Board of Governors of the Federal Reserve System

International Finance Discussion Papers

Number 781

October 2003

Revised: October 2004

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by

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Abstract

Most macroeconomic models imply that faster output growth tends to lower a country's trade balance by raising its imports with little change to its exports. Krugman (1989) proposed a model in which countries grow by producing new varieties of goods. In his model, faster-growing countries are able to export these new goods and maintain balanced trade without suffering any deterioration in their terms of trade. This paper analyzes the growth of U.S. imports from different source countries and finds strong support for Krugman's model.

Keywords: import demand, income elasticity, international trade, product differentiation

JEL Classification: F1, F4

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[1]Assistant Director, Division of International Finance, Board of Governors of the Federal Reserve System. (Mail Stop 19, 2000 C Street NW, Washington, DC 20551, joseph.e.gagnon@frb.gov) This paper is a major revision and extension of International Finance Discussion Paper No. 754. The earlier paper obtained similar results using a different dataset, but in most respects it is encompassed and superseded by this paper. I would like to thank Tam Bayoumi, David Bowman, Chris Erceg, Carolyn Evans, Luca Guerrieri, Chris Gust, Jane Haltmaier, Bill Helkie, Dale Henderson, Steve Kamin, Jane Little, Jaime Marquez, Trevor Reeve, John Rogers, Diego Valderrama and Kei-Mu Yi for helpful comments. The views expressed here are my own and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.

What are the long-run implications of the U.S. productivity acceleration for the U.S. trade balance and the dollar?

In most macroeconomic models, a permanent increase in a country's income relative to its trading partners tends to reduce its trade balance through higher imports, which must be offset in steady state by lower domestic prices or a depreciated exchange rate. This paper argues that higher U.S. income (or output)[2] need not cause a real depreciation in the long run. The key to this result is that economic growth increases the number of different goods that are produced as well as the variety of products within any given category. Because consumers have a taste for variety, they will consume more goods from a country that is growing faster, even in the absence of a decline in the relative price.

The topic of this paper is fundamentally a time-series question and the macroeconomic models typically used to address it also have a time-series orientation. The mechanism we are proposing does not lend itself easily to empirical time-series analysis, however, because the variety of goods in an economy is not directly measured by statistical agencies. Moreover, to the extent that this variety is linked to total output, it is most likely related to smoothly-growing potential output and not transient or cyclical output. This means that there are few inflection points in the data with which one could hope to identify the effect. The approach adopted in this paper is to take advantage of the fact that countries have experienced different average output growth rates over the past 30 years. We test whether these different long-run growth rates have been related to long-run export performance.

This cross-sectional approach shares much in common with the empirical gravity model

[2]For simplicity we assume that growth in income equals growth in output. This assumption holds very closely for nearly all of the countries in our sample.

literature. As in the gravity equation, the estimated equation of this paper is a reduced form resulting from the interaction of supply and demand for trade. The two main differences in our approach from the standard gravity model are 1) we focus on the long-run growth rate of trade rather than the level of trade at a point in time; and 2) we carefully model the role of relative production costs in order to help distinguish between the roles of exporter production capacity in the supply curve and in the demand curve.

We find that over the period 1972-2000 average growth of U.S. bilateral manufactured imports was strongly correlated with the average growth rate of GDP in the exporting country beyond the extent that can be explained by any plausible supply curve. This result is robust to the inclusion of a number of auxiliary variables, including different measures of income and real exchange rates, alternative measures of the number of varieties of traded goods, and measures of trade barriers, immigration, and foreign direct investment. This result is also robust to sample selection and to estimation technique – it is not an artifact of outliers in the data or of reverse causality from U.S. imports to foreign GDP. There is no reason to believe that this result does not apply to U.S. exports, although our methodology is not well-suited to focusing on differences in the varieties effect across exporting countries.

Previous Studies

Empirical macroeconomic models are used by both academics and policymakers to study the propagation of shocks through trade flows and exchange rates.[3] These models employ

[3]Examples include the Federal Reserve Board's FRB/US and FRB/Global models (Brayton *et. al.* (1997) and Levin *et. al*. (1997)), the IMF's MULTIMOD (Laxton *et. al.* (1998)), the OECD's Interlink model (Le Fouler *et. al*. (2001)), as well as open-economy dynamic general equilibrium models such as those of Chari *et. al.* (2002) and Erceg *et. al.* (2002).

import demand equations that are a function of aggregate demand or activity in the importing country and the relative price of imports. Export supply is typically modeled as part of aggregate supply in the exporting country, with perfect substitutability between domestic sales and exports. In some cases, exports are not perfectly substitutable for domestic sales, which allows for a degree of "pricing to market."

This approach to trade modeling has been termed the "elasticities approach" and it is one of the most successful areas of empirical economics. Equations relating trade flows to relative prices and importer income have been derived and estimated since the 1950s, with generally good statistical fit and sensible economic interpretation. The basic structure and theoretical motivation of import demand and supply equations are covered in Leamer and Stern (1970); Goldstein and Khan (1985) provide a thorough review of published empirical findings; and Hooper, Johnson, and Marquez (2000) and Marquez (2002) present updated estimates and discuss recent methodological advances. A key assumption of the elasticities approach is that each country produces a single good which is an imperfect substitute for goods produced in other countries. The one-country one-good assumption is sometimes referred to as the Armington assumption, after Armington (1969).

One empirical property of traditional import demand equations that has been noted since at least Houthakker and Magee (1969) is that income elasticities differ substantially across countries. In particular, U.S. imports are generally characterized by a higher income elasticity and U.S. exports by a lower income elasticity than imports and exports in other countries. One implication of this asymmetry is that at constant relative prices and equal growth rates of income across countries, the United States would be expected to have an ever-growing trade deficit. Alternatively, to keep trade in balance requires that the United States grow more slowly than most other countries or that it experience a continuous depreciation of its terms of trade. In this framework, an acceleration of U.S. potential output must be associated with a faster decline in the trade balance or a faster decline in the price of U.S. exportables relative to prices in foreign countries.

Krugman (1989) questioned this interpretation of the typical elasticity estimates. He noted that there is a negative cross-country correlation between the ratio of countries' estimated import and export income elasticities and their average income growth rates. In other words, slow-growing countries tend to have higher income elasticities of imports and lower income elasticities of exports than fast-growing countries. This property has allowed countries to grow at different rates over long periods of time with relatively modest trends in relative prices and small trade imbalances for the most part. Krugman thought this outcome was too fortuitous to be a coincidence. Instead, he argued that product differentiation and scale economies imply that countries grow by producing new goods that can be exported without an adverse effect on the terms of trade. This theory is based on earlier work by Helpman and Krugman (1985) and it is related to subsequent work by Grossman and Helpman (1991). The theory implies that standard trade equations are mis-specified – they omit a varieties term in import demand.[4]

The simple model of Krugman (1989) channels all economic growth into product proliferation, so that real output is directly proportional to the number of varieties produced. In the empirical work of this paper, we follow the Krugman model and use potential output growth

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[4]Riedel and Athukorala (1995) propose an alternative explanation based on the assumption that traded goods are perfect substitutes. However, the overwhelming consensus in the literature (see Goldstein and Khan (1985)) is that manufactures produced in different countries are not close to being perfect substitutes. For most OECD economies, including the United States, manufactures comprise around 80 percent of total merchandise imports.

in the exporting country as the varieties term in import demand.[5] We also employ another measure of this varieties effect based on the number of 4-digit SIC categories that are exported to the United States from a given source country.

Unbeknownst to Krugman when he published his paper, other studies had already found evidence of a varieties effect in import demand. Sato (1977) and Helkie and Hooper (1988) estimated import demand equations that augmented the usual relative price and importer income terms with a measure of exporter potential output. Sato's term was based on manufacturing capacity in the exporting countries. Helkie and Hooper used relative capital stocks between the exporting and importing countries. In both studies, the addition of an exporter potential output term eliminated the asymmetry of income elasticities in import demand equations between fast-growing and slow-growing countries.[6]

One weakness of the Sato and Helkie-Hooper approaches is that capacity and capital stocks are both very smooth time series, and in most countries capacity and the capital stock must be estimated statistically rather than observed directly. These properties make it difficult to get precise and significant estimates of the effect of exporter potential output in pure time-series

[5]Note that incomplete quality adjustment in import prices may provide an alternative role for exporter potential output to the extent that growth in output is associated with production of higher quality goods. In such a case, incorporating exporter potential output in the import demand equation can help to correct the bias introduced by mis-measured import prices.

[6]An alternative to introducing a varieties term in import demand is to correct the bias in import prices that arises from ignoring brand proliferation and not fully capturing quality improvement. In principle, the introduction of a new brand could be viewed as a decline in the price of the brand from a value that exceeds the reservation price of demand. Feenstra (1994) makes partial progress toward explaining the elasticity asymmetry by adjusting aggregate import prices downward with the entrance of new source countries in specific categories of U.S. imports. However, the Feenstra approach does not take into account new brands and varieties from countries that already export within a given category, nor does it address the issue of quality improvement.

data. The approach adopted in this paper is to estimate changes in potential output using changes in actual output. For sufficiently long time periods, the change in actual output should be very close to the change in potential output. The drawback of this approach is that we have very few observations for any one exporting country. In order to gain statistical power we disaggregate U.S. imports by source country and regress long-run changes in imports by source country on long-run changes in source-country GDP.

This cross-sectional approach shares much in common with the gravity model of trade. In the gravity model, bilateral trade is specified as a function of exporter GDP, importer GDP, distance between exporter and importer, and other variables that may affect trade such as tariffs, transportation costs, and cultural and political factors. Anderson (1979) and Bergstrand (1989) provide theoretical underpinnings for, and surveys of, the gravity model. The gravity literature is primarily concerned with explaining the pattern of trade among countries at a point in time and testing for the effects of various factors such as trade policies and currency unions.[7]

Recently, several studies have employed gravity-style models to quantify the relative importance of different theories of trade. Among the questions posed are whether there is more empirical support for the Armington assumption of product differentiation by country or for the Helpman-Krugman assumption of increasing returns to scale and endogenous product differentiation within countries. Two papers – Feenstra, Markusen, and Rose (2001) and Evenett and Keller (2002) – use gravity equations estimated at a point in time for different categories of

[7]Glick and Rose (2002) use a gravity model in panel data to look at the time series evidence on the effect of currency unions on trade. Their model constrains the exporter and importer GDP effects to be equal.

goods.[8] They interpret the estimated coefficients as providing support for a less restrictive version of the Helpman-Krugman model, at least for trade in differentiated manufactures. Their results are consistent with the results of this paper, but they do not rely on time-series properties of the data nor do they control for relative price effects.

Three other papers use different approaches to test the Armington versus Helpman-Krugman models. Hummels and Klenow (2002) examine total exports of 121 countries in 1995 disaggregated into roughly 5000 U.N. harmonized categories. They attribute 60 percent of the greater exports of large countries to the fact that they export more categories of goods than small countries and 40 percent to a greater volume of exports within each category. Head and Ries (2001) examine disaggregated data on U.S. and Canadian production and trade. They find the cross-sectional pattern is more consistent with the Helpman-Krugman model, while the time-series pattern (over 5 years) is more consistent with the Armington model. In contrast, Funke and Ruhwedel (2001, 2002) find support for the varieties effect in pooled time-series regressions of aggregate exports of several developing Asian economies (2001) and the OECD countries (2002) over the 1990s. Funke and Ruhwedel use a measure of variety based on the number of different categories of goods exported.

We are aware of only two studies that utilize the time-series information in trade data over a long sample to identify the varieties effect in trade. Baier and Bergstrand (2001) seek to quantify the sources of trade growth over a 30-year period. Their gravity-style regressions do indicate a significant role for exporter output in explaining the growth of trade, but this result is not the focus of their paper. Bayoumi (1999) uses pooled bilateral time-series regressions and he

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[8]These two papers follow the lead of Hummels and Levinsohn (1995), which raised questions about the empirical relevance of the Helpman-Krugman model.

also finds a significant role for exporter output in trade (among other conclusions). Neither study examines whether the role of exporter output derives from the supply curve or the demand curve. This paper focuses on the Krugman varieties effect and extends the bilateral estimates of Bayoumi (1999) and Baier and Bergstrand (2001) in several ways. We consider alternative measures of the growth in varieties. We explore the effects of bilateral tariffs and transportation costs. We use a much larger sample of exporting countries and conduct numerous robustness checks. We focus on long-run growth rates to avoid the problem of dynamics and autocorrelated errors. We exclude commodity imports which are unlikely to be characterized by changing product varieties. We combine a theoretical treatment of supply and demand (as in Baier and Bergstrand) with a consideration of the implications of exchange rate fluctuations and pricing to market (as in Bayoumi).[9]

Data

The dependent variables in the regressions of this paper are long-term average growth rates of U.S. bilateral manufactured imports for various source countries. In any given regression we include only one growth rate per source country, so that the statistical analysis is cross-sectional. We restrict our analysis to long-term changes in the data for two reasons: 1) the focus of the paper is on long-run demand and supply elasticities and we do not wish to specify and estimate adjustment dynamics; and 2) we do not observe exporter productive capacity and we want to proceed on the assumption that actual and potential output grow at the same rate in

[9]Gagnon (2004) examines multilateral exports of goods and services for up to 89 countries over the period 1960-2000, a sample for which no direct measures of variety and trade barriers exist.

the long run.

Bilateral manufactured imports disaggregated at the 4-digit SIC level were obtained from the NBER website (http://www.nber.org/data/) and are documented in Feenstra, Romalis, and Schott (2002).[10] These data include c.i.f.-f.o.b. differentials from 1978 forward and import duties from 1989 forward. Penn World Table data on per capita real GDP, population, and GDP price indexes are documented in Heston, Summers, and Aten (2002) and are available at their website: http://pwt.econ.upenn.edu/. All other variables were taken from the IMF's International Financial Statistics (IFS) database, including consumer price indexes (CPIs), producer (or wholesale) price indexes (PPIs), GDP volumes, and exchange rates. The growth rates are calculated as averages over two periods: 1972-2000 and 1989-2000. The longer period has the advantage of smoothing over transitory shocks. The data on cif-fob differentials and duties are available only over the shorter period. Sample countries were chosen based on data availability with the following exceptions: 1) countries with non-market economies for most of the sample were excluded, but China and Hungary were included because they opened up earlier than most of the transition economies; and 2) Iran and Libya were excluded due to the imposition of U.S. sanctions. The full sample is listed in Table 1.

Specification

The simple model presented in Krugman (1989) shows how the presence of economies of scale and a taste for variety in the consumption of differentiated products leads to a role for exporter production capacity in determining import demand. Krugman did not allow for

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[10]Manufactures are defined as SIC categories between 2000 and 3999.

nontraded goods, home bias in traded goods (or transportation costs), or price discrimination across countries. His model took the particularly simple form of equation (1), where *M* denotes imports, *YM* denotes importer income, *YX* denotes exporter income, and *YW* denotes world income.

$$(1) \qquad M = \left(\frac{YX}{YW}\right) YM$$

In the Krugman model, agents consume all of their income (*YM*). The share of their income that is spent on goods from any particular country is equal to that country's share of world output (*YX/YW*), and this relationship also applies to goods produced at home. Consumer demand for a country's goods is proportional to that country's share of world output because the number of varieties produced is assumed to be proportional to total output. We wish to test for the importance of this effect in a model without such strong auxiliary assumptions. Equation (2) is a standard import demand (Armington) equation augmented with terms for the production capacity of the exporting country and world income.

$$(2) \qquad M = \alpha Y^{\beta} \left(\frac{PM}{P}\right)^{\gamma} QP^{\lambda}\, W^{\sigma}\, U$$

In this equation, *M* denotes real imports, *PM* denotes the price of imports, *Y* denotes importer real income,[11] *P* denotes the price level of competing goods in the importing country,

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[11]The static theory of import demand traditionally is based on the importer's income. In an intertemporal setting it would be more appropriate to use domestic absorption, under the assumption that the intertemporal spending decision can be separated from the allocation of spending between imports and domestic goods. For the long-run growth rates we examine, absorption and income are nearly identical. Alternatively, to the extent that imports are inputs into the production process, income (output) may be the appropriate activity variable.

QP denotes exporter production capacity, *W* denotes world income, *U* is a stochastic shock, and parameters are denoted by Greek letters. In the standard (Armington) model there is no role for exporter capacity or world income ($\lambda = \sigma = 0$) whereas in the Krugman model imports respond proportionally to both exporter capacity and importer income ($\lambda = \beta = 1$) and inverse proportionally to world income ($\sigma = -1$). Here we allow all terms to be estimated freely.

Taking logarithms and focusing on the changes in variables eliminates the parameter α and yields equation (3) where lower-case letters denote log variables and we have made the assumption that long-term changes in potential output (*QP*) are equal to long-term changes in actual output (*Q*). Gagnon (2004) derives equation (3) in an optimization framework that enforces the relationship $\sigma = -\lambda$.

(3) $$\Delta m = \beta \Delta y + \sigma \Delta w + \lambda \Delta q + \gamma \Delta \left(pm - p \right) + \Delta u$$

The main difficulty in estimating equation (3) is that we have data on nominal bilateral imports of manufactures but not on the prices and quantities of these imports. The approach we take here is to specify an import supply relationship that will be combined with the demand relationship in equation (3) to create a reduced form that can be estimated with nominal import data. Equations (4) and (5) present a model of import supply. Equation (4) incorporates the concept of pricing to market, so that import prices are a markup (δ) on an exponentially weighted average of marginal cost in the exporting country (*MC*) and competitors' prices in the importing country (*P*).[12] Knetter (1989) derives such a pricing model under the assumption of monopolistic competition and segmented markets. The parameter ϕ captures the extent of pass-

[12]Goldberg and Knetter (1997) provide a survey of the pass-through and pricing to market literature.

through of exporter costs, where ϕ=1 implies full pass-through (no pricing to market) and ϕ=0 implies no pass-through (complete pricing to market).[13] Equation (5) models marginal cost as a function of the share of exports in exporter output (*M/Q*) scaled by the overall level of prices in the exporting country (*PF/E*). Here *PF* is a foreign-currency index of tradables prices in the exporting country and *E* is the exchange rate expressed as the amount of exporter currency per unit of importer currency. The parameter θ captures the elasticity of marginal cost with respect to the share of exports in output. The multiplicative constant, μ, captures costs of trade that are invariant over time, such as those related to the distance between exporter and importer. A disturbance term can be entered into either or both of equations (4) and (5) without loss of generality; here it is entered into the pricing relationship and denoted by *V*.

$$PM = \delta\, MC^{\phi}\; P^{1-\phi}\, V \tag{4}$$

$$MC = \mu \left(\frac{M}{Q}\right)^{\theta} \frac{PF}{E} \tag{5}$$

Converting equations (4) and (5) to log differences and combining with equation (3) yields a system of equations that can be solved for the reduced form shown in equation (6), where nominal imports are deflated by the competing price level and *r* denotes the (log) real exchange rate (*pf-e-p*) of tradables. As in the derivation of equation (3), the conversion to log

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[13] ϕ is determined by the curvature of the firm's demand schedule. Constant-elasticity demand implies $\phi = 1$. A flatter demand schedule implies $\phi < 1$, whereas a more curved demand schedule implies $\phi > 1$. Flatter demand schedules are generally more plausible, but for simplicity equation (2) assumes a constant elasticity. Feenstra, Gagnon, and Knetter (1996) show how the presence of multiple competing firms in each country leads each firm's perceived demand schedule to be relatively flat, thus implying $\phi \leq 1$, even when consumer demand has constant elasticity. Exploratory regressions found no evidence that terms based on nonlinear functions of the relative price are statistically significant.

differences in equation (6) eliminates the multiplicative parameters, δ and μ, and thus our gravity-style regressions do not include the distances between trade partners. The subscripts *i* denote individual exporting countries.

$$\Delta\left(pm_i + m_i - p\right) = \frac{\beta(1+\theta\phi)}{1-\theta\phi\gamma}\Delta y + \frac{\sigma(1+\theta\phi)}{1-\theta\phi\gamma}\Delta w + \frac{\lambda(1+\theta\phi)-\theta\phi(1+\gamma)}{1-\theta\phi\gamma}\Delta q_i + \frac{\phi(1+\gamma)}{1-\theta\phi\gamma}\Delta r_i + \frac{1+\theta\phi}{1-\theta\phi\gamma}\Delta u_i + \frac{1+\gamma}{1-\theta\phi\gamma}\Delta v_i \tag{6}$$

Consistent estimation of equation (6) requires that the independent variables be exogenous with respect to imports. It is a standard assumption in the trade literature that neither importer nor world income is significantly affected by bilateral trade. This assumption seems all the more justified here, because the variables are long-run growth rates. We would expect income to be determined in the long run by factors of production that are relatively exogenous with respect to trade flows. There is a stronger theoretical case that the real exchange rate could be significantly affected by trade. However, a large literature has been devoted to testing for trade-related and other explanations of nominal and real exchange rate behavior, and the results have been almost uniformly negative.[14] The prevailing presumption is that poorly understood swings in investor preferences and expectations about future macroeconomic policies dominate

[14]The seminal work in this area is Meese and Rogoff (1983). Gagnon (1989) finds that bilateral trade flows between the United States and some of its largest trading partners are Granger-caused by real exchange rates and GDP, while the latter variables are not Granger-caused by trade flows. On the other hand, Gagnon (1996) and Cheung, Chinn, and Pascual (2002) find some evidence that trade flows can affect exchange rates through the associated buildup of net foreign assets, but this effect at most accounts for only a small fraction of exchange rate movements, even in the long run.

both nominal and real exchange rate dynamics. Finally, U.S. demand for imports from specific countries could have an effect on output growth in those countries. This effect is probably more important in the short run than the long run. In the following section we show that our results are not sensitive to excluding from the regression those countries for whom exports to the United States comprise a significant share of GDP.

There are six parameters in equation (6) but only four coefficients with which to identify these parameters. (In practice, there are only three coefficients because the importer income and world income effects are not separately identified.) However, there are *a priori* benchmark assumptions about some of these parameters that we can use to identify plausible ranges for the remaining parameters. First, the marginal cost elasticity θ is likely to be quite low in the long run. Baier and Bergstrand (2001) estimate a value of 0.12 using log changes in annual data. Adjustment costs should be even lower in our data on log changes over 28 years, implying a value of θ close to 0 and almost surely bounded above by 1. Setting θ = 0 in equation (6) leads to equation (7) in which the varieties effect, λ, is identified.[15] The shocks *U* and *V* have been dropped for simplicity.

(7) $$\Delta\,(pm_i + m_i - p) = \beta\Delta\, y + \sigma\Delta\, w + \lambda\Delta\, q_i + \phi(1+\gamma)\Delta\, r_i$$

A second benchmark range is the usual assumption that pricing to market, ϕ, lies between 0 and 1.[16] Setting ϕ = 0 yields the simple reduced form shown in equation (8). A third parameter that has been extensively researched is the price elasticity of import demand, γ. The

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[15]Setting θ = 0 is equivalent to assuming that the supply of imports to any given country is infinitely elastic. This assumption has been common in the time-series literature. See, for example, Marquez (2002).

[16]The survey by Goldberg and Knetter (1997) reports a preponderance of estimates between ½ and 1, with U.S. imports of manufactures near the lower end of this range.

macro time-series literature, as surveyed by Goldstein and Khan (1985) and Marquez (2002), finds trade price elasticities in the range 0 to -2, with a clustering around or slightly smaller than -1. The micro trade literature reports a range of price elasticities that is both wider and larger, roughly -1 to -15.[17] Assuming a price elasticity of -1 also yields the simple reduced form in equation (8). Note that the supply curve parameters, θ and ϕ, drop out when γ = -1 because supply shifts cause equal and offsetting effects on price and quantity under unit elastic demand.

$$(8) \qquad \Delta\,(pm_i + m_i - p) = \beta\Delta\, y + \sigma\Delta\, w + \lambda\Delta\, q_i$$

The central parameter of interest for this paper is the varieties effect, λ. Setting λ = 0 yields the reduced form in equation (9). As can be seen, testing for the existence of the varieties effect is not simply a matter of testing for the significance of the coefficient on exporter output. Growth in exporter potential output can lead to growth in imports to the extent that it reduces the marginal cost of imports (θ > 0). This effect depends critically on having a price elasticity, γ, that is both negative and larger than 1 in magnitude. We show in the next section that the restriction λ = 0 is not consistent with the estimated coefficients and any plausible values assumed for the remaining theoretical parameters.

$$(9) \qquad \Delta\,(pm_i + m_i - p) = \frac{\beta(1+\theta\phi)}{1-\theta\gamma\phi}\Delta\, y + \frac{\sigma(1+\theta\phi)}{1-\theta\gamma\phi}\Delta\, w - \frac{\theta\phi(1+\gamma)}{1-\theta\gamma\phi}\Delta\, q_i + \frac{\phi(1+\gamma)}{1-\theta\gamma\phi}\Delta\, r_i$$

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[17]See, for example, Harrigan (1993) and Feenstra (1994). The source of the discrepancy between macro and micro estimates is an open question. One interpretation is that the micro estimates are capturing the response of consumers to a price change that is unique to a specific good. The macro estimates may be capturing the behavior of consumers in the face of price changes to a wide range of goods. Micro estimates that rely on measures of trade barriers may be biased upward to the extent that measured barriers are positively correlated with unobserved barriers.

Although Krugman's simple model is constructed so that the number of varieties produced in each country is proportional to that country's total output, some readers of an early version of this paper suggested that more direct measures of product variety may be worth exploring. The 4-digit SIC import data allow us to construct measures of the number of product varieties imported from a given source country. The measure we employ here is the proportion of the universe of SIC categories that have positive entries for a given exporting country.

Before turning to the empirical results, we note that U.S. real income (*Y*) and world real income (*W*) are the same for all source countries, so their independent effects are not identified in the unrestricted model. Under the Armington assumption, however, the effect of world income is zero and the importer income effect may be identified through the equation intercept. Alternatively, a natural restriction to impose under the Krugman model (see equation (1)) is that the effect of world income is equal and opposite in sign to the effect of exporter income ($\sigma = -\lambda$). In the regressions of the next section, the constant is set equal to U.S. GDP growth so that its coefficient may be interpreted as the income effect under the Armington assumption. Also displayed in the tables is the implied U.S. income effect under the Krugman model assuming $\sigma = -\lambda$.

It is somewhat unusual to make economic interpretations of the coefficient on the constant term. We note that such interpretations require a strong assumption about any omitted variables in the regression. Usually one need only assume that omitted variables are not correlated with the independent variables. In this specification we must assume not only that any omitted variables are not correlated with the independent variables but also that any omitted variables have zero mean. Two candidate omitted variables are trade barriers and transportation costs. These are likely to have diminished over time, and as they have a negative effect on imports, their omission would be expected to bias the intercept term upward. We test for the significance of this bias in a subsample for which we have measures of tariffs and transportation costs.

Empirical Results

Table 2 presents reduced-form estimates of average growth in bilateral manufactured imports (M, deflated by the U.S. PPI) over the period 1972 through 2000. The explanatory variables are average growth rates over the same period of U.S. GDP (USGDP), exporter GDP (EXPGDP), the proportion of categories imported (CATS), and the real exchange rate in terms of GDP price indexes (RER).[18] The estimating equation, based on equation (6), is rewritten here as equation (10) in terms of identified coefficients.

$$\Delta\ M_i \ = \ C_0 \times \Delta\ USGDP + C_1 \times \Delta\ EXPGDP_i + C_2 \times \Delta\ CATS_i + C_3 \times \Delta\ RER_i \tag{10}$$

The first column of Table 2 displays the basic regression including both measures of product varieties: EXPGDP and CATS. Somewhat to our surprise the coefficients on both “varieties” variables are very highly significant, and as columns 2 and 3 show, deleting each one in turn raises the other by only a modest amount. We speculate that CATS may be proxying for some omitted factors such as demand shocks for goods that are intensively produced by particular countries, trade barriers, transportation costs, and other globalization-related effects.

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[18]Ideally we would like to use a real exchange rate in terms of tradable goods. Our preferred measure is based on producer price indexes in each country. Column 8 shows results using this measure. However, producer prices are not available over a long sample for many countries. Hence we use GDP price indexes in most of the regressions. In calculating the real exchange rates, the U.S. comparison price is always the same conceptual measure as the foreign price, so that foreign PPIs are deflated by the U.S. PPI and foreign GDP prices are deflated by the U.S. GDP price. The U.S. PPI is used to deflate nominal imports in all regressions to ease comparisons across specifications.

Changes in these factors may enable countries to export for the first time in categories of goods that they were already producing. (There is some support for this hypothesis when we consider trade barriers and transportation costs in Table 3 below.) None of this is to deny that CATS may also capture some of the changes in the varieties of goods produced in these countries. While CATS may be a mongrel whose coefficient is difficult to interpret, it does help to explain a lot of the variation in the import data without significantly affecting the estimate of the other varieties variable, EXPGDP.

Turning to the exporter GDP term, we note that the estimated coefficients in Table 2 are somewhat larger than the value of 1 implied by the simple Krugman model, though rarely to a significant extent. This may reflect that the supply of imports is not perfectly elastic – we explore this and other interpretations of the underlying parameters in the next section.

The coefficient on USGDP under the Armington assumption is highly sensitive to inclusion of the exporter GDP term, as can be seen by comparing the estimates in columns 1 and 2 to those in columns 3 and 4. Inclusion of EXPGDP, which is strongly significant, leads to much lower estimates of the U.S. income elasticity. These implausibly low estimates of the income elasticity under the Armington assumption are not particularly sensitive to the inclusion of CATS, as can be seen by comparing columns 1 and 2. The alternative income elasticity estimates based on the Krugman assumption are shown at the bottom of each column. By adjusting for the negative effect of world income, the Krugman assumption leads to much higher estimates of the income elasticity. Although these estimates are significantly above the theoretical value of 1 implied by the simple Krugman model, we do not necessarily view them as evidence against the Krugman model because the intercept term is likely to be biased upward by omitted variables. In particular, reduction of trade barriers in the broadest sense (i.e., globalization) and faster productivity growth in tradables – as evidenced by the secular decline in tradables prices relative to nontradables prices – have both contributed to faster trade growth in real terms.[19]

Figures 1-3 are scatter plots of the average annual growth rates of bilateral manufactured imports against the independent variables for all the source countries that were included in column 1 of Table 2. For a concordance of country symbols, see Table 1. A strong positive correlation is visible for EXPGDP and for CATS. Little correlation is apparent for RER. The simple correlations with import growth are 0.57 for CATS, 0.47 for EXPGDP, and -0.08 for RER.

Robustness of results

Figures 1-3 indicate the presence of some outliers, many of which are small economies that export little to the United States. To check on the robustness of our results, we performed numerous alternative regressions, some of which are reported in the remaining columns of Table 1. Column 5 displays estimates obtained from a regression that minimizes the sum of the absolute values of the residuals instead of the sum of the squared residuals. This approach tends to give less weight to outlying observations. It has very little effect on the estimated coefficients (compared to column 1) although the relative price term is statistically significant in this regression. Column 6 explores the possibility that the coefficient on exporter GDP may be biased by feedback to foreign growth from exports to the United States. In this regression we removed all source countries for whom exports to the United States exceeded 5 percent of GDP

[19]For the 36 countries for which we have both PPI and CPI data over the 28-year sample, CPIs grew 0.5 percentage points faster on average than PPIs. For the United States, the gap was 0.7 percentage points.

in either 1972 or 2000. As may be seen, the estimated coefficient on EXPGDP is slightly larger than in column 1, effectively ruling out the possibility that feedback from U.S. demand is biasing the EXPGDP estimate. Column 7 limits the sample to countries defined by the IMF as "industrial," these are countries that were highly developed at the beginning of our sample and their data is generally more reliable. (Table 1 lists the industrial countries in our data.) The EXPGDP effect is slightly larger in column 7 than in column 1. Interestingly, the CATS effect is significantly *negative* for these countries. Further exploration (not shown) revealed that the CATS effect in this sample is significant only when EXPGDP is also included in the regression. EXPGDP is significantly positive both with and without CATS. We suspect that the effect of CATS on imports is nonlinear; for the industrial countries it appears to be offsetting a very high estimate of the EXPGDP effect.[20] Column 8 displays results using an alternative measure of RER. Recall that this variable is meant to capture the relative cost of production of traded goods. In the basic regression we used relative GDP price indexes from the Penn World Table (PWT). In column 8 we consider relative producer price indexes, adjusted for exchange rate changes, from the IMF's IFS database. Although there is a greatly restricted range of countries, the resulting coefficients are not significantly different from those in column 1. Finally, column 9 replaces the PWT data entirely with IFS data on GDP volumes and relative consumer prices. (Consumer prices are more widely available than producer prices.) The IFS data are available through 2001, so we calculated import growth through 2001 for this regression. Once again, none of the coefficients is significantly different from those in column 1.

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[20]One distinguishing feature of the industrial countries is that they had much lower growth in CATS than the developing countries, as most of them exported in most categories already by 1972.

Exploration of the CATS effect

Because the CATS term is nontraditional, we performed a number of experiments to determine the best construction of this variable. These are not included in Table 2. None of these alternatives had a significant effect on the EXPGDP coefficient, which always remained significantly greater than zero.

The first alternative was to weight the categories exported by each country according to their share in total U.S. imports; this alternative was statistically significant on its own but it was dominated by the unweighted version when both measures were included. The second alternative was to compute the Herfindahl concentration index across import categories for each country's bilateral exports to the United States; this alternative was not statistically significant on its own but it was marginally significant (with the wrong sign) when included with CATS. The third alternative was to compute a variant of CATS using the vastly greater number of categories available with data at the tariff line level; on its own this alternative yielded essentially the same R^2 as in the basic model but the variable was highly collinear with CATS so that neither was significant when both were included.[21] We decided to stick with CATS based on the 4-digit SIC data because the tariff data had a major reorganization in the middle of our sample, which threatened the comparability of the category proportions measures between 1972 and 2000, and because the delineation of product categories was highly skewed by the dictates of trade policy. For example, in 1972 there were over 2300 categories for textiles and apparel but only 24 categories for all office machinery including typewriters, printers, calculators, computers, photocopiers, etc.

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[21]As with the SIC-based measure, weighting the categories by total U.S. imports deteriorated the fit of this variable.

Further robustness checks

We explored several other hypotheses that are not shown in Table 2. First, we split exporter GDP into per capita GDP and population to test whether the two components have a different effect on trade. The two effects were almost identical and the restriction of equality could not be rejected. Second, we tested whether immigration might help to explain the pattern of imports, following Marquez (2002), who finds that aggregate imports are significantly related to the share of foreign-born in the population. The Bureau of the Census website contains estimates of the number of U.S. residents that were born in 26 industrial and large developing countries as of 1970 and 1990 (http://www.census.gov/population/www/documentation/-twps0029/tab04.html). We extended these estimates to 2000 by cumulating annual immigration data by country from the *2002 Yearbook of Immigration Statistics* (Bureau of Citizenship and Immigration Services) and applying the national average mortality rate each year to the lagged population stocks. We calculated average growth rates over the period 1970-2000 and included these growth rates in our basic reduced form equation. The resulting coefficient estimate was slightly negative and not statistically significant.

Third, we tested whether the pattern of U.S. direct investment abroad might help to explain import growth. The Bureau of Economic Analysis maintains historical data on the U.S. direct investment position in individual foreign countries on its website (http://www.bea.doc.gov/bea/di/di1usdbal.htm). We computed growth rates of the dollar positions from 1972 through 2000 as well as simple changes in the share of total U.S. direct investment accounted for by each country. Neither measure was statistically significant in explaining bilateral U.S. import growth.

Fourth, we included a dummy variable for the three countries with which the United

States implemented free trade agreements between 1972 and 2000 (Israel, Canada, and Mexico). This variable was not significant. Finally, we tested whether pricing to the U.S. market might be systematically related to per capita income differences across exporting countries by adding a term that interacts the real exchange rate with real per capita income. Regardless of whether it was based on per capita income in 1972 or 2000, the interaction term was never significant.

Subsamples and trade barriers

All of the results discussed so far are based on average growth rates over a roughly 30-year period. We believe that the varieties effect in imports should be most apparent when transient and cyclical factors are excluded from the data. Using long-run growth rates is the best way to eliminate these temporary factors. However, two of the leading candidates for omitted variables – tariffs and transportation costs – are available for only a subsample of our data beginning in 1989. Table 3 displays regression results for average growth rates over the 11 years from 1989 through 2000.

Column 1 of Table 3 shows that the basic reduced form with ordinary least squares fits much worse over this subsample than over the entire sample, which is probably due to greater cyclical factors and noise in the average growth rates. Nevertheless, the coefficients on both EXPGDP and CATS have the same sign and order of magnitude as in Table 2. The most notable difference is the larger USGDP coefficient under the Armington assumption, though it is not statistically significant. The USGDP coefficient under the Krugman assumption is also somewhat larger in this subsample. Columns 2, 3, and 4 show that, as before, the EXPGDP and CATS terms are essentially independent of each other, but the USGDP coefficient does increase significantly when exporter GDP is dropped from the regression.

Given the noisy data, it is not surprising that the minimum absolute deviations regression in column 5 yields results that are both more statistically significant and more similar to those over the longer sample. Note the increase in EXPGDP effect and decrease in USGDP coefficient (Armington). While CATS is highly significant, it is somewhat smaller than estimated over the longer sample, which may indicate some nonlinearity in the relationship. As in the 28-year sample, the effect of CATS in the 11-year sample does not show through among the industrial countries (column 6), whereas the EXPGDP effect is most pronounced in this case. Columns 7, 8, and 9 add the data on tariff duties collected and transportation charges (c.i.f.-f.o.b. differential) to the reduced form.[22] Using data for all countries (columns 7 and 8) transportation charges are highly significant with the expected sign, whereas tariffs have no significant effect. By comparing to columns 1 and 5, we see that adding DUTY and CHARGE has little effect on the USGDP and EXPGDP coefficients, but it noticeably dampens the coefficient on CATS (though not by a statistically significant amount). This provides some support to the view that CATS partly proxies for trade barriers and globalization effects. As before, restricting the sample to industrial countries (column 9) leads to a negative estimate of the CATS effect. The apparent significance of this negative effect is probably spurious as it occurs in conjunction with a large drop in the coefficients on RER and USGDP, and the number of estimated coefficients is high relative to the number of observations. The coefficient on EXPGDP remains positive and significant. In this specification, DUTY is highly significant with the correct sign while CHARGE is no longer significant.

Overall, the performance of the trade barrier variables is not robust. There are several

[22]DUTY and CHARGE are computed as gross price markups in each year in order to make the average growth rates comparable with those for RER. The gross price markups are defined as 1 plus the ratio of duties collected to total imports (DUTY) and as the c.i.f. value of imports divided by the customs (f.o.b.) value (CHARGE).

potential explanations. First, it is well-known that the value of duties collected has a highly nonlinear relationship to the underlying tariff rates. Second, it has also been documented (see Baier and Bergstrand (2001) for example) that c.i.f.-f.o.b. differentials are poorly measured. Third, many trade barriers are not captured by available measures. Fourth, globalization effects probably go beyond the decline of explicit trade barriers and transportation costs, and they may include the rise of English in international business, better communications technology, rising educational levels, and other factors that are difficult to quantify.

Interpretations

The most tightly estimated and statistically significant effect is that of exporter GDP, which is essentially confined to the range of 1 to 1.5.

The number of categories imported from each country is highly important when developing countries are included, but not for industrial countries. The CATS effect is also somewhat sensitive to the inclusion of trade barrier measures. When the sample includes developing countries, the CATS coefficient ranges from around 0.5 to 1.5.

Estimates of the USGDP (constant) effect are strongly affected by the sample period, by the inclusion or exclusion of the other explanatory variables, and by the assumption made on the role of world income. Under the Armington assumption, the range of the USGDP effect is roughly 0 to 1 when exporter GDP is included, which seems rather low. Under the Krugman assumption, the USGDP effect is generally around 2, which seems rather high but may be biased upward for reasons discussed earlier. Note that both Houthakker and Magee (1969) and Hooper, Marquez, and Johnson (2000) estimate a U.S. income elasticity of around 2.

The real exchange rate effect is typically slightly positive but not statistically different from 0.

The effects of tariff duties and transportation charges are occasionally significant, but not robust.

What do these results imply about the underlying parameters of demand and supply?

The first step is to decide how to interpret the CATS coefficient. Although it was originally motivated as an alternative to exporter GDP as a measure of the number of varieties produced in each country, the evidence indicates that it is probably proxying for other factors such as the effects of falling trade barriers and globalization, which are particularly important for developing countries.

Next we consider whether the estimated coefficients seem consistent with any of the simplifying assumptions that lie behind equations (7)-(9). In particular, we note that the RER coefficients are almost always close to zero. According to equation (6) a small RER coefficient implies that either pass-through of costs by foreign exporters (ϕ) is low or that the price elasticity of demand (γ) is close to -1. Assuming either $\phi = 0$ or $\gamma = -1$ yields the simple reduced form of equation (8). In this case, the coefficient on exporter GDP can be interpreted directly as the varieties effect, λ. Under the Armington model, the coefficient on USGDP (constant) could be interpreted as the effect of U.S. income. However, under the Armington model the effect of exporter GDP is zero, which is rejected strongly. Under the Krugman model, the coefficient on USGDP commingles the positive effect of U.S. income with the negative effect of world income, which may explain why this coefficient is typically estimated well below 1. If we are willing to assume that the effect of world income is equal and opposite in sign to that of exporter GDP, the Krugman model implies a much higher effect – perhaps too high – of USGDP. Given the sensitivity of the intercept coefficient to omitted variables, we are inclined not to place too much emphasis on it. The main puzzle under the Krugman model is why the exporter GDP effect is often estimated to be a bit larger than its theoretical value of 1. We return to this question below.

Is it possible to explain the significant coefficient on EXPGDP without appealing to the Krugman model? The following matrix displays the coefficient on EXPGDP implied by different values of γ, θ, and ϕ assuming that the Krugman varieties effect, λ, is zero.[23] The columns of the matrix refer to different values of the price elasticity, γ. The typically positive estimated coefficients on RER suggest that $0 > \gamma > -1$, and empirical estimates of γ for 53 countries by Senhadji and Montenegro (1999) yield a median value of -0.78. These results motivate our choices of -0.5 and -1 in the first two columns. However, much of the theoretical literature on firm behavior assumes that γ is greater in magnitude than 1, and some estimates for specific categories of traded goods (e.g., Harrigan (1993)) are larger, motivating a value of -5 in the third column.[24]

	$\gamma = -0.5$	$\gamma = -1$	$\gamma = -5$
$\phi\theta = 0$	0	0	0
$\phi\theta = 0.1$	-0.05	0	0.27
$\phi\theta = 0.25$	-0.07	0	0.44

The rows refer to the value $\phi\theta$, which is the product of pass-through and the elasticity of real marginal cost with respect to the share of exports in output. As discussed earlier, Baier and

[23] This matrix is based on equation (9).

[24] Krugman (1988) noted that high values of price elasticities for traded goods would imply a profound puzzle in the observed behavior of real exchange rates. The large swings in real exchange rates are not plausibly driven by swings in the cost of production across countries, yet they also do not induce large swings in the volumes of exports and imports across countries. The apparent explanation is that price elasticities in trade cannot be much greater than -1.

Bergstrand (2001) estimate $\theta = 0.12$ in data on annual changes, and we would expect an even smaller effect over the long time periods used here because factors of production can move between the domestic and export sectors. Goldberg and Knetter (1997) find $\phi = 0.5$ for U.S. imports. These benchmarks motivate our choice of 0 and 0.1 in the first two rows. We include 0.25 as an extreme upper bound in the third row. The entries of the matrix show that in the absence of the Krugman varieties effect, the coefficient on exporter GDP would be very close to zero. Even the lower right value of 0.44, which is based on implausibly large price and marginal cost elasticities, is less than half of the typical estimated value.

Can the Krugman model and the traditional supply channel together explain a coefficient greater than 1 on exporter GDP? Yes and no. The coefficient on exporter output in equation (6) can be rewritten as

$$1 + \frac{(\lambda - 1)(1 + \theta\phi)}{1 - \theta\phi\gamma},$$

which reveals that the Krugman varieties effect at its predicted value ($\lambda = 1$) shuts down any additional role for the traditional supply channel. However, a value of λ greater than 1 can be levered up or down by the supply side. In particular, when $0 > \gamma > -1$, which is consistent with a small positive coefficient on RER, the coefficient on EXPGDP will be larger than λ. In any case, the coefficient on EXPGDP is generally not significantly greater than 1.

The effect of potential output on the trade balance

Consider the implications of an increase in a country's potential output on its trade balance holding constant the real exchange rate and the potential output of foreign countries. Under the Armington model, imports would increase and exports would be constant, leading to a decline in the trade balance. Under the Krugman model using the base case elasticities from column 1 of Table 2, each 1 percent increase in potential output would raise imports by 1.8 percent and exports by 1.4 percent assuming that the number of categories of exports (CATS) is not affected and the country is small relative to the rest of the world. To the extent that CATS does capture some of the varieties effect of long-run growth, the stimulus to exports would be even greater than 1.4 percent. On the other hand, it is important to recall that CATS may also respond to demand in the importing country and the CATS coefficient may be capturing the effects of omitted factors related to globalization. Overall, under the Krugman model, higher potential output has a relatively small and ambiguous effect on the trade balance.

Conclusions

This paper has presented strong evidence that the trade equations in most macroeconomic models are misspecified by the exclusion of a varieties effect in import demand. This varieties effect is roughly proportional to potential output in the exporting country. Exclusion of the varieties effect may be responsible for the puzzling differences in estimated income elasticities of imports and exports across countries that has been noted since Houthakker and Magee (1969).

The presence of a varieties effect has profound implications for the evolution of a country's exchange rate and trade balance in the face of a shock to potential output. In standard models, an increase in a country's growth rate leads either to a decrease in its trade balance or a depreciation in its real exchange rate. With a varieties effect, a country that begins to grow faster will also experience an increase in demand for its exports that can partially or fully offset the increased demand for imports at a given real exchange rate.

Table 1. Data Coverage by Source Country

Country	Symbol	PWT7200	PWT8900	PPI7200	IFS7201	Industrial
Algeria	AG	x	x			
Argentina	AR	x	x		x	
Australia	AL	x	x	x	x	x
Austria	AT	x	x	x	x	x
Bangladesh	BG	x	x			
Barbados	BB	x	x			
Belgium-Luxembourg	BE	x	x		x	x
Belize	BL		x			
Benin	BN	x	x			
Bolivia	BO	x	x		x	
Brazil	BZ	x	x	x		
Burkina Faso	BF	x	x			
Burundi	BR	x	x			
Cameroon	CM	x	x			
Canada	CA	x	x	x	x	x
Chile	CL	x	x	x	x	
China	CH	x	x			
Colombia	CO	x	x	x	x	
Congo (Brazzaville)	CG	x	x			
Congo (Zaire)	ZR				x	
Costa Rica	CR	x	x	x	x	
Cote d'Ivoire	CI	x	x			
Denmark	DK	x	x	x	x	x
Dominican Republic	DR	x	x		x	
Ecuador	ED	x	x		x	
Egypt	EG	x	x	x		
El Salvador	ES	x	x	x	x	
Ethiopia	ET	x	x			
Fiji	FJ				x	
Finland	FI	x	x	x	x	x
France	FR	x	x		x	x
Gabon	GB	x	x			
Gambia	GA		x			
Germany	GE	x	x	x	x	x
Ghana	GH	x	x			
Greece	GR	x	x	x	x	x
Guatemala	GT	x	x		x	
Guinea	GI	x	x			
Haiti	HA				x	
Honduras	HO	x	x		x	
Hong Kong	HK	x	x		x	
Hungary	HU	x	x	x	x	
Iceland	IC	x	x		x	x
India	IN	x	x	x	x	
Indonesia	ID	x	x	x	x	
Ireland	IR	x	x	x	x	x
Israel	IS	x	x	x	x	
Italy	IT	x	x		x	x
Jamaica	JM	x	x		x	
Japan	JP	x	x	x	x	x
Jordan	JO	x	x			
Kenya	KE	x	x			
Korea	KO	x	x	x	x	
Kuwait	KU			x	x	

Table 1. (cont'd.) Data Coverage by Source Country

Country	Symbol	PWT7200	PWT8900	PPI7200	IFS7201	Industrial
Madagascar	MG	x	x		x	
Malawi	MW	x	x			
Malaysia	MA	x	x		x	
Mali	MI	x	x			
Malta	MT				x	
Mauritius	MS	x	x			
Mexico	MX	x	x	x	x	
Morocco	MR	x	x		x	
Mozambique	MZ	x	x			
Nepal	NP	x	x		x	
Netherlands	NL	x	x	x	x	x
New Zealand	NZ	x	x	x	x	x
Niger	NG	x	x			
Nigeria	NI	x	x			
Norway	NO	x	x		x	x
Pakistan	PK	x	x	x	x	
Panama	PA	x	x	x	x	
Paraguay	PG	x	x		x	
Peru	PE	x	x		x	
Philippines	PH	x	x	x	x	
Portugal	PT	x	x			x
Rwanda	RW	x	x		x	
St. Kitts and Nevis	SK		x			
Saudi Arabia	SA				x	
Senegal	SE	x	x		x	
Seychelles	SC	x	x			
Singapore	SI				x	
South Africa	SF	x	x		x	
Spain	SP	x	x	x	x	x
Sri Lanka	SL	x	x		x	
Sweden	SD	x	x	x	x	x
Switzerland	SZ	x	x	x	x	x
Syria	SY	x	x			
Tanzania	TN	x	x			
Thailand	TH	x	x	x	x	
Togo	TO	x	x			
Trinidad and Tobago	TT	x	x			
Tunisia	TU	x	x	x		
Turkey	TK	x	x		x	
Uganda	UG	x	x			
United Kingdom	UK	x	x	x	x	x
Uruguay	UR	x	x	x	x	
Venezuela	VE	x	x	x	x	
Zambia	ZB	x	x			
Zimbabwe	ZW	x	x			

Note: PWT7200 denotes all PWT data available from 1972 through 2000. PWT8900 denotes PWT data from 1989 through 2000. PPI7200 denotes availability of IFS PPI data. IFS7201 denotes availability of IFS data on CPIs and GDPs from 1972 through 2001. Industrial denotes countries defined as such by the IMF.

Table 2. Growth of U.S. Bilateral Imports, Equation (10), 1972-2000
(robust standard errors)

	OLS, Full Sample				Min. Abs. Deviation	Low U.S. Share[1]	Industrial Countries	PPI RER	IFS Data 1972-2001
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
USGDP[2] (Armington)	0.18 (.43)	0.38 (.48)	1.43*** (.21)	2.39*** (.19)	0.43 (.29)	-0.11 (.50)	0.31 (.65)	0.63 (.40)	0.40 (.32)
EXPGDP	1.39*** (.43)	1.98*** (.48)			1.28*** (.27)	1.46*** (..48)	1.67* (.82)	1.26** (.48)	1.11*** (.28)
CATS	1.46*** (.33)		1.76*** (.32)		1.28*** (.20)	1.48*** (.34)	-0.76*** (.26)	1.17** (.49)	1.66*** (.36)
RER	0.23 (.38)	-0.28 (.42)	0.30 (.40)	-0.33 (.45)	0.50** (.23)	0.48 (.32)	0.38 (.50)	0.80 (.65)	0.10 (.37)
R^2	.43	.22	.33	.01	.42	.53	.44	.42	.43
No. Obs.	89	89	89	89	89	64	21	34	62
USGDP[3] (Krugman)	1.77*** (.24)	2.64*** (.20)	n.a.	n.a.	1.88*** (.17)	1.55*** (.23)	2.21*** (.35)	2.07*** (.26)	n.a.[4]

***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.
[1]Excludes countries for which exports to the United States exceeded 5 percent of GDP in either 1972 or 2000.
[2]Assumes world income effect equals zero.
[3]Assumes world income effect equal and opposite to EXPGDP effect.
[4]Insufficient country coverage to calculate world income growth.

Table 3. Growth of U.S. Bilateral Imports, Equation (10), 1989-2000
(robust standard errors)

	OLS, Full Sample				Min. Abs. Deviation	Industrial Countries	Trade Barriers		
							OLS	MAD	Industrial
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
USGDP[1] (Armington)	1.38 (.84)	1.77** (.83)	2.17*** (.39)	2.62*** (.31)	0.70 (.62)	0.14 (.52)	1.12 (.80)	0.69 (.57)	-1.31** (.47)
EXPGDP	0.77 (.62)	0.82 (.65)			1.46*** (.50)	2.49*** (.55)	0.94* (.55)	1.23*** (.44)	2.19*** (.29)
CATS	0.74** (.35)		0.76** (.36)		0.86*** (.26)	-1.01 (1.15)	0.51 (.33)	0.49** (.22)	-1.40 (.88)
RER	0.48 (.37)	0.36 (.36)	0.54 (.37)	0.42 (.36)	0.26 (.32)	0.18 (.55)	0.46 (.37)	0.42 (.30)	-1.24** (.47)
DUTY							1.82 (2.82)	3.13 (2.86)	-26.01*** (5.08)
CHARGE							-6.58*** (2.35)	-10.00*** (1.49)	3.79 (5.22)
R^2	.11	.04	.09	.02	.10	.62	.26	.25	.80
No. Obs.	92	92	92	92	92	21	92	92	21
USGDP[2] (Krugman)	2.26*** (.37)	2.71*** (.31)	n.a.	n.a.	2.38*** (.37)	2.99*** (.34)	2.20*** (.45)	2.10*** (.36)	1.19** (.47)

***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.
[1]Assumes world income effect equals zero.
[2]Assumes world income effect equal and opposite to EXPGDP effect.

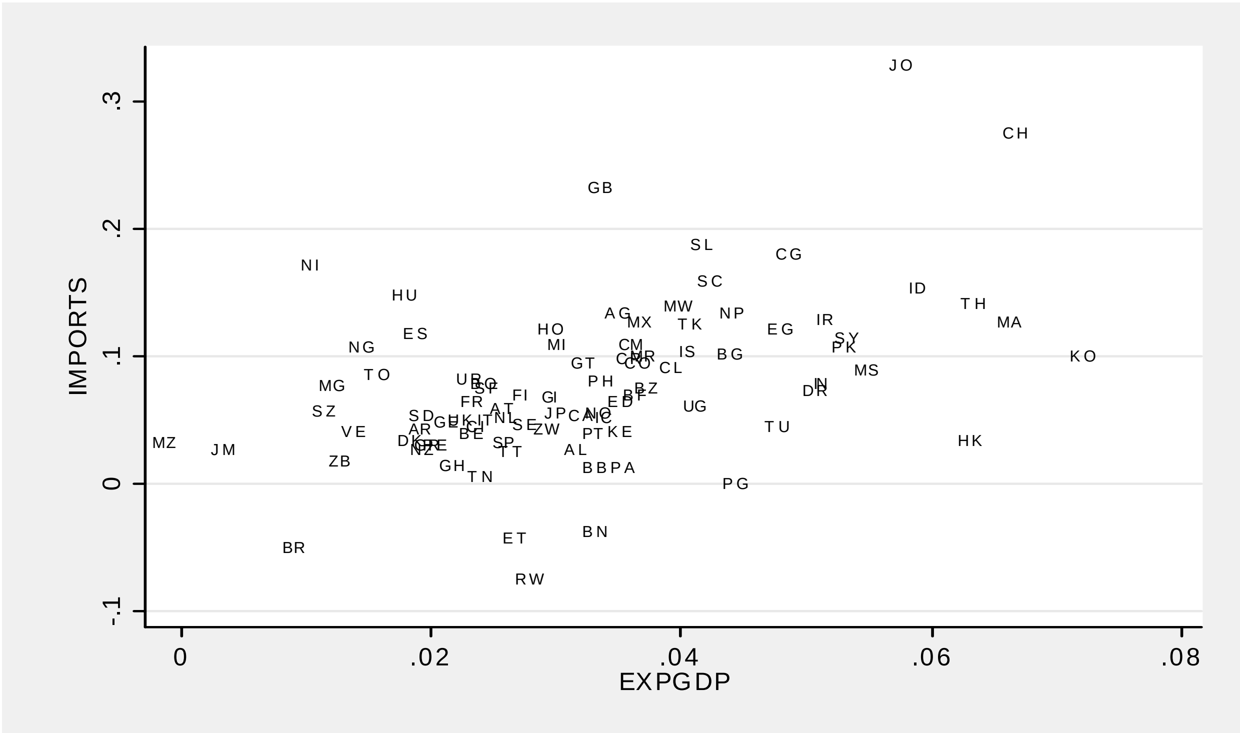

Figure 1 U.S. Import Growth and Exporter GDP Growth, 1972-2000

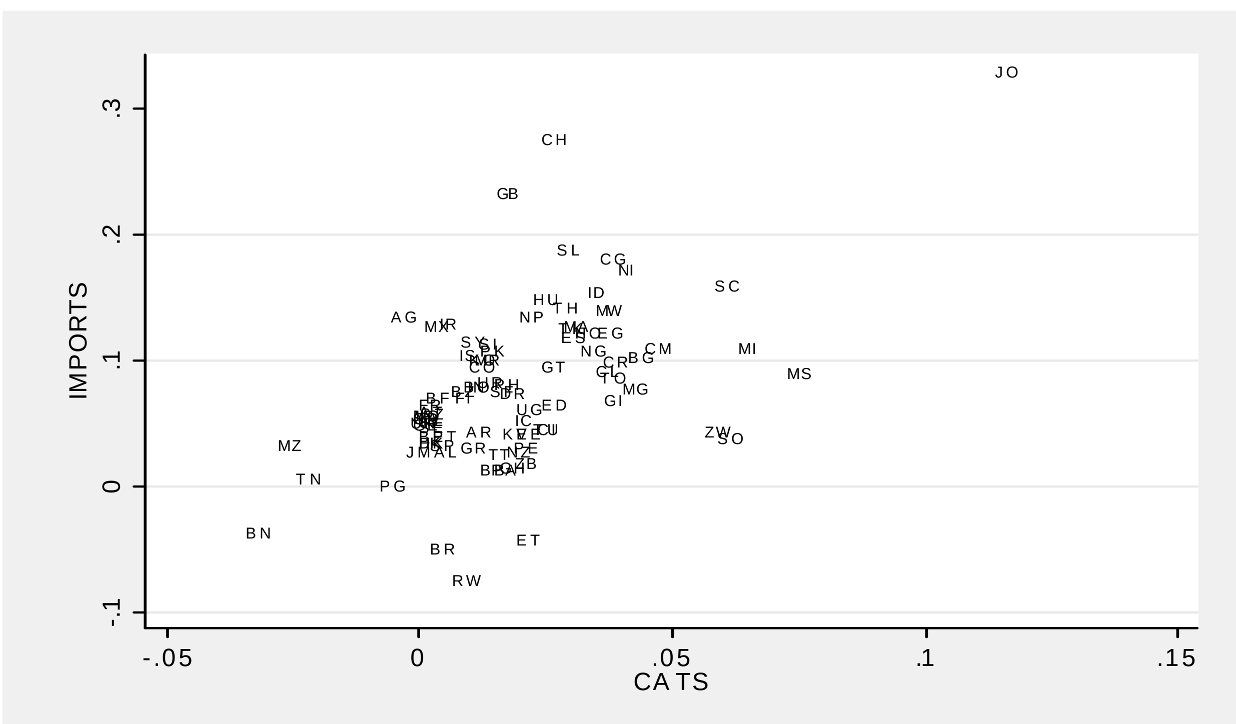

Figure 2 U.S. Import Growth and Growth in Categories Exported, 1972-2000

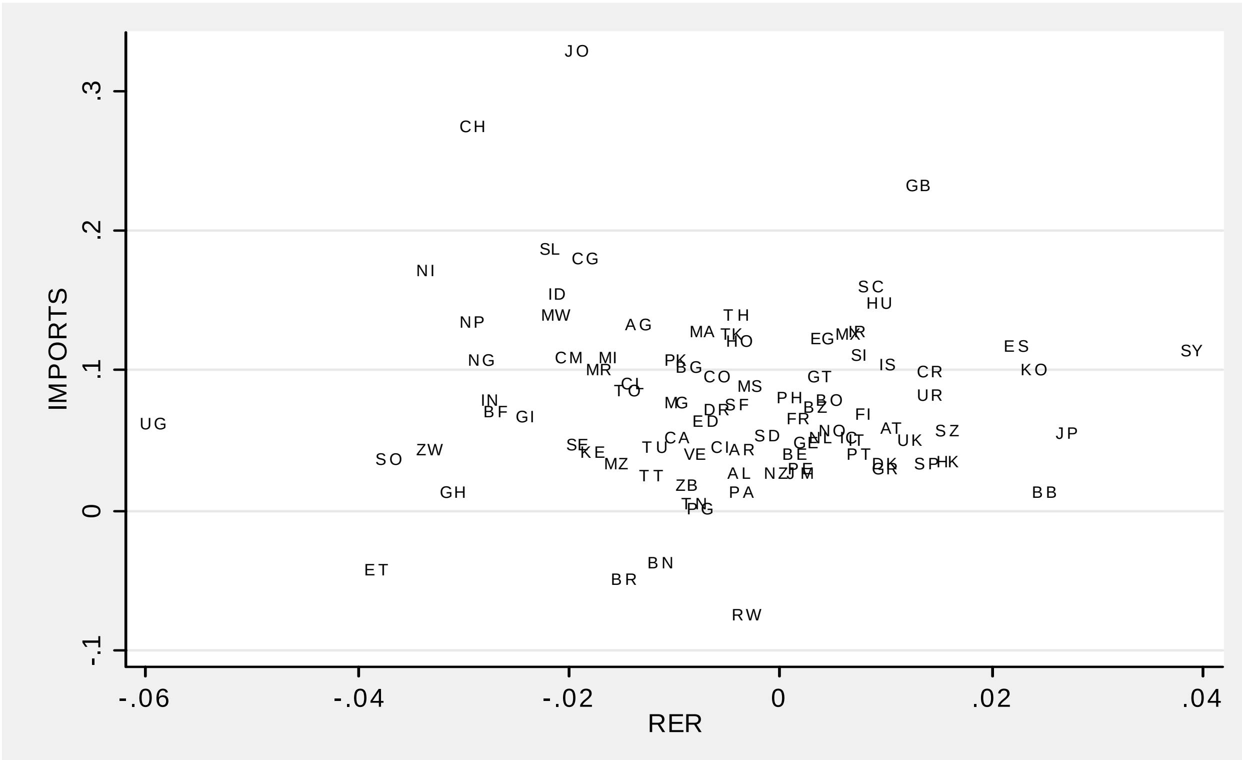

Figure 3 U.S. Import Growth and Change in Real Exchange Rate, 1972-2000

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