MEASURING PRODUCT-MARKET INTEGRATION

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ABSTRACT

Globalization -- the integration of national economies -- has become one of the most widely used buzzwords of the late 20th century. Yet there are remarkably few statistical measures of product-market integration across time, countries, and goods. In this paper we present some new measures of product-market integration based on price and quantity data. We find evidence of greater integration, but we also find that this process has not been uniform over time, countries, or goods.

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1 Introduction

Globalization—the integration of national economies--has become one of the most widely used buzzwords of the late 20th century. It is frequently given credit or blame for all manner of economic outcomes. While many signs of globalization are quite obvious, it is hard to say whether market integration is more important for economic performance today than it was thirty years ago. But one thing is certain: Few people have done more to advance our understanding of the manifold dimensions of economic integration than Robert Lipsey. Lipsey and numerous co-authors have chronicled market integration in all its dimensions--the behavior of relative prices, national price levels, volume flows of traded goods, and volume flows of foreign direct investment--in as much detail as anyone. As a result, much of what we know about the extent of international economic integration is due to him. In this paper we try to make a further contribution to that understanding, particularly in the area of the integration of markets for traded goods.

What drives globalization? In financial markets, integration has been driven by declines in both natural and political trade barriers. For example, the proliferation of computer technology has drastically cheapened trading and communication; at the same time, policy makers have eliminated a wide range of restrictions on international capital flows. The results are clear in terms of both quantities and prices. In 1973 the daily turnover in worldwide foreign-exchange trading averaged about $10 billion; today this quantity has increased more than a hundred fold to well over $1 trillion. And across many countries, covered interest parity holds much more closely today than it did 20 years ago. In light of this evidence on both quantities and prices, there is a consensus that financial markets are much more integrated today than they were 20 years ago.

Many of the same forces driving financial-market integration have also been operating in goods markets, so it is tempting to conclude that product markets have integrated as well. Natural trade barriers have fallen with improvements in transportation such as supertankers and wide-body jets. On the political side, successive General Agreement on Tariffs and Trade (GATT) rounds have greatly reduced tariffs on manufactures and have expanded the scope of liberalization to many non-manufacturing sectors as well. In addition to multilateral liberalization, many countries have also

lowered barriers through regional arrangements such as the European Union (EU) and the North American Free Trade Agreement (NAFTA).

Other factors have been working against product-market integration, however. First, the many regional trading blocs which have formed in recent years can divert trade as well as create it. Second, as tariff barriers have declined, many countries have increasingly resorted to non-tariff barriers (NTBs) to impede trade. Arrangements such as the Multi-Fiber Agreement (MFA) and "voluntary" export restraints in the U.S. automobile market have proliferated. The aggressive use of antidumping laws to protect domestic industries is common in the United States and Europe. Recent complaints levied by U.S. steel makers remind us of the importance of these tools in restricting the flow of goods and distorting prices. Rough measures of the existence of NTBs are available, such as coverage ratios. But these measures do little to gauge the extent to which NTBs actually inhibit trade. Unlike tariff rates, they do not tell us how great a wedge is created between prices of similar goods in different markets. Overall, with the decline of natural trade barriers and tariffs on the one hand and the rise of regional blocs NTBs on the other, it is difficult to say *a priori* just how much more integrated product-markets have become in recent years.[1]

In this paper we present some new price- and quantity-based measures of product-market integration. Documenting trends in market integration is interesting in itself. But it will also help us understand the link between countries' trade policies and their economic performance. Do countries grow faster as their product markets become more connected to those of other countries? Has product-market integration contributed to rising income inequality in countries? By studying product-market integration in multiple dimensions--across countries, industries, and time--we hope to assemble some facts on integration that will permit more powerful tests of the impact of integration on national economic performance.

This paper is organized as follows. Section two discusses the process of economic integration and its implications for economic outcomes. Section three presents our data and framework for

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[1]Widely available volume measures, such as (trade/GDP) ratios, may really reflect something about the nature of economic growth rather than the integration of product markets. Harrigan (1993) provides direct evidence on how much trade barriers reduce import volumes. Using a 1983 sample of OECD countries, he finds that tariffs and transportation costs reduce import volumes much more than NTBs do.

analyzing product price evidence on integration. Section four presents our data and framework for analyzing quantity evidence on integration. Section five concludes.

2 Perspectives on Economic Integration

Before discussing the conceptual issues that underlie the measurement of product market integration, it is worth remembering why we care about this integration in the first place. Economic integration has many consequences for the operation of a market economy. First, it can affect an economy's response to monetary and fiscal policies. In each case, tighter connections between domestic and foreign markets can reduce the potency of conventional demand stimuli. For example, increased lending by domestic banks or increased spending by domestic consumers may be directed at foreign firms. Second, greater integration can allow external factors to exert greater influence on domestic outcomes. For example, increased product-market competition from less-developed countries might be contributing to the ongoing rise in the U.S. skill premium. The exact degree to which economic integration affects domestic outcomes remains open to speculation, however. In part, this is because we have only rough metrics by which to measure the extent of integration, especially in product markets. Our paper aims to provide some new measures.

Broadly speaking, there are two ways to proceed in measuring product-market integration. One approach would be to assemble direct evidence on the magnitude of barriers between national markets. Included here would be shipping costs, tariffs, and any other barriers that make costly the international movement of goods. In general, we expect the degree of market integration will vary inversely with the magnitude of these barriers.

Available data on tariff rates and transport costs certainly confirm the view that markets have become more integrated in recent years. Figure 1 presents some evidence of declining U.S. barriers. Average tariff rates cover all U.S. manufacturing imports; each year's rate measures the total tariff revenue collected divided by the value of all dutiable imports. Average transportation costs also cover all U.S. manufacturing; each year's rate measures the cost, insurance, and freight for all U.S. imports divided by the value (excluding the shipping costs) of all imports. These data come from Feenstra (1996). As Figure 1 shows, average U.S. tariffs and transportation costs

have generally been declining the past 20 years. This suggests that U.S. product markets have become more integrated with world markets.

These direct measures of integration are suggestive, but they face at least three important limitations. First, these *ex post* measures omit the cost of prohibitive barriers -- i.e., tariffs or transportation costs that are so high that U.S. imports are zero. Second, these tariff measures completely omit all NTBs. This matters because NTBs, both intended and unintended, are now the primary barrier between countries in many product categories. Third, even if NTB data were readily available they likely could not be easily quantified as a cost of moving goods. Details of NTBs vary so much by product that it would be hard to systematically assemble such information. On all counts, these measures may overstate the degree of product-market integration.

These limitations suggest the need for an alternative approach to measuring economic integration. This is to examine equilibrium outcomes—the prices and quantities generated in various markets—to see if they are consistent with a marked change in the magnitude of barriers separating national markets for goods. For example, price equalization for a good would suggest that trade barriers for that good had been eliminated. This is the approach we use in this paper.

One advantage of this approach is that, relative to measuring barriers, measuring outcomes offers more hope for comparability of data across countries, product categories, and time, thanks in part to the efforts of Robert Lipsey through initiatives such as the International Comparisons Project (ICP) and the NBER World Trade Flows Database. For efforts to measure globalization across lots of dimensions, this advantage is particularly important. One disadvantage of this approach is it does not link outcomes back to barriers. Without these links one cannot rule out that changes in outcomes are caused by forces other than declining barriers, such as economic growth. Increased trade flows among a set of countries might be caused by declining trade barriers. As Helpman (1987) has shown, however, it might also be caused by convergence of country incomes--caused in turn by forces like technological convergence or factor accumulation. We acknowledge this disadvantage of outcome-based measures, yet point out that for many important issues outcome-based integration matters independent of the cause(s). For example, if changes in

a country's relative product prices are raising domestic wage inequality, that outcome is the same for workers whether caused by reduced transportation costs or by growth abroad.

To date, most descriptions of product-market integration have focused on trade volumes rather than trade prices.[2] However, in standard models trade benefits a country both by compelling its producers to reallocate resources across industries and by presenting its consumers with an improved range of options. The mechanism which generates these gains is a change in the vector of tradable-goods prices facing the country. As these prices come to match those of the world, a country benefits by specializing in its comparative-advantage goods and exporting them in exchange for the rest of the world's comparative-advantage goods. The potential benefits of facing world prices are not limited to these gains from reallocating resources. At least three additional gains from facing world prices arise in some models: reduced market power for firms and thus smaller price-cost margins in the imperfect-competition models from new trade theory; higher firm productivity via reduced X-inefficiencies; and greater capital accumulation. Thus, trade theory makes clear that an important--if not the most important--aspect of goods-market integration is facing world prices of traded goods.

While it may be true that prices carry the important economic signals associated with increased market integration, it is also true that in most cases, these signals will lead firms and consumers to make new allocation decisions. The patterns of production and consumption (and thus, of imports and exports) are almost certain to change in concert with the change in prices. Therefore, it is of great interest to look at quantity data as well in assessing the changing extent of economic integration across countries.

Given our decision to measure integration with price and quantity outcomes, it is important to clarify how reductions in natural and political trade barriers change these equilibrium outcomes. To do this we outline these changes from two alternative perspectives. The first is the standard Heckscher-Ohlin (HO) model in which the key determinant of trade is international differences in relative factor endowments. In the textbook two-good setup, we imagine one country specializes

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[2] See, for example, Krugman (1995) or Irwin (1996). Another popular strain of the literature on integration relies on gravity models of trade volumes.

in cars and the other in shirts, and they trade to satisfy their preferences. When barriers fall, countries specialize more in production (production becomes more dissimilar across the countries) and trade more with each other. Our second perspective also presumes endowment differences, but here the product space actually evolves as a result of the opportunity to trade. The production of the car may become fragmented into car components. The country that specializes in shirts may now make the fabric for the car seats. The country that specialized in cars may now make the machines that make shirts. We call this second model "HO Plus Production Fragmentation."[3] Feenstra (1998, p.13) describes this model as characterized by "the increased use of imported [intermediate] inputs, and narrowing of production activities within each country."

In both models, declining trade barriers permit production reorganization according to comparative advantage. In the standard model, there is no real distinction between "industries" and "activities". In the modified model, the distinction is quite important. Specialization occurs on the basis of comparative advantage in activities. This distinction matters because data are organized by industry, rather than activity. As a result, the normal patterns of specialization by industry, that seem natural from the perspective of the standard HO model, may not arise in the data if vertical specialization is occurring within industries according to activity. In the rest of this section we briefly discuss these differences. We start with prices.

First, consider prices charged to various destination markets by exporters in a particular source country. With integration, price dispersion across destination markets should decline over time in the standard HO world. This follows from the Law of One Price (LOP). As barriers preventing cross-country arbitrage decline, a particular source country must charge increasingly uniform prices to destination markets. In the HO-fragmentation world things are less clear because integration can change the activity composition of exports. For example, initially a country might export fully assembled cars. Declining barriers might lead the country to export partially assembled cars to certain markets and fully assembled cars to other markets. If there are destination-specific

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[3] What we are calling fragmentation has been labeled differently by various authors: "kaleidoscope comparative advantage" (Bhagwati and Dehejia (1994)), "slicing the value chain" (Krugman (1995)), and "delocalization" (Leamer (1998)).

differences in goods arising as a result of specialization by activity, then price dispersion across destinations need not decline. In fact, it could easily increase.

Second, consider relative price structure for producer goods within each country. With integration, the relative price structure should become more similar across countries over time in the standard HO world. Again, this follows from the LOP. But in the HO-fragmentation world, relative producer prices need not become more similar across countries. Industry-level producer prices might actually become less similar across countries as the mix of activities within each industry becomes less similar across countries thanks to greater specialization by activity.

Third, consider relative consumer prices for final goods (across all industries) within each country. If consumers worldwide share similar tastes for consumption in terms of industries, then integration should make these relative prices more similar across countries. Note this is true even from the HO-fragmentation perspective. Within-industry activities matter for price dispersion in intermediate goods, but not for final goods.

We now consider how integration from these two perspectives affects quantities, both of trade and production. In a multilateral world, with either standard HO or HO-fragmentation we expect to see rising trade "incidence" in terms of the frequency of bilateral trade flows for each industry. However, in the standard HO world all this trade would be interindustry trade while in the HO-fragmentation world much of it would be intraindustry trade of activities within industries.

Production patterns should also look different across the two perspectives. In the standard HO world, if countries focus production on comparative-advantage industries then the vector of output shares should grow more dissimilar across countries over time for given factor endowments. In the HO-fragmentation world, however, the product mix might grow more similar across countries over time. Consider the example of automobile production for these two cases. With integration in the standard HO model, countries with a comparative-advantage in automobiles would increase their automobile share of domestic production, while countries with a comparative-disadvantage would reduce their automobile share. But in the HO-fragmentation world most (perhaps all) countries move into some aspect of car production: different countries focus on different activities,

but many might have at least some output in the car industry. Another different feature of the HO-fragmentation world is that the share of domestic value added in industry gross output might fall across industries and countries as countries increasingly rely on imported intermediate inputs. The standard HO world does not carry this prediction.

In general, the predicted effects of integration on industry-level data are less clear for the HO-fragmentation model than for the standard HO model. While this is not a new idea, it is an important empirical consideration because most readily available international data are at high enough levels of aggregation to mask particular activities. Feenstra (1998) provides rich anecdotal and systematic evidence that production fragmentation has increased in recent years.

3 Evidence from Prices

The absolute version of LOP provides one natural benchmark for assessing the integration of markets. Presumably, globalization would reduce the magnitude of deviations from LOP. Another benchmark might involve relative prices: globalization should force countries to face increasingly similar relative-price vectors for traded goods. This definition might be attractive in instances where misalignments of exchange rates might generate substantial short-run deviations from absolute or relative LOP.

The usefulness of these benchmarks are limited by data constraints, however. There are no *comprehensive* data on *local currency prices* of *identical* products across countries. Thus, any attempt to measure integration using product prices will typically require a compromise in one of the three dimensions emphasized above: comprehensiveness, unit of measure (e.g., comparing measures such as indices whose levels are arbitrary), or product differentiation. Although much research has tested the relative LOP (e.g., Kravis and Lipsey (1977)), most of this work says nothing about the changing degree of integration. Somewhat ironically, the movement from segmented to integrated markets would appear in the data as a departure from the relative LOP (or, alternatively, as pricing to market). In general, it is difficult to study price convergence with indices--which contain no information about price levels.

3a The Behavior of Deviations from the Law of One Price

It may seem obvious that deviations from LOP should be decreasing as markets integrate, but it is less clear whether what matters are absolute or relative (i.e., percentage) deviations from LOP. Therefore, it worth considering what price dispersion actually reveals about integration.

Theoretically, price discrimination across markets arises as a result of: (1) differences in demand characteristics across groups of consumers (where in our case the groups refer to countries) and (2) the ability of firms to exploit differences in demand because of costs of resale across markets. Our definition of increased market integration is that the costs of resale are falling relative to other costs in the economy, either because nations have reduced barriers to the free flow of goods across borders or because transport and information costs have decreased between markets.[4] These definitions of price discrimination and market integration have important consequences for measurement and interpretation.

First, it is important to recognize that the degree of price dispersion we observe in the data is not purely a function of market integration. Variation in demand elasticities due to underlying variation in fundamentals such as income, exchange rates, or availability of substitutes can give rise to variation in price dispersion as well. Unfortunately, the precise link between these fundamental factors and the dispersion in demand elasticities is likely to be quite complicated and difficult to discern in the amount of data we have available. We will make no explicit attempt to control for them, but merely note their potential impact on our findings.

Second, it is important to account for the fact that resale costs may be rising in nominal terms, but falling relative to other costs. Ideally, we would like to know whether the permissible range of price dispersion is rising or falling relative to the product price itself. To capture this concept we will use the coefficient of variation (CV), which equals the standard deviation of the prices across countries within a given period divided by the mean of prices across countries for that period. A falling CV will be interpreted as falling resale costs and increased integration.

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[4] It is important to measure resale costs relative to other costs in order to abstract from the effects of inflation.

We study the dispersion of prices across markets and over time for four different types of price data: German export unit values, U.S. export unit values, the Big Mac, and *The Economist.* Each of these samples has nominal prices, converted if necessary into units of a common currency. The data samples vary in the length of time they span and the destinations they include, although in general these data measure prices in OECD countries only. It is more difficult to get comparable price data in nominal currency units for many of the less developed economies. For evidence on integration between the developed and less developed countries, which has arguably been a more important phenomenon in recent decades, we will turn to quantity data in the next section.

Table 1 reports the estimated linear trend in the CVs calculated for each of 16 U.S. export unit value series from 1973-87. For each industry, the CV is calculated for each year across the set of destinations in the sample. Then the time series of CVs for that industry are regressed on a constant and a linear time trend. The cross section of destination markets includes between 5-8 countries, typically including Canada, Japan, Germany, and the United Kingdom plus one or more other European markets. Because the set of destinations is not fixed across products, the variation in results across industries may partly reflect variation in the markets in the sample. If price dispersion were declining steadily, we would expect the regression to yield a negative coefficient. In fact, only four of the 16 estimates are negative and only two of them are significant at conventional levels. About four of the positive coefficients are statistically significant.

Table 2 reports the analogous regressions for 29 German export industries from 1975-87. The cross section of destinations is similar to that in the U.S. sample, except that the U.S. replaces Germany as a destination in each industry. In this sample, a small majority, 16 out of 29, cases show a declining trend, although only five t-statistics are below -2.20 which is required for statistical significance at the 5% level for a two tailed test with 11 degrees of freedom. In contrast, nine out of 13 positive coefficients are statistically significant. One factor that may help explain the number of significant positive coefficients in this set of regression is the overvaluation of the dollar in the second half of the data sample. In general, DM prices of shipments to the U.S. rose sharply relative to the DM prices of shipments to other markets during the dollar's rise from 1980-85.

However, in repeating the regressions excluding the U.S. from the sample of German export destinations, similar qualitative results were obtained. Therefore, it is clear that the overvaluation of the dollar was not by itself responsible for the significant trend increase in price dispersion across German export markets.

One problem with the results for the U.S. and German exports is that in each case the data are based on unit values of shipments. The unit-value data are susceptible to quality change.   If product varieties have become more specialized in a destination-specific manner over time, this may account for increasing dispersion in unit values (see Lipsey (1963) for detailed analysis of these issues). Arbitrage forces are not as strong when product substitutability is low. While there are no comprehensive data on identical products, it is quite easy to get price data for the Big Mac and *The Economist* (cover or newsstand price) on a local currency basis for a number of markets.

While Big Macs and *The Economist* do not strike people as classical "tradables" for which trade arbitrages away international price differentials, there are still good reasons to expect that prices for these goods should converge as a result of market integration. First, many of the inputs used in producing a Big Mac (flour, beef) or a magazine (paper) are in fact tradable goods. As these prices converge across countries, prices of the final goods should as well.   Second, if product-market integration induces factor-price convergence across countries, then we have further reason to think the prices of these goods might converge across markets.

What do these data show us about price dispersion?   Results for the Big Mac prices are reported in Table 3 for three different samples. The first sample uses prices from 12 different markets, but excludes the 1987 observation (which is missing for half of these markets). The regression shows a slight, but insignificant tendency for dispersion to fall over time for the ten annual data points. If we restrict the sample to the six markets for which prices are available in all 11 periods, there is an increase in the estimated convergence trend, but the coefficient is still not statistically significant. Finally, if we exclude the U.S. from the sample of six, the remaining five markets—Belgium, U.K., France, Netherlands, and Germany—do show a significant trend

toward lower dispersion. This might be expected since European integration is taking hold over this period and exchange rates are perhaps more tightly linked.

Results for *The Economist* are in Table 4. These data cover the longest time span of any of our data: 1967-1991. The whole sample of 11 markets shows little evidence of trend. This result does not change markedly when the U.S. is excluded. When the U.S., U.K., and Ireland are removed from the sample, the remaining set of European and Scandinavian markets do show some tendency toward reduced dispersion. If we restrict the sample of countries to the same six used in the Big Mac, we see significantly lower dispersion over time.

What do we take away from the reported evidence on price dispersion? Basically, that there is little evidence in the data that product markets in developed economies have become more closely linked in the 1970s and 1980s. That may be a result of the fact that this set of countries was already fairly integrated by the 1970s. We do note that with the Big Mac and *The Economist* there is some evidence that countries of Europe may be more closely linked today than they were ten or 20 years ago. This is not surprising.

3b The Behavior of Relative Prices

Our second approach to looking for integration of national economies in price data is to examine whether countries seem to be converging toward a common set of internal relative prices. This approach is appropriate for two reasons. First, resource-allocation decisions within a country are a function of relative prices. Second, the best source of information on internal relative prices for fairly detailed product categories is found in the International Comparisons Project data. This collection effort was spearheaded by a group of scholars that included Robert Lipsey.

While the ICP data exist in principle for many countries at five year intervals from 1970 to the present, we were only able to obtain the data for 1975, 1980, and 1985. We focus on the two endpoints and ask whether the relative prices within countries are converging toward a common benchmark. This requires a choice of benchmark. Ideally one would like a "world price" that would prevail in an open market. By definition, this does not exist. Instead, we pick individual countries as a benchmark: first the United States, then Germany.

To measure variation relative to the base country, we first normalize the data by multiplying each country's price for a given product by the reciprocal of the base-country price of that product. This is done for all products, ensuring that the price vector for the base country is a vector of ones. For each other country in the sample, we compute the coefficient of variation of the prices across individual products. If the country has a relative price structure identical to the base country, the CV will equal zero, since the price vector will be a constant. Specifically, each element of the price vector for a particular country would be equal to the exchange rate (local currency per unit of base country currency) between the particular country and the base country that prevailed for this set of products. Since that exchange rate need not equal the actual market exchange rate, prices in the two countries need not be equal to have a common relative price structure.[5] On the other hand, as prices within a country depart from the cross-category mean price, the coefficient of variation rises.

Table 5 reports the coefficient of variation of internal relative prices for 17 countries in 1975 and 1985 benchmarked against the U.S. relative price structure. The CV is calculated for two separate groupings of goods—producer goods and consumer goods—and for the total.[6] The measure for producer goods is based on a sample of only three products and should be judged accordingly. The cross-country variation in the CVs seems to correlate with stages of economic development. Most developed countries in the sample have lower CVs than the less developed countries, which probably is in part a reflection of the extent to which product market distortions in the traded goods sector can undermine development.[7] It may also reflect the different degrees of non-traded services included product prices, especially for certain consumer goods.

Turning to the time dimension of the U.S.-benchmarked sample, there is a large decline in the calculated CVs between 1975 and 1985 for Korea and India, and to a lesser extent for Japan, Belgium, and France. This suggests some convergence toward common relative prices between

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[5] It is easy to imagine how a sudden currency swing might cause systematic violations in the law of one price without necessarily altering the relative price structure between two markets.

[6] Note that the CV for the total is not equal to the average of the two subgroups. This is primarily because the two subgroups may have different means. Looking within the subgroup does not capture this additional source of change in the overall coefficient of variation.

[7] The raw data also reveal another interesting feature: the less developed countries tend to have higher relative prices for producer vs. consumer goods relative to the United States. Other developed countries distortions relative to U.S. prices seem to be unrelated to the broad groupings of producer and consumer goods.

the United States and these countries. On the other hand, the CVs for Philippines and Thailand increase by large amounts between the two periods, suggesting a movement toward more diverse relative prices vis-à-vis the United States. Overall, this relative price evidence shows that linkages are much closer between the United States and the other developed countries than they are between the United States and developing counties. Furthermore, the big movements in relative prices suggest convergence or roughly no change with respect to some developed countries, while there are signs of convergence and divergence with respect to the set of developing countries.

Turning to the German benchmarked sample, one feature that stands out is how small the CVs are vis-à-vis other Continental European countries. It seems that relative prices within Europe were already quite close to the relative prices in Germany. The only notable changes among this set of countries were declines by Austria and Italy. Price dispersion is somewhat greater vis-à-vis the United Kingdom and Ireland, with only slight declines in the CVs over the decade. Looking outside European markets, we see that CVs declined markedly for Japan, Kenya, Korea, and the United States. They rose for Philippines, Poland, and Thailand. This evidence seems broadly consistent with what was observed in the U.S. sample. Relative prices are much more similar within the developed economies, and the main tendency among developed markets is toward further convergence of prices. However, with developing countries, we see cases of both convergence and divergence over this decade.

Taken together, the totality of price evidence we have examined here points to increased linkages between the developed economies over recent decades, especially within the European markets, which were already quite closely integrated with each other. It is more difficult to tell what the price evidence says about integration between developed and developing countries, partly due to lack of data. For the data we have at present, the results are mixed.

4 Evidence From Quantities

4a Market "Thickness": Evidence from Trade Flows

Our first quantity-based integration measure looks at how "thick" product markets are in terms of breadth of trade flows. Define the categorical variable Z_{ijkt} to be equal to one if country j has

some positive value of exports to country k in industry i during year t, and zero otherwise. If there are N countries in the world at time t, then for each industry i there can be up to $[(N)x(N-1)]$ total bilateral trade flows. One possible measure of market "thickness" might be the share of total possible bilateral trade flows for which trade actually happens. This thickness measure can be calculated for each industry-year as follows.

$$(1) \qquad \theta_{it} \qquad \left(\frac{\sum_j \sum_k \sum_j Z_{ijkt}}{[(N)x(N-1)]_t} \right)$$

By construction, the thickness measure θ_{it} ranges from zero to one and reports the share of total possible bilateral trade "hits" in which trade actually happened. If every (no) country-pair worldwide has two-way trade in industry i at time t, then θ_{it} equals one (zero). We interpret higher values of θ_{it} to indicate a thicker world market. In accounting for the incidence of trade (i.e., because Z_{ijkt} is categorical), note that this measure does not incorporate any information about trade volumes. Given this property, we intend for this measure to capture the competitiveness of product markets under the assumption that competitiveness depends "on the margin" on the incidence of trade regardless of the volume of that trade. We hypothesize that globalization might increase market thickness over time, insofar as lower trade barriers permit more bilateral trade hits. Of course, lower barriers might have countervailing effects as well: if national production mixes become more specialized, for some industries there might be fewer exporters and thus fewer bilateral trade hits. Whatever the case, we think the θ_{it} measure is informative.

To construct θ_{it} we use the world trade data in Feenstra, Lipsey, and Bowen (1997) . These data cover 34 manufacturing industries (as defined by the Bureau of Economic Analysis) from 1970 through 1992. We try two different sets of countries: the 24 original OECD countries, and "the world" defined as 122 countries with trade data available for all 23 years of the sample. In addition, each observation of θ_{it} from the world group of countries is decomposed into four components: exports from an OECD country to another OECD country; exports from an OECD country to a non-OECD country; exports from a non-OECD country to a non-OECD country; and exports from a non-OECD country to an OECD country. That is, for each industry-year observation of the world sample:

$$(2) \qquad \theta_{it} = \theta_{ioot} + \theta_{iont} + \theta_{inot} + \theta_{innt} \ .$$

Each of the four components is constructed by varying the countries j and k in Z_{ijkt}. For example, for θ_{iont} the set of j exporting countries is the OECD and the set of k importing countries is the non-OECD. By keeping N=122 for all four components we end up with equation (2). With this decomposition, we can see how changes in θ_{it} are accounted for by major country groupings.[8]

Table 7 reports some summary statistics for the OECD sample, the world sample, and the four components of the world sample. Note that on average, markets are much thicker within the OECD sample than within the broader sample. This squares with the general fact that most world trade is among OECD countries. Within the world sample, note that total exports from non-OECD countries account for about two-thirds of all bilateral trade "hits." These summary statistics mask a lot of heterogeneity across industries. Table 8 reports the mean thickness indexes for all 34 industries for both the OECD and full-world samples. Over the full time series, in both samples Tobacco Products is the thinnest market (0.53 in the OECD, 0.07 in the world) while Miscellaneous Food Products is the thickest market (0.97 in the OECD, 0.31 in the world).

To see how market thickness has evolved over time, we pooled the industry thickness measures and regressed them on a full set of industry dummy variables (which control for time-invariant differences in market integration across industries) and a time trend:

$$(3) \qquad \theta_{it} = \beta(ID)_i + \gamma t + e_{it} \ ,$$

where e_{it} is an additive error term. For both our thickness measures (OECD and world) the time trend in equation (3) had a significantly positive coefficient estimate, suggesting that markets have been thickening over time. Regressions with a time trend, however, do not allow us to see whether the pace of integration has varied over time. To do this we replace the time trend in equation (3) with a full set of time dummies and estimate equation (3').

$$(3') \qquad \theta_{it} = \beta(ID)_i + \delta(TD)_t + u_{it}$$

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[8] One concern we have in constructing our trade-thickness measures is whether the raw data contain threshold levels of trade required for a non-zero entry and, relatedly, how these threshold levels change over time. Any discrete changes in thresholds might cause discrete changes in trade thickness. The available data documentation did not flag any problems here, but we highlight the issue nevertheless.

Table 9 reports the parameter estimates on the time dummies from equation (3') using the world sample and all six thickness measures: those from the OECD sample, those from the world sample, and the four world components as described in equation (2). The key message of Table 9 is that the market thickening process looked very different in the 1970s and 1980s. During the 1970s the coefficients on the time dummies increased almost uniformly for all six thickness measures. This indicates that market thickening proceeded continually throughout the 1970s.

The 1980s looked very different, however. After 1979 the coefficients on the time dummies *decreased* for some time, and only after some additional time did they return to their 1979 level. This suggests that market thickening proceeded much less uniformly during the 1980s. The extent of this thickening slowdown varies among thickness measures. Among the OECD countries the slowdown lasted the shortest period: for the OECD-sample $_{it}$ the time dummies return to their 1979 levels in 1984, and for $_{ioot}$ the 1979 level held steady until 1985. Trade flows involving non-OECD countries took longer to rebound--particularly exports from non-OECD countries. For the world-sample $_{it}$ the time dummies do not return to the 1979 level until 1988. The other three components of the world-sample $_{it}$ returned as follows: $_{iont}$ 1986, $_{inot}$ 1989, and $_{innt}$ 1988. Figure 2 summarizes the difference across decades for all manufacturing together by averaging $_{it}$ across all 34 industries in each year. The rise in the 1970s and subsequent stalling in the 1980s is clear. Figure 3 shows the same pattern for a single industry, Textiles and Apparel. The pattern in this figure is repeated in many other industries; altogether they give rise to Figure 2.

In interpreting regression results from (3') as evidence of integration, we reiterate our caveat that our analysis does not link outcomes back to trade barriers. Without these links we cannot rule out that changes in outcomes are caused by forces other than declining barriers, such as economic growth. To address this issue we reestimated equation (3') by adding in additional regressors to control for forces affecting $_{it}$ other than declining barriers as proxied by time dummies. Our choice of regressors, as with our empirical strategy more generally, does not follow from a specific trade model. Instead, we chose measures aimed at capturing cross-country differences in endowments, tastes, technology, and the resulting international dispersion of production.

In Table 10 we report estimation results for equation (3') augmented by three alternative controls: cross-country dispersion in capital-to-labor endowment ratios; cross-country dispersion in GDP per worker; and cross-country dispersion in industry production. We intend for these three controls to capture the role of endowments, tastes and technology, and the equilibrium international dispersion of production, respectively. The first two controls vary only over time; both come from the Penn World Tables assembled by Summers and Heston (1997). The third control is from UNIDO (1995); it varies by both time and industry. For each control, the dispersion of the variable of interest is constructed as the standard deviation of the log of that variable calculated by pooling across the relevant set of countries (i.e., the set of countries used in the thickness measure -- either the OECD or the 122 countries in "the world").[9]

Table 10 reports results for six regressions: three for the OECD and three for the world, each estimates of equation (3') plus one of the control regressors.[10] The key message of this table is that the time-series patterns in our thickness measures appear robust to controlling for other plausible determinants of thickness. In all but one case, the general pattern remains of rising thickness over the 1970s followed by a decline and then recovery in thickness over part or most of the 1980s. Only for the OECD sample using endowment dispersion do we find a much shorter decline period. As for the controls, both endowment and per capita GDP dispersion were very significantly positive in all specifications. The industry-output control was significantly positive at the 10% level for the OECD sample, but significantly negative at that level for the world sample.

Finally, Table 11 reports how the worldwide trade thickening from 1970 to 1992 was allocated across the four components in equation (2). For each of the four components Table 11 reports the level in 1970 and 1992, the level change between 1970 and 1992, and finally the share of the total level change in $_{it}$ accounted for by that component, all averaged in each year across the 35 industries. Slightly less than half of the total increase in $_{it}$ was accounted for by trade among

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[9] For our third control, the UNIDO data contain 28 3-digit ISIC manufacturing industries. Our thickness measures are constructed for the 34 BEA manufacturing industries. We matched the UNIDO industries to the BEA industries as best we could without a true concordance; accordingly, we acknowledge that this procedure introduced some measurement error.

[10] For the world sample, for brevity we report using just total world trade hits thickness measure -- i.e., only the left-hand side of equation (2).

non-OECD countries. About 28% was accounted for by exports from the OECD to non-OECD countries, while another 22% was accounted for by trade in the other direction. Only about 5% of the total increase was accounted for by trade among OECD countries.

4b The Geographic Dispersion of Production

Our second quantity-based integration measure is the degree of production concentration worldwide, measured with industry-year Herfindahl indexes of production. Let X_{jit} be the output of country j in industry i at time t. Then we define the following:

$$(4) \qquad \text{HerfX}_{it} \qquad \sum_j \left(\frac{X_{jit}}{X_{worldit}}\right)^2 \ .$$

By construction, HerfX_{it} ranges from zero to one. It equals one if a single country produces all the world's output in some industry-year, and it approaches zero as world production is spread evenly across all countries. In a standard HO model HerfX_{it} should increase with integration as world production becomes more specialized according to comparative advantage. In an HO-fragmentation world HerfX_{it} might decline as production activities within industries spread across more countries. To construct HerfX_{it} we use data from UNIDO (1995) covering the 28 3-digit ISIC manufacturing industries from 1970 through 1992, with "the world" defined as all countries with output data available for all 23 years of the sample. We have information on both value added and gross output; for completeness we use both, and thus measure X_{jit} in terms of either value added or gross output.[11]

Table 12 reports summary statistics for the two Herfindahl indexes. Note that, on average, HerfX_{it} is slightly larger for value-added output than for gross output. To see how these indexes evolved over time we pooled all observations and regressed each HerfX_{it} on a full set of industry dummy variables (which control for time-invariant differences in market integration across industries) and a time trend:

$$(5) \qquad \text{HerfX}_{it} = (ID)_i + t + e_{it} \ ,$$

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[11] Strictly speaking, the standard HO model refers to industry net outputs. We have data only on value added and gross output, and are assuming that the Herfindahl indexes rise for these output measures whenever it rises in terms of net output.

where e_{it} is an additive error term. For both our output measures the time trend in equation (5) had a significantly negative coefficient estimate, suggesting that world production has become less concentrated over time. As before, however, regressions with a time trend do not allow us to see whether the pace of integration has varied over time. To do this we estimate equation (6).

$$(6) \qquad HerfX_{it} = \quad (ID)_i + \quad (TD)_t + u_{it} \ ,$$

where as before TD is a full set of time dummies.

Table 13 reports the parameter estimates on the time dummies from equation (6) for both measures of $HerfX_{it}$. For each measure, Table 13 also reports results for equation (6) modified by adding the world-endowment-dispersion control. As with trade thickness here, too, the 1970s and 1980s look different. Both measures of $HerfX_{it}$ had uniformly declining time dummies during the 1970s. But this trend reversed after 1980, with the time dummies increasing for several years before coming down again. This pattern holds even controlling for the world distribution of endowments (similar results obtained using the other controls described earlier; for brevity we omit these). Figure 4 visualizes the difference across decades for all manufacturing together by averaging the gross-output $HerfX_{it}$ across all 28 industries in each year. The fall in the 1970s and subsequent stalling in the 1980s is clear.

What these time-series patterns in $HerfX_{it}$ say about integration depends on which framework is applied. From the standard HO perspective the patterns suggest no integration in the 1970s, then greater integration in the 1980s. From the HO-fragmentation perspective the opposite is suggested: marked integration during the 1970s and then very little integration in the 1980s. We note that this later interpretation is consistent with the trade-thickness evidence.

4c Production Fragmentation: Evidence from Value Added and Gross Output

Our final quantity-based integration measure is the ratio of value added to gross output within industries. With the UNIDO data we can construct this ratio for each industry-year, $VAGO_{it}$, again for all 28 3-digit ISIC manufacturing industries from 1970 through 1992. In the full sample $VAGO_{it}$ had a mean value of 0.376 (with a standard deviation of 0.102). In the HO-fragmentation

world, with integration VAGO$_{it}$ should decline as countries focus on narrower mixes of activities within industries and import other activities as intermediate inputs. To test this we estimate

$$(7) \qquad \text{VAGO}_{it} = \quad (\text{ID})_i + \quad (\text{TD})_t + u_{it} \quad ,$$

where as before TD is a full set of time dummies. An important data caveat here is that VAGO$_{it}$ can change because of changing reliance on *domestic* intermediate inputs, not just foreign inputs. We have no data on imported intermediate inputs; our results should be interpreted accordingly.

Table 14 reports the parameter estimates on the time dummies from equation (7); it also reports results for equation (7) modified by adding the world-endowment-dispersion control. Again the 1970s and 1980s look different. With or without the control for endowments, the time dummies in equation (7) generally declined during the 1970s, then plateaued during the 1980s and increased sharply the last few years. Figure 5 visualizes these trends by averaging VAGO$_{it}$ across all 28 industries in each year. The fall in the 1970s and subsequent stalling is clear.

4d Summary of Quantity Evidence

Viewed from the HO-fragmentation perspective, our quantity evidence suggests that product markets have integrated since 1970 but at quite different rates over time. There was sizable, steady integration during the 1970s. But the 1980s had very little integration overall: integration actually reversed initially, only to recover this reversal by the end of the decade. We note that these decade differences broadly match the trend in U.S. natural trade barriers in Figure 1. These differences also have a parallel in the recent product-price studies liking rising U.S. wage inequality with Stolper-Samuelson price effects. The consensus of these studies is that during the 1970s the U.S. relative price of unskilled-labor-intensive products declined but that this decline did not continue during the 1980s. These price changes suggest that the U.S. economy liberalized during the 1970s but not the 1980s -- a split in timing which matches our quantity evidence.

In interpreting these price and quantity measures as evidence of integration, we reiterate our caveat that these measures do not link outcomes back to trade barriers. Without these links we cannot rule out that changes in outcomes are caused by forces other than declining barriers, such as economic growth. In our regression analysis we have included some first-pass controls for these

other forces, such as cross-country dispersion of endowments and per capita income. Our outcomes-based measures of integration look quite similar with and without these controls, so we hope that these measures reflect something about the underlying integration process.

5 Conclusion

In this paper we have presented some new price- and quantity-based measures of product-market integration. Our price measures do not permit very strong conclusions about the changing nature of market integration. Both the absolute and relative price information available does confirm that European countries seem to be moving toward a single market. There is little to suggest convergence toward common prices between Europe and the United States or United Kingdom, however. We have limited price data on linkages between developed and developing countries. The developing-country evidence is mixed: some countries seem to converge in relative prices but others do not. Our quantity evidence suggests that product markets have integrated since 1970, but at quite different rates over time. There was sizable, steady integration during the 1970s. But the 1980s had much less integration overall: it reversed initially and then recovered.

These new measures we regard as a first step in trying to quantify more accurately the process of product-market integration. With refinement, we think measures like these will help researchers understand the links between integration and domestic-economy outcomes.

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Figure 1

Declining Political and Natural Trade Barriers
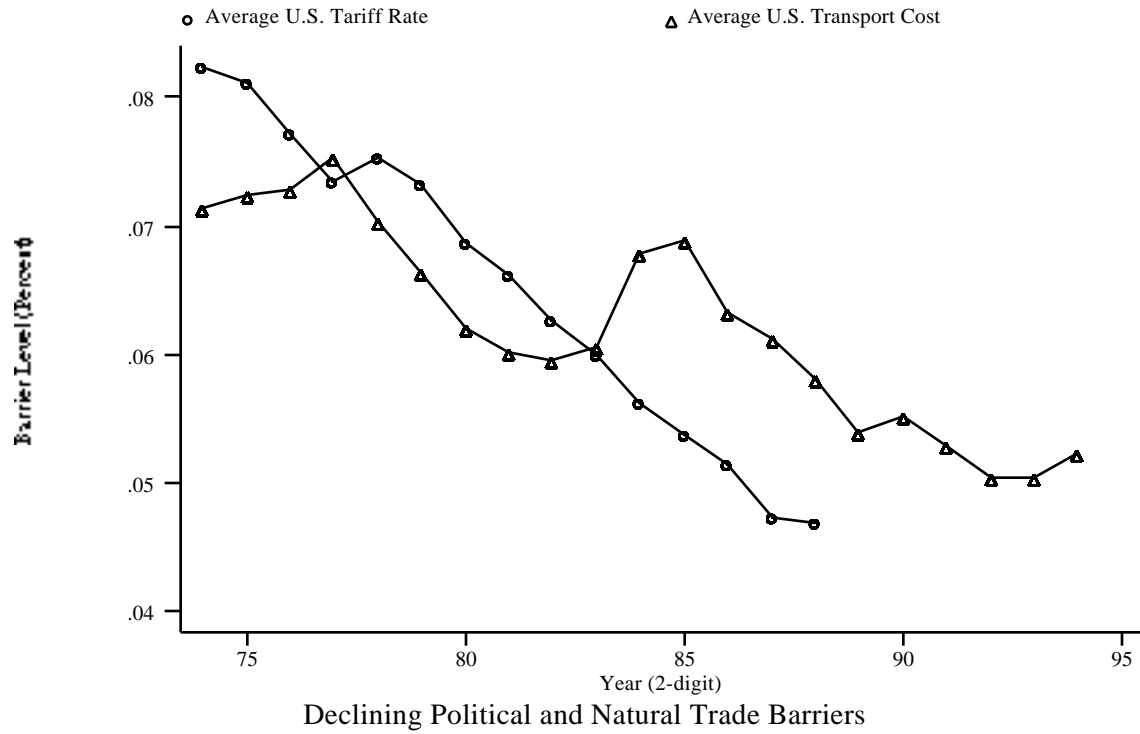
Notes: Data cover all U.S. manufacturing. Tariff rate is defined as total manufacturing duties collected divided by total manufacturing f.o.b. imports. Transportation cost is defined as the difference between total manufacturing imports valued c.i.f. and f.o.b. divided by total manufacturing f.o.b. imports.
Source: Feenstra (1996).

Figure 2
World Trade Thickness
All Manufacturing
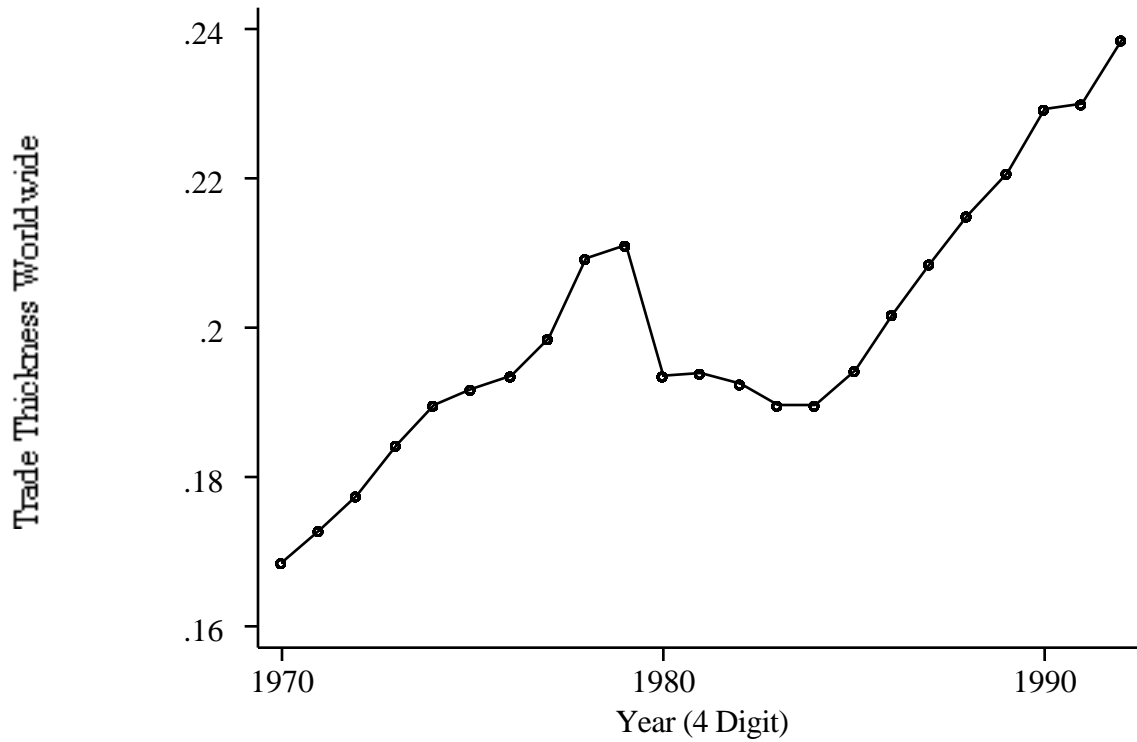
Notes: Each year plots the thickness of world trade (as defined in Equation (1)) averaged across all 34 manufacturing industries.
Source: Feenstra, Lipsey, and Bowen (1997).

Figure 3
World Trade Thickness
Textiles and Apparel
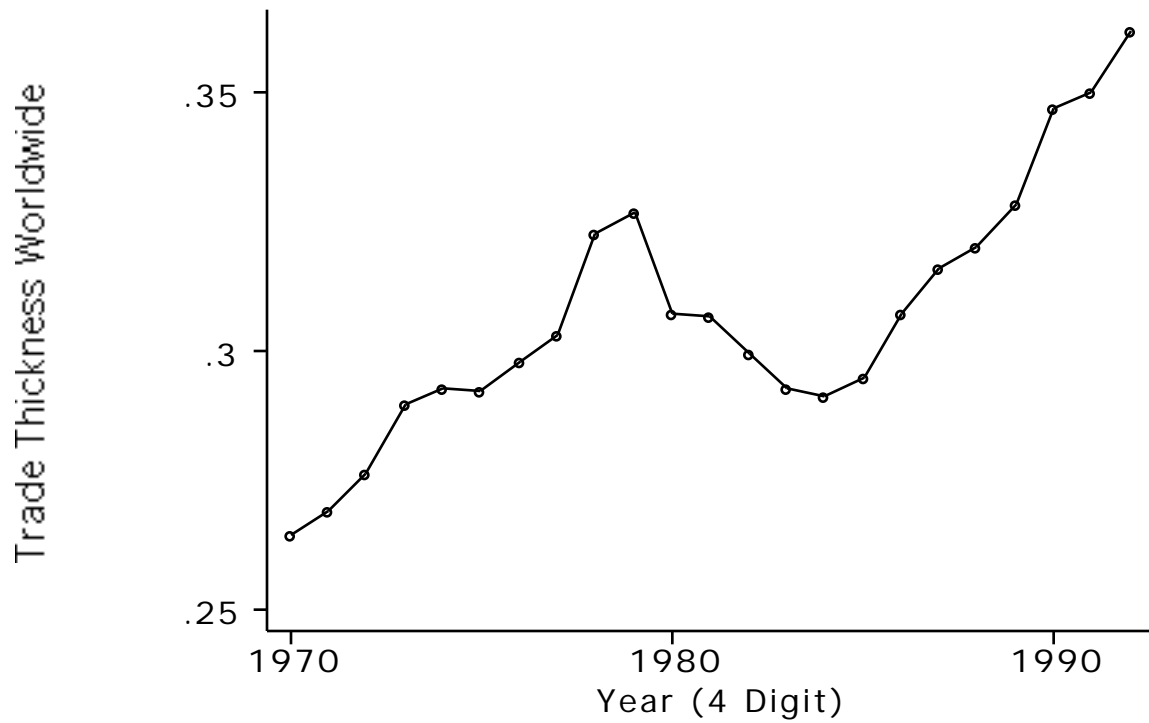
Notes: Each year plots the thickness of world trade (as defined in Equation (1)) for the industry Textiles and Apparel.
Source: Feenstra, Lipsey, and Bowen (1997).

Figure 4
World Production Dispersion
All Manufacturing
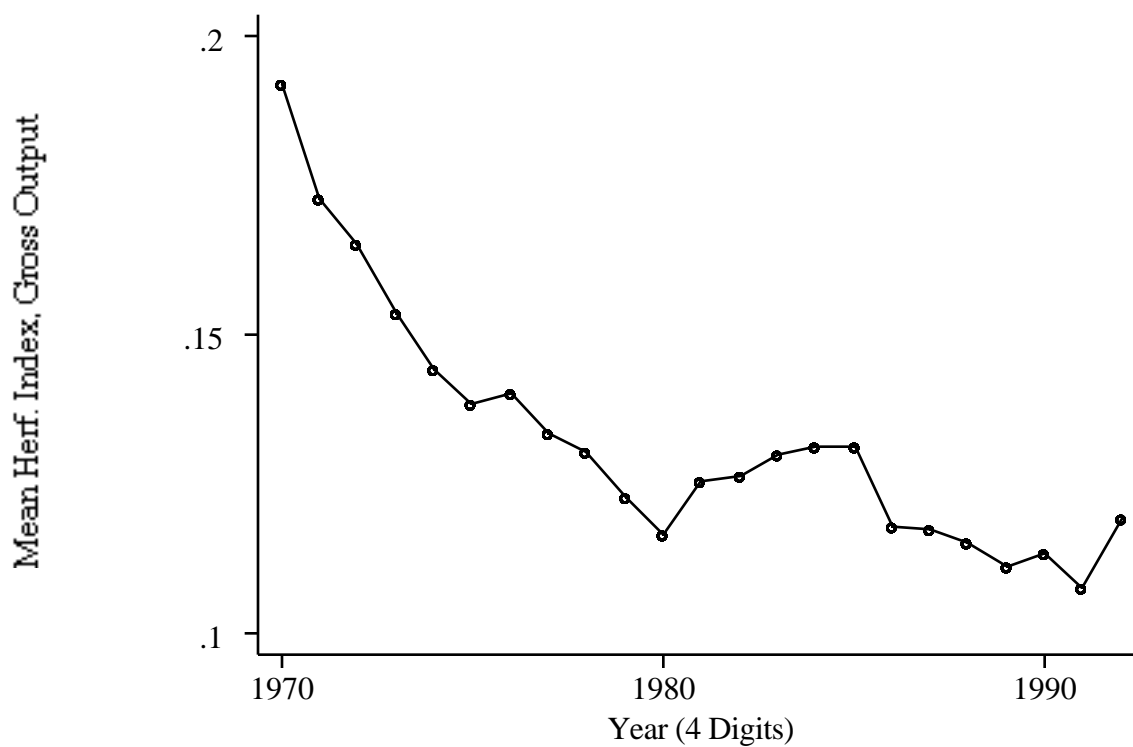
Notes: Each year plots the dispersion of world production (as defined in Equation (4)) averaged across all 28 manufacturing industries.
Source: Unido (1995).

Figure 5
World (Value Added/Gross Output)
All Manufacturing
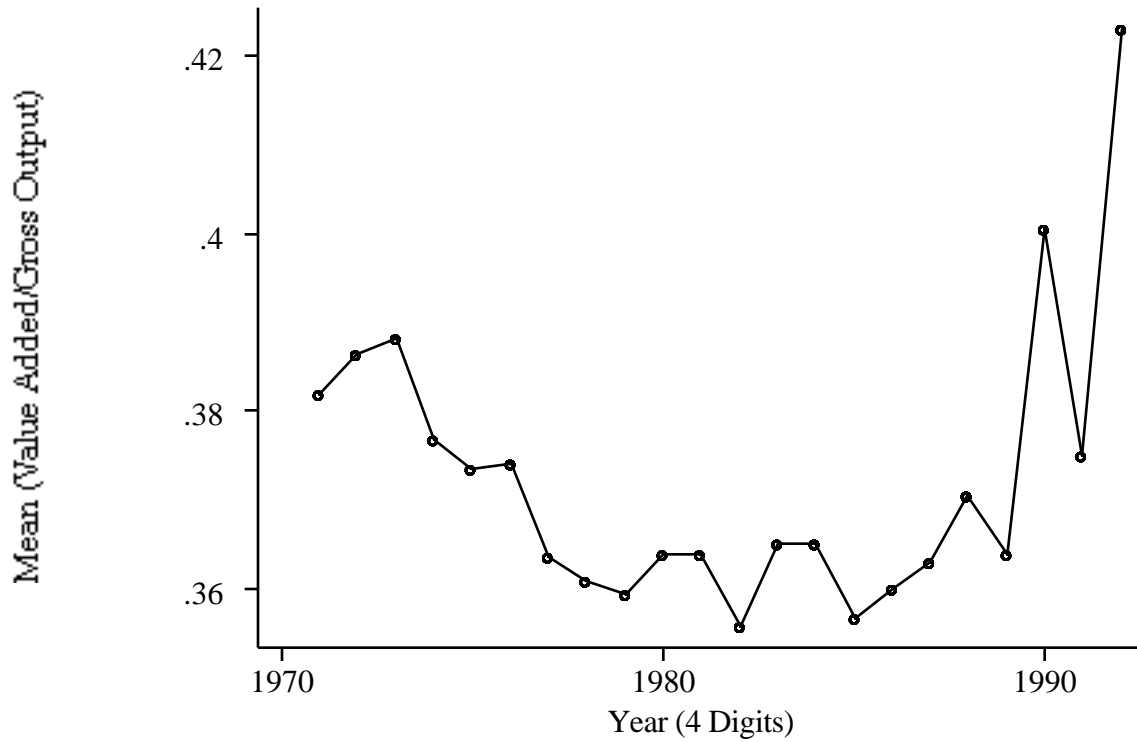
Notes: Each year plots the ratio of value added to gross output averaged across all 28 manufacturing industries.
Source: Unido (1995).

Table 1: Trends in U.S. Export-Price Dispersion

Industry	Trend	Std. Error	t-statistic
Aluminum Foil	0.0383	0.0039	9.78
Aluminum Oxide	-0.0274	0.0111	-2.47
Integrated Circuit	0.0068	0.0053	1.28
Kraft Linerboard Paper	-0.0036	0.0020	-1.77
Autos, over 8 cyl.	0.0108	0.0043	2.51
Primary Cell Batteries	0.0071	0.0203	0.35
Photocopier Paper	0.0040	0.0067	0.6
Putty	0.0054	0.0048	1.14
Cigarettes	0.0102	0.0015	6.74
Industrial Lacquers	0.0097	0.0059	1.63
Nitrile Rubber	-0.0053	0.0056	-0.96
Raw Cotton	0.0060	0.0059	1.02
Autos, under 8 cyl.	0.0023	0.0012	1.92
Titanium Dioxide	0.0162	0.0128	1.26
Bourbon Whiskey	-0.0086	0.0035	-2.47
Yellow Corn	0.1880	0.0320	5.87

Notes: Each trend is the coefficient estimate of annual export-price dispersion regressed on a time trend. Annual export-price dispersion is measured as the coefficient of variation in bilateral U.S. export unit values across all destination markets. Each regression contains 14 observations.
Source: U.S. Department of Commerce.

Table 2: Trends in German Export-Price Dispersion

Industry	Trend	Std. Error	t-statistic
Aluminum Oxide	-0.0080	0.0086	-0.92
Autos, 1.5 – 2 L	0.0095	0.0024	3.94
Autos, 2 – 3 L	-0.0058	0.0012	-4.65
Autos, over 3 L	-0.0091	0.0044	-2.07
Glykocides	0.0052	0.0045	1.16
Induction Furnaces	-0.0169	0.0065	-2.60
Record Players	-0.0136	0.0077	-1.78
Razor Blades	0.0055	0.0044	1.24
Pneumatic Tires	-0.0005	0.0021	-0.22
Platinum Plating	0.0117	0.0021	5.51
Aluminum Hydroxide	0.0087	0.0034	2.52
Autos, under 1.5 L	0.0193	0.0069	2.80
Titanium Pigment	-0.0143	0.0033	-4.28
Titanium Dioxide	0.0052	0.0087	0.60
Aldehyde Derivatives	-0.0211	0.0207	-1.02
Hydrocarbons	-0.0066	0.0055	-1.19
Hydrogen	0.0080	0.0022	3.67
Vitamin A	0.0197	0.0078	2.54
Vitamin C	-0.0022	0.0023	-0.94
Beer	-0.0081	0.0023	-3.48
Synthetic Dyes	-0.0026	0.0027	-0.97
Special Dyes	0.0090	0.0026	3.41
Glazed Ceramic Tiles	-0.0021	0.0030	-0.72
Calcium	-0.0234	0.0099	-2.36
Olive Oil	-0.0064	0.0045	-1.42
Sandals	0.0332	0.0047	7.08
Semi-Finished Platinum	0.0059	0.0036	1.63
Cocoa Powder	-0.0013	0.0045	-0.29
Women's Blouses	0.0322	0.0048	6.69

Notes: Each trend is the coefficient estimate of annual export-price dispersion regressed on a time trend. Annual export-price dispersion is measured as the coefficient of variation in bilateral German export unit values across all destination markets.
Source: Statistisches Bundesamt.

Table 3: Trends in Price Convergence for the Big Mac, 1986-1997

Country Group	Trend	Std. Error	t-statistic
"Big Mac 12"	-0.0014	0.0023	-0.62
"Big Mac 6"	-0.0029	0.0026	-1.14
"Big Mac 5"	-0.0069	0.0020	-3.44

Notes: Each trend is the coefficient estimate of annual price dispersion regressed on a time trend. Annual price dispersion is measured as the coefficient of variation in Big Mac prices across all countries in the Country Group. Country Groups are defined in the text.
Source: *The Economist* magazine.

Table 4: Trends in Price Convergence for *The Economist*, 1961-1991

Country Group	Trend	Std. Error	t-statistic
"Economist 11"	0.0003	0.0010	0.25
"Economist 10"	0.0005	0.0010	0.47
"Economist 8"	-0.0014	0.0008	-1.77
"Big Mac 6"	-0.0049	0.0012	-4.01
"Big Mac 5"	-0.0028	0.0014	-1.94

Notes: Each trend is the coefficient estimate of annual price dispersion regressed on a time trend. Annual price dispersion is measured as the coefficient of variation in prices of *The Economist* across all countries in the Country Group. Country Groups are defined in the text.
Source: *The Economist* magazine.

Table 5
Dispersion in National Relative Prices
Relative to U.S. Relative Prices

Country	1975			1985		
	All Goods	Cons Goods	Prod Goods	All Goods	Cons Goods	Prod Goods
Austria	0.23	0.20	0.10	0.21	0.22	0.18
Belgium	0.28	0.30	0.14	0.18	0.18	0.19
Denmark	0.27	0.29	0.20	0.30	0.30	0.28
France	0.26	0.28	0.09	0.19	0.19	0.20
Germany	0.23	0.23	0.23	0.24	0.25	0.16
India	0.69	0.79	0.07	0.42	0.41	0.13
Ireland	0.33	0.36	0.15	0.31	0.33	0.27
Italy	0.30	0.31	0.13	0.26	0.28	0.20
Japan	0.37	0.37	0.28	0.29	0.29	0.15
Kenya	0.47	0.42	0.20	0.46	0.48	NA
Korea	0.76	0.83	0.20	0.38	0.39	0.34
Netherlands	0.23	0.22	0.17	0.29	0.31	0.18
Philippines	0.61	0.61	0.20	0.88	0.36	1.02
Poland	0.37	0.41	0.12	0.35	0.34	0.41
Spain	0.26	0.25	0.04	0.26	0.26	0.22
Thailand	0.48	0.42	0.12	0.60	0.47	0.16
United Kingdom	0.35	0.38	0.06	0.30	0.31	0.26

Notes: Each cell reports the coefficient of variation in the country's price basket. For each product, price levels have been normalized worldwide such that the U.S. price equals one.
Source: International Comparison Program, from The World Bank (1993).

Table 6
Dispersion in National Relative Prices
Relative to German Relative Prices

Country	1975			1985		
	All Goods	Cons Goods	Prod Goods	All Goods	Cons Goods	Prod Goods
Austria	0.22	0.19	0.28	0.12	0.12	0.14
Belgium	0.16	0.17	0.10	0.15	0.16	0.05
Denmark	0.18	0.16	0.31	0.19	0.18	0.27
France	0.17	0.18	0.16	0.15	0.17	0.05
India	0.61	0.69	0.14	0.58	0.63	0.26
Ireland	0.28	0.28	0.30	0.26	0.28	0.21
Italy	0.22	0.22	0.20	0.16	0.17	0.11
Japan	0.48	0.46	0.45	0.34	0.35	0.03
Kenya	0.46	0.37	0.37	0.38	0.38	NA
Korea	0.96	1.03	0.30	0.48	0.51	0.40
Netherlands	0.12	0.11	0.08	0.12	0.12	0.08
Philippines	0.60	0.61	0.37	0.97	0.48	1.09
Poland	0.35	0.37	0.29	0.46	0.47	0.39
Spain	0.44	0.48	0.21	0.25	0.24	0.20
Thailand	0.49	0.52	0.16	0.73	0.69	0.27
United Kingdom	0.25	0.27	0.15	0.21	0.22	0.20
United States	0.31	0.32	0.21	0.22	0.24	0.14

Notes: Each cell reports the coefficient of variation in the country's price basket. For each product, price levels have been normalized worldwide such that the German price equals one.
Source: International Comparison Program, from The World Bank (1993).

Table 7
Summary Statistics
Trade-Thickness Measures

Variable	Mean	Std. Dev.	Min.	Max.
it OECD	0.851	0.088	0.496	0.994
it World	0.200	0.054	0.061	0.362
ioot	0.029	0.003	0.017	0.034
iont	0.035	0.016	0.005	0.089
inot	0.082	0.018	0.028	0.122
innt	0.054	0.022	0.009	0.135

Notes: These variables are trade-thickness measures as defined by equations (1) and (2) in the text. The sample contains 782 observations (34 industries x 23 years).
Source: Feenstra, Lipsey, and Bowen (1997).

Table 8
Average Trade-Thickness Measures by Industry

Industry Name	it OECD	it World
Grain-Mill and Bakery Products	0.780	0.147
Beverages	0.832	0.162
Tobacco Products	0.535	0.072
Miscellaneous Food Products	0.974	0.308
Apparel and Textile Products	0.967	0.307
Leather Products	0.877	0.200
Pulp, Paper, and Board Mills	0.801	0.168
Other Paper Products	0.834	0.177
Printing and Publishing	0.874	0.188
Drugs	0.863	0.218
Soaps, Cleaners, and Toilet Goods	0.789	0.153
Agricultural Chemicals	0.672	0.145
Industrial Chemicals and Synthetics	0.914	0.258
Other Chemical Products	0.885	0.218
Rubber Products	0.852	0.197
Miscellaneous Plastic Products	0.889	0.191
Ferrous Metal Products	0.836	0.182
Nonferrous Metal Products	0.908	0.219
Fabricated Metal Products	0.926	0.257
Farm and Garden Machinery	0.785	0.124
Construction, Mining, and Related Machinery	0.836	0.189
Computer and Office Equipment	0.835	0.167
Other Nonelectric Machinery	0.932	0.278
Household Appliances	0.841	0.177
Audio, Video, and Communication Equipment	0.892	0.222
Electronic Components and Accesories	0.762	0.115
Other Electrical Machinery	0.897	0.236
Motor Vehicles and Equipment	0.858	0.228
Other Transportation Equipment	0.839	0.188
Lumber, Wood, Furniture, and Fixtures	0.857	0.214
Glass Products	0.845	0.178
Stone, Clay and Other Mineral Products	0.889	0.210
Instruments and Related Products	0.898	0.248
Other Manufactures	0.948	0.254

Notes: These variables are average trade-thickness measures as defined by equation (1) in the text.
The sample contains 782 observations (34 industries x 23 years).
Source: Feenstra, Lipsey, and Bowen (1997).

Table 9
Time-Series Trends in
Trade-Thickness Measures

Thickness Measure	it OECD	it World	ioot	iont	inot	innt
1970	0.899	0.223	0.031	0.049	0.081	0.062
1971	0.909	0.227	0.031	0.050	0.082	0.064
1972	0.918	0.232	0.031	0.051	0.083	0.066
1973	0.933	0.239	0.032	0.054	0.085	0.068
1974	0.936	0.244	0.032	0.054	0.086	0.071
1975	0.933	0.246	0.032	0.055	0.087	0.073
1976	0.935	0.248	0.032	0.055	0.087	0.074
1977	0.935	0.253	0.032	0.056	0.089	0.076
1978	0.939	0.264	0.032	0.058	0.095	0.079
1979	0.942	0.265	0.032	0.059	0.095	0.079
1980	0.929	0.248	0.032	0.054	0.089	0.072
1981	0.933	0.248	0.032	0.055	0.089	0.072
1982	0.933	0.247	0.032	0.055	0.090	0.070
1983	0.936	0.244	0.032	0.055	0.089	0.068
1984	0.944	0.244	0.032	0.055	0.090	0.066
1985	0.951	0.249	0.033	0.056	0.092	0.068
1986	0.962	0.256	0.033	0.059	0.092	0.072
1987	0.971	0.263	0.033	0.061	0.094	0.075
1988	0.983	0.269	0.034	0.064	0.093	0.079
1989	0.989	0.275	0.034	0.064	0.095	0.081
1990	0.998	0.283	0.034	0.065	0.096	0.087
1991	1.001	0.284	0.034	0.065	0.095	0.089
1992	1.004	0.293	0.034	0.068	0.098	0.093

Notes: Each column is a different trade-thickness measure as defined in equations (1) and (2) in the text. For each thickness measure, each row reports the coefficient estimate on that year's time dummy variable from regression equation (3'). All regressions contain 782 observations.
Source: Feenstra, Lipsey, and Bowen (1997).

Table 10
Time-Series Trends in
Trade-Thickness Measures:
Specifications With Controls

Thickness Measure	it OECD	it OECD	it OECD	it World	it World	it World
1970	N.A.	N.A.	0.876	-0.055	N.A.	0.232
1971	0.030	0.052	0.888	-0.049	0.005	0.236
1972	0.058	0.086	0.898	-0.042	0.007	0.240
1973	0.096	0.107	0.914	-0.033	0.012	0.246
1974	0.118	0.129	0.918	-0.026	0.017	0.251
1975	0.126	0.167	0.916	-0.022	0.019	0.253
1976	0.139	0.182	0.917	-0.019	0.018	0.255
1977	0.148	0.207	0.918	-0.012	0.024	0.260
1978	0.168	0.205	0.922	0.001	0.036	0.270
1979	0.180	0.200	0.926	0.006	0.037	0.272
1980	0.174	0.182	0.914	-0.008	0.012	0.254
1981	0.184	0.186	0.917	-0.006	0.017	0.255
1982	0.189	0.200	0.917	-0.007	0.018	0.253
1983	0.196	0.204	0.919	-0.011	0.016	0.251
1984	0.205	0.200	0.927	-0.013	0.015	0.251
1985	0.209	0.209	0.935	-0.011	0.024	0.256
1986	0.220	0.235	0.947	-0.002	0.029	0.263
1987	0.229	0.260	0.956	-0.001	0.036	0.269
1988	0.241	0.268	0.968	0.001	0.039	0.275
1989	0.252	0.282	0.974	0.007	0.044	0.281
1990	0.263	0.341	0.982	0.012	0.055	0.290
1991	0.294	N.A.	0.986	0.002	N.A.	0.291
1992	0.339	N.A.	0.988	N.A.	N.A.	0.300
Control Regressor	Endowments	Per Capita GDP	Output	Endowments	Per Capita GDP	Output

Notes: Each column is a different trade-thickness measure as defined in equation (1) in the text. For each thickness measure, each row reports the coefficient estimate on that year's time dummy variable from regression equation (3') expanded to include the control regressor listed in the bottom row. Exact definitions of control variables are given in the text. All regressions contain 782 observations.
Source: Feenstra, Lipsey, and Bowen (1997), Summers and Heston (1997), Unido (1995).

Table 11
Changes in World Trade Thickness

Thickness Measure	ioot	iont	inot	innt
Level in 1970	0.028	0.028	0.074	0.044
Level in 1992	0.031	0.048	0.090	0.075
, 70-92	0.003	0.020	0.016	0.031
Share of it world	0.054	0.284	0.223	0.439

Notes: These levels and changes for each measure are averaged across all 34 industries in the sample. The thickness measures are defined in equation (2).
Source: Feenstra, Lipsey, and Bowen (1997).

Table 12
Summary Statistics
World Production Dispersion

Variable	Mean	Std. Dev.	Min.	Max
Value-Added HerfXit	0.164	0.063	0.064	0.465
Gross-Output HerfXit	0.133	0.045	0.056	0.346

Notes: These variables are Herfindahl indexes of production dispersion as defined by equation (4) in the text. The sample contains 644 observations (28 industries x 23 years).
Source: Unido (1995).

Table 13
Time-Series Trends in
World Production Dispersion

Dispersion Measure	Gross-Output HerfXit	Gross-Output HerfXit	Value-Added HerfXit	Value-Added HerfXit
1970	0.233	0.081	0.255	0.078
1971	0.214	0.063	0.250	0.074
1972	0.206	0.057	0.242	0.067
1973	0.195	0.046	0.222	0.048
1974	0.185	0.038	0.211	0.038
1975	0.179	0.032	0.198	0.027
1976	0.181	0.035	0.205	0.034
1977	0.174	0.030	0.206	0.036
1978	0.171	0.027	0.203	0.035
1979	0.164	0.022	0.197	0.031
1980	0.157	0.018	0.181	0.017
1981	0.166	0.027	0.196	0.033
1982	0.167	0.028	0.200	0.037
1983	0.171	0.031	0.203	0.039
1984	0.172	0.031	0.209	0.044
1985	0.172	0.030	0.210	0.044
1986	0.159	0.018	0.192	0.026
1987	0.158	0.014	0.193	0.024
1988	0.156	0.009	0.187	0.016
1989	0.152	0.006	0.185	0.013
1990	0.154	0.006	0.180	0.006
1991	0.148	0.006	0.181	0.000
1992	0.160	N.A.	0.187	N.A.
Control Regressor	None	Endowments	None	Endowments

Notes: Each column is a Herfindahl index of production dispersion as defined in equation (4) in the text. For each dispersion measure, each row reports the coefficient estimate on that year's time dummy variable from regression equation (6). Exact definition of control variable is given in the text. All regressions contain 644 observations.
Source: Unido (1995) and Summers and Heston (1997).

Table 14
Time-Series Trends in
World (Value Added/Gross Output) Dispersion

Quantity Measure	(Value Added/Gross Output)	(Value Added/Gross Output)
1970	0.423	0.066
1971	0.336	-0.019
1972	0.340	-0.012
1973	0.342	-0.007
1974	0.331	-0.016
1975	0.327	-0.018
1976	0.328	-0.015
1977	0.317	-0.023
1978	0.315	-0.023
1979	0.313	-0.021
1980	0.318	-0.011
1981	0.318	-0.010
1982	0.310	-0.017
1983	0.319	-0.010
1984	0.319	-0.012
1985	0.311	-0.023
1986	0.314	-0.019
1987	0.317	-0.023
1988	0.325	-0.020
1989	0.318	-0.027
1990	0.355	0.006
1991	0.329	0.034
1992	0.377	N.A.
Control Regressor	None	Endowments

Notes: Each row reports the coefficient estimate on that year's time dummy variable from regression equation (7), where the dependent variable is the ratio of value added to gross output. Exact definition of control variable is given in the text. All regressions contain 644 observations.
Source: Unido (1995) and Summers and Heston (1997)..