ketil Hviding, and Laura Papi, data sharing by Li Cui and Murtaza Syed, and research assistance by Mehmet Ziya Gorpe.

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I. INTRODUCTION

In recent years, much has been written about the China's rising current account surplus and the importance of its exchange rate policy. The effects of a change in the value of the renminbi or the lack of it on China's and the global economy is now one of the most discussed issues in international policy debates (e.g., see Goldstein, 2007; and Roubini, 2007). At the same time, the increasing integration of China into the global economy has raised questions about how the economy might be affected if the external environment changes (Prasad, 2007). Central to all these analyses is the size and stability of China's trade elasticities. If they are low, whether with respect to external demand or prices, then changes in external conditions or the exchange rate are unlikely to have much of an impact on China's growth or its current account. If trade elasticities are not stable, then little can be said with any degree of confidence on how the economy might react to such changes. In addition, certain methodologies used to compute the underlying or equilibrium exchange rate critically depend on stable trade elasticities. For example, in the macroeconomic-balance approach, price elasticities of exports and imports are used to determine the adjustment in the real effective exchange rate needed to close the gap between the underlying current account balance of a country and its equilibrium level to uncover the degree to which the exchange rate is misaligned (Goldstein, 2004; Coudert and Couharde, 2005; and Wang, 2004).

While papers such as those by Dunaway and Li (2005) and Dunaway, Leigh, and Li (2006) underscore that answers to the above questions are very sensitive to the stability of estimated trade elasticities, little systematic analysis of China's trade elasticities has been undertaken. Using both aggregate and disaggregated data, this paper conducts such an analysis and finds that while the aggregate import demand and price elasticities have remained relatively stable, export elasticities have increased over time. Much of the increase in the aggregate export elasticities reflects changes in the composition of China's trade, particularly the increasing sophistication of exports and the rising domestic content of processing trade.

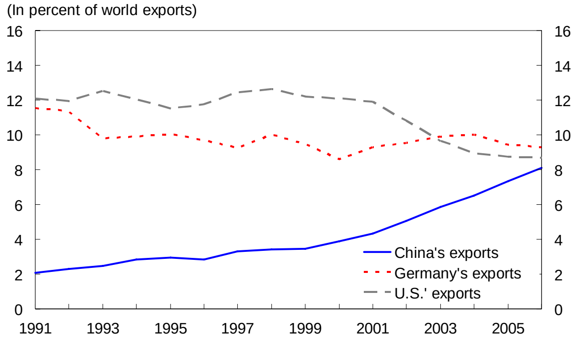
These results are not surprising. Given the fast pace of development in China in the last decade, it is likely that trade has shifted away from the basic processing production that long caricatured China's "growth model" to the manufacturing of increasingly sophisticated export goods with rising local sourcing of inputs. In turn, such a shift should have affected aggregate elasticities, as has long been established by studies on other countries (Goldstein and Khan, 1985). What is surprising in the case of China is the extent of the rise in the export demand and price elasticities. The elasticity with respect to external demand has risen from 3.6 in 1995−1999 to around 4.3 by 2000−2006; the price elasticity has increased from −1.3 in 1995−1999 to −2.0 by 2000−2006 (Appendix II). These are large shifts, especially given the short period over which they have taken place.

What the changing trade elasticities suggest is that caution needs to be exercised in assessing how China's economy and trade balance might react to external demand shocks or changes in the exchange rate. These elasticities estimates suggest that relatively moderate changes in external demand or in the exchange rate could have large effects on the economy and the trade balance. But given China's recent experience, it is dangerous to expect that even these new elasticity estimates will be stable over the medium term. Not only has the structure of trade changed rapidly in China, it is also likely that trade composition itself will be affected by the changes in the exchange rate.

II. How China's Trade Has Changed

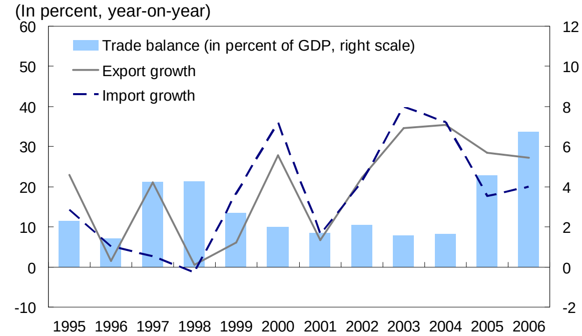
After a decade of rapid trade growth, China is now the world's third largest exporter (Figures 1 and 2), behind the United States and Germany. Meanwhile, China's trade surplus has widened sharply in recent years as import growth has lagged that of exports. The causes behind this are still being debated. Increasingly, a number of studies using disaggregate data point to large structural shifts in the structure of trade, which must have affected trade elasticities. These structural changes include privatization of the export sector, trade liberalization, increasing share of exports with relative high elasticities, and rising domestic content of exports as processing exports move away from pure assembly operations.

Figure 1. China: Share of Exports in the World
(In percent of world exports)



Sources: CEIC Data Co. Ltd.; and authors' estimates.

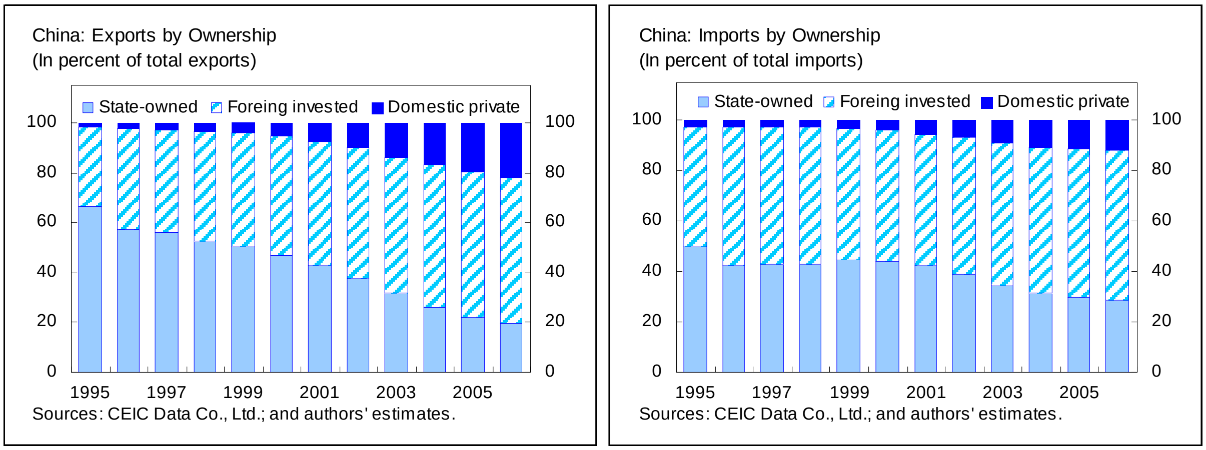
Figure 2. China: Trade Developments
(In percent, year-on-year)



Sources: CEIC Data Co. Ltd.; and authors' estimates.

Economic liberalization, continued privatization, and large inflows of foreign investment have reduced the share of state-owned enterprises in exports; while in 1995 more than one third of total exports was produced by state-owned enterprises, by 2006 this share had fallen to about one fifth (Figure 3).

Figure 3. China: Trade by Ownership



Particularly important was the decline in trade barriers. Unweighted average tariffs declined from about 43 percent in 1992 to 16.4 percent in 2000—just prior to China's joining the WTO—and then to under 10 percent by 2005 (Figure 4). Import quotas and licensing were all abolished by 2005. This increased the responsiveness of enterprises to market signals as discussed in Cerra and Saxena (2003), based on disaggregated quarterly trade data from the mid-1980s through 2001.

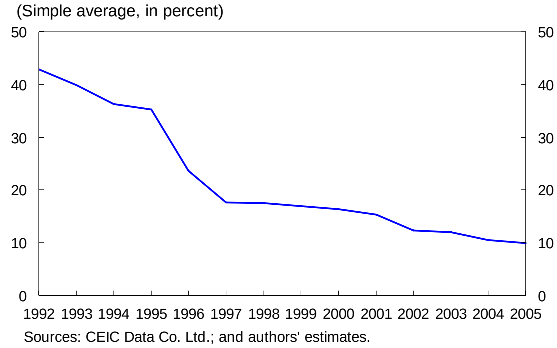
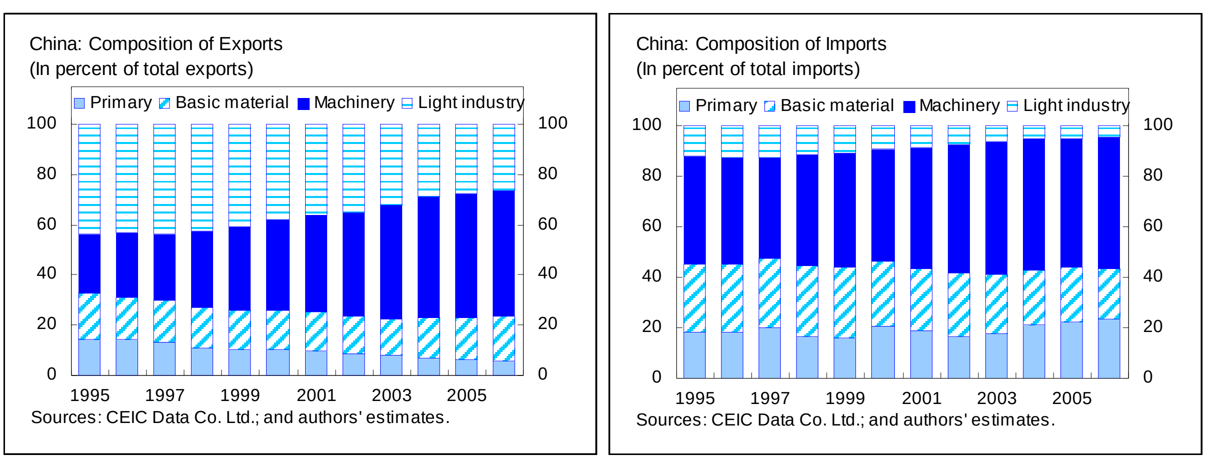
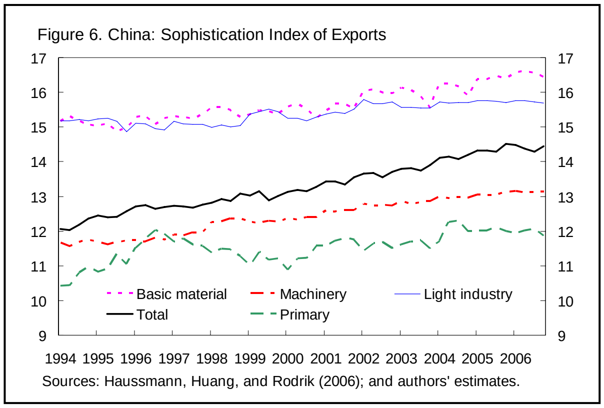


Figure 4. China: Import Tariffs
(Simple average, in percent)

In terms of the composition of trade, the share of exports that are less price sensitive, such as primary products, declined from 15 percent in 1995 to 3 percent in 2006; meanwhile those that are typically more sensitive to prices, such as machinery (including electronics), rose from 20 percent to about 60 percent during the same period (Figure 5). Within each category,

Figure 5. China: Composition of Trade





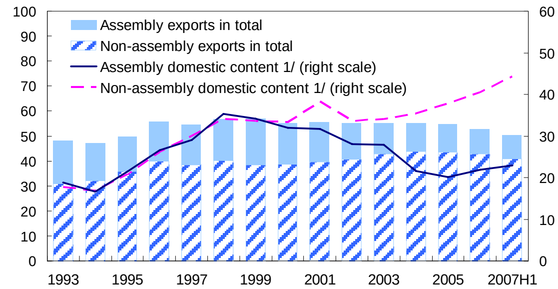
the composition of products has also changed. Cui and Syed (2007), Amiti and Freund (2007), Schott (2007), and Haltmaier and others (2007) all show that the technology content of Chinese exports and imports has increased. In addition, Cui and Syed also show that products with higher technology content are more sensitive to prices. Figure 6 shows that the increase in sophistication of China's exports has been across all major categories,[2] and a shift toward high-productivity products has caused the overall sophistication index to rise more sharply than individual categories.

A striking development has been the change in the nature of China's processing trade. Back in the 1990s China was—what many still mistakenly believe it to be—essentially a very large workshop importing sophisticated inputs that were assembled into consumer goods for the West. This is important as under this caricature of China's trade, changes in the exchange rate or external demand have only muted effects on the economy and the trade balance. If exports decline, either because of soft external demand or because of an appreciation, so do imports, such that the impact on the trade balance and the economy as a whole is small. This popular view of Chinese trade is, unfortunately, substantiated by a cursory reading of China's trade and customs statistics, which differentiates exports between those that are for "processing" industry and those that are not. Under this classification, processing trade makes up more than fifty percent of China's total exports. However, this is not a functional classification. Rather the classification is made for tax purposes. A careful look at the tax classification shows that there are two subcategories within "processing" trade: (i) processing that is based on contractual agreements with foreign suppliers of inputs and foreign buyers of final products and (ii) processing using imported inputs. Under the first category, firms do not pay import taxes or VAT, while under the second category firms first pay the required taxes and then claim rebates later. It is the first category that conforms to conventional view of processing trade, where the exports are inextricably linked to imported inputs. In the second category, the share of imported inputs can vary arbitrarily, depending on the extent of domestic sourcing.

[2] The sophistication index is computed based on an index developed by Hausman, Huang, and Rodrik (2006) that measures the productivity level of each good at the HS5 level. A weighted average of per capita GDPs of all countries exporting a particular product is used to measure the sector's productivity level and defined as PRODY. The sophistication of China's export (or import) is then measured by trade-weighted PRODY.

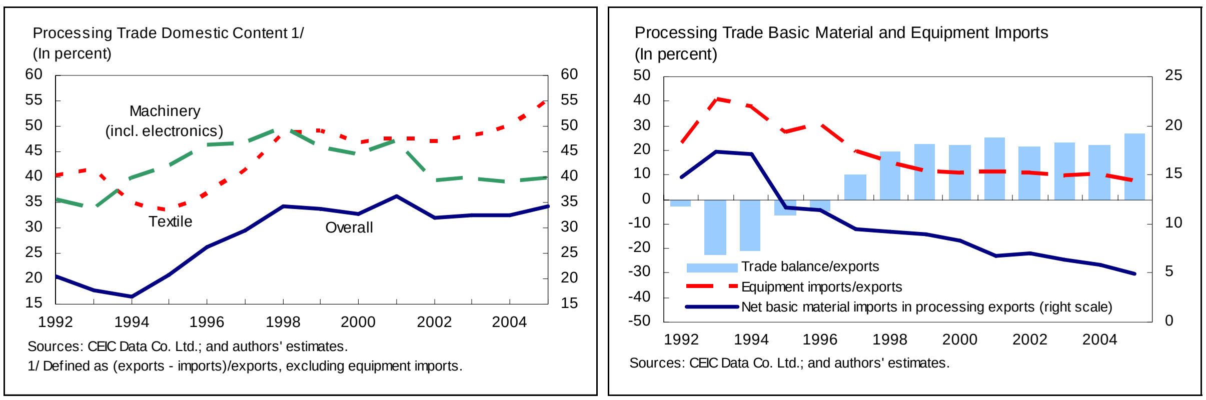
As Figure 7 shows, while processing trade as classified under China's customs data has remained around 50 percent of total exports, the share of assembly exports has declined to less than 10 percent by 2006, about half its share in 1992. The domestic content of the nonassembly processing exports (excluding equipment imports) rose from about 20 percent to close to 35 percent during 1992–2005 (Figure 8). The trend was driven by a substitution away from both imported sector-specific inputs and more basic raw materials. Sector-specific domestic content, as measured by the ratio of sectoral trade balance to sectoral exports, rose over time in the two main processing exports, machinery and textiles.[3] At the same time, the ratio of net processing imports of basic materials—which cannot be allocated to sectors that use them—to total processing exports plummeted from a high of 25 percent to 5 percent by 2005. Besides noninvestment inputs, imported equipment was also increasingly replaced by domestic products: the ratio of machinery imports to total exports of processing trade tumbled from a peak of 40 percent in the early 1990s to 7 percent by 2005.

Figure 7. China: Evolution of Processing Trade
(In percent)



Sources: CEIC Data Co. Ltd.; and authors' estimates.
1/ (exports-imports)/exports, excluding machinery from imports.

Figure 8. China: Rising Domestic Input in Processing Exports



At the same time, Chinese exporters have branched into new and more sophisticated products with growing domestic sourcing of inputs.

The rising domestic content of processing exports is also likely to have sensitized producers to exchange rate changes. When the domestic content of processing exports is low, an exchange rate appreciation has a limited impact on processing exports because of a large

[3] Domestic content for machinery and textile is underestimated because the declining imported basic material that is used in the processing production is not taken into account, owing to a lack of end-use data. In addition, because imports of electronics parts and components are often used in machinery production, it is not possible to calculate the domestic content of machinery and electronics separately without additional end-use data.

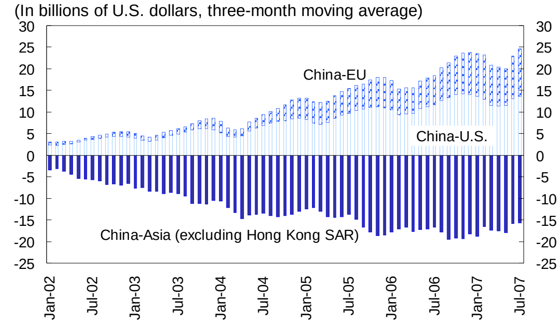
offsetting impact from imported inputs. This offsetting impact weakens as the import content declines. Furthermore, the share of machinery in total processing exports more than doubled, which was likely to have raised the sensitivity of processing exports to prices and the external demand because capital goods demand is more sensitive to market conditions than basic consumer products, such as textiles (Table 1).

Table 1. China: Sectoral Composition of Processing Exports

	1992	1995	2000	2005
Basic material	18.5	23.2	17.3	13.0
Textiles	38.5	29.0	20.1	9.1
Machinery	30.1	37.1	52.7	71.0
Others manufacturing	12.9	10.7	10.0	6.9

This shift from assembly based processing trade is also reflected in China's changing regional trade balances. Until recently, China's trade surplus with the West (the main export destination) was nearly mirrored by the trade deficit with Asia (the source of the intermediate inputs), reinforcing the assembly-line caricature of China's trade. This has also changed. China still imports a lot from Asia, but the growth of trade deficit with Asia has fallen far behind the surplus with the West (Figure 9).

Figure 9. China: Regional Trade Balance
(In billions of U.S. dollars, three-month moving average)



Sources: CEIC Data Co. Ltd.; and authors' estimates.

With the changes in the trade structure, China has also become a dominant player in many markets. And size matters in trade. While it was relatively easy to expand market share before, as a major player in world markets further expansion will likely require Chinese firms to cut prices. If the price cuts needed to sell the created capacity turn out to be deep, many of today's investments could become unviable and turn into loan defaults of tomorrow.

III. Empirical Analysis of China's Trade Elasticities

A. Model Specification and Data

The standard reduced-form partial-equilibrium trade model is used as the basic analytical framework, relating the volume of exports (imports) to real foreign (domestic) demand and relative prices. The export equation is modified to take into account the effect of fast productivity improvement in China unleashed by structural reforms. This rapid productivity improvement relative to the trading partners has been a main driving force behind the rapid rise of China's export share in the world, as noted in Section II, and is not fully reflected in the real exchange rate movement. This breakdown of the Balassa-Samuelson effect reflects China's large excess labor (estimated at around 100−150 million in underemployed agricultural workers) that has held back more generalized pressure on wage generated by productivity improvement.[4] Therefore, productivity gains or the catching up effect should be included as an explanatory variable of China's exports. All variables are in natural logs. The basic equations are specified as follows:

$$X = \alpha + \beta D^{*} + \lambda P^{x} + \varphi Prod$$
$$M = \alpha + \beta D + \lambda P^{m}$$

Where X and M are China's total export and import volumes;[5] D^{*} is the real demand of China's advanced country trading partners from IMF's Global Economic Environment Indicator, and D is China's real domestic demand, approximated by industrial sales deflated by the producer price index; P^{x} and P^{m} are domestic prices to relative external prices for exports and imports, respectively. Since over 60 percent of China's exports are final goods, consumer price index (CPI) is more relevant than the producer price index (PPI) for exporters when deciding whether to export or to sell domestically. Therefore, CPI based real effective exchange rate is used as the relative price in the export equation.[6] In contrast, about 80 percent of China's imports are nonfinal goods; therefore, the relevant domestic price should be PPI.[7] The relative import prices are aggregated from trade weighted ratios of China's producer price indices to external price indices at the SITC2 level.[8] Relative

[4] Balassa-Samuelson effect predicts that a country experiencing productivity gains relative to its trading partners tends to have an appreciating real exchange rate. This effect is predicated on a full employment and a higher productivity growth in the traded than the nontraded goods sector. Under such conditions, a relative productivity gain translates into an economy-wide wage increase that drives up relative nontraded goods' price, hence, the average price and the real exchange rate.

[5] Export and import deflators are approximated by U.S. import price indices at the SITC2 level weighted by China's exports and imports, respectively.

[6] This is confirmed by an empirical test. When the PPI based relative price is used, the sign of its coefficient in the export equation changes over subsample periods. This indicate that PPI based index does not capture the relative prices faced by exporters.

[7] When using REER as the relative price in the import equation, the sign of its coefficient changes over subsamples, indicating that REER is not a good proxy for relative price of imports.

[8] Relative price for imports is China's import weighted ratios of China's PPI to import prices of the United States at the SITC2 level. Similar price indices for exports are complied using China's exports as weights. Import price indices for United States are used as a proxy for prevailing international prices when compiling PPI based relative price for both exports and imports. This is based on the assumption that U.S. exports are

(continued…)

productivity, Prod, is measured by the ratio of per capita GDP in China to that in the United States.[9] Quarterly data from 1995Q1−2006Q4 are used. Data prior to 1994 were excluded, as the unification of exchange rate system in 1994 was likely to have introduced a structural break.

Dynamic OLS (DOLS) proposed by Saikkonen (1991) and Stock and Watson (1993) is used to estimate the export and import equations. This procedure is chosen because the Dickey-Fuller test shows that almost all the series are nonstationary, and cointegration tests show that variables in both the export and import equations are cointegrated (Appendix I). DOLS is also chosen because of its small sample property. Monte Carlo experiments show that with finite sample, DOLS performs well relative to other six asymptotically efficient estimators, including Johansen's (1988a) vector error correction (VECM) maximum likelihood estimator (Stock and Watson, 1993). DOLS adds leads and lags of the first differences of the independent variables to the basic equations. Seasonal dummies are also included to take into account seasonality. Because data series are short, one lead and one lag are chosen. In addition, the general to specific model developed by Hendry and Krolzig (2005) was used to eliminate insignificant leads and lags, as well as seasonal dummies.

B. Empirical Results Using Aggregate Data

Trade elasticities for the aggregate exports and imports using the full sample are presented in Table 2. It shows that export elasticity to foreign demand is 3.8, and to relative price is −1.6, while import elasticity to domestic demand is 1.3 percent and to relative price is 0.9. These

Table 2. Aggregate Trade Elasticity 1/

	Dependent Variable Total Exports			Dependent Variable Total Imports	
Variables	Coefficient	Standard deviation 2/	Variables	Coefficient	Standard deviation 2/
D^*	3.77	0.29 ***	D	1.32	0.04 ***
P^x	-1.55	0.27 ***	P^m	0.92	0.20 ***
Prod	1.30	0.09 ***			
			C	-3.60	1.01 ***
$\Delta D^*(-1)$	-7.12	2.21 ***	$\Delta P^m(-1)$	-1.53	0.60 ***
Dummy for Q1	-0.17	0.02 ***			
R-squared	0.99		R-squared	0.98	
Adj. R-squared	0.99		Adj. R-squared	0.98	

1/ *significant at 10 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1)
2/ Based on Newey-West HAC standard errors.

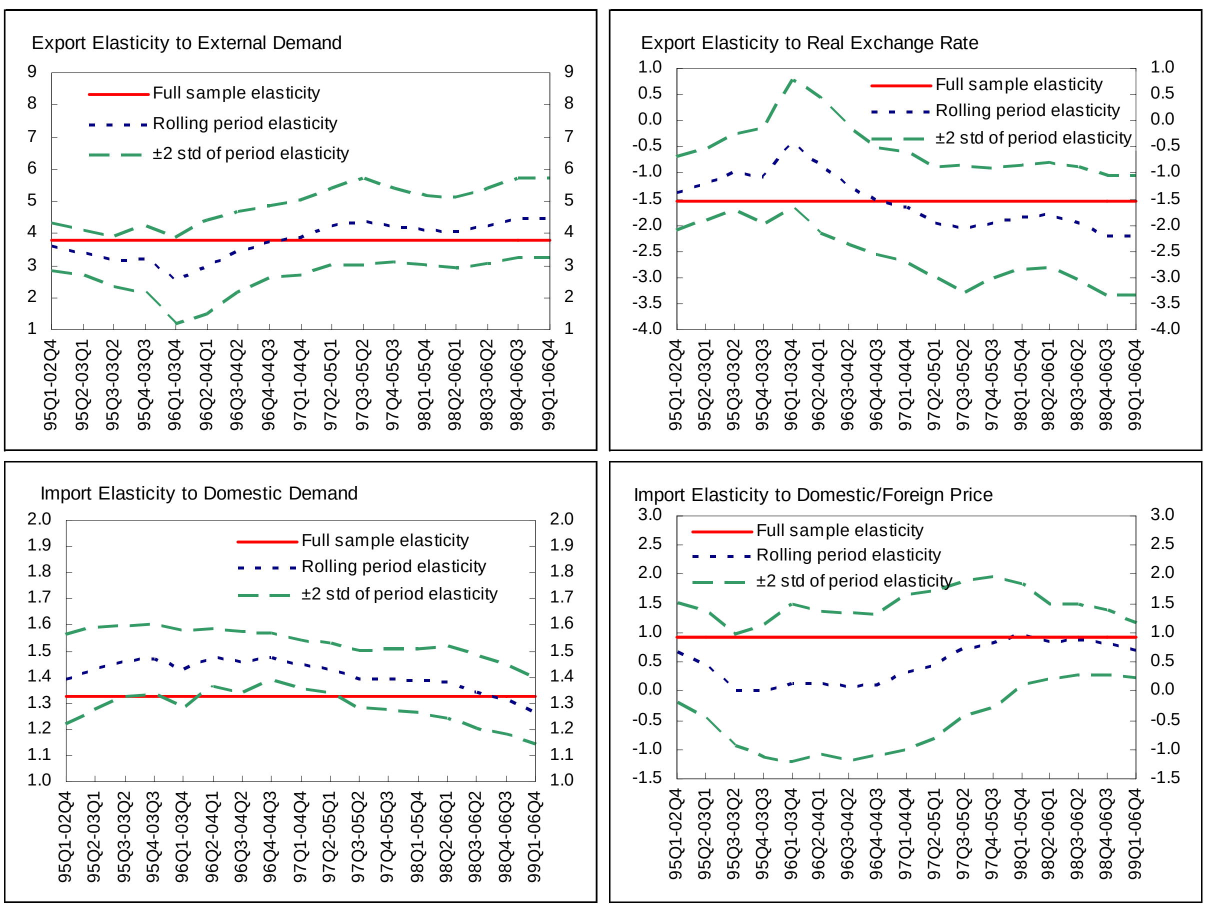
likely to have higher technology content than both China's exports and imports, while U.S. imports are likely to have similar technology content with both China's exports and imports.

[9] There are no reliable employment data in China for compiling the labor productivity index.

estimates are within the range of other studies (Goldstein and Khan, 1985; Mann and Plück, 2005; Cheung, Chinn, and Fuji, 2007) and satisfy the Marshall-Lerner condition. In particular, these estimates are very close to estimates by Shu and Yip (2006). Using panel data of China's exports to the United States, the European Union, and Japan between 1995Q1 and 2006Q1, the authors find China's export demand and price elasticities are 4.27 and −1.32, respectively. A study by Liu, Fan, and Sheck (2006) find slightly higher elasticities (in absolute terms). Using bilateral trade between China and Hong Kong, the authors show that China's export demand and price elasticities are 4.33 and −3.26, while import elasticities for demand and price are 0.89 and 2.29, respectively. Since Hong Kong is an important entrepôt for Mainland China, bilateral trade estimates between Hong Kong and China do have an important bearing on China's overall external trade. Incidentally, both estimates in this paper and the bilateral trade elasticity estimates by Liu, Fan and Sheck show that export elasticities (in absolute terms) are larger than import elasticities.

To examine their stability, the trade equations are re-estimated for six rolling subsamples of eight years each. The first subsample spans 1995Q1−2002Q4; the subsequent sample period rolls ahead by one quarter, dropping one at the end; and the last sample covers 1999Q1−2006Q4. The estimated coefficients are plotted in Figure 10.

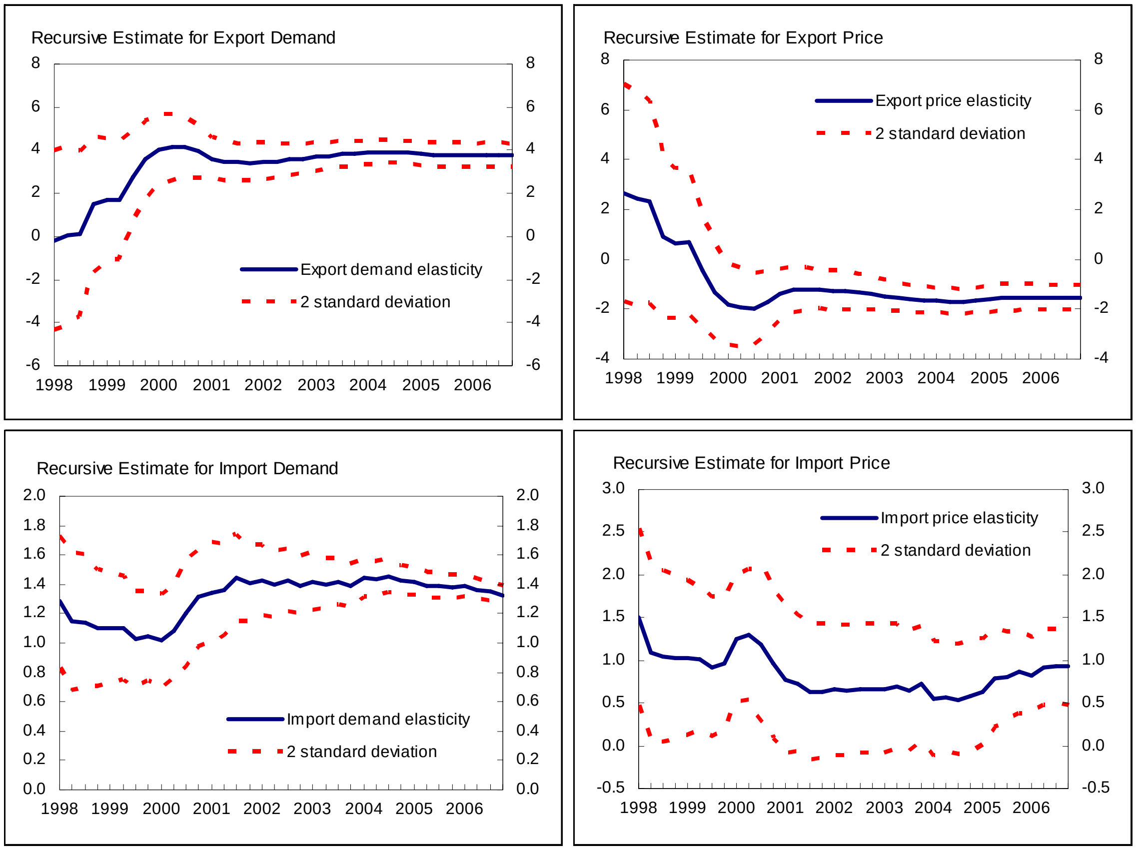
Figure 10. Aggregate Trade Elasticity



The results from the rolling period regressions show that China's export elasticities have changed significantly over time. In absolute value, the external demand and relative price (real exchange rate) elasticities increased. The point estimates from the latest sample for both demand and price elasticities lie outside the confidence bands estimated using earlier samples. This trend of increasing export elasticities is consistent with the rising share of products with high elasticities, as well as increased responsiveness of exporters to market signals. Import elasticities show less variability, consistent with smaller changes in the import composition;[10] the slight decline in import demand elasticity is consistent with increased domestic sourcing of inputs.

The export and import equations were also estimated recursively, with the results presented in Figure 11. The recursive estimates broadly confirm the results from the rolling period regressions. Exports have become more sensitive to both external demand and relative prices.

Figure 11. Recursive Estimates



[10] Before China opened up, imports were dominated by resource and capital goods because trade restrictions were targeted at consumer goods. China has since built up its manufacturing capacity of consumer goods, and many foreign brands of consumer goods are being produced in China. Consequently, imports are still dominated by resource and capital goods.

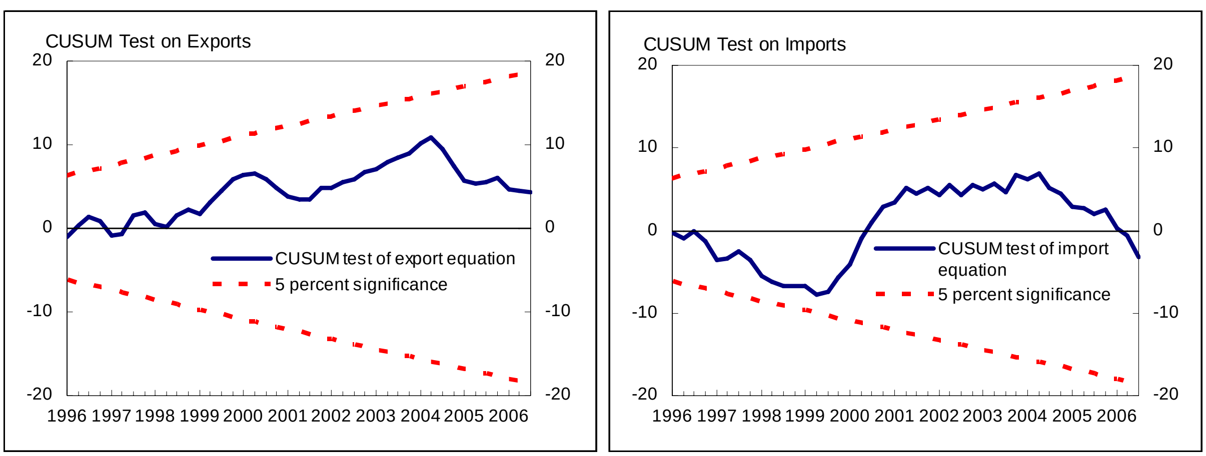
Import elasticities are less variable. In addition, elasticities for exports and imports appear to have changed significantly around 1999−2000. Chow tests show that 1999Q4 is a breakpoint for both export and import equations (Table 3). Both F-test and log likelihood test are

Table 3. Chow Test of Breakpoint at 1999/Q4

Export Equation				Import Equation			
F-statistic	2.3	Prob. F(5,38)	0.1	F-statistic	2.3	Prob. F(4,40)	0.0
Log likelihood ratio	12.5	Prob. Chi-Square(5)	0.0	Log likelihood ratio	12.5	Prob. Chi-Square(4)	0.0

significant. Two other tests are also performed. The Bai-Perron (2003) test confirms the breakpoint in the import equation at 1999Q4, but fails to detect any breaks in the export equation.[11] CUSUM tests proposed by Brown, Durbin, and Evans (1975) do not detect breaks in either of the two equations (Figure 12). The failure of these tests to detect breaks is likely due to the absence of a large abrupt one-time shift in the data. Both the rolling sample and recursive results demonstrate that trade elasticities varied widely during the early sample periods and continued to shift in the later periods. This is consistent with continuous and frontloaded trade policy changes during the sample period (Figure 4). In preparation for the WTO entry, import tariffs were reduced sharply in the 1990s, and further trade reform was phased in afterwards. Estimates of trade elasticities for the periods of 1995Q1−99Q4 and 2000Q1−2006Q4 are presented in Appendix II.

Figure 12. CUSUM Test



[11] The authors provide a gauss program for the test. Because the series are short, in both export and import equations the maximum possible breakpoints are specified as 2, even though the program allows up to 4 breaks.

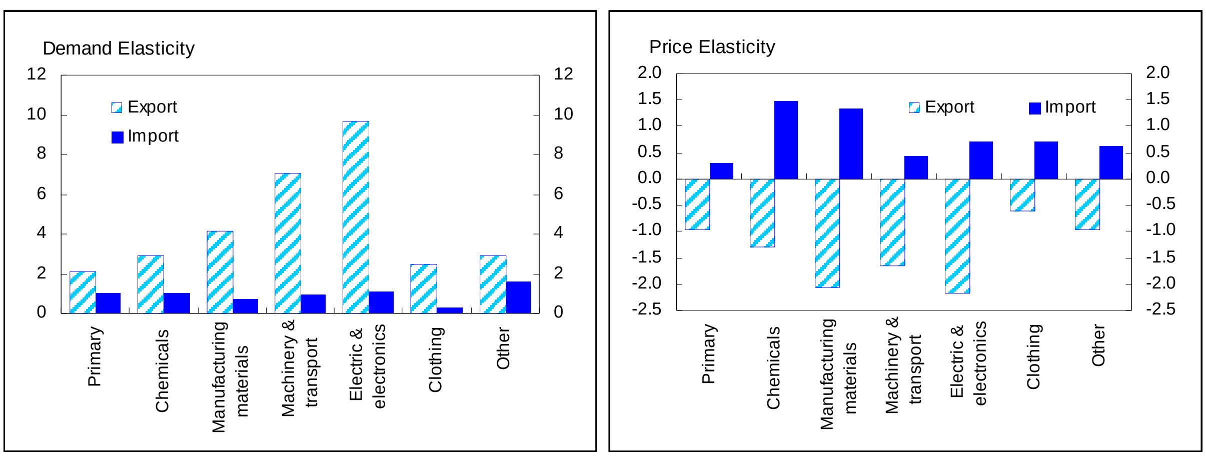
C. Sources of Changes

Three sets of tests are conducted to examine the factors behind the changes in the trade elasticities. The results confirm the initial conjectures. First, estimates of trade elasticities at sectoral levels demonstrate that both changes in the composition of trade and variations of sector specific elasticities over time affected the stability of trade elasticities at the aggregate level. Second, rising domestic content in processing trade also raised the price elasticity of exports. Lastly, export elasticities rose in absolute terms as products became more sophisticated.

Sectoral Composition and Sectoral Elasticity Shifts

Sectoral elasticities are estimated for seven product groups, and the detailed results are reported in Appendix II.[12] Figure 13 shows that sectoral trade elasticities vary widely. Variations in export elasticities are more pronounced than those for import elasticities. In particular, export demand elasticities are highest for capital goods such as machinery (7.0) and electric and electronics machinery (9.7), and lowest for primary goods (2.1). Export price elasticities have the similar sectoral distribution, with electric and electronics machinery (−2.2), manufacturing by material (−2.1), and machinery (−1.6) the most elastic. Variations in import demand elasticities are small. Among import price elasticities, chemicals (1.5) and manufacturing by material (1.4) have the highest elasticities.

Figure 13. Sectoral Trade Elasticities

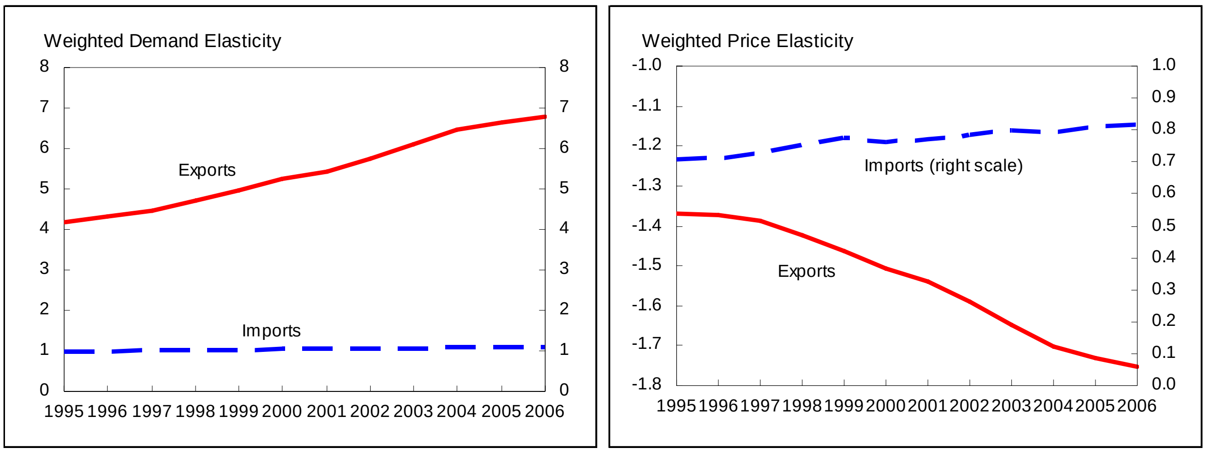


[12] The explosive growth of electric machinery and electronics exports in China has been driven more by the regional production location shift in East Asia (China, Korea, Japan, and Taiwan) than overall relative productivity growth in China. As a result, China's share in the region's electronics exports increased from about 18 percent in 1994 to close 60 percent by 2006. Therefore, in the export equation of this sector the productivity proxy is replaced by a regional location shift indicator. This indicator is approximated by per capita electronics output in China relative to that in Japan. Because imports of electric machinery and electronics are closely linked to exports, the export volume of the sector is included in the import equation as an explanatory variable.

To see how sectoral compositions affect the aggregate elasticities, trade weighted average sectoral elasticities based on the full sample period are plotted in Figure 14. The sectoral elasticities are fixed at the full sample estimates; the movement of weighted averages of trade elasticity thus reflects only the impact of changes in sector composition and differences in trade elasticities across sectors.

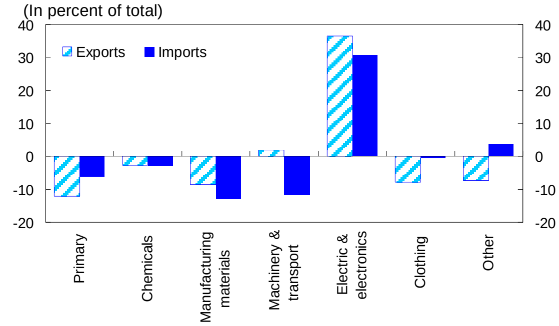
Figure 14 shows that the weighted average of elasticities mirror the patterns of aggregated trade elasticities. Weighted elasticities for export increased, while those for import are broadly unchanged. A substantial increase in the share of electronics and electric machinery

Figure 14. Weighted Trade Elasticities



in exports (Figure 15), which has the highest export demand and price elasticities, has been driving the rising weighted averages of trade elasticity. In contrast, changes in the composition of imports have less of an impact on the weighted average elasticities of imports because of the relative small variations in elasticities across sectors.

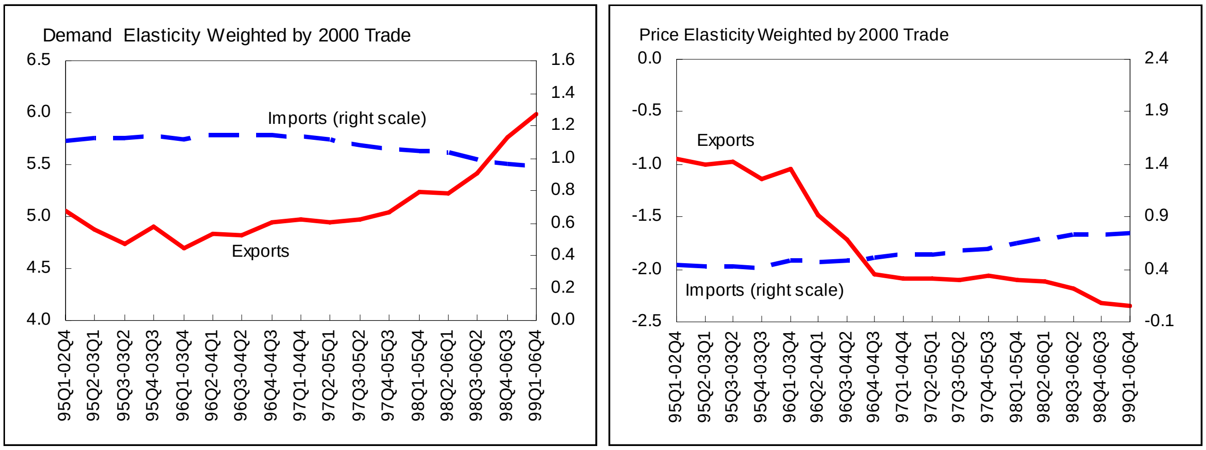
Figure 15. Change in Trade Shares, 1995–2006
(In percent of total)



Sources: CEIC Data Co., Ltd.; and authors' estimates.

To check whether the changes in the elasticities were caused by underlying instability in the elasticities, rolling regressions were estimated using the sectoral data. The evolution of elasticities at the sectoral level are summarized in Figure 16, where the 2000 trade data is used to weight the estimates of elasticities from each rolling sample period. The movement of the weighted average export elasticities mirrors those estimated from the aggregate exports, demonstrating that variations of export elasticities at the individual sector level also contributed to the increase in elasticities observed in the aggregate data. In particular, changes in the price elasticities of electric machinery and electronics exports and clothing exports are the largest (Appendix II). The fact that these two sectors are the most important ones in processing trade, where domestic content has increased substantially, suggests that rising domestic content in processing exports is an important factor for the rising export price elasticities in absolute terms. As with the elasticities estimated with aggregated data, weighted import elasticities are broadly stable.

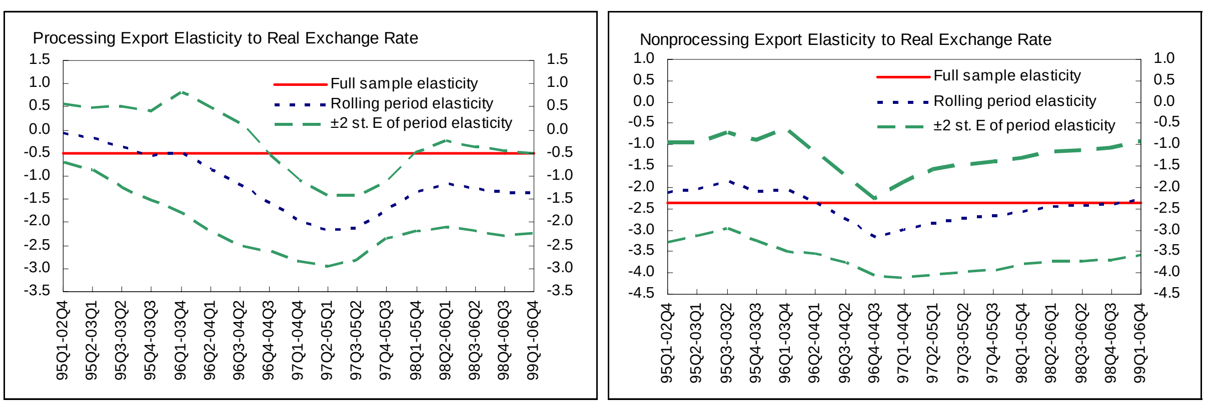
Figure 16. Average Rolling Sectoral Elasticities Weighted by 2000 Trade



Elasticities of Processing and Nonprocessing Exports

Processing and nonprocessing export elasticities are estimated separately, using the same rolling periods as for total trade. Figure 17 shows that the relative price elasticity of processing exports increased, while that of nonprocessing exports stayed broadly unchanged. This is consistent with the hypothesis that rising domestic content of processing trade is a main factor that drives the evolution of the export elasticities.

Figure 17. Export Elasticity to Real Exchange Rate by Processing and Nonprocessing Trade



The impact of rising domestic content in processing trade and a shifting away from assembly processing exports is tested formally using the following model:

$$X^p = \alpha + \beta D^* + \lambda P^x + \varphi Prod + \beta' P^{x*} \times DC$$

$$X = \alpha + \beta D^* + \lambda P^x + \varphi Prod + \beta' D^* \times AS + \lambda' P^x \times AS$$

Where X^p denotes processing exports, DC is domestic content of processing trade,[13] and AS is the share of assembly in total exports.[14] The interaction terms of DC and AS are of interest in these two tests.

Table 4 shows the coefficient of the product of DC and the relative price, P^x, is significant, and points to an increase in the price elasticity of processing trade as the domestic content increases. In contrast, Table 5 shows that the share of assembly exports has no effect on either the demand or the price elasticity of exports as the coefficients for both interaction terms are insignificant.[15]

Table 4. Impact of Domestic Content 1/
Sample: 2001/Q1–2006/Q4

(Dependent variable is total export,X)

Variable	Coef-ficient	Standard Deviation 2/	Proba-bility
D^*	3.86	0.48	***
P^x	-1.29	0.54	***
Prod	1.15	0.21	***
$P^x \times$ DC	-0.09	0.04	**
Dummy for Q1	-0.16	0.03	***
R-squared	0.99		
Adj. R-squared	0.98		

1/ * significant at 1 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1) first lag.
2/ Based on Newey-West HAC standard errors.

Table 5. Impact of Assembly Trade 1/
Sample: 1995/Q1–2006/Q4

(Dependent variable is processing export, X^p)

Variable	Coef-ficient	Standard Deviation 2/	Proba-bility
D^*	3.70	0.27	***
P^x	-1.48	0.26	***
Prod	1.31	0.08	***
$D^* \times$ AS	0.04	0.14	
$P^x \times$ AS	-0.04	0.14	
$\Delta D^*(-1)$	-6.94	2.23	**
Dummy for Q1	-0.17	0.02	***
R-squared	0.99		
Adj. R-squared	0.99		

1/ * significant at 1 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1) first lag.
2/ Based on Newey-West HAC standard errors.

Product Sophistication and Trade Elasticity

To test the effect of product sophistication on the elasticities of trade, the following equations are estimated using DOLS:

[13] Defined as the trade balance of processing trade (excluding machinery imports) in percent of processing exports and transformed into natural log.

[14] Deviations from the historical average share of assembly exports in total exports.

[15] The result is robust to switching to the subsample of 2001Q1−2006Q4, when trade policy changes were less pronounced.

$$X = \alpha + \beta D^* + \lambda P^x + \varphi Prod + \beta' D^* \times S^x + \lambda' P^x \times S^x$$
$$M = \alpha + \beta D + \lambda P^m + \beta' D \times S^m + \lambda' P^m \times S^m$$

Where S^x and S^m are the sophistication indices of exports and imports,[16] respectively.

Table 6 shows that the export sophistication index is highly significant for export elasticities. As product sophistication increases, exports become more sensitive to both external demand and relative price. In contrast, the import sophistication index affects demand elasticities, but not price elasticities.

Table 6. Trade Sophistication Indices and Elasticities 1/

	Dependent Variable Total Exports			Dependent Variable Total imports	
Variables	Coefficient	Standard Deviation 2/	Variables	Coefficient	Standard Deviation 2/
D^*	6.21	1.54 ***	D	1.19	0.04 ***
P^x	-2.01	0.40 **	P^m	0.35	0.07 ***
Prod	-0.01	0.41	$D \times S^m$	6.58	3.91 *
$D^* \times S^x$	16.27	7.01 **	$P^m \times S^m$	-10.00	6.46
$P^x \times S^x$	-15.71	6.97 **			
$\Delta D^*(-1)$	-9.83	3.89 **			
C	-8.02	5.44			
Dummy for Q1	-0.22	0.03 **			
Dummy for Q2	-0.07	0.02 **			
R-squared	0.99		R-squared	0.98	
Adj. R-squared	0.99		Adj. R-squared	0.98	

1/ * significant at 1 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1) first lag.

2/ Based on Newey-West HAC standard errors.

IV. CONCLUSION

Trade elasticities have been widely used to analyze how exports and imports respond to changes in external and domestic demand, as well as to relative prices and the exchange rate. These analyses, however, require that the estimated elasticities are at least stable. The discussions in the previous sections show that such empirical backing is hard to find for China.

Evidence presented here suggests that extra cautious is needed when using trade elasticities to estimate the response of the Chinese economy to price and demand shocks. Trade elasticities used in existing studies on such subjects vary widely. Such variation reflects not only data and methodological issues involved in estimating elasticities for all countries,

[16] For both series, deviations from their means are used.

including developed countries, but also a continuous structural shift in how production is organized in China. China is shifting way from stereotypical processing trade that involves mostly assembling imported parts and components to domestically sourcing larger portions of the production chain. This paper shows that export elasticities for China during 1995−2006 have changed significantly at both the aggregate and sectoral level. Changes in the composition of trade, the increasing domestic content of processing exports, and the move up the quality ladder are all likely causes.

Taken at face value, the increased demand elasticity in recent years implies greater dependence of the Chinese economy on external conditions. A one percent decline in external demand could lead to about 4½ percent contraction in China's export or about ¾ percent decline in GDP. Meanwhile, the large shift in the export price elasticity, from −1.3 during 1995−1999 to −2.0 during 2000−2006, suggests that for a 10 percent reduction in exports, the required real appreciation would be about one-third less than previous estimates. But the much larger demand elasticity suggests that demand changes have a much larger effect than price changes: for example, a 10 percent real appreciation would, ceterus paribus, reduce exports by 2 percent that would not show up in aggregate trade numbers if at the same time external demand grew by just 0.5 percent! However, the fast changing structure of China's trade also raises questions about how much one can rely on these later estimates, especially the interaction between exchange rate and trade composition changes. Quantitative assessments that do not take into account these factors and remain overly influenced by China's trade structure of the 1980s and 1990s could turn out to be wrong.

APPENDIX I: UNIT ROOT AND CONINTEGRATION TESTS

Augmented Dikey−Fuller tests show that all the variables, with the exception of relative import price index, used in the aggregated export and import equations are nonstationary.

Table I.1. Augmented Dickey-Fuller Test Statistic of Original Variables

		t-Statistic	Probability			t-Statistic	Probability
Aggregate exports	X	2.79	1.00	Aggregate imports	M	0.06	0.96
External demand	D*	-1.13	0.70	Domestic demand	D	2.18	1.00
Real exchange rate	P^x	-1.41	0.57	Relative import price	P^m	-3.20	0.03
Relative productivity	Prod	0.41	0.98				
Export quality index	Xqu	-0.52	0.88	Import quality index	Mqu	-1.16	0.68

Contintegration tests show that variables used in both export and import equations are cointegrated. The varibles for the export equation may have upto two conintegration vectors, while the import equation only has one.

Table I.2. Unrestricted Cointegration Rank Test (Trace) 1/

Variables: X, D*, P^x, Prod					Variables: M, D, P^m,				
Number of CE(s)	Eigen value	Trace statistic	Critical value	Proba-bility**	Number of CE(s)	Eigen value	Trace statistic	Critical value	Proba-bility**
None *	0.69	85.38	47.86	0.00	None *	0.32	31.01	29.80	0.04
At most 1 *	0.35	30.54	29.80	0.04	At most 1	0.17	12.56	15.49	0.13
At most 2	0.18	10.13	15.49	0.27	At most 2	0.07	3.53	3.84	0.06
At most 3	0.02	0.85	3.84	0.36					
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level					Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				

1/ * Denotes rejection of the hypothesis at the 0.05 level; and **MacKinnon-Haug-Michelis (1999) p-values.

Augmented Dickey−Fuller tests shows that residulas of the export and import equations are stationary, confirming that long−run relationships exist as hypothesized in the export and import equations.

Table I.3. Augmented Dickey-Fuller Test Statistic of Residuals

	t-Statistic	Probability
Export equation residuals	-4.2	0.0
Import equation residuals	-2.7	0.1

APPENDIX II: ELASTICITIES IN SUB-SAMPLES AND AT THE SECTORAL LEVEL

Elasticities for two sub-sample periods, based on the Chow breaking point test, are presented below. Note that export elasticity estimated for the first period, 1995Q1−1999Q4 is not significant, possibly a result of major trade policy reform during that period.

Table II.1. Sub-Period Elasticity Estimates 1/

	Dependent Variable: X					Dependent Variable: M			
	1995/Q1–1999/Q4		2000/Q1–2006/Q4			1995/Q1–1999/Q4		2001/Q1–2006/Q4	
Variable	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Variable	Coef-ficient	Standard error 2/	Coef-fecient	Standard error 2/
D*	3.56	0.89 ***	4.26	0.45 ***	D	1.10	0.13 ***	1.17	0.05 ***
P^x	-1.31	0.93	-2.00	0.41 ***	P^m	1.03	0.59 **	0.41	0.18 **
Prod	1.08	0.57 *	1.08	0.17 ***	C	-2.59	2.87	0.00	1.10
$\Delta D^*(-1)$	-10.44	4.00 ***	-3.81	2.67	$\Delta P^m(-1)$	0.65	1.26	-1.04	0.45 **
Dummy for Q1	-0.20	0.05 ***	-0.15	0.03 ***					
R-squared	0.85		0.99		R-squared	0.80		0.97	
Adj. R-squared	0.80		0.99		Adj. R-squared	0.75		0.96	

1/ * significant at 10 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1) first lag.
2/ Based on Newey-West HAC standard errors.

Table II.2. Export Elasticities by Sector Using Full Sample 1/

	Primary		Chemical		Manufactures by Material		Machinery		Electric-Electronics 3/		Clothing		Other Manufactures	
	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/
D*	2.09	0.16 ***	2.94	0.21 ***	4.14	0.94 ***	7.03	0.87 ***	9.71	0.95 ***	2.47	0.51 ***	2.90	0.43 ***
P^x	-0.96	0.23 ***	-1.28	0.20 ***	-2.06	0.38 ***	-1.64	0.33 ***	-2.17	0.38 ***	-0.61	0.48	-0.97	0.40 ***
Prod					0.73	0.28 ***	0.67	0.26 ***	0.26	0.07 ***	0.86	0.16 ***	1.08	0.17 ***
C	3.81	0.75 ***	0.98	0.07 ***	-0.51	3.15	-16.51	2.78 ***	-25.34	2.97 ***				
$\Delta D^*(-1)$	-7.41	3.14 **	-7.00	1.34 ***	-7.38	2.61 ***	-9.84	2.78 ***	-11.91	3.76 ***			-4.64	2.41 *
$\Delta P^x(1)$									-1.34	0.46 ***				
ΔProd(-1)													-1.07	0.54 *
Dummy for Q1	-0.27	0.03 ***	-0.12	0.03 ***	-0.17	0.03 ***	-0.13	0.03 ***			-0.24	0.04	-0.20	0.02 ***
Dummy for Q2	-0.13	0.03 ***									-0.10	0.04	-0.08	0.02 ***
Dummy for Q3	-0.16	0.02 ***									0.15	0.03		
R-squared	0.89		0.98		0.98		0.98		0.99		0.96		0.98	
Adj. R-squared	0.87		0.98		0.98		0.98		0.99		0.96		0.98	

1/ * significant at 10 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1) first lag, (1) first lead.
2/ Based on Newey-West HAC standard errors.
3/ Per capita electronics output in China relative to that in Japan is used as Prod as discussed in section III. Full sample seasonality is imposed for exports in this sector by seasonally adjust the data using dummy variables to accommodate the issue of a small sample (especially in sub-sample regressions) and a large number of independent variables.

Subsample estimates of export elasticites are ploted below. For brevity, import elasticities are not reported because they are relatively stable.

Table II.3. Import Elasticities by Sector Using Full Sample 1/

	Primary		Chemical		Manufactures by Material		Machinery		Electric-Electronics 2/		Clothing		Other Manufactures	
	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/	Coef-ficient	Standard error 2/
D	1.01	0.03 ***	1.05	0.03 ***	0.72	0.04 ***	0.93	0.06 ***	1.13	0.04 ***	0.32	0.02 ***	1.63	0.07 ***
P^m 3/	0.30	0.05 ***	1.49	0.15 ***	1.35	0.24 ***	0.44	0.10 ***	-0.63	0.09 ***	0.70	0.04 ***	0.99	0.32 ***
Xelec 4/									0.72	0.10 ***				***
C			-6.08	0.84 ***	-2.62	1.21 **							-9.01	1.93 ***
ΔP^m (-1)	-0.59	0.24 ***	-1.64	0.39 ***	-0.72	0.25 ***			-1.44	0.44 ***			-2.18	0.79 ***
Dummy for Q1			0.09	0.02 ***							-0.25	0.02 ***		
Dummy for Q2					0.10	0.03 ***							-0.09	0.03 ***
Dummy for Q3			0.07	0.03 ***	0.09	0.03 ***					0.16	0.03 ***		
R-squared	0.93		0.98		0.93		0.89		0.99		0.93		0.97	
Adj. R-squared	0.92		0.98		0.92		0.88		0.99		0.92		0.97	

1/ *significant at 10 percent, **significant at 5 percent, and ***significant at 1 percent. Δ, first difference. (-1) first lag.
2/ Based on Newey-West HAC standard errors.
3/ The price indice used are sector specific; they are import weighted ratio of China's sector PPI to U.S. import price indices at SITC2.
4/ Export volume of electric machinery and electronics, included in this sector's import equation to reflect the large share of processing exports.

Figure II.1. Sectoral Export Elasticities by Rolling Sample Periods

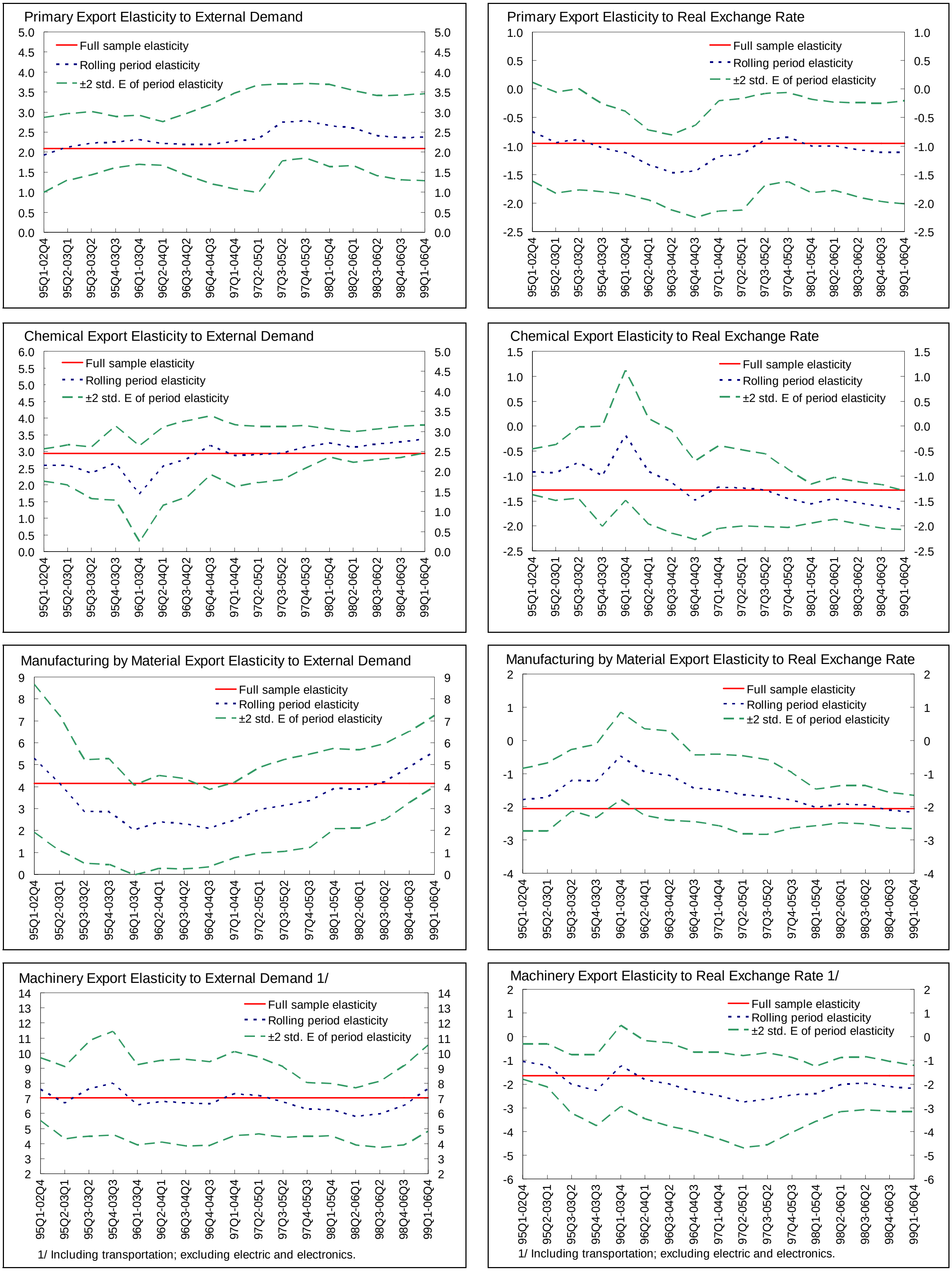
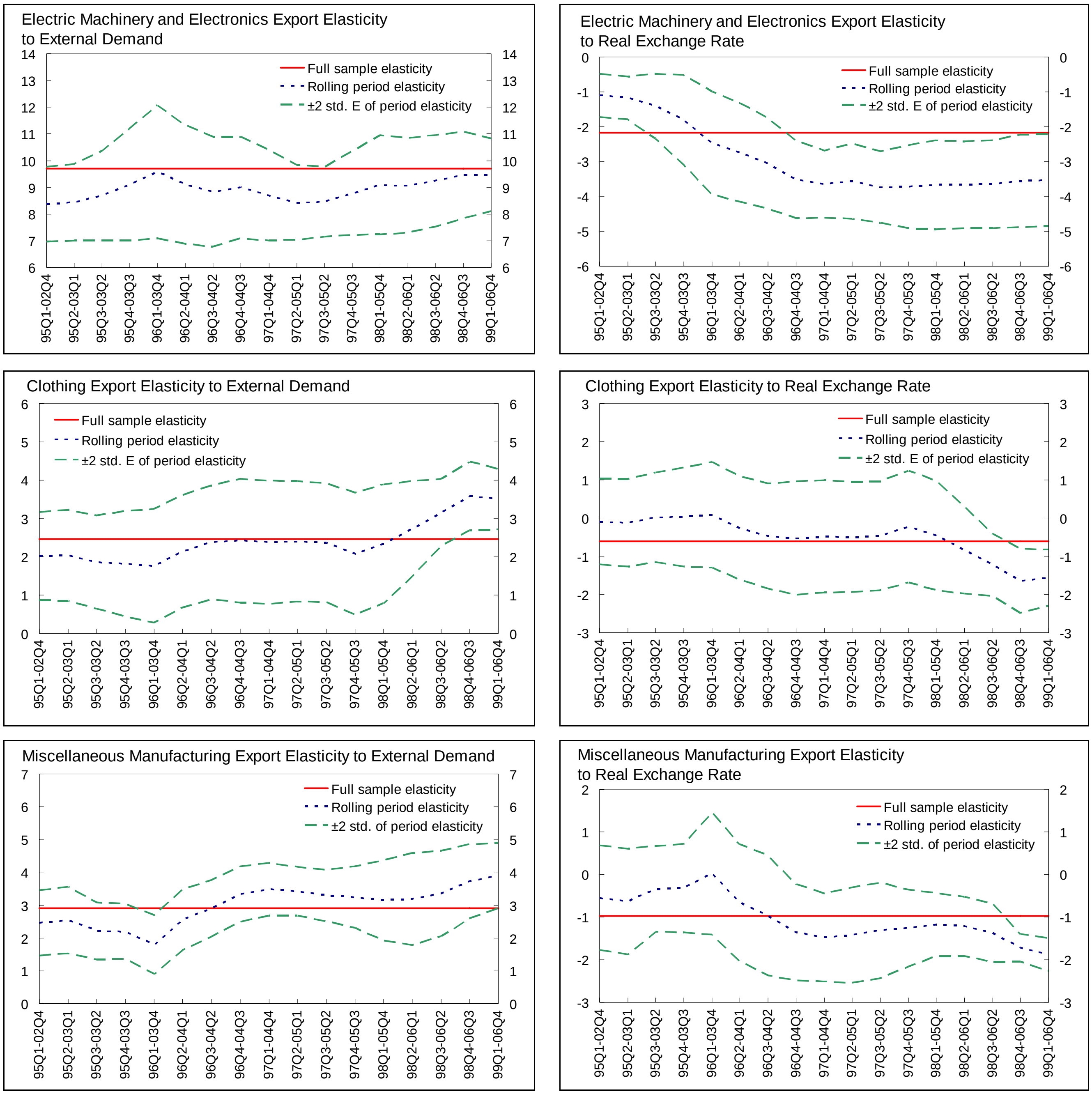


Figure II.1. Sectoral Export Elasticities by Rolling Sample Periods (Concluded)



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