Supply Capacity, Vertical Specialization and Tariff Rates: The Implications for Aggregate U.S. Trade Flow Equations

by

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Abstract

This paper re-examines aggregate and disaggregate import and export demand functions for the United States. This re-examination is warranted because (1) income elasticities are too high to be warranted by standard theories, and (2) remain high even when it is assumed that supply factors are important. These findings suggest that the standard models omit important factors. An empirical investigation indicates that the rising importance of vertical specialization combined with decreasing tariffs rates explains some of results. Accounting for these factors yields more plausible estimates of income elasticities, as well as smaller prediction errors.

Keywords: imports, exports, elasticities

JEL Classification: F12, F41

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1. Introduction

This analysis is inspired by both current events – the widening of the trade deficit as a proportion of GDP, illustrated in Figure 1 – and recent findings of the persistence of the Houthakker-Magee results, namely that the income elasticity of U.S. imports exceeds that of exports. Over the past 30 years, the gap is at least 0.3 for total goods and services, regardless of the method of estimation. In Chinn (2005), the gap is as high as 0.65. Table 1 presents estimates obtained from OLS, dynamic OLS, single equation error correction estimates and the Johansen maximum likelihood procedures. Furthermore, there is little evidence that the asymmetry is disappearing, at least for imports. Breaking the last 30 years into three equal sub-periods, one obtains the income elasticities in Figure 2. In other words, the asymmetry is proving to be quite durable.

Moreover, the absolute values of the income elasticities are quite high. In Table 1, the income elasticities are as high as 2.3 for imports, and 2.0 for exports. These large elasticities are difficult to reconcile with the standard differentiated goods model (see Goldstein and Khan, 1985). From a forecasting standpoint, high income elasticities[1] are not troubling; but – as discussed below – from an economic perspective, they are perplexing.[2] Finally, the behavior of trade flows during 1999-2000 is difficult to explain using standard models. As illustrated in Figure 3, both series surge in this period.

In this paper, I re-investigate the behavior of export and import flows, motivating the analysis by referring to new theories of trade behavior. These include differentiated

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[1] This phenomenon has been noted before (Rose, 1991).

[2] Barrell and Dées (2005) and Camerero and Tamarit (2003) address the issue of very high income elasticities by incorporating FDI. IMF (2007) incorporates exports of intermediates in the import equation, and imports of intermediates in the export equation,

goods models such as those forwarded by Krugman (1991). Such approaches do yield some insights. However, in this paper, I adopt a different approach. Disaggregating the data, one finds that some of the odd behavior of goods exports and imports can be isolated to the peculiar behavior of capital goods; since such goods are often used to manufacture other capital goods or consumer goods, it seems that growth in such categories is “inflating” the volume of such trade flows. Various papers have pointed out that the growth of such trade may be nonlinearly related to the decline in trade barriers and the heightened importance of capital expenditures during certain phases of the business cycle. More recently, Mann and Plück (forthcoming) have argued that disaggregation along category line and trading partner helps in obtaining reasonable parameter estimates.

Once one includes the variables that one thinks should matter for such vertical specialization, the parameter estimates become more plausible. That being said, the parameter estimates for the auxiliary variables are not always in the expected direction or statistically significant, and the results cannot be construed as definitive. In addition, the estimates based upon disaggregated data yield less biased estimates of the long run equilibrium levels of imports.

2. The Standard Model and the Supply Side

2.1 The model specification

The empirical specification is motivated by the traditional, partial equilibrium view of trade flows. Goldstein and Khan (1985) provide a clear exposition of this “imperfect

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to account for vertical specialization. This procedure reduces the estimated income substitutes" model. To set ideas consider the algebraic framework similar to that used by Rose (1991). Demand for imports in the US and the Rest-of-the-World (RoW) is given by:

$$D_{im}^{US} = f_1^{US}(Y^{US}, \hat{P}_{im}^{US}) \qquad (1)$$

$$D_{im}^{RoW} = f_1^{RoW}(Y^{RoW}, \hat{P}_{im}^{RoW}) \qquad (2)$$

where $\hat{P}_{im}$ is the price of imports relative to the economy-wide price level. The supply of exports is given by:

$$S_{ex}^{US} = f_2^{US}(\hat{P}_{ex}^{US}, Z^{US}) \qquad (3)$$

$$S_{ex}^{RoW} = f_2^{RoW}(\hat{P}_{ex}^{RoW}, Z^{RoW}) \qquad (4)$$

Where $\hat{P}_{ex}$ is the price of exports relative to the economy-wide price level. Note that the price of imports into the US is equal to the price of foreign exports adjusted by the real exchange rate.

$$\hat{P}_{im}^{US} \times P^{US} = E \times \hat{P}_{ex}^{RoW} \times P^{RoW} \Rightarrow \hat{P}_{im}^{US} = Q\hat{P}_{ex}^{RoW} \qquad (5)$$

where E is the nominal exchange rate in US$ per unit of foreign currency, the real exchange rate is

$$Q = \frac{EP^{RoW}}{P^{US}}$$

where P represents the *aggregate* level of prices of domestically produced goods and services. Z is a supply shift variable, representing the productive capacity of the exportables sector.

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elasticities.

An analogous equation applies for imports into the rest-of-the-world. Imposing the equilibrium conditions that supply equals demand, one can write out import and export equations (assuming log-linear functional forms, where lowercase letters denote log values of upper case):[3]

$$im_t = \beta_0 + \beta_1 q_t + \beta_2 y_t^{US} + \beta_3 z^{RoW} + \varepsilon_{2t} \qquad (6)$$

$$ex_t = \delta_0 + \delta_1 q_t + \delta_2 y_t^{RoW} + \delta_3 z^{US} + \varepsilon_{1t} \qquad (7)$$

Where $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$ and $\delta_1 > 0$, $\delta_2 > 0$, $\delta_3 > 0$.

Notice that exports are the residual of production over domestic consumption of exportables; similarly imports are the residual of foreign production over foreign consumption of tradables. The difference between this specification and the standard is the inclusion of the exportables supply shift variable, *z*. In standard import and export regressions, this term is omitted, implicitly holding the export supply curve fixed; in other words, it constrains the relationship between domestic consumption of exportables and production of exportables to be constant (see Helkie and Hooper, 1988 for an exception to this rule). A bout of consumption at home that reduces the supply available for exports would induce an apparent structural break in the equation (6) if the *z* term is omitted. Similarly, omission of the rest-of-world export suppy term from the import equation makes the estimated relationships susceptible to structural breaks.

[3] As Marquez (1994) has pointed out, there are a number of problems with this specification, in terms of assumptions regarding expenditure shares. A number of other potentially important factors are also omitted, including other trend factors (e.g, immigration as in Marquez (2002) or the rise of services exports as in Mann (1999)).

Note that the supply term here is explicitly partial equilibrium in nature. Unlike the Krugman (1991) model, where balanced trade implies supply creates its own demand, no specific presumptions are made regarding the source of this supply effect.

The problem, of course, is obtaining good proxies for these supply terms. Obvious candidates, such as US industrial production for US exports, exhibits too much collinearity with rest-of-world GDP to identify the supply effect precisely.[4] That is why this supply factor has typically been identified in panel cross section analyses (Bayoumi, 2003; Gagnon, 2004).

2.2 Data and Estimation

Data on real imports and exports and components of real GDP (2000 chain weighted dollars) were obtained for the 1967q1-2007q1 period (BEA April 27, 2007 release). Domestic economic activity was measured by U.S. GDP in 2000 chain weighted dollars. Foreign economic activity was measured by real Rest-of-World GDP, weighted by U.S. exports to major trading partners. The Federal Reserve Board's broad trade weighted value of the dollar is used. This index uses the CPI as the deflator.[5] (Additional details on all these variables are contained in Appendix 1.)

Estimation is implemented on data spanning a period of 1975q1-2006q4 (I drop the advance estimate for GDP in 2007q1). This period spans three episodes of dollar

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[4] In addition, industrial production is in some sense too "endogenous" a variable to include in the regression. An alternative is to obtain capital stock measures as a measure of the supply capacity of exportables, as in Helkie and Hooper (1988). The question is whether these variables are measured with too much error, especially to the extent that we want to capture the impact of the newly industrializing countries and China.

[5] For an analysis of how different results are obtained using different deflators, see Chinn (2005). In that analysis, I examine the impact of using alternatively CPI, PPI and unit labor cost deflated real exchange rates. I leave aside the question of whether Divisia

appreciation and three episodes of dollar depreciation; the broad measure of dollar is used, as opposed to the major currencies measure, which as has been pointed out in recent reports, is unrepresentative of relative prices faced by the U.S. import competing sector in recent years (see Figure 4).

The cointegrating relationship is identified using dynamic OLS (Stock and Watson, 1993). Two leads and four lags of the right hand side variables are included. In a simple two variable cointegrating relationship, the estimated regression equation is:

$$y_t = \gamma_0 + \gamma_1 x_t + \sum_{i=+2}^{-4} \Gamma_i \Delta x_{t+i} + u_t$$

Although this approach presupposes that there is only one long run relationship, this requirement is not problematic, as in these extended samples at least one cointegrating vector is usually detected. The Johansen cointegrating regressions, conforming to the results in Tables 2-6, are reported in Appendix 2 (Tables A1-A5).

2.3 Empirical Results

First we consider equations (6) and (7) suppressing the *z* terms. The long run elasticities are reported in Table 2. The income elasticity for total exports of goods and services is 1.87 (Column [1]). This finding is not an artifact of the inclusion of services. In fact, the goods only elasticity is 1.94 (Column [3]). The high coefficients hold for different aggregates including goods ex Agricultural goods, and services.

A similar result obtains for imports. As reported in Table 3, Column [1], total imports of goods and services also exhibit a long run elasticity of 2.21. The fact that the estimates are sensitive to the inclusion of a time trend suggests that a cointegrating

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indices fully capture the impact of Chinese relative prices. For this question, see Thomas relations does not exist between the variables and these very aggregated trade flow measures.

Consequently, in addition to the empirical motivation for examining different aggregates, there is a good economic reason to consider, for instance, an import aggregate excluding petroleum. The trade equations in (6) and (7) are derived from an imperfect substitutes model, well suited to manufactured goods. However, oil is a natural resource commodity that does not quickly respond to market signals, and exhibits trends due to resource depletion. A related argument might be used to motivate a focus on a non-agricultural goods export variable.

Interestingly, these remarkably high estimated income elasticities persist, for both export goods ex Agriculture and import goods ex Oil (columns [3] in Tables 2 and 3). On the other hand, estimated price elasticities *are* higher (in absolute value).

These high estimated income elasticities inform the debate over the durability of the Houthakker-Magee (1969) findings. Exports involving goods respond 1.9 percent for each one percentage point increase in rest-of-world income. In contrast, imports rise about 2.2 to 2.7 percentage points for each percentage point increase in US GDP. This set of findings suggests that the Houthakker-Magee income asymmetry persists. Hence, even if U.S. and foreign growth rates were to converge, net exports would continue to deteriorate even starting from balanced trade. Obviously, starting from an initial trade deficit, the trend deterioration would be even more pronounced.

All of the preceding specifications exclude a role for the supply side, suggested by Equations (6) and (7). As noted earlier, it is hard to find good measures of the supply

and Marquez (2006).

side. Helkie and Hooper (1988) used a measure of relative capital stock, but it is hard to think of how one would accurately estimate the relevant rest of the world capital stock, especially with the entry of China.

For exports of goods, accounting for supply is fairly successful. In Table 4, when U.S. manufacturing industrial production is included, the export income elasticity falls from 1.9 to 1.0, with the supply coefficient equal to close to unity (Column [1]). Interestingly, the results are not sensitive to the inclusion of a time trend. Counterintuitively, exports of goods ex Agriculture are not as easily modeled. Inclusion of a time trend leads to a negative coefficient estimate on real GDP.

On the import side, the inclusion of supply side effects is less successful. In this case, the supply side variable is import-weighted real GDP. In Table 4, Column [5], the import income elasticity rises to 2.80 from 2.65, with the coefficient on foreign GDP equal to *negative* (but not significant) 0.12. The results are slightly more promising when using export-weighted Rest-of-World GDP. Then the foreign supply variable coefficient rises to 0.52 (although still not significant), while the home activity coefficient drops to 2.

Unfortunately, in all these instances, the demand and supply variables are so collinear that the results are sensitive to the inclusion of the time trends.[6] This is why cross-section and panel regressions such as Gagnon (2003) and Bayoumi (2003) obtain more supportive evidence of supply side effects.

[6] The slope coefficient of a regression of U.S. GDP on rest-of-world GDP is 0.93, with adjusted R^2 over 0.99.

3. Vertical Specialization and Tariffs

One hint of why the income elasticities are so large is provided by the surge in both exports and imports during 1999-2000. In informal discussions, this jump is associated with the investment boom; the category experiencing the largest jump is capital goods.

The fact that the surge and collapse occurred in both categories could be coincidence – evidence of a synchronized worldwide investment boom. Or it could be a reflection that the two are interlinked.

Recent research has focused on the rise of intermediate goods in international trade. However, intermediate goods are not in and of themselves sufficient to explain the rise in trade. It is intermediate goods trade used to produce other traded goods – in other words vertical specialization (Hummels, et al., 2001; Yi, 2003; Chen et al., 2005) – that is required. This process of importing in order to export has also been termed the "fragmentation" of the production process (Arndt, 1997). At this juncture, it is useful to recognize that services exhibit less of this fragmentation. This explains in part the differential import income elasticities: 2.65 for goods ex oil versus 1.69 for services.[7]

Table 5 estimates the basic regressions specification (trade flow on income and real exchange rate) for the trade flow ex capital goods and capital goods trade flows. For the specifications excluding a time trend, goods exports ex capital goods (Column [1]) exhibit an income elasticity of 1.15 while capital goods exports (Column [3]) exhibit an elasticity of 2.90. For imports, this pattern is repeated, but more sharply. The income elasticity for total goods imports ex oil and capital goods is 1.98, while that for capital goods is nearly 4.79, for specifications excluding time trends (Columns [5] and [7]). In both cases, the trend-augmented specifications exhibit a similar, although less pronounced, pattern.

These findings suggest two not necessarily inconsistent conclusions. First, that it is important to disaggregate goods exports and imports in order to model aggregate trade flows. Second, if one is to model aggregate goods flows, one needs to include the measures that have a specific impact on the capital goods portions.

Figures 5 and 6 show how differently different goods aggregates behave. Note that the series excluding capital goods exhibits much less of a pronounced hump. Figure 7 illustrates how capital goods exports and imports covary with investment in equipment and software, particularly in the 1999-2001 period. The importance of vertical specialization was suggested, particularly for hi-tech goods, in analyses around the time of the capital goods surges (e.g., Council of Economic Advisers, 2001, Chapter 4).

The regression results in Column [1] of Table 6 indicate the impact of export-weighted Rest-of-World investment in equipment and software on total goods exports: income now has a less than elastic impact, while investment has an elasticity of 1.70. Yi (2003) argues that reductions in the tariff rate have induced large, non-proportionate, changes in the extent of vertical specialization. To incorporate this factor, we augment the regression with the (square of the) average tariff rate of the US, Europe and Japan. This variable does not enter with the correct sign for goods exports ex Agricultural goods, or ex Agricultural and Capital goods (Columns [2] and [3]).

When examining capital goods exports (Column [4]), the income elasticity is slightly above unity and the price elasticity is 0.4. Investment again enters in with a high

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[7] Marquez (2005) obtains similar estimates, but points out that further disaggregation of

elasticity, while squared tariff rate does not enter with a statistically significant coefficient.

Examining non-oil goods imports in a specification augmented in by investment (Column [5]) yields a relatively high income elasticity of 2.31 (although lower than 2.65). Investment is statistically significant, as expected. Augmenting the specification with the tariff rate squared (Column [6]) yields a statistically significant coefficient on this variable, in the expected direction, while raising the investment coefficient. This is suggestive that the decline in G-3 tariff rates and the rise in investment are correlated. In addition the income coefficient declines to 1.9; most likely income was picking up the trend in the tariff variable in the standard specifications. Non-oil, non-capital goods imports (Column [7]) show a minor effect from investment and a wrong-signed effect from tariffs.

In contrast, imports of capital goods (Columns [8]) exhibit a strong responsiveness to income and tariff rates. Exchange rates exhibit wrong signedness and equipment and software expenditures are not statistically significant.

The results for capital goods imports are sensitive to the specific time sample. Restricting the sample to 1990-2006 yields the results in column [9]. Estimated coefficients on income and investment are not statistically significant, while tariffs and the exchange rate are not. The absence of strong effects could be due to the lower variability of these variables during the later time period. On the other hand, one advantage of a shorter sample period is that the standard error of regression shrinks from 0.072 to 0.038.

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services leads to different insights on income and price elasticities.

4. Long Run Equilibria and Actual Values

One potential benefit of obtaining a better fit for the trade flows, aside from a greater understanding of the economic mechanisms at work, is that better predictions might be possible. What has proven particularly challenging is adequately modeling imports; hence in this section I investigate whether one can improve upon the predictions obtained using only aggregate data. In Figure 9, the long run equilibrium values from the a simple DOLS incorporating only income and exchange rates (conforming to Column [5] of Table 3) is depicted, alongside the actual log level of real non-petroleum imports (the actual dynamic OLS fit, incorporating the short run dynamics, matches almost exactly the actual). In Figure 10, the actual and long run equilibria for log non-oil non-capital goods imports and capital goods imports are depicted (conforming to Columns [8] and [9] respectively of Table 6). Once again, short run dynamics are omitted from the predictions.

In principle it would be useful to compare the prediction errors obtained from the equation estimated using the aggregate non-oil imports, and compare it against the summed prediction errors for the components, non-oil non-capital goods imports and capital goods imports. However, because the trade flows are "chained" quantities that do not obey adding up constraints, this procedure is not appropriate.

Instead, I convert the predicted long run flows into nominal flows using the ex post price indices. These actual and nominal trade flows can then be added and subtracted. Then, to make the errors somehow comparable over time, I normalize by GDP. The prediction error for the aggregate specification is compared against the sum of the prediction errors for the components in Figure 11. Over the 1990q1-2007q1 period, using the disaggregated data yields a smaller mean error: $21.61 billion versus $41.14 billion. In percent terms, the errors were 2.3% versus 4.6% (the root mean squared error is 4.1% versus 6.1%).

Of course, not all problems are solved. Both approaches underpredict the recent level of non-oil imports, particularly in 2004.

5. Summary

In this paper the data for U.S. trade flows up to end of 2006 are investigated. The results indicate. A variety of different aggregates are examined. In addition, supply side factors and the implications of vertical specialization are accounted for. A number of conclusions are derived from this assessment.

First, the examination confirms that the Houthakker-Magee finding of income asymmetries persists into the most recent period. This characterization applies most strongly to specifications involving highly aggregated trade flows, and no role for supply or other factors.

Second, the disaggregation of trade flows into services and some subcategory of goods usually yields higher estimated price elasticities. This outcome suggests some role for aggregation bias in driving down estimated price elasticities. A similar finding was obtained in the recent IMF study, but in that case, the results pertained to price elasticities for relative prices, instead of the real exchange rate as in this study.

Third, the inclusion of supply-side variables reduces the magnitude of income elasticities for goods. However, the results are not robust to the inclusion of time trends. Consequently, one can only make tentative conclusions regarding the importance of supply side factors in driving the increasing volume of international trade. On the other hand, cross-section studies of trade do suggest that the finding of a supply side role is not completely coincidental.

Fourth, capital goods and non-capital goods imports appear to behave differently. Capital goods exports respond strongly to investment in equipment and software. Depending upon the sample period, capital goods imports respond strongly to the tariff rate or investment. However, because the results are sensitive to the sample period and trade flow measure, additional work is required to identify the channels by which trade barriers and vertical specialization interact. In particular, one might want a better measure of trade barriers for trade in capital goods.

Finally, it appears that disaggregation – even of a limited extent – might prove helpful in improving predictions of aggregate trade flows. One key dividing line appears to be between non-oil non-capital goods and capital goods. Sums of predicted import sub-aggregates appear to yield smaller prediction errors than using a predicted aggregate import variable. This finding -- while not definitive – suggests that one can improve our forecasts of trade flows without resorting to modeling many very highly disaggregated trade series.

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Table 1: Estimates of Export and Import Elasticities, 1975q1-2006q4

	Exports of Goods and Services				Imports of Goods and Services			
	OLS	DOLS [a/]	ECM [b/]	VECM	OLS	DOLS [a/]	ECM [b/]	VECM
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Income (Demand)	**1.853**	**1.869**	**1.895**	1.898	**2.214**	**2.211**	**2.239**	2.259
	[0.040]	**[0.036]**	**[0.054]**	[0.051]	**[0.040]**	**[0.036]**	**[0.082]**	[0.049]
Exchange rate	**0.498**	**0.616**	**0.974**	0.962	**-0.205**	-0.289	**-0.322**	-0.222
	[0.073]	**[0.081]**	**[0.203]**	[0.186]	**[0.084]**	[0.099]	**[0.190]**	[0.153]
Adj. R2	0.99	0.99	0.38	Na	0.99	0.99	0.34	Na
SER	0.063	0.050	0.018	Na	0.056	0.054	0.024	Na
N	128	128	128	128	128	128	128	128
Coint. Vectors	Na	na	1	0,0	na	na	1	0,0

Notes: Point estimates and HAC standard errors for OLS and DOLS in [brackets], implied long run coefficients from ECM and cointegrating vector coefficients for VECM [asymptotic standard errors in brackets]. SER is standard error of estimates. N is number of observations. Cointegrating vectors is the number of indicated cointegrating vectors; under VECM, {#,#} indicates the number of vectors as indicated by the trace and maximal eigenvalue statistics at the 5% level, using the asymptotic critical values. **[bold face]** indicates significance at the 10% level.
[a/] Includes 2 leads and 4 lags of the first differenced right hand side variables.
[b/] Includes 3 lags of the first differenced right hand side variables.

Table 2: Export Equations, 1975q1-2006q4

	Total goods & svcs.	Total goods & svcs.	Total goods	Total goods	Total goods ex. Agric.	Total goods ex. Agric.	Total svcs.	Total svcs.
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Income (Demand)	**1.869**	**3.854**	**1.938**	**4.584**	**1.902**	**5.416**	**1.712**	**1.604**
	[0.036]	**[0.986]**	**[0.041]**	**[1.088]**	**[0.064]**	**[1.753]**	**[0.040]**	**[1.326]**
Output (Supply)								
Exchange Rate	**0.616**	**0.428**	**0.648**	**0.398**	**0.867**	**0.535**	**0.502**	**0.513**
	[0.081]	**[0.115]**	**[0.112]**	**[0.130]**	**[0.207]**	**[0.214]**	**[0.104]**	**[0.143]**
time		**-0.016**		**-0.022**		-0.029		0.001
		[0.008]		**[0.009]**		[0.014]		[0.011]
Adj. R2	0.99	0.99	0.99	0.99	.97	98	0.99	0.99
SER	0.050	0.047	0.059	0.056	0.094	0.090	0.058	0.058
N	126	126	126	126	126	126	126	126

Notes: Point estimates and HAC standard errors for OLS and DOLS in [brackets]. SER is standard error of estimates. N is number of observations. Regressions include 2 leads and 4 lags of first differenced right hand side variables. **[bold face]** indicates significance at the 10% level.

Table 3: Import Equations, 1975q1-2006q4

	Total goods & svcs. [1]	Total goods & svcs. [2]	Total goods [3]	Total goods [4]	Total goods ex oil [5]	Total goods ex oil [6]	Total svcs. [7]	Total svcs. [8]
Income (Demand)	**2.211**	**2.977**	**2.325**	**3.121**	**2.653**	**2.283**	**1.685**	**2.138**
	[0.036]	**[0.539]**	**[0.045]**	**[0.700]**	**[0.015]**	**[0.366]**	**[0.027]**	**[0.490]**
Output (Supply)								
Exchange Rate	**-0.199**	**-0.212**	-0.167	**-0.179**	**-0.460**	**-0.454**	**-0.344**	**-0.352**
	[0.106]	**[0.093]**	[0.136]	**[0.123]**	**[0.066]**	**[0.067]**	**[0.094]**	**[0.094]**
time		-0.006		-0.006		0.003		-0.003
		[0.004]		[0.005]		[0.003]		[0.004]
Adj. R2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
SER	0.054	0.052	0.068	0.067	0.033	0.033	0.053	0.053
N	127	127	127	127	127	127	127	127

Notes: Point estimates and HAC standard errors for OLS and DOLS in [brackets]. SER is standard error of estimates. N is number of observations. Regressions include 2 leads and 4 lags of first differenced right hand side variables. **[bold face]** indicates significance at the 10% level.

Table 4: Supply Augmented Specifications, 1975q1-2006q4

	Exports				Imports			
	Total goods, supply side	Total goods, supply side	Total goods, ex. Agric, Supply side	Total goods, ex. Agric, Supply side	Total goods ex oil, supply side	Total goods ex oil, supply side	Total goods ex oil, supply side [a/]	Total goods ex oil, supply side [a/]
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Income	**0.988**	0.969	**0.193**	**-2.971**	**2.796**	**2.742**	**2.098**	**2.647**
(Demand)	**[0.180]**	[1.510]	**[0.183]**	**[1.536]**	**[0.390]**	**[0.372]**	**[0.553]**	**[0.562]**
Output	**0.998**	**1.000**	**1.797**	**2.086**	-0.118	**-0.914**	0.520	**-1.157**
(Supply)	**[0.179]**	**[0.220]**	**[0.180]**	**[0.246]**	[0.320]	**[0.550]**	[0.518]	**[1.057]**
Exchange Rate	**0.769**	**0.771**	**1.083**	**1.401**	**-0.414**	**-0.283**	**-0.520**	**-0.376**
	[0.073]	**[0.167]**	**[0.069]**	**[0.159]**	**[0.066]**	**[0.109]**	**[0.078]**	**[0.118]**
time		0.000		0.024		0.008		0.000
		[0.011]		[0.011]		[0.005]		[0.005]
Adj. R2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
SER	0.042	0.042	0.053	0.050	0.033	0.032	0.034	0.033
N	126	126	126	126	127	127	127	127

Notes: Point estimates and HAC standard errors for OLS and DOLS in [brackets]. SER is standard error of estimates. N is number of observations. Regressions include 2 leads and 4 lags of first differenced right hand side variables. **[bold face]** indicates significance at the 10% level.

[a/] Uses export weighted rest-of-world GDP.

Table 5: Capital Goods versus Non-Capital Goods Trade Flows, 1975q1-2006q4

	Exports				Imports			
	Total goods ex Agric., capital goods	Total goods ex Agric., capital goods	Capital goods	Capital goods	Total goods ex oil, capital goods	Total goods ex oil, capital goods	Capital goods	Capital goods
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Income	**1.154**	**4.343**	**2.902**	**6.591**	**1.979**	**1.709**	**4.722**	**2.801**
(Demand)	**[0.065]**	**[1.782]**	**[0.083]**	**[2.285]**	**[0.019]**	**[0.277]**	**[0.127]**	**[1.449]**
Exchange Rate	**0.854**	**0.552**	**0.915**	**0.566**	**-0.587**	**-0.583**	-0.221	-0.190
	[0.224]	**[0.225]**	**[0.205]**	**[0.273]**	**[0.045]**	**[0.046]**	[0.372]	[0.346]
time		-0.026		**-0.031**		0.002		**0.015**
		[0.015]		**[0.019]**		[0.002]		**[0.012]**
Adj. R2	0.99	0.99	0.98	0.98	0.99	0.99	0.99	0.99
SER	0.09933	0.095	0.112	0.108	0.032	0.031	0.163	0.160
N	126	126	126	126	127	127	127	127

Notes: Point estimates and HAC standard errors for OLS and DOLS in [brackets]. SER is standard error of estimates. N is number of observations. Regressions include 2 leads and 4 lags of the first difference terms of the right hand side variables. **[bold face]** indicates significance at the 10% level.

Table 6: Vertical Specialization and Trade Flows

	Exports of goods ex. Agric.	Exports of goods ex. Agric	Exports of goods ex Agric., capital goods	Exports of capital goods	Imports of goods ex oil	Imports of goods ex oil	Imports of goods ex oil, ex capital goods	Imports of capital goods	Imports of capital goods a/
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Income	**0.441**	**1.178**	**1.151**	**1.225**	**2.312**	**1.885**	**2.067**	**2.489**	**1.418**
(Demand)	**[0.195]**	**[0.373]**	**[0.196]**	**[0.627]**	**[0.134]**	**[0.264]**	**[0.281]**	**[0.686]**	**[0.735]**
Exchange Rate	**0.489**	-0.097	**-0.346**	0.397	**-0.521**	**-0.395**	**-0.764**	**0.688**	-0.135
	[0.103]	[0.198]	**[0.112]**	[0.326]	**[0.080]**	**[0.089]**	**[0.082]**	**[0.232]**	[0.339]
Invest (Equip)	**1.699**	**1.868**	**1.644**	**1.982**	**0.163**	**0.247**	0.076	-0.147	**1.168**
	[0.202]	**[0.347]**	**[0.194]**	**[0.567]**	**[0.065]**	**[0.090]**	[0.082]	[0.237]	**[0.218]**
Tariff rate (sq.)		**8.032**	**12.873**	0.212		**-2.183**	**2.122**	**-21.689**	1.775
		[1.765]	**[1.076]**	[2.876]		**[0.973]**	**[1.086]**	**[2.426]**	[5.103]
Adj. R2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
SER	0.072	0.054	0.035	0.088	0.031	0.030	0.028	0.072	0.038
N	126	126	126	126	127	127	127	127	67

Notes: Point estimates and HAC standard errors for OLS and DOLS in [brackets].. SER is standard error of estimates. N is number of observations. Regressions include 2 leads and 4 lags of the first difference terms of the right hand side variables. **[bold face]** indicates significance at the 10% level.

a/ 1990-2006. Uses major currencies exchange rate.

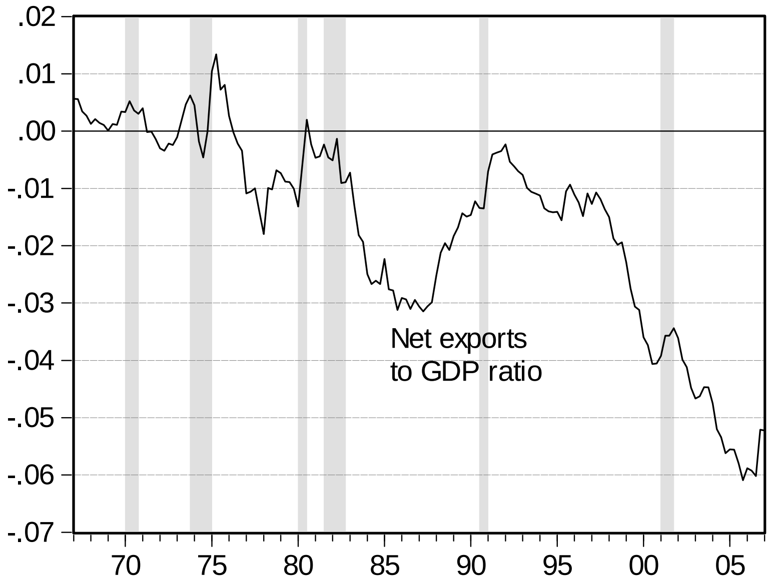

Figure 1: Net Exports of goods and services to GDP ratio, SAAR. Shaded areas denote recession dates. Source: BEA (April 2007 release) and NBER for recession dates.

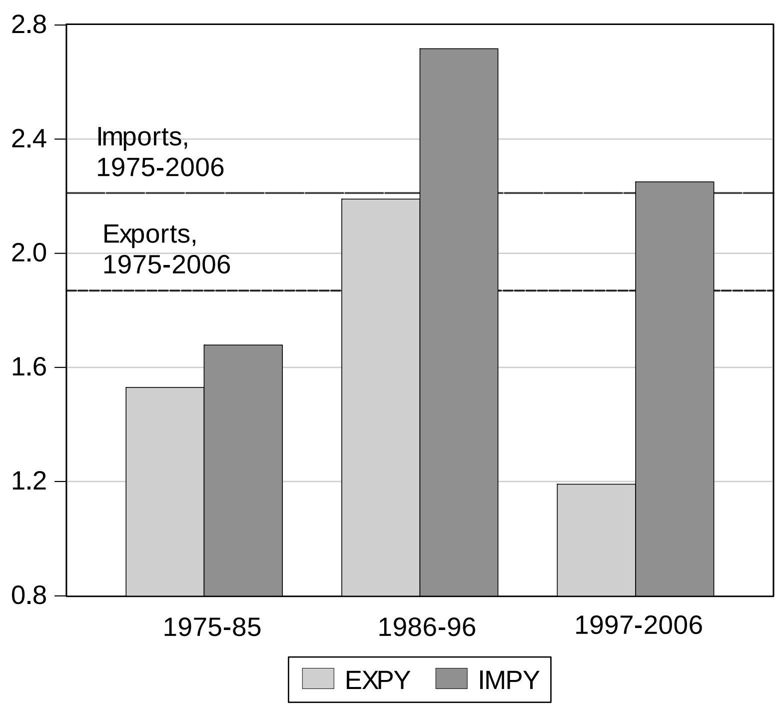

Figure 2: Income Export (EXPY) and Import (IMPY) Elasticities for Subperiods. Source: Columns [2] and [6] from Table1, and DOLS regressions on the indicated subperiod.

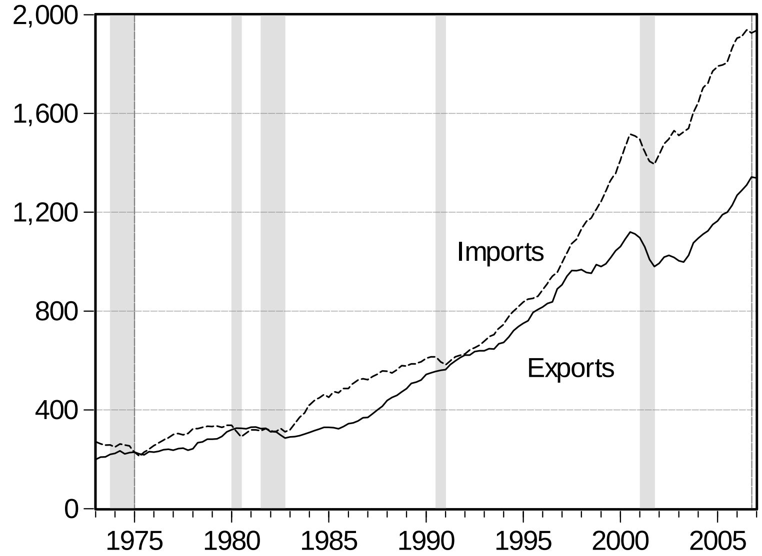

Figure 3: Real Exports and Imports of Goods and Services, in 2000 Ch$ (SAAR). Source: BEA (April 2007 release).

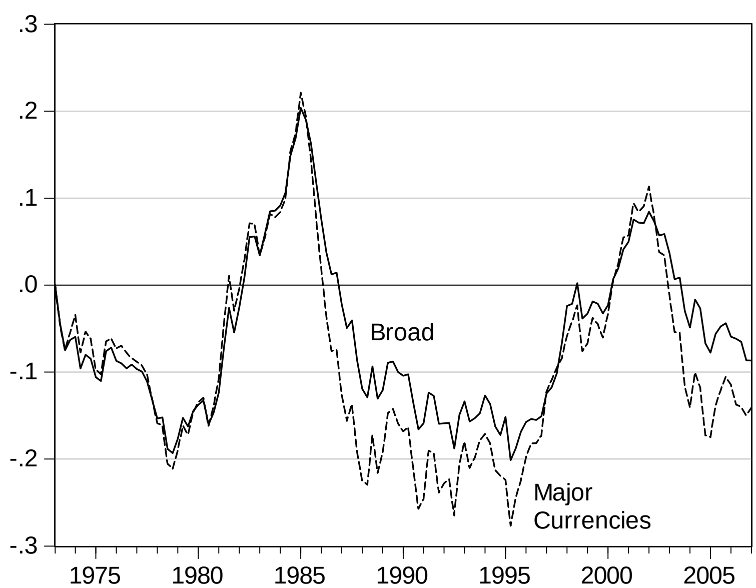

Figure 4: Federal Reserve Board Broad and Major Currencies Indices of the Real Value of the Dollar, in logs, 1973q1=0. Source: Federal Reserve Board.

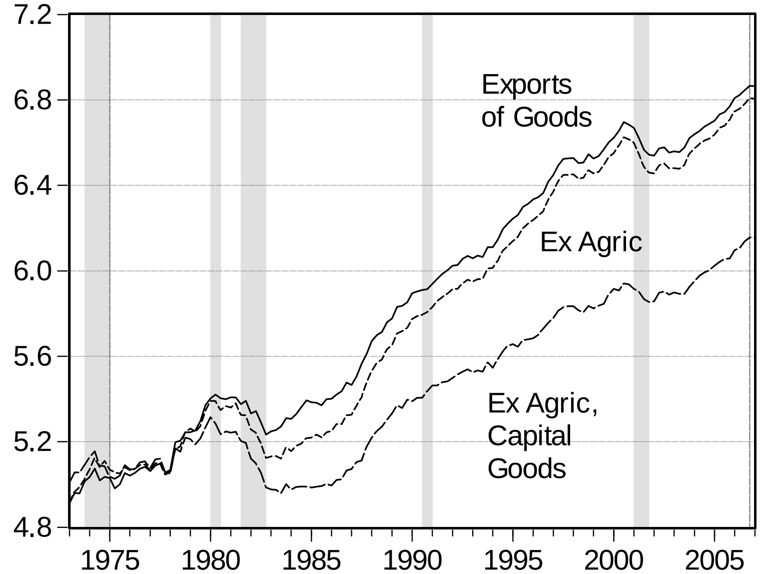

Figure 5: Real Exports of Goods, Goods ex Agricultural Goods, Goods ex Agricultural and Capital Goods, billions of 2000 Ch.$, SAAR. Source: BEA (April 2007 release), and author's calculations.

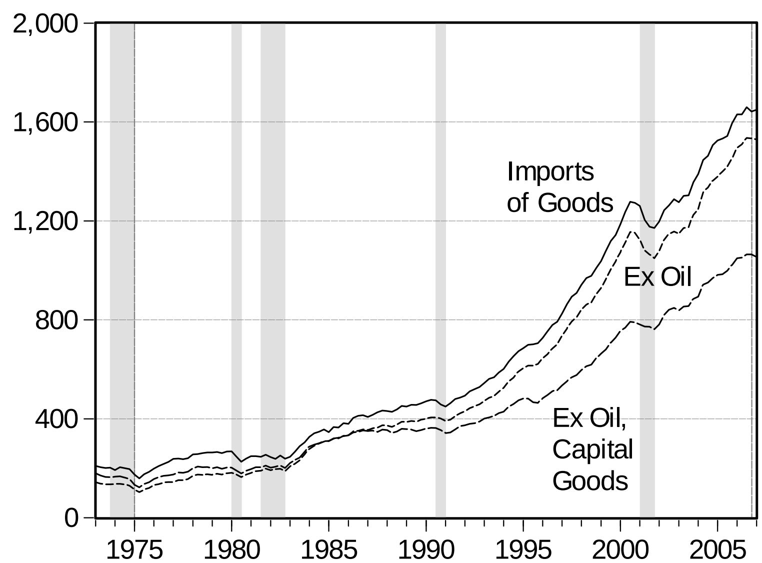

Figure 6: Real Imports of Goods, Goods ex Oil, and Goods ex Oil and Capital Goods, billions of 2000 Ch.$, SAAR. Source: BEA (April 2007 release), and author's calculations.

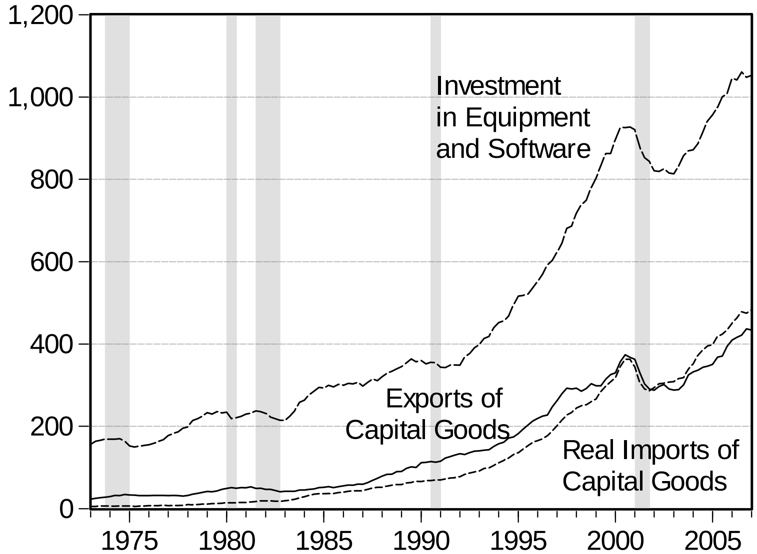

Figure 7: Real Exports and Imports of Capital Goods and Investment in Equipment and Software, billions of 2000 Ch.$, SAAR. Source: BEA (April 2007 release).

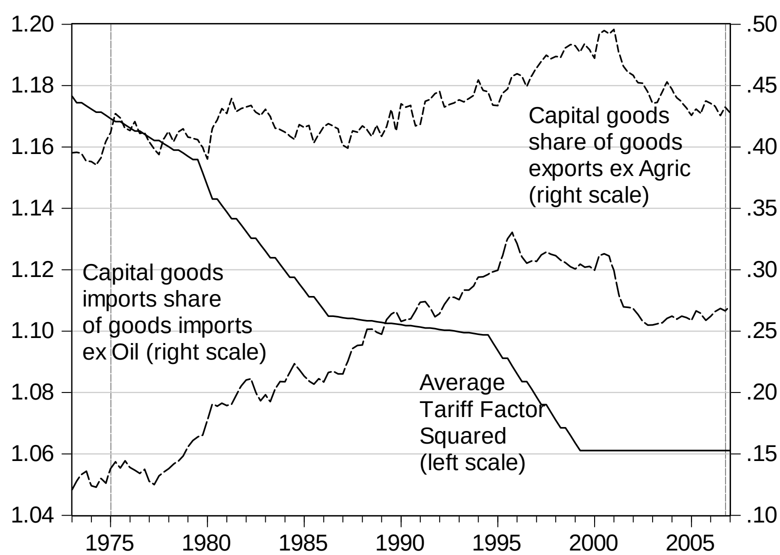

Figure 8: Average Tariff Factor Squared and Share of Capital Goods in Goods Exports ex Agricultural Goods, and in Goods Imports ex Oil. Source: Kei-Mu Yi, BEA and author's calculations.

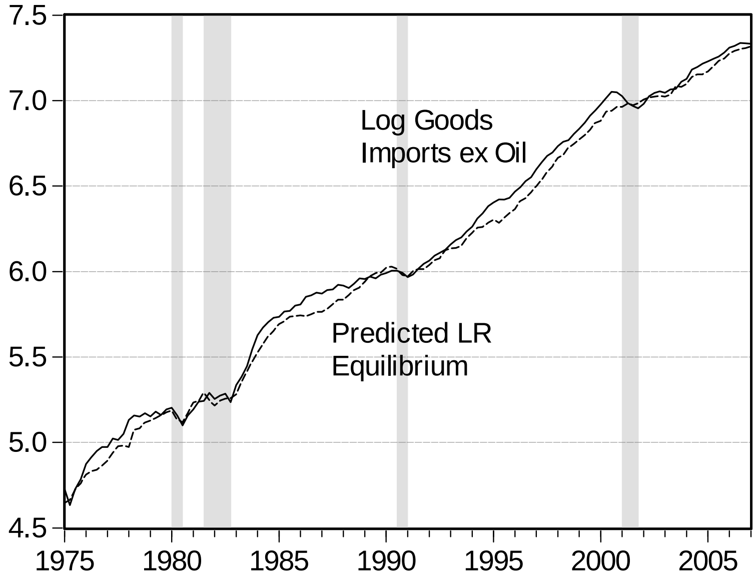

Figure 9: Non-oil Goods Imports and Estimated LR Equilibrium Values. Source: BEA (April 27 release) and author's calculations.

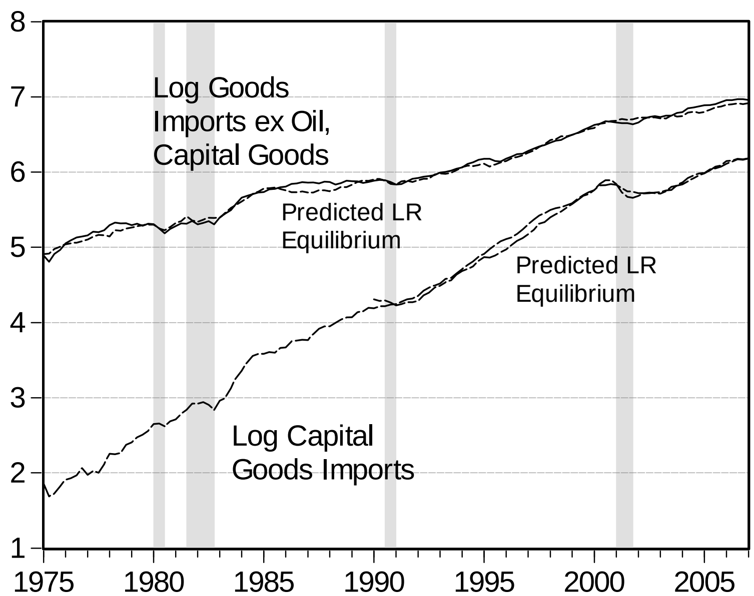

Figure 10: Non-oil, Non-Capital Goods Imports and Estimated Long Run Equilibrium Values. Source: BEA (April 27 release) and author's calculations.

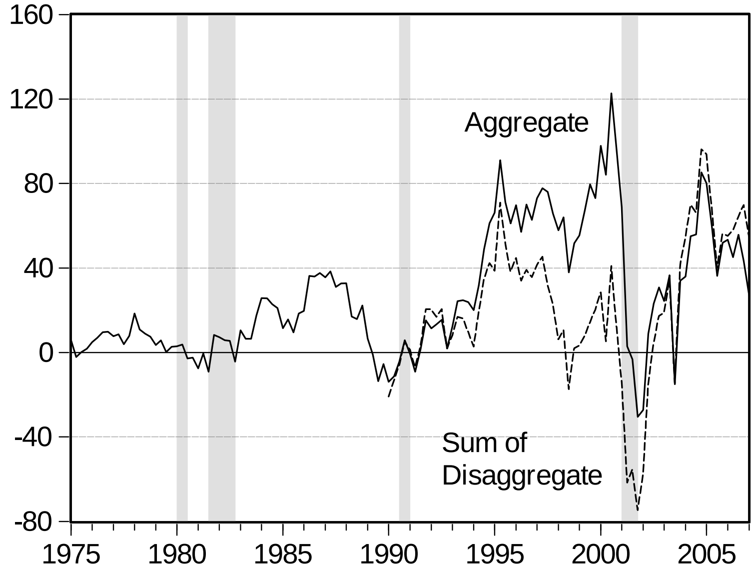

Figure 11: Prediction Error from Aggregate and Sum of Prediction Errors from Disaggregate Components, in billions of current $, annual rate. Source: Author's calculations.

Appendix 1: Data Sources and Description

Exchange Rate Indices

- US "Major currencies" and "broad" trade weighted exchange rate (CPI deflated). Source: Federal Reserve Board website, http://www.federalreserve.gov/releases/h10/Summary/indexnc_m.txt . Weights are listed at http://www.federalreserve.gov/releases/h10/Weights/ . Data accessed May 2007. See Loretan (2005) and Leahy (1998) for details. The economies are Euro area, Canada, China, Japan, Mexico, United Kingdom, Korea, Taiwan, Hong Kong, Malaysia, Singapore, Brazil, Switzerland, Thailand, Australia, Sweden, India, Philippines, Israel, Indonesia, Russia, Saudi Arabia, Chile, Argentina, Colombia, and Venezuela.

Trade Flows, Economic Activity

- Real and nominal imports and exports of goods and services, and gross domestic product (2000 chain weighted dollars). Source: BEA, April 2007 release.
- Goods exports ex Agricultural and Capital Goods, and Goods imports ex Oil and Capital Goods calculated using Tornqvist approximation. See Whelan (2000) for an explanation of the procedure.
- Export-weighted Rest-of-World GDP (2000 dollars). U.S. exports weighted rest-of-world GDP, provided by Jaime Marquez. Updated over 2006q1-2006q4 period using implied *World Economic Outlook* (April 2007 version) rest-of-world growth rate. Import-weighted Rest-of-World GDP, constant currency, calculated using year-by-year trade weights. Import weighted and export weighted Rest-of-World capital expenditure (equipment where available, otherwise total capital expenditure), calculated using annual growth rates, converted to quarterly using quadratic match average.
- Industrial production. For US, manufacturing industrial production, seasonally adjusted. Source: BEA via St. Louis Fed, accessed May 18, 2007.

Tariffs

- Tariff rates, average of U.S., Japan and European Union, provided by Kei-Mu Yi, and described in Yi (2003). Annual data interpolated by moving average to create quarterly data.

Appendix 2: Johansen ML Estimates

Table A1: Export Equations

	Total goods	Total svcs.	Total goods ex. Agric.	Total goods, ex. Agric. w/supply
	[1]	[2]	[3]	[4]
Income (Demand)	**1.993** **[0.055]**	**1.453** **[0.500]**	**2.103** **[0.079]**	**0.600** **[0.259]**
Output (Supply)				**1.463** **[0.265]**
Exchange Rate	**1.048** **[0.200]**	**4.685** **[1.721]**	**1.589** **[0.277]**	**1.410** **[0.145]**
cv	1,1	0,0	1,1	1,1
N	128	128	128	128
lag	4	4	4	4

Notes: Point estimates asymptotic standard errors for Johansen ML estimates, assuming trend in data. Cv is the number of implied cointegrating variables in the Trace, Maximum Eigenvalue statistics, using the 10% MSL. N is number of observations. Regressions include 4 lags of in the VAR specification of the model. **[bold face]** indicates significance at the 10% level.

Table A2: Import Equations

	Total goods	Total svcs.	Total goods & svcs. Ex oil,
	[1]	[2]	[3]
Income (Demand)	2.400 [0.070]	1.694 [0.052]	**2.653** **[0.020]**
Output (Supply)			
Exchange Rate	-0.153 [0.218]	0.003 [0.171]	**-0.453** **[0.062]**
Cv	0,0	0,0	1,1
N	128	128	128
lag	4	4	4

Notes: Point estimates asymptotic standard errors for Johansen ML estimates, assuming trend in data. Cv is the number of implied cointegrating variables in the Trace, Maximum Eigenvalue statistics, using the 10% MSL. N is number of observations. Regressions include 4 lags of in the VAR specification of the model. **[bold face]** indicates significance at the 10% level.

Table A3: Supply Augmented Specifications

	Total goods, supply side	Total goods & svcs. Ex Ag	Total goods ex oil, supply side	Total goods & svcs. Ex oil
	[1]	[4]	[5]	[4]
Income	**0.953**	**0.600**	**18.803**	**2.1204**
(Demand)	**[0.230]**	**[0.259]**	**[2.472]**	**[0.408]**
Output	**1.046**	**1.463**	**-13.450**	0.445
(Supply)	**[0.236]**	**[0.265]**	**[2.009]**	[0.332]
Exchange Rate	**0.956**	**1.410**	**2.175**	**-0.495**
	[0.128]	**[0.145]**	**[0.511]**	**[0.085]**
Adj. R2	1,1	1,1	1,1	2,2
SER	128	128	128	128
lag	4	4	4	4

Notes: Point estimates asymptotic standard errors for Johansen ML estimates, assuming trend in data. Cv is the number of implied cointegrating variables in the Trace, Maximum Eigenvalue statistics, using the 10% MSL. N is number of observations. Regressions include 4 lags of in the VAR specification of the model. **[bold face]** indicates significance at the 10% level.

Table A4: Capital Goods versus Non-Capital Goods Trade Flows

	Exports		Imports	
	Total goods ex Agric. Capital goods	Capital goods	Total goods ex oil, capital goods	Capital goods
	[1]	[2]	[3]	[4]
Income	**1.597**	2.992	**1.988**	5.435
(Demand)	**[0.106]**	[0.108]	**[0.018]**	[0.427]
Exchange Rate	**1.900**	1.370	**-0.588**	-3.549
	[0.343]	[0.391]	**[0.057]**	[1.355]
cv	1,1	0,0	1,1	0,0
N	128	128	128	128
lag	4	4	4	4

Notes: Point estimates asymptotic standard errors for Johansen ML estimates, assuming trend in data. Cv is the number of implied cointegrating variables in the Trace, Maximum Eigenvalue statistics, using the 10% MSL. N is number of observations. Regressions include 4 lags of in the VAR specification of the model. **[bold face]** indicates significance at the 10% level.

Table A5: Vertical Specialization and Trade Flows

	Exports of goods ex Agric.	Exports of goods ex. Agric.	Exports of goods ex Agric., capital goods	Exports of capital goods	Imports of goods ex oil	Imports of goods ex oil	Imports of goods ex oil, ex capital goods	Imports of capital goods
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Income	**1.039**	**1.370**	**0.714**	**2.042**	**2.384**	**2.155**	**2.162**	**6.696**
(Demand)	**[0.324]**	**[0.493]**	**[0.240]**	**[0.070]**	**[0.171]**	**[0.251]**	**[0.214]**	**[1.282]**
Exchange Rate	**1.074**	**1.508**	-0.160	**2.322**	**-0.236**	**0.194**	**-0.632**	**0.927**
	[0.224]	**[0.378]**	[0.171]	**[0.525]**	**[0.082]**	**[0.088]**	**[0.076]**	**[0.440]**
Invest (Equip)	**-1.176**	0.586	**1.901**	-0.196	**0.140**	**0.150**	0.030	**-1.656**
	[0.369]	[0.464]	**[0.219]**	[0.671]	**[0.084]**	**[0.085]**	[0.072]	**[0.434]**
Tariff rate (sq.)		-2.739	**10.356**	**-12.003**		**-1.900**	**1.956**	**-14.385**
		[3.416]	**[1.611]**	**[4.825]**		**[0.949]**	**[0.814]**	**[4.906]**
cv	1,1	1,2	1,2	1,1	2,2	2,3	2,2	1,1
N	128	128	128	128	128	128	128	128
lag	4	4	4	4	4	4	4	4

Notes: Point estimates asymptotic standard errors for Johansen ML estimates, assuming trend in data. Cv is the number of implied cointegrating variables in the Trace, Maximum Eigenvalue statistics, using the 10% MSL. N is number of observations. Regressions include 4 lags of in the VAR specification of the model. **[bold face]** indicates significance at the 10% level.