Understanding the evolution of trade deficits: Trade elasticities of industrialized countries

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Introduction and summary

In 2006, Americans bought $1,928 billion of goods and services produced in foreign countries. In the same year, American sales of goods and services to foreigners amounted to only $1,304 billion.[1] The difference between American exports and imports of $624 billion is known as the trade deficit. When this number is positive—that is, when the U.S. sells more to foreign countries than it buys—it is called a trade surplus. More generally, the difference between the value of a country's exports and imports is known as the trade balance. Over the past several years, the U.S. trade deficit has attracted a great deal of attention in the popular press and among policymakers in Washington, DC. Why is there so much interest in the trade deficit?

To place things in a historical context, the U.S.'s trade balance has been negative—that is, the U.S. has been importing more than it has been exporting—for much of the post-World War II period. Over the past 25 years, the trade deficit has tended to become a larger and larger fraction of the total output of the U.S. economy, or U.S. gross domestic product (GDP). In the first quarter of 2005, the U.S. trade deficit peaked at a post-World War II high of 5.7 percent of GDP. Most recently, in response to a weakening U.S. dollar, the trade deficit has shrunk a bit, standing at 5.2 percent of GDP in the first quarter of 2007. However, the U.S.'s trade deficit of more than 5 percent of GDP is large both by historical standards and in comparison with other industrialized countries'.

Why does the size of the U.S. trade deficit matter? Whenever the U.S. trade balance is in deficit, this means that the U.S. is borrowing from foreigners to finance its consumption of imports. Borrowing in and of itself is not necessarily a bad thing. In fact, one way to view the trade deficit is to recognize that foreigners are choosing to invest in the United States. One can imagine that they choose to do so because they think that the returns they will earn on an investment here are better than the returns they will earn in other countries.

However, debts need to be repaid, and the large and persistent U.S. trade deficit means that the U.S. has been borrowing more and more from foreigners for a long time. This raises the concern that at some point in the future, foreigners may begin to doubt the ability of the U.S. to repay its debts and will cease lending. Or, more likely, that the cost of borrowing from foreigners will increase significantly. Trouble could also arise if the dollar experiences a "hard landing," a sudden large fall in its value relative to other currencies. A large fall in the value of the dollar would eventually result in much higher prices for imports, which could leave U.S. consumers much worse off than they otherwise would be. So the size of the trade deficit matters because it could be a contributing factor to a sudden change in the value of the dollar. In turn, an abrupt change in the value of the dollar could, by raising the prices of imported goods and services, reduce the consumption of Americans (see box 1).

Given the importance of the trade balance, economists want to understand how it will evolve in the future. Two important factors in determining how much Americans import from other countries are U.S. national income and the relative price of imported goods to domestically produced ones. Similarly, important determinants of U.S. exports are the income of our trading partners and the relative price of U.S. exports

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BOX 1

The trade balance, the current account balance, and the macroeconomy

The trade balance represents the overwhelming share of another measure of a country's external balance—the current account. To gain some insight into the macroeconomic significance of the U.S. trade deficit, we review the three different, yet equivalent, definitions of the current account. Mann (2002) describes these as three perspectives on the current account. Ferguson (2005) refers to them as three different lenses through which to view the current account. Ultimately, the current account changes in response to the forces underlying all of its three different definitions. Each perspective highlights different forces that drive the current account and can be analyzed empirically by economists who wish to quantify the importance of different forces that change its value.

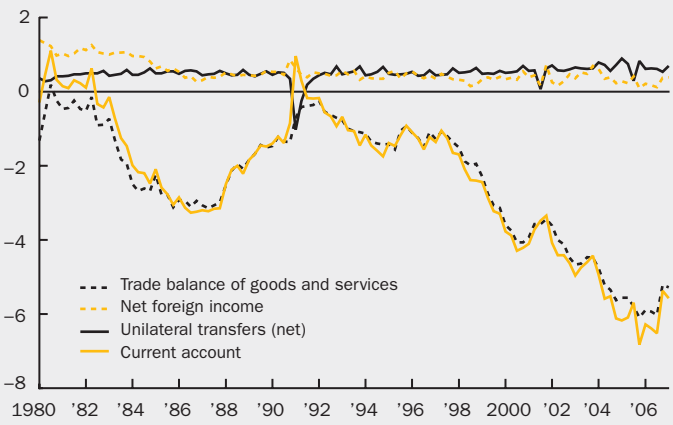
A first perspective on the current account emphasizes its domestic macroeconomic foundations. The current account balance is defined as the difference between a nation's total income and its expenditures on consumption and investment or, equivalently, as the difference between the nation's total (public and private) saving and its total (public and private) investment. From this perspective, we can see that the U.S. current account deficit reflects the fact that investment expenditures exceed saving in the U.S. Thus, many critics of the U.S. current account deficit argue that Americans should save more. It is true that an increase in the level of saving, holding the level of investment constant, will by definition lead to a smaller current account deficit. However, this argument tends to oversimplify the complexity of a world in which individuals make consumption and saving decisions in response to relative prices and investment returns.

A second perspective on the current account deficit focuses on its international financial foundations. The current account measures international transactions as changes in current trade flows, income payments, and unilateral transfers. It is roughly equivalent to the financial account, which measures international transactions arising from changes in the stocks of real and financial assets, including foreign direct investment, as well as the public and private holdings of stocks, bonds, bank accounts, and currency. Thus, the financial account balance is equal to the difference between foreign spending for U.S. assets (U.S. capital inflows) and U.S. spending on foreign assets (U.S. capital outflows). The financial account surplus is loosely understood to reflect U.S. net borrowing from the rest of the world. That is, when U.S. expenditures exceed U.S. income, the shortfall is made up in a net inflow of capital to the U.S. or, equivalently, the purchase of U.S. assets by foreigners. One interpretation of the large U.S. current account in recent years is that it has been driven by foreign investors' strong desire for relatively secure U.S. assets (Bernanke, 2005).

A final perspective on the current account deficit is one that emphasizes the international trade flows that underlie it. The current account is equal to the sum of the trade balance (exports less imports), net foreign income, and unilateral transfers. Net foreign income is the difference between the overseas earnings of U.S. investors that are sent to the U.S. and the domestic U.S. earnings of foreign investors that are sent to their countries. Unilateral transfers are payments by governments or individuals to foreign governments or residents of foreign countries. This includes foreign aid and remittances from U.S. residents to family and friends overseas. Figure B1 presents the components of the U.S. current account balance as a fraction of U.S. GDP from 1980 through 2007. The trade balance and current account move together closely throughout this period. Thus, one way to understand the evolution of the current account is to study the evolution of its largest component, the trade deficit. The international trade perspective examines how flows of imports and exports respond to changes in the national incomes of the importing countries and the relative prices of imported and exported goods and services.

FIGURE B1

Components of the U.S. current account



Sources: Authors' calculations based on data from the U.S. Bureau of Economic Analysis and Haver Analytics.

to the price of other goods that are available to consumers in foreign countries. In order to predict how exports or imports will change in the future, economists estimate trade elasticities. Trade elasticities measure how much a country's imports or exports will change in response to changes in national incomes or the relative price of imported goods and services to domestically produced ones. For example, the import elasticity with respect to income is a number that specifies how much imports will increase in response to a 1 percent increase in the total income of a country.

In this article, we present updated trade elasticities for the United States and six other industrialized economies—Canada, France, Germany, Italy, Japan, and the United Kingdom. These countries are collectively known as the Group of Seven (G-7) industrialized countries. We find that the imports of the G-7 countries are slightly more responsive to changes in a country's total income over a period that ends in 2006 compared with a sample period that ends in 1994.[2] Similarly, the exports of the G-7 countries appear to be as responsive or more responsive to changes in the trade-weighted average income of the country's trading partners over the period 1981–2006 compared with the period 1981–94. With respect to prices, we find that the imports of several G-7 countries are more responsive to import price changes than other studies have indicated. Our estimates of the responsiveness of G-7 exports to price changes for most countries differ from those in previous studies, but not in any systematic way.

What do our findings imply about the magnitude of the U.S. trade deficit? We can use the elasticities estimated in this article to make predictions about how large or small the U.S. trade deficit would have been if prices or incomes had been different. For example, suppose that the relative price of U.S. imports had been 10 percent higher and the relative price of U.S. exports had been 10 percent lower than they actually were in 2006. Our estimates of the price elasticity of demand for imports of –0.63 and of the price elasticity of demand for exports of –0.61 imply that the U.S. trade deficit in 2006 would have been $424 billion instead of the actual $624 billion.[3]

In addition to our national level estimates, we estimate elasticities for different U.S. industry sectors. We find that the U.S. export elasticity for services with respect to foreign income exceeds the U.S. import elasticity for services with respect to income over the period 1988–2006. This means that if the U.S. were to grow at the same rate as its trading partners and prices remained constant, over time the U.S. trade balance in services would move toward larger and larger trade surpluses.

In the following section, we discuss what trade elasticities are. Then, we review previous empirical studies of trade elasticities. Next, we present our econometric model and discuss the data we used in estimating trade elasticities for the G-7 countries. Finally, we present our results and draw some conclusions from them.

What are trade elasticities?

The theoretical model underlying the estimation of trade elasticities is an imperfect substitutes model—that is, a model in which it is assumed that exports and imports are imperfect substitutes for domestically produced goods. Goldstein and Khan (1985) provide a detailed discussion of this model.

In an imperfect substitutes model, the foreign demand for U.S. goods and services is determined by three main factors: foreign income, the prices of U.S. goods and services, and the prices of goods and services that compete with U.S. goods and services in the foreign market. Similarly, U.S. demand for foreign goods and services is determined by U.S. income, the prices of foreign goods and services, and the prices of goods and services that compete with foreign goods and services in the U.S. market.

The income elasticity of demand for imports measures to what extent changes in an importing country's income affect changes in its imports. Similarly the income elasticity of demand for exports measures to what extent changes in foreign countries' incomes affect the exporting country's exports.

Theoretically, the import and export elasticities with respect to income are positive. That is, an increase in a country's income leads it to buy more from foreign countries. An income elasticity of imports or exports that is equal to one implies that imports or exports increase proportionately with income. Deviations from this imply long-term imbalances in the global economy. Specifically, an income elasticity for imports of more than one implies that domestic consumers have a stronger preference for foreign goods than for domestic goods. If prices do not adjust, having imports increase more than proportionately to income growth means that imports would eventually exceed GDP. Because estimates of the elasticity with respect to income that are greater than one yield this kind of implausible prediction, they are hard to reconcile with a view of long-term balance in the global economy.

Turning to the relationship between prices and imports, we estimate how imports respond to the price of imported goods and services *relative* to the price of domestically produced goods and services that compete with imported goods. As imported

goods become more expensive relative to domestic goods, economic theory predicts that the volume of imported goods will fall. In other words, the import elasticity with respect to the relative price of imports is negative. A similar relationship holds for prices and exports. As the price of exported goods increases relative to the price of domestically produced goods in the importing countries, the volume of exports falls. Thus, the export elasticity with respect to the relative price of exports is also negative.

Figure 1 presents the U.S. trade balance from 1955 through 2006 as a fraction of U.S. GDP, along with two measures of international prices—the relative price of imports and the relative price of exports. In this figure, we see that an increase in the relative price of imports leads to a fall in the volume of goods and services imported, which, in turn, leads the U.S.'s trade deficit to shrink. In a similar manner, an increase in the relative price of exports (which often coincides with an appreciation of a country's currency) makes exports less attractive to foreign consumers and, thus, leads to a fall in the volume of goods and services that a country exports. This, in turn, leads to an increase in a country's trade deficit.

From figure 1, we can see that a relationship between relative prices and the trade balance is apparent, but it is not strikingly clear. The econometric analysis we conduct in this article will allow us to precisely quantify the relationship between relative prices and trade flows.

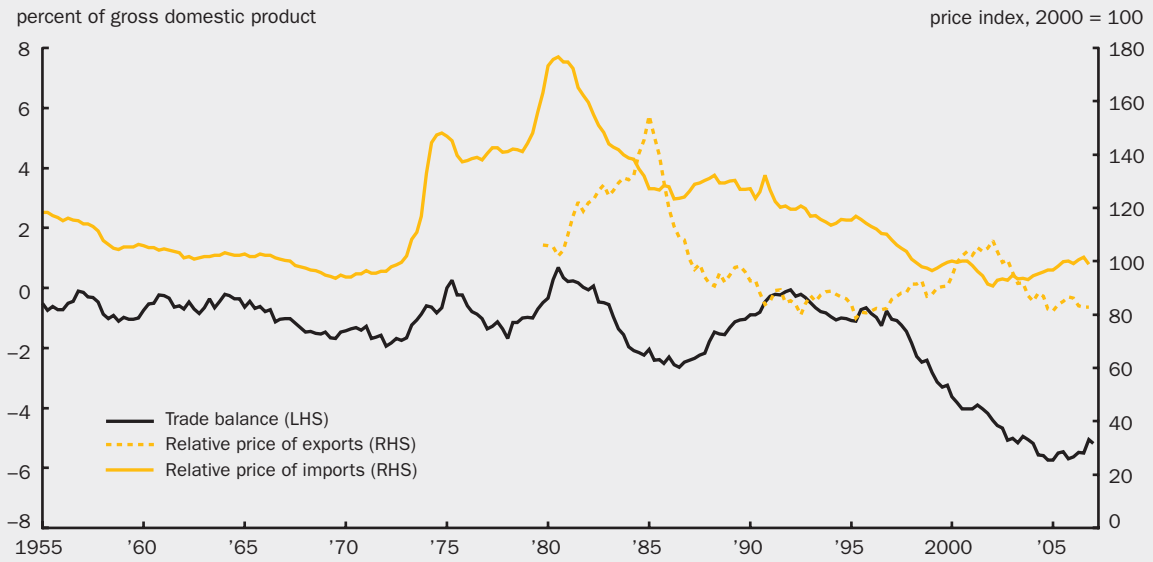
Previous research on trade elasticities

A highly influential paper by Houthakker and Magee (1969) estimated the income elasticity of demand for imports and exports with ordinary least squares for 15 industrialized countries, using annual data from 1951 through 1966. They identified an important robust empirical relationship that has become known as the Houthakker–Magee asymmetry. Specifically, the U.S.'s income elasticity with respect to imports was higher than its income elasticity with respect to exports by a factor of roughly 1.5. See table 1. Houthakker and Magee's estimate of the U.S. income elasticity with respect to imports of 1.51 implies that for every 1 percent increase in U.S. GDP, Americans increase their purchases of imports by 1.51 percent. In contrast, Houthakker and Magee's estimate of the U.S.'s income elasticity with respect to exports of 0.99 means that for every 1 percent increase in the GDP of the U.S.'s trading partners, the U.S.'s exports increase by only about 1 percent. The asymmetry between these two estimates has important implications for the U.S. trade deficit.

Johnson (1958) noted that how the trade balance evolves over time depends crucially on each economy's income elasticity of exports and imports. Johnson

FIGURE 1

U.S. trade balance



Notes: LHS means left-hand scale. RHS means right-hand scale.
Sources: Authors' calculations using data from the U.S. Bureau of Economic Analysis; International Monetary Fund, International Financial Statistics database; and Haver Analytics.

TABLE 1

Selected estimates of U.S. long-run trade elasticities

	Imports			Exports				
	Income	Relative price	Real effective exchange rate	Income	Relative price	Real effective exchange rate	Methods	Sample period
Houthakker and Magee's estimates	1.51	–0.54		0.99	–1.51		OLS	1951–66
Hooper, Johnson, and Marquez's estimates	1.79	–0.31		0.83	–1.47		Johansen ML	1961–94, imports 1976–94, exports
Chinn's estimates	2.29		–0.12	1.62		–0.73	Johansen ML	1975–2003
Cardarelli and Rebucci's estimates	2.03	–0.69		1.85	0.02		OLS	1973–2006
Cardarelli and Rebucci's estimates—correcting for aggregation bias	1.68	–1.45		1.60	–0.26		OLS	1972–2006
Authors' estimates	1.93	–0.63		2.34		–0.61	Johansen ML	1960–2006, imports 1981–2006, exports

Notes: OLS means ordinary least squares. Johansen ML means Johansen's (1988) maximum likelihood estimator.
Sources: Authors' calculations; Haver Analytics; Houthakker and Magee (1969); Hooper, Johnson, and Marquez (2000); Chinn (2004); and Cardarelli and Rebucci (2007).

showed that if trade between two countries is initially balanced, relative prices are constant, and income growth is constant in both economies, and if an economy's income elasticity of demand for imports is not the same as the foreign income elasticity of demand for its exports, then the trade balance in each economy can change over time. Johnson's model and the Houthakker–Magee asymmetry together imply that if the U.S. and the rest of the world grew at the same rate, the U.S. trade deficit would widen over time if relative prices remained constant.

Various reasons have been put forward to explain the Houthakker–Magee asymmetry in the literature. Mann (2002) lists demographic differences between the U.S. population and its major trading partners as possible reasons for the asymmetry. Citing Gould (1994) and Marquez (2002), Mann notes that there is a relatively high share of immigrants in the U.S. population and that these immigrants have a strong preference for goods from their respective home countries. Furthermore, a relatively young population in the U.S. has a greater demand for goods, especially imported goods, compared with the relatively older populations in Europe and Japan that spend proportionally more on domestic services, such as health care.

A misspecified model could also be behind the asymmetry. Krugman (1989) developed a model in which countries grow by producing new goods that can be exported. His theory implied that empirical models used to estimate elasticities should include a supply term in the import demand equation. Gagnon (2004) includes a supply term—the GDP of the exporting country—in the import demand equation, and finds strong evidence of a supply effect. The inclusion of this variable in the equation leads to a reduction in the estimate of the U.S.'s income elasticity for imports.

The U.S.'s trade elasticities have been estimated in numerous papers since Houthakker and Magee's findings were published in 1969, but the asymmetry has proven to be robust across time periods and econometric methods.[4] See table 1.

Table 1 summarizes the results of several recent papers. An important contribution by Hooper, Johnson, and Marquez (2000) uses Johansen's (1988) cointegration technique to estimate the long-term trade elasticities for the G-7 countries, and finds that the U.S. income elasticity of imports is roughly twice as high as the income elasticity of exports. Chinn (2004), using different measures of relative import and export prices and several additional years of more recent data, estimates

income elasticities of imports and exports that are larger in magnitude than both Houthakker and Magee (1969) and Hooper, Johnson, and Marquez (2000). While the absolute difference between the import and export elasticities is a substantial 0.7, the relative asymmetry appears more modest than in earlier studies, with the income elasticity for imports only 1.4 times larger than the income elasticity for exports.

Continuing down the rows of table 1, Cardarelli and Rebucci (2007) estimate large income elasticities for imports and exports of 2.0 and 1.9, respectively. Their study notes that trade elasticities are affected by aggregation bias. Specifically, aggregate price elasticities might be understated relative to a trade-weighted average of sector elasticities if goods with relatively low price elasticities face stronger price variation than goods with relatively high price elasticities. Cardarelli and Rebucci correct for aggregation bias by estimating separate trade elasticities for 17 categories of imports and 16 categories of exports and then taking the simple average of these separate estimates. Income elasticities are lower and price elasticities are higher when the aggregate estimate is constructed from sector-level estimates. It is interesting to note that the Houthakker–Magee asymmetry almost disappears in Cardarelli and Rebucci's estimates that correct for aggregation bias.

Finally, one important feature of U.S. imports and exports that has been changing recently is that services trade is becoming more prominent. To the extent that trade elasticities for services differ from those for goods, this could have important implications for the evolution of the U.S. trade balance. For example, Wren-Lewis and Driver (1998) find that the elasticity of U.S. exports of services to foreign income of 1.95 is much higher than that of manufactured goods (1.21), and they find that the elasticity of U.S. imports of services with respect to U.S. income (1.72) is much lower than that of manufactured goods (2.36).[5] In other words, the Houthakker–Magee asymmetry is reversed for U.S. trade in services. Mann (2002) argues that the Houthakker–Magee asymmetry between the import and export elasticities of trade in *goods and services* might gradually attenuate as the world's economies mature and spend more on services and less on manufactured goods.

Econometric model

The empirical model relating imports to national income and relative import prices and the model relating exports to foreign national income and relative export prices come from Hooper, Johnson, and Marquez (1998, 2000). These models assume that income and price elasticities of demand for imports and exports are constant over time. We estimate each system of equations using quarterly data for each of the G-7 countries.

The system for real imports is

$$1)\quad m_{it} = \sum_{j=1}^{n} \alpha_{ij} m_{it-j} + \sum_{j=1}^{n} \gamma_{ij} y_{it-j} + \sum_{j=1}^{n} \lambda_{ij} rpm_{it-j} + \varepsilon_{it},$$

$$2)\quad y_{it} = \sum_{j=1}^{n} \tau_{ij} m_{it-j} + \sum_{j=1}^{n} \upsilon_{ij} y_{it-j} + \sum_{j=1}^{n} \phi_{ij} rpm_{it-j} + \varsigma_{it},$$

$$3)\quad rpm_{it} = \sum_{j=1}^{n} \theta_{ij} m_{it-j} + \sum_{j=1}^{n} \nu_{ij} y_{it-j} + \sum_{j=1}^{n} \chi_{ij} rpm_{it-j} + \varphi_{it},$$

where m_{it} is the log of real imports of country i at time t, y_{it} is the log of real GDP of country i at time t, and rpm_{it} is the log of the relative price of imports to domestic goods and services, or more precisely, the log of import prices relative to the GDP deflator for country i at time t.

Similarly, the system for real exports is given by

$$4)\quad x_{it} = \sum_{j=1}^{n} \delta_{ij} x_{it-j} + \sum_{j=1}^{n} \kappa_{ij} fy_{it-j} + \sum_{j=1}^{n} \xi_{ij} rpx_{it-j} + \mu_{it},$$

$$5)\quad fy_{it} = \sum_{j=1}^{n} \rho_{ij} x_{it-j} + \sum_{j=1}^{n} \eta_{ij} fy_{it-j} + \sum_{j=1}^{n} \iota_{ij} rpx_{it-j} + \sigma_{it},$$

$$6)\quad rpx_{it} = \sum_{j=1}^{n} \omega_{ij} x_{it-j} + \sum_{j=1}^{n} \varsigma_{ij} fy_{it-j} + \sum_{j=1}^{n} \psi_{ij} rpx_{it-j} + e_{it},$$

where x_{it} is the log of real exports of country i at time t, fy_{it} is the log of real trade-weighted foreign GDP of country i's export partners at time t, and rpx_{it} is the log of a measure of the relative price of exports for country i at time t. Construction of all variables is detailed in the next section.

In brief, we construct a trade-weighted foreign GDP series for each exporting country i, using data on all of its trading partners for which we could obtain a quarterly real seasonally adjusted GDP series over a sufficiently long time horizon. Thus, our confidence in the estimated export elasticities with respect to prices and income rises with the coverage of our foreign GDP series. For the U.S., we also estimate the model using real annual data because although this reduces the number of observations in our data sample considerably, it increases the country coverage of our foreign GDP variable.

We use two different price series as the relative price of exports. The first measure follows Hooper, Johnson, and Marquez (1998, 2000) and is essentially the log of the ratio of export prices to the trade-weighted GDP deflators in the importing countries. Although this measure is theoretically preferred, our relatively low level of country coverage led us to use also the International Monetary Fund's (IMF) real effective exchange rate, or REER (the ratio of unit labor costs in the exporting country divided by export-weighted unit labor costs in the destination markets), as a proxy for the relative price of exports.

We estimate both the import system and the export system by using Johansen's (1988) full information maximum likelihood estimator, and report estimates for which test statistics support our assumption that at least one cointegrating relationship is present in the data. This estimator essentially assumes that each variable in the system is stationary in first differences, but information on the level of a variable or variables also helps to describe the system.

Data

Quarterly data on real seasonally adjusted imports and exports of goods and services and chained price indexes of imports and exports of goods and services for each of the G-7 countries come from Haver Analytics' Group of Ten (G-10) database.[6] Data on quarterly real GDP and GDP deflators for the G-7 countries and their trading partners come from Haver Analytics' G-10 database and the Organization for Economic Cooperation and Development's (OECD) *Main Economic Indicators*.[7] The GDP data for six additional G-7 trading partners—Argentina, Brazil, China, Hong Kong, Singapore, and Taiwan—come from internal estimates of Federal Reserve Board staff. The periods for which data are available vary by country. The periods used in estimating the import and export systems of each G-7 country are reported in tables 3 and 4.

While we have tried to use data from the OECD whenever possible, estimates for France, Germany, and Japan utilize additional data sources.[8]

The construction of all variables follows Hooper, Johnson, and Marquez (2000). The relative price of imports (rpm_i) is constructed as:

$$rpm_i = \log (PM_i/PY_i),$$

where PM_i is the chained price index of imports for country i and PY_i is the GDP deflator for country i.[9]

The relative price of exports (rpx_i) is constructed as follows:[10]

$$rpx_i = \log (PX_i \times E_{\$/i}/GPF_i),$$

$$GPF_i = \Pi(GDPF_j \times E_{\$/j})^{wij}, \Sigma w_{ij} = 1,$$

where PX_i is the export price of country i and GPF_i is the geometric mean of the domestic prices of country i's export partners adjusted by the nominal exchange rate index. Note that $GDPF_j$ is the GDP deflator for country j.[11] Also, note that $E_{\$/j}$ is an exchange rate index for country j that normalizes the amount of dollars that can be bought with a unit of local currency to a value of 1 in the year 2000. The weight w_{ij} is the proportion of country i's exports going to country j. The weights are constructed using bilateral exports of goods in 2000, which were obtained from the OECD's STAN Bilateral Trade Database.[12] For estimates reported in table 2 on a data sample that ends in 1994, we construct foreign GDP, using weights on bilateral exports of goods in 1995.

The foreign income used in the export equation is constructed as the geometric mean of the real GDP of each of country i's export partners weighted by the export shares of trade in goods. It is calculated as follows:

$$FY_i = \Pi(Y_j \times E_{\$/j})^{wij}, \Sigma w_{ij} = 1,$$

where FY_i is the aggregate foreign income for country i, Y_j is the real GDP of trading partner j for country i, and the weight w_{ij} is the proportion of country i's exports going to country j.

Lastly, we also estimate the export system using the IMF's real effective exchange rate as a measure of the relative price of exports. The appendix contains a description of the REER and compares it with the relative price of exports (rpx_i) measure described previously.

Results: Long-run elasticities

Estimates of long-run trade elasticities are presented in table 2 through table 6. Our results are generally in line with previous studies, but some interesting differences exist. Notably, our estimates of the import elasticities with respect to income for the G-7 countries over a period of time that ends in 2006 are generally higher than those reported by Hooper, Johnson, and Marquez (1998, 2000), whose sample period ends in 1994. Further, many of our import price elasticities are larger and more negative than those reported by Hooper, Johnson, and Marquez. On the export side, our estimates of the export elasticities with respect to income are as large as or larger than Hooper, Johnson, and Marquez's estimates, which cover an earlier period. The export price elasticities we report differ markedly from those in Hooper, Johnson, and Marquez's research, but not in any systematic way.

TABLE 2

Long-run elasticities of industrialized countries through 1994

A. Estimates

	Income				Price			
	Hooper, Johnson, and Marquez's estimates		Authors' estimates		Hooper, Johnson, and Marquez's estimates		Authors' estimates	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Canada	1.1*	1.4*	1.56*	1.50*	–0.9*	–0.9*	–0.61*	–1.14*
France	1.5*	1.6*	—	1.30*	–0.2	–0.4*	—	–0.50*
Germany	1.4*	1.5*	2.06*	2.26*	–0.3	–0.06*	–0.79*	–0.42*
Italy	1.6*	1.4*	1.64*	1.63*	–0.9*	–0.4*	–0.57*	–0.33*
Japan	1.1*	0.9*	0.99*	1.65*	–1.0*	–0.3*	–0.74*	–0.15*
UK	1.1*	2.2*	0.97*	1.70*	–1.6*	–0.6	–1.31*	–0.38*
U.S.	0.8*	1.8*	2.33*	1.92*	–1.5*	–0.3*	–0.24*	–0.25*
U.S., annual	—	—	1.06*	1.78*	—	—	–0.97*	–0.19*

B. Lags and sample periods

	Number of lags				Sample period start dates			
	Hooper, Johnson, and Marquez's estimates		Authors' estimates		Hooper, Johnson, and Marquez's estimates		Authors' estimates	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Canada	9	8	4	2	1976:Q1	1961:Q1	1981:Q1	1961:Q1
France	2	3	—	5	1975:Q4	1971:Q3	—	1978:Q1
Germany	2	2	3	3	1977:Q4	1968:Q1	1981:Q1	1979:Q4
Italy	2	4	3	5	1976:Q1	1971:Q2	1981:Q1	1981:Q1
Japan	5	6	3	8	1976:Q1	1955:Q2	1981:Q1	1980:Q1
UK	4	5	6	4	1976:Q1	1955:Q1	1981:Q1	1955:Q1
U.S.	2	9	3	4	1976:Q1	1959:Q3	1981:Q1	1955:Q1
U.S., annual	—	—	3	3	—	—	1981	1955

*Significant at the 5 percent level.
Note: All sample periods end in 1994:Q4.
Sources: Authors' calculations; Haver Analytics; and Hooper, Johnson, and Marquez (2000).

To summarize, most of our estimates appear reasonable; however, some estimates, discussed in detail later, appear questionable. Interestingly, our estimates suggest that trade elasticities with respect to income are increasing over time. This is consistent with a globalizing world economy in which trade is becoming more important.

Comparing our results with previous research

Table 2 presents our estimates of the long-run trade elasticities of the G-7 countries for the period through the fourth quarter of 1994.[13] The objective of this exercise is to replicate as closely as possible the long-run elasticities of Hooper, Johnson, and Marquez (2000). This is a useful starting point because before we can draw any conclusions about whether elasticities have changed over time, we would like to understand how closely our data and econometric techniques are able to reproduce previous work.

Overall, our import elasticities with respect to income and prices are close to those of Hooper, Johnson, and Marquez (2000), but they do not match perfectly. We suppose that the differences are due to three causes: 1) Hooper, Johnson, and Marquez have a longer time series of data extending further back into history than ours; 2) they likely made adjustments to some data series;[14] and 3) we report estimates using a different number of lags than Hooper, Johnson, and Marquez.[15]

As for the estimates of export elasticities with respect to income and prices, the differences between our estimates and those of Hooper, Johnson, and Marquez (2000) using data through 1994 are small for most countries. However, our estimate for the U.S. income elasticity using quarterly data seems implausibly large. In addition to the differences in sample periods,[16] there are likely two additional causes for the discrepancies between our estimates and Hooper, Johnson, and Marquez's estimates of export elasticities: 1) We use the IMF's REER as a measure of the relative export prices (see the discussion in the appendix) and 2) Hooper, Johnson, and Marquez likely have a measure of foreign GDP that covers a larger share of each country's

trading partners. Because Johansen's (1988) estimator uses information on the level of foreign GDP as well as the growth rate, the estimated elasticities are sensitive to the construction of the foreign GDP variable.

Turning to columns 2 and 4 of panel A of table 2, we see the estimates of the import elasticities with respect to income of Hooper, Johnson, and Marquez (2000) and our own, respectively. The major discrepancies between the Hooper, Johnson, and Marquez's estimates and our estimates occur for the UK, Germany, and Japan. Our estimated income elasticity of 1.7 for the UK is closer to the long-run equilibrium elasticity of 1 suggested by economic theory. Further, we estimate a statistically significant negative price elasticity of –0.38 in line with the negative elasticity predicted by theory, whereas Hooper, Johnson, and Marquez's estimate was not statistically different from zero.

For both Japan and Germany, our estimated income elasticities with respect to imports diverge from Hooper, Johnson, and Marquez's by more than a factor of 1.5. We attribute these differences to the longer time span of their data and possible differences in their handling of German reunification. They use German data series that begin in 1968, while ours start in 1979. Moreover, we constructed long time series of German imports, import prices, and GDP from series on West Germany and reunified Germany. Also, Hooper, Johnson, and Marquez's Japan data series begins in 1955, while ours begins in 1981.

In columns 1 and 3 of panel A of table 2, we show Hooper, Johnson, and Marquez's (2000) estimates for export elasticities with respect to income, as well as our own. There are small differences between the two sets of estimates for most countries. For Italy, Japan, and the UK, our export elasticities with regard to income are quite close to Hooper, Johnson, and Marquez's. However, we estimate substantially larger income elasticities for Canada, Germany, and the U.S. We do not report export coefficients for France because no specification gave sensible results. On the price side, our estimated elasticities are uniformly smaller, with the exception of Germany.

Lastly, we estimated the import and export systems using annual data for the U.S. through 1994 (last row of panel A of table 2). Our annual estimates of trade elasticities are close to or the same as Hooper, Johnson, and Marquez's estimates using quarterly data. On the export side, by estimating the system on annual data, we were able to incorporate a measure of foreign GDP that includes several of the U.S.'s smaller trading partners for which we only have annual data on real GDP. The annual model's generally better agreement with Hooper, Johnson, and Marquez's results suggests that the construction of foreign GDP is of primary importance.

Import elasticities for industrialized countries through 2006

In table 3, we present our estimates of the import elasticity with regard to income and prices through 2006 alongside our estimates for the period through 1994. For all countries except the UK, the estimated import elasticities with respect to income are higher over the sample period through 2006, suggesting that income elasticities might be increasing over time.[17]

Income and price elasticity estimates for Canada, France, Italy, the UK, and the U.S. are of the expected sign, and they are statistically significant at a 5 percent significance level. Estimates for Germany and Japan, which are unreasonably high for income and no different from zero for price, may be attributed to the data issues outlined earlier.

The import income elasticities are substantially greater than one for all countries over both sample periods. As mentioned earlier, this implies a long-run imbalance in that, as a nation grows, if relative prices are constant, imports will eventually exceed GDP. Second, the income elasticities have increased in all of the G-7 countries except the UK and possibly the U.S. Estimates of the income elasticity for the U.S. using quarterly data show no change between the earlier and later sample periods. However, estimating the import system on annual U.S. data suggests that the income elasticity has increased over time. Estimates of the U.S. price elasticity appear to have increased over time using either quarterly or annual data.

The higher price elasticities that we estimate for France, the UK, and the U.S. could be the result of increasing global price competition. As tariffs and other trade barriers fall, consumers might be able to switch their purchases to lower-cost producers more easily, resulting in an increased sensitivity of imports to prices.

Two different phenomena could be behind the apparently higher income elasticities in the sample that includes data through 2006. First, import price indexes tend to overstate the true price of imports. It is well known that much trade growth comes from new products, which could be an old product that is coming from a new, cheaper market (for example, China) or a truly new product that is likely to be of higher quality or a relatively lower price than the previously existing product. Because statistical agencies tend to treat imports of new products as having the same price as old products, this creates an upward bias in import prices. As increasing shares of imports come from developing countries, this bias could be increasing. In estimating the import elasticity with respect to income and prices, an upwardly biased price measure would lead to a larger income elasticity and a smaller (in absolute value) price elasticity.

TABLE 3

Long-run import elasticities for industrialized countries through 2006

A. Estimates

	Start through 2006		Start through 1994	
	Income	Price	Income	Price
Canada	1.67*	–1.17*	1.50*	–1.14*
France	1.62*	–0.61*	1.30*	–0.50*
Germany	3.28*	0.08	2.26*	–0.42*
Italy	2.48*	–0.23*	1.63*	–0.33*
Japan	1.94*	0.05	1.65*	–0.15*
UK	1.65*	–0.60*	1.70*	–0.38*
U.S.	1.93*	–0.63*	1.92*	–0.25*
U.S., annual	1.95*	–0.47*	1.78*	–0.19*

B. Sample periods

	Start through 2006	Start through 1994
Canada	1961:Q1–2006:Q4	1961:Q1–1994:Q4
France	1978:Q1–2005:Q2	1978:Q1–1994:Q2
Germany	1979:Q4–2006:Q4	1979:Q4–1994:Q4
Italy	1981:Q1–2006:Q4	1981:Q1–1994:Q4
Japan	1980:Q1–2006:Q3	1980:Q1–1994:Q3
UK	1955:Q1–2006:Q4	1955:Q1–1994:Q4
U.S.	1955:Q1–2006:Q4	1955:Q1–1994:Q4
U.S., annual	1955–2006	1955–1994

C. Number of lags

	Start through 2006	Start through 1994
Canada	4	2
France	3	5
Germany	2	3
Italy	7	5
Japan	3	8
UK	4	4
U.S.	3	4
U.S., annual	3	3

*Significant at the 5 percent level.
Sources: Authors' calculations and Haver Analytics.

Second, vertical integration is thought to be behind much of the recent rapid expansion of trade. Vertical integration is the process by which firms have spread their production processes across several countries so that production processes requiring lower-skilled labor (such as manual assembly) happen in less developed countries, whereas production processes that are more capital intensive and require higher-skilled labor (such as building an engine) happen in more developed countries. An example of a vertically integrated production process would be a car manufacturer that previously produced an entire car from start to finish in the U.S. Under a vertically integrated production process, the engine and other higher-tech components would be made in the U.S. and then exported to Mexico, where the assembly of the car would take place. When the finished car is imported into the U.S., the total value of the car (including not only the value created in Mexico when the car was assembled, but also the value of the parts exported from the U.S.) is recorded in U.S. import statistics. Thus, because the total value of imports increases with vertical integration, this leads estimates of the import elasticity with respect to income to be overstated.[18]

Lastly, returning to our estimates in table 3, we note that Germany has the largest increase in income elasticity across the two periods as well as the largest income elasticity in both periods. The sizable increase may be attributable to the inclusion of both preunification and postunification Germany in the sample. Preunification (West) Germany had relatively higher import growth and GDP growth than postunification Germany. The sample of data through 1994 includes only a few years of unified German data; thus, the model essentially estimates elasticities for preunification Germany. In contrast, the sample through 2006 includes several years of both preunification and postunification data. The differences in GDP and import growth rates between the preunification and postunification periods might make it appear that there is a particularly strong relationship between income and imports.

Export elasticities for industrialized countries in 1981–2006

Table 4 compares our estimates of export elasticities on data from 1981 through 1994 with our estimates on data from 1981 through 2006. The last column reports the share of each country's exports that each foreign GDP series covers. With the exception of Canada, estimates of the income elasticity for the G-7 countries over the period 1981–2006 are as large as or larger than those for the period 1981–94. This could be interpreted as evidence that export elasticities with respect to income are increasing over time.

For Canada, France, Germany, Italy, Japan, and the U.S., estimates of the export elasticities with regard to income and prices are of the expected sign and are statistically significant. The estimate of the UK's export elasticity with respect to income is of the correct sign, but its elasticity with respect to relative export prices is positive. This implies that the UK

TABLE 4

Long-run export elasticities for industrialized countries through 2006

A. Estimates

	1981–2006		1981–94		Export share
	Income	Price	Income	Price	
Canada	1.06*	–0.18*	1.56*	–0.61*	95
France	1.22*	–2.86*	—	—	57
Germany	2.67*	–1.15*	2.06*	–0.79*	55
Italy	1.74*	–0.74*	1.64*	–0.57*	70
Japan	1.70*	–0.34*	0.99*	–0.74*	72
UK	1.28*	1.17*	0.97*	–1.31*	61
U.S.	2.34*	–0.61*	2.33*	–0.13*	77
U.S., annual	—	—	1.06*	–0.97*	83

B. Number of lags

	1981–2006	1981–94
Canada	8	4
France	4	—
Germany	3	3
Italy	4	3
Japan	4	3
UK	4	6
U.S.	2	3
U.S., annual	—	3

*Significant at the 5 percent level.
Note: Estimates use a 1981:Q1–2006:Q4 sample and a 1981:Q1–1994:Q4 sample.
Sources: Authors' calculations and Haver Analytics.

exports more when its products are more expensive than its competitors' and, consequently, is difficult to reconcile with an imperfect substitutes model of trade.

The export share of a country's trading partners included in its foreign GDP measure (column 5) appears to be highly correlated with the quality of the estimates. The countries that have the most implausible income (Germany) and price (France, Germany, and the UK) elasticities also have the smallest share of their trading partners included in their respective foreign GDP measures. For example, we cover only 57 percent of French exports in constructing the foreign GDP measure for France, and estimate an extremely large price elasticity over the period 1981–2006. As stated previously, we estimate a positive and significant price elasticity for the UK, where our foreign GDP series covers only 61 percent of exports. These results contrast sharply with the estimates for Canada, where we cover 95 percent of Canada's trade-weighted trading partners in our foreign GDP variable and the coefficients are much closer to those implied by theory.

Comparing the import and export elasticities on the samples through 2006, we see that the Houthakker–Magee asymmetry holds for all the G-7 nations except the U.S. Of particular interest, in our estimates the asymmetry holds for Japan, both on the sample through 2006 and on the sample through 1994. This diverges from previous estimates that found that Japan's export elasticity for income exceeded its import elasticity for income (Houthakker and Magee, 1969; and Hooper, Johnson, and Marquez, 2000).

There is no obvious time trend in the Houthakker–Magee asymmetry across countries. The asymmetry appears to have increased in Canada, Germany, and Italy, while it moderated in Japan and the UK. Returning to table 1 (p. 6), we see that studies of U.S. elasticities incorporating the most recent data have tended to find a more moderate relative asymmetry in the U.S.

Estimates of import elasticities for the U.S. by sector

Table 5 presents disaggregated import elasticities with respect to income and prices for three periods: 1967–2006, 1967–87, and 1988–2006.[19] In choosing 1988 as a somewhat arbitrary breakpoint, we hoped to split the sample into an early period of relatively high trade barriers and high inflation and a later period of lower trade barriers and more stable prices. Moreover, by 1988, much of the U.S. dollar depreciation formalized in the Plaza Accord of 1985 and the Louvre Accord of 1987 is likely to have fully passed through into import prices.[20] Comparing the early and later sample periods across disaggregated imported goods and services, we generally observe higher income elasticities and, with some exceptions, higher price elasticities in the later period.

The first two columns present the estimates on the 1967–2006 sample. The next two present the estimates on the 1967–87 sample. The following two columns present the estimates on the 1988–2006 sample. To give the reader a sense of how important each category is, the final column of table 5 shows each end-use category's share of year 2000 imports.

Beginning in the top row of table 5, the income elasticity for total imports appears to have increased over time. The price elasticities for total imports show the same upward trend over time as the estimates in table 3.[21] We turn next to the estimates for industrial durables (row 4) and industrial nondurables excluding oil (row 5). Imports of industrial durables are primarily composed of iron, steel, other metals, and building materials. In the 1988–2006 period, the estimated price elasticity of industrial durables is not significantly

TABLE 5

Long-run U.S. import elasticities, by sector

	1967–2006		1967–87		1988–2006		2000 import share
	Income	Price	Income	Price	Income	Price	
Total imports	1.98*	–0.47*	1.94*	–0.37*	2.11*	–0.62*	100
Goods	2.10*	–0.42*	1.98*	–0.22*	2.18*	–0.69*	84
Industrial goods except oil	1.33*	–0.43*	1.12*	–0.32*	1.82*	–0.41*	12
Industrial durables	1.14*	–0.89*	0.62*	–0.21*	2.11*	–0.04	6
Industrial nondurables	1.63*	–0.32*	1.71*	–0.41*	1.56*	–0.79*	6
Petroleum	1.05*	1.00*	0.30	0.82*	1.23*	–0.03	8
Capital goods except autos	2.54*	–1.04*	4.08*	–0.87*	–1.20	–2.39*	24
Autos	1.64*	–0.38	3.07*	–1.10*	2.03*	0.11	13
Consumer goods except autos	2.42*	–0.84*	2.83*	–0.97*	1.76*	–1.78*	19
Durable consumer goods	2.21*	–1.05*	2.68*	–0.90*	2.56*	–0.87*	10
Nondurable consumer goods	2.41*	–1.02*	3.05*	–1.04*	3.68*	1.34	9
Services	1.58*	–1.32*	1.80*	–1.55*	1.64*	0.06	16
Nonpetroleum goods	2.20*	–0.63*	2.41*	–0.81*	1.82*	–1.07*	76

*Significant at the 5 percent level.

Notes: All estimates were calculated using three lags. The 2000 import share column presents that sector's or subsector's import value as a percent of total imports. Because we present the import shares of both aggregated sectors (for example, goods and services) and some of the finely disaggregated subsectors (for example, industrial durables and nondurables), the shares do not necessarily add up to 100.

different from zero. The high income elasticity and the low price elasticity may be indicative of price mismeasurement or vertical integration. Alternatively, since steel and other metals form a large share of industrial durables, government intervention and the threat of trade policy restrictions may play a role. The prospect of government action to protect the domestic industry may discourage price competition among exporters. In contrast, imported industrial nondurables are mostly chemicals and paper products. The increasing price elasticity we observe for industrial nondurables might suggest international price competition is increasing in this sector.

Continuing down to row 7, the income and price elasticities of demand for imports of capital goods excluding automobiles are of particular interest, since capital goods represent almost a quarter of total imports. Unfortunately, our estimates for this sector are not easily interpretable. The large negative price elasticity for the period 1988–2006 is probably an artifact of rapidly falling, yet difficult to measure, computer prices. Because computers make up a large share of this category, we might expect there would be significant difficulties in the construction of a price index for this sector. On both the 1967–2006 sample and the 1967–87 sample, the income elasticity of capital goods is quite high, higher than any other category. This is consistent with investment or purchases of capital goods being strongly pro-cyclical. These results are consistent with Chinn (2004), who found high income elasticities on capital goods.

Next, we turn to the estimates of the elasticities for consumer durables (row 10) and consumer nondurables (row 11). As with capital goods, income elasticities of consumer goods are higher than those of most other categories. This suggests that luxury goods may be playing an important role in imports of consumer goods. The elasticities for consumer durable imports are remarkably stable over both the 1967–87 and 1988–2006 samples. The pattern of change in the consumer nondurables coefficients suggests price mismeasurement. Given that this category is primarily apparel, one might not expect price measurement problems to be present (as opposed to a sector including computers). However, price varies widely across import source, and the end of textile quotas has led to a great deal of change in the source of apparel imports.

Finally, elasticities for imported services are presented in row 12 of table 5. We estimate the income elasticity for services imports to be 1.64 over the period 1988–2006, considerably lower than our estimated elasticity for imports of goods of 2.18. These estimates are close to those reported by Wren-Lewis and Driver (1998), who found the income elasticity for services imports to be 1.72 and for goods to be 2.36 by using the same methodology over an earlier period (1980–95).

Estimates of export elasticities for the U.S. by sector

Table 6 reports the disaggregated export elasticities by end-use category. Because quarterly real foreign GDP data are only available since 1981, we only estimate on the 1981–2006 and 1988–2006 samples. We present estimates that use the real effective exchange

TABLE 6

Long-run U.S. export elasticities, by sector

	Real effective exchange rate				Relative price of exports				2000 export share
	1981–2006		1988–2006		1981–2006		1988–2006		
	Income	Price	Income	Price	Income	Price	Income	Price	
Total exports	2.34*	–0.61*	1.86*	–5.07*	2.76*	0.12	3.83*	1.78*	100
Goods	2.51*	–0.63*	1.91	–8.56*	3.04*	0.20	4.90*	2.21*	72
Industrial goods except oil	1.62*	0.03	1.65*	–0.07	1.62*	0.07	1.58*	0.26*	15
Industrial durables	1.85*	–0.16	1.78*	0.30	2.16*	0.23	8.70	–76.98*	6
Industrial nondurables	1.48*	0.04	1.57*	–0.18*	1.48*	0.06	1.54*	–0.09	9
Agriculture	0.98*	0.19	1.10*	0.07	1.41*	0.55*	1.27*	0.30*	5
Capital goods except autos	3.33*	–1.79*	–5.94	–63.07*	7.12*	1.28*	–21.51*	–11.47*	24
Autos	2.42*	–0.01	2.53*	–0.82*	2.83*	0.35*	2.68*	0.19	7
Consumer goods except autos	2.79*	–0.83*	2.76*	–0.49*	2.77*	–0.75*	2.53*	–0.39	8
Durable consumer goods	3.00*	–1.11*	2.91*	–0.59*	2.79*	–1.09*	2.53*	–0.56*	4
Nondurable consumer goods	2.59*	–0.44*	2.59*	–0.41*	2.78*	–0.26	2.58*	–0.10	4
Services	2.04*	–0.25*	1.87*	–0.61*	2.38*	0.10	2.00*	0.31	28
Nonagricultural goods	2.70*	–0.77*	1.96	–10.14*	3.32*	0.23	5.60*	2.60*	67

*Significant at the 5 percent level.

Notes: All estimates were calculated using two lags and year 2000 weights. The 2000 export share column presents that sector's or subsector's export value as a percent of total exports. Because we present the export shares of both aggregated sectors (for example, goods and services) and some of the finely disaggregated subsectors (for example, industrial durables and nondurables), the shares do not necessarily add up to 100.

Sources: Authors' calculations and Haver Analytics.

rate in the first four columns and, for comparison, estimates using the relative price of exports in columns 5 through 8. The final column shows each end-use category's share of total U.S. exports in the year 2000.

While both price measures produce some problematic estimates, the REER estimates in general appear more reasonable. Using the REER as our price variable, most of the disaggregated categories have sensible estimates. These include the consumer goods categories, industrial goods, services, and automobiles. Some of these sectors have price elasticities that are not significantly different from zero. The very small price elasticities might be attributable to high-quality or unique U.S. exports, for which few substitutes exist. The major problem is the extreme capital goods price elasticity, which further appears to dominate any aggregate measure that includes capital goods. Given that U.S. exports include not only a large amount of high tech but also airplanes, we should expect problems.

Lastly, row 12 of table 6 presents the income and price elasticities of demand for exported services. Using the REER as the foreign relative price measure, we find that the income elasticity for services over the 1988–2006 period is a relatively large 1.87. Consistent with the findings of Wren-Lewis and Driver (1998), we find that the Houthakker–Magee asymmetry is reversed for services trade. Our income elasticity for services exports is considerably larger than the elasticity of services imports reported in table 5 of 1.64.

Conclusion

In this article, we present new estimates of trade elasticities for seven industrialized countries using data through 2006. We find that the Houthakker–Magee asymmetry, which implies an increasing trade deficit if relative prices are held constant, is present in all countries, with the exception of the U.S. Our high estimate of the U.S. income elasticity of demand for exports is found to be highly sensitive to the construction of foreign GDP. Thus, we do not think that our estimate is definitive.

While the Houthakker–Magee asymmetry has been present for most of the G-7 countries for a long time, our article is the first that we know of to find Japan's estimated import elasticity with respect to income is larger than its export elasticity with respect to income.

Finally, in estimating elasticities for disaggregated sectors, we find that our estimate of the U.S. export elasticity for services with respect to foreign income of 1.87 exceeds the U.S. import elasticity for services with respect to income of 1.64. This means that if the U.S. were to grow at the same rate as its trading partners, over time the U.S. trade balance in services would move toward larger and larger trade surpluses. This is consistent with previous research (Wren-Lewis and Driver, 1998) and suggests that the Houthakker–Magee asymmetry for aggregate trade in goods and services could gradually attenuate as services trade increases as a share of total trade.

NOTES

[1]These numbers are provided by the U.S. Bureau of Economic Analysis, and they are in real 2000 chain-weighted dollars. In current dollars, which do not adjust for inflation, 2006 imports were $2,229 billion and exports were $1,467 billion.

[2]The start dates for the estimation sample for each country vary according to data availability. We use the longest period available for each country. Sample start dates are reported in panel B of table 2 (p. 9).

[3]These numbers are in real 2000 chain-weighted dollars.

[4]Goldstein and Khan (1985) contain references to the early literature.

[5]Wren-Lewis and Driver's (1998) sample period is 1980–95. The cited numbers are those estimated using Johansen's (1988) maximum likelihood estimator.

[6]The Group of Ten actually comprises 11 nations: namely, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the UK, and the U.S. Luxembourg is an associate member of the G-10. Haver Analytics' G-10 database provides statistics from each country's national accounts in an easy-to-use format.

[7]Trading partners available from the OECD for sufficiently long periods include Australia, Canada, France, Germany, Italy, Japan, South Korea, Mexico, the Netherlands, Switzerland, Taiwan, the UK, and the U.S.

[8]For France, we follow Pluyaud (2006) and use the import price deflator from Eurostat, rather than the OECD, beginning in 1995. The two price indexes for French imports (Eurostat versus OECD) diverge after the introduction of the euro, apparently reflecting a difference in methodology. For Germany, we construct a time series for German real GDP growth by splicing the GDP series for the unified Germany to the (appropriately scaled) West German GDP series in 1991. Data on real German imports come from the IMF's International Financial Statistics (IFS) database. For Japan, real chain-weighted GDP is available from 1994 to the present. To obtain a longer time series of Japanese GDP, we splice a fixed-weighted GDP series for the period 1981–93 onto the chain-weighted series. For Japanese imports, we use real imports from the IMF's IFS database.

[9]The relative price measure has the same product coverage as our aggregate measure of trade. One disadvantage of this price measure is that it includes commodities such as oil, which should be perfectly substitutable across locations of production, and thus, the measure is somewhat inconsistent with the imperfect substitutes model of trade.

[10]The product coverage in the export price index of country *i* coincides with that country's aggregate measure of exports. This price measure is designed to incorporate price differences between exported goods from country *i* and the domestic goods at the export destination. It fails to incorporate the price of exports of other countries that compete with country *i*'s exports.

[11]Countries included in the calculation of the relative price of exports are: Argentina, Australia, Brazil, Canada, France, Germany, Hong Kong, Italy, Japan, South Korea, Mexico, the Netherlands, Singapore, Switzerland, Taiwan, the UK, and the U.S. For Argentina, Brazil, Hong Kong, Singapore, and Taiwan, the GDP deflator was not available. We used the Consumer Price Index (CPI) in place of a GDP deflator for these countries.

[12]Table A1 in the appendix lists the cumulative share of exports accounted for by those countries listed in note 11 for each of the G-7 countries.

[13]As noted previously, the sample start dates vary by country according to data availability, and they are reported in panel B of table 2 (p. 9).

[14]For example, a long time series for German data must be built from historical data on West Germany and reunified Germany. In the process of constructing this series, different researchers are likely to make different adjustments to the raw data.

[15]We estimate the model using between two and nine lags and then select the shortest lag length that corresponds to at least one cointegration vector and produces plausible results.

[16]Hooper, Johnson, and Marquez's (2000) export series start in the mid to late 1970s, while ours start in 1981. The omission of the second period of oil shock years from our sample could be an important source of differences.

[17]We do not conduct any formal tests for structural breaks or parameter stability. Hooper, Johnson, and Marquez (2000) conduct parameter stability tests and find that export elasticities are generally more instable than import elasticities.

[18]Cardarelli and Rebucci (2007) estimate trade elasticities for the U.S. after making an adjustment for the value of U.S. exports in categories of goods that are likely to be parts in a vertically integrated production process. They find that this correction for vertical integration lowers the income elasticity with respect to imports.

[19]Data on quarterly imports and exports disaggregated by end-use category from the U.S. Bureau of Economic Analysis begin in 1967.

[20]The Plaza Accord of 1985 was an agreement among the central banks of France, Germany, Japan, the UK, and the U.S. to reduce the value of the dollar through coordinated intervention in currency markets. The Louvre Accord of 1987 was a similar agreement in which the same central banks agreed to stop the dollar's decline.

[21]Differences between table 3 (p. 11) and table 5 (p. 13) are due to the use of slightly different sample periods.

APPENDIX

In this appendix, we discuss the IMF's real effective exchange rate and then compare the REER with the relative price of exports to foreign GDP deflators.

The IMF's real effective exchange rate

The REER for each of the G-7 countries is taken from the International Monetary Fund, Statistics Department (2007). It is calculated as:

$$REER_i = \log\left(ULC_i \times E_{\$/i} / ULCF_i\right),$$

$$ULCF_i = \Pi\left(ULC_j / E_{\$/j}\right)^{w_{ij}}, \Sigma w_{ij} = 1,$$

where ULC_i is the unit labor cost of the ith country expressed in U.S. dollars and $ULCF_i$ is the unit labor cost for rest of the world expressed in U.S. dollars. Note that $ULCF_i$ is calculated as the geometric mean of the unit labor cost in country i's trading partners, adjusted by the exchange rate. The 20 trading partners, denoted by j, are selected from the 21 industrialized countries.[1] The weights w_{ij} are based on aggregate trade flows for manufactured goods. An increase in the REER represents a real appreciation of the domestic currency.

According to the International Monetary Fund, Statistics Department (2007), unit labor costs are compensation of employees per unit of real output (or value added) in the manufacturing sector. It takes into account employer-paid social insurance premiums and other employment taxes in addition to wages and salaries. However, the International Monetary Fund, Statistics Department (2007) also notes that for the most recent quarters, indexes typically refer more narrowly to wages or wages and salaries per unit of total output of manufactured goods (rather than that of value added in the manufacturing sector).

The total trade weights were chosen to make the REER index sensitive to movements in costs affecting exports and imports of manufactured goods. The weights, which are built up from aggregate trade flows for manufactured goods (Standard International Trade Classification 5–8, or SITC 5–8) and are averaged over the period 1999–2001, take into account the relative importance of a country's trading partners in its direct bilateral relations with them, in both the home and foreign markets; they also take into account the relative importance of the competitive relations with third countries in particular markets.

Chinn (2004) calls this measure an empirical proxy for "cost competitiveness" and points out that one of the drawbacks of this measure as a proxy for cost competitiveness is that it reflects competitiveness in terms of labor cost, and not total cost. Given that we are estimating trade elasticities of goods and services, the facts that the weights (w_{ij}) are based on only manufactured goods and the compensations are from the manufacturing sector are further drawbacks of this measure.

TABLE A1

Percentage of trade accounted for in the relative price of exports and the real effective exchange rate

	Relative price	Real effective exchange rate
Canada	95	94
France	57	77
Germany	55	73
Italy	70	71
Japan	72	49
UK	61	79
U.S.	77	54

Sources: Authors' calculations and Haver Analytics.

Comparing the REER with the relative price of exports to foreign GDP deflators

The REER has more extensive country coverage than the relative price term for France, Germany, Italy, and the UK. Table A1 reports the percentage of exports accounted for by the countries included in the calculation of the REER and the relative price of exports. The countries included in the REER account for 77 percent of France's exports, 73 percent of Germany's exports, 71 percent of Italy's exports, and 79 percent of the UK's exports.[2] The relative price term has a better coverage of export partners for Canada, Japan, and the U.S.

The weights in the relative price of exports are based on exports of all goods, while the weights in the REER are based on aggregate manufacturing trade flows. This makes the relative price measure a more appropriate price measure in the export equation.

Important emerging markets are left out of the REER. Countries such as Argentina, Brazil, Hong Kong, South Korea, Mexico, Singapore, and Taiwan are included in the relative price of exports, but not in the REER. Hooper, Johnson, and Marquez (2000) report that including developing countries in the relative price and foreign GDP measure affects the estimated trade elasticities.

[1]The 21 countries included in the calculation of the REER are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the UK, and the U.S.

[2]The trade shares are the authors' own estimates using information from the IMF on countries included in the measure. Trade shares are calculated using 2000 bilateral trade of goods from the OECD's STAN Bilateral Trade Database.

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