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How Important Is the New Goods Margin in International Trade?*

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ABSTRACT

We propose a methodology for studying changes in bilateral commodity trade due to goods not exported previously or exported only in small quantities. Using a panel of 1,900 country pairs, we find that increased trade of these "least-traded goods" is an important factor in trade growth. This extensive margin accounts for 10 percent of the growth in trade for NAFTA country pairs, for example, and 26 percent in trade between the United States and Chile, China, and Korea. Looking at country pairs with no major trade policy change or structural change, however, we find little change in the extensive margin.
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1. Introduction

Recent research in international trade has focused on changes in trade patterns driven by countries starting to export goods that they had not exported before. We refer to these sorts of changes in trade as changes on the extensive margin, or the new goods margin. Changes in trade on the intensive margin are changes in exports of goods that were previously exported. Recently, models have been developed that rely on the extensive margin to deliver results. Models with heterogeneous firms facing fixed export costs, as in Melitz (2003), or market penetration costs, as in Arkolakis (2010), have proven useful in understanding firm-level export patterns, and models of Ricardian comparative advantage, as in Yi (2003), use the extensive margin to explain the growth in aggregate trade volumes. The theoretical models predict that changes in the underlying fundamentals of an economy — changes in tariffs, for example — have an effect on the extensive margin. We take this idea to the data: Do we see changes in the extensive margin during periods of structural change? How important are these newly traded goods?

In this paper, we use detailed trade data — specifically, bilateral commodity trade data disaggregated at the five-digit level of the Standard International Trade Classification (SITC) (revision 2) — to determine the importance of the extensive margin in international trade. We construct a new measure of the extensive margin that takes into account the relative importance of a good in a country's trade, rather than declaring a good to be nontraded only if the reported value of trade is zero. Studying trade data disaggregated by type of good is complementary to, but conceptually distinct from, studying data disaggregated by firm, as done, for example, by Eaton, Kortum, and Kramarz (2011).

We begin by documenting the relationship between the growth in total trade and the growth in the extensive margin for 1,913 bilateral country pairs that make up more than 80 percent of world trade. We find a significant and robust connection between the extensive margin and total trade growth. Over the period 1995–2005, a 10 percent increase in trade between two countries was associated with a 36 percent increase in the extensive margin. Using this large dataset, we also show that this relationship between the extensive margin and growth in total trade is stronger over longer time horizons and weakens over shorter time horizons.

After using the 1,913 country pairs to establish the general importance of the extensive margin, we turn to particular sets of countries that have undergone significant trade

liberalizations or other structural changes that have been important for trade. We find that the extensive margin is a significant factor in explaining the growth in total trade surrounding trade liberalizations and times of structural change. On average, the extensive margin accounts for 9.9 percent of the growth in trade for the NAFTA country pairs, and 26.0 percent of the growth in trade between the United States and Chile, China, and Korea. When we study the United States and its top trading partners that did not experience structural or policy changes, we find that the extensive margin is not important. On average, the extensive margin accounts for only 2.4 percent of total trade growth between the United States and Germany, Japan, and the United Kingdom.

Our study includes such large-scale trade liberalizations as the North American Free Trade Agreement (NAFTA), the Canada-U.S. Free Trade Agreement (FTA), and China's accession to the World Trade Organization (WTO), as well as the structural transformation episodes in Chile, Korea, and China. We find significant evidence of growth in the extensive margin following a decrease in trade barriers. The set of least-traded goods that accounted for only 10 percent of trade before the trade liberalization may grow to account for 30 percent of trade or more following the liberalization. Furthermore, we construct a time-series measure and find that the growth in the extensive margin coincides with the trade liberalization, supporting our hypothesis that the extensive margin growth is driven by the trade liberalization and is not the consequence of other factors, such as the product cycle.

The extensive margin is also important in explaining the growth in trade that accompanies episodes of rapid economic growth and development. Studying Chile and Korea during the 1970s and 1980s, we find substantial extensive margin growth. In the case of Korea's trade to the United States, the least-traded goods, which made up only 10 percent of exports in 1975, made up more than 60 percent of exports in 1980, reflecting Korea's change from an exporter of commodities and light manufactures to an exporter of a wide variety of manufactured goods. Currently, we see a similar pattern in China as the country has begun exporting and importing new kinds of goods as it moves away from being a centrally planned economy.

In contrast, when we examine the trade between the United States and its major trade partners with which there has been no substantial trade policy or structural changes, we find little evidence of growth on the extensive margin. This suggests that extensive margin growth is

brought about by structural changes and moves very little in response to events like business cycles.

The method we develop for measuring the extensive margin represents a break from previous studies. These other studies use a fixed cutoff to determine whether a good is traded or not in a particular period. Hummels and Klenow (2005) and Broda and Weinstein (2006), following Feenstra (1994), classify a good as not traded if the value of trade is 0 dollars, while Evenett and Venables (2002) classify a good as not traded if its annual value of trade is 50,000 dollars or less. Since countries have very different aggregate trade quantities, this cutoff can imply a drastically different relative importance of a good that is regarded as not traded, and biases small countries toward trading very few goods. Compare Chile and the United States in 1985: Chile had commodity exports of 3.9 billion dollars, while the United States had 213.3 billion dollars in exports, more than 50 times larger. A 50,000 dollar cutoff implies that a good trading for 0.00128 percent or less of Chile's total trade is not considered traded, while a good trading for anything more than 0.00002 percent of total trade in the United States is counted as traded. In our measure of tradedness, we allow the actual dollar value of the cutoff to differ across countries, relying instead on the relative importance of these goods in a country's trade.

In section 5.2 we compare our methodology with ones employing fixed cutoffs of 0 or 50,000 dollars. When we use a fixed cutoff to determine a good's trade status, we are unable to capture the changing composition of trade surrounding trade liberalizations. The problem is that for large countries there are very few goods that do not register trade of at least one dollar. Our methodology allows us to capture the growth in trade of the goods that initially had zero trade as well as the goods with small, but positive, trade.

Most closely related to our work is Arkolakis et al. (2008), who document the change in imported varieties following trade liberalization in Costa Rica. As do we, they find that imported varieties increased as tariffs fell. Broda and Weinstein (2006), who apply the methodology in Feenstra (1994), study the growing number of varieties in U.S. imports from 1972 to 2001. Their focus is not on specific episodes, but on the effects of newly traded goods on aggregate import price indices. They find, as does Feenstra (1994), that ignoring the increase in varieties leads to an overstatement of inflation and an understatement of the gains from trade. In section 4 we develop a decomposition of total trade growth based on Feenstra (1994).

Other authors have studied the extensive margin in the cross section, looking for relationships between the number of goods a country exports and variables known to be important for explaining aggregate trade volumes. Evenett and Venables (2002) study the geographic distribution of exports in developing countries and find that a significant fraction of a country's trade growth can be attributed to exports of "long-standing exportables" to new destinations; they are measuring the extensive margin in terms of exporting existing products to new markets. Hummels and Klenow (2005) decompose a nation's trade into an extensive margin and an intensive margin for a large cross section of countries. They find that the extensive margin is important in explaining why big countries trade more than small countries, in that big countries trade more kinds of goods than small countries. Our study, particularly the decompositions in section 3.1, is the time-series analogue of their cross-sectional measurements. Hillberry and McDaniel (2002) use the Hummels-Klenow decomposition to study the growth in trade between the United States and its NAFTA partners. They find growth in both the intensive and extensive margins.

Following the methodology laid out here, Mukerji (2009) studies the liberalization of trade in India in the 1990s. Growth in the extensive margin is found in both Indian exports and imports. Sandrey and van Seventer (2004) also use the methodology developed here to study the liberalization of trade brought about by the Closer Economic Relationship agreement between Australia and New Zealand starting in 1988. They find evidence that the extensive margin was growing for New Zealand exports to Australia during this period, while the export share of these goods from New Zealand to the rest of the world was relatively stable. Their results in this respect are similar to ours in that extensive margin growth coincides with trade liberalization.

Additionally, in developing time-series measures of changes in the extensive margin, we have discovered and documented a major limitation in the data that we use. In 1988 and 1989, most countries in the world changed their systems for classifying commodity trade to the Harmonized System (HS). The data that we use are meant to be consistent before and after these changes, but we find the concordances between the SITC and the different classifications used before and after the switch to the Harmonized System to be far from perfect. We discuss this issue in the appendix.

2. Methodology

For a given pair of countries, we study data on annual trade flow values by good. We define a good as an SITC (revision 2) five-digit code, of which there are 1,836. The data are from the United Nation's COMTRADE database. A complete list of countries, years, and classifications is contained in the data appendix that can be found at www.econ.umn.edu/~tkehoe.

To characterize the extensive margin, we need a definition of a nontraded good. We certainly want to include goods with zero trade in the set of nontraded goods. There is no absolute concept of zero in trade data, however, since small-value shipments tend to go unreported. For example, export shipments from the United States are, in general, required to be reported only if the value of the shipment is greater than 2,500 U.S. dollars, and import shipments must be reported only if the shipment value is greater than 2,000 U.S. dollars. A good could be traded in a number of shipments smaller than this limit and still be reported as having zero trade. The minimum reporting level tends to vary across countries as well. In Canada, for example, exports must be reported if the shipment value is greater than 2,000 Canadian dollars. In our definition of a nontraded good, we choose to consider goods with zero trade as well as goods with very small amounts of trade. We refer to the goods in this set as the least-traded goods. It is worth noting that the goods with very small but nonzero amounts of trade play a crucial role in the theory of market penetration costs developed by Arkolakis (2010).

Goods may also register zero or very little trade due to the inherent lumpiness of international shipments. Armenter and Koren (2010) and Alessandria, Kaboski, and Midrigan (2010) document the discrete nature of international trade shipments. The concern here is that there may be goods for which export relationships exist between a pair of countries, but a particular good may not be traded in a given year. We minimize the chance that a good is "traded," but not traded in any one year, by averaging over three years when we determine the initial status of a good as being traded or not traded: Specifically, to construct the set of least-traded goods from exporter m to importer n, we order the goods by their average value of trade over the first three years of the sample. By averaging over a few years, we also minimize the ordering's dependence on our choice of base year. We cumulate the ordered codes to form 10 sets, each representing one-tenth of total exports. The first set is constructed, starting with the codes with the smallest amounts of trade, by adding codes to the set until the sum of their trade reaches one-tenth of total export value. The next set is formed by summing the smallest

remaining codes until the value of the set reaches one-tenth of total export value. The first set consists of the least-traded goods: the codes with the smallest export values, including all the SITC codes with zero trade value. To create sets that account for exactly 10 percent of total trade, some SITC codes have to be split across different sets.

Given our system of partitioning the SITC codes, we study two features of the data. First, we compute the change in each set's trade share over the sample period. The resulting statistics summarize the change in the distribution of the goods being traded. Second, we compute the evolution of the least-traded set of codes to summarize the timing of the growth in these goods.

To see how this methodology works, we use Canadian exports to Mexico as an example. Figure 1 summarizes the changing trade pattern of Canadian exports to Mexico over 1989–1999, the period that includes most of the implementation of the NAFTA. The 10 bars in figure 1 correspond to the 10 sets of SITC codes, as determined by their average trade over 1989–1991; the total value of each set of codes was equal to 10 percent of total Canadian exports to Mexico in 1989 by construction. The numbers above each bar in the figure are the number of SITC codes needed to account for 10 percent of the trade flow. The distribution of trade is skewed; it requires 1,747.6 least-traded goods — 1,247 of which have zero recorded export value in 1989 — to account for 10 percent of total exports from Canada to Mexico, while the most traded good (automobile parts, code 78490) makes up more than 10 percent of exports itself.

The bars in figure 1 are the fractions of total trade in 1999. To interpret these values, consider two extreme cases. If the growth in trade were driven only by a proportional increase in the value of all the goods already traded — that is, if the growth in trade were entirely on the intensive margin — each set of codes would retain its one-tenth share in trade and the bars in figure 1 would all be 0.1. On the opposite extreme, if the growth in trade were driven only by trade in goods not previously traded — that is, if the growth were only on the extensive margin — the set of least-traded goods would gain trade share, while the trade shares of the other sets would decline.

As we can see in figure 1, the trade data do have a very large positive spike in the share of trade accounted for by the least-traded goods. The 1,747.6 least-traded goods that accounted for 10 percent of Canadian exports to Mexico in 1989 account for 30.3 percent in 1999. Furthermore, the increases in exports are spread across many goods. Of the 1,247 least-traded goods that have zero recorded export value in 1989, for example, 131 have positive recorded

export value in 1999, and exports of these goods account for 12.8 percent of exports from Canada to Mexico in that year.

Our second computation uses the same partition of SITC codes, but focuses only on the set of least-traded goods — the goods with the smallest trade values that account for 10 percent of trade. For each year in the sample, we compute the share of the total trade flow accounted for by the codes in the least-traded set. As in the first measure, if there is growth on the extensive margin, we should see an increase in the share of trade accounted for by this set of goods. More importantly, this computation shows us the timing of any changes in the trade of newly traded goods. An increase in the share of exports that coincides with the implementation of trade reforms provides evidence of the link between lower trade barriers and growth in the extensive margin.

3. Growth in the extensive margin

We begin by summarizing the relationship between growth in total bilateral trade volumes and growth in the extensive margin among all the bilateral pairs in our sample, a total of 1,913 trade relationships. We characterize this relationship over various time horizons and find that the extensive margin is stronger over longer time frames. We then consider three types of episodes involving bilateral country pairs in our analysis: first, trade liberalization episodes; second, periods of rapid growth driven by structural transformation to one of the countries, which we refer to as structural transformation episodes; and, third, episodes in which neither country has significant structural transformation nor significant changes in trade policies. We refer to these last sorts of episodes as business cycle episodes, since these stable bilateral relationships allow us to observe how the extensive margin changes in response to the usual turbulence of business cycle fluctuations.

3.1. The extensive margin and total trade growth

We begin by presenting the general relationship between growth in the extensive margin and growth in overall trade between countries.[1] Do country pairs that experience large increases in total trade — for any reason — also have large increases in the extensive margin? To answer this question, we assemble data for the period 1995–2005. This sample frame is different from

[1] We are grateful to Sam Kortum for suggesting that we apply our methodology to the complete set of countries.

the ones we will use later to study specific episodes because we would like to include as many countries as possible, and this time period has data available for many countries in a common system of classification. We begin with all of the country pairs available in the COMTRADE database, and we drop country pairs that do not trade in at least 10 percent of the possible goods — for the SITC data, this requires positive trade in at least 184 goods in 1995. We drop these country pairs because their trade is so dominated by growth in the extensive margin that, if we included them, their data would swamp the estimates reported below and would exaggerate the importance of the new goods margin. These "sparse" country pairs are small: the 1,913 country pairs that remain account for 82 percent of world trade in 1995 and 84 percent of world trade in 2005. A listing of the country pairs in our sample is available in the data appendix.

Table 1 reports summary statistics for our sample, broken down by characteristics of the exporter-importer pair. Looking at the entire sample, the mean growth rate in total trade is 158 percent over the 10-year period and the mean growth rate of the least-traded goods is 703 percent.[2] The distribution of growth rates across country pairs is skewed: the median growth rate is 80 percent for total trade and 334 percent for the least-traded goods. Growth rates in country pairs in which both countries are members of the OECD do not differ much from those in which neither country is a member of the OECD.

We break the sample into fast- and slow-growing countries to take a first look at how experiences may differ for countries undergoing a structural change. We consider a country to be fast growing if its real GDP per capita grows at a rate of 4.0 percent per year or greater over the sample period. This group includes, among others, China, India, Ireland, and Vietnam. Countries that grow at less than 4.0 percent per year are slow-growing countries. Country pairs that include a fast-growing country have much larger growth rates both in total trade and in the least-traded goods. The median least-traded goods growth rate for a pair that includes a fast-growing country is 3–8 times larger than that of a country pair with no fast-growing country. The finding is similar for total trade as well: growth rates of pairs that include a fast-growing country are 4–9 times as large as trade relationships between slow-growing countries. We see a similar pattern with General Agreement on Tariffs and Trade / World Trade Organization (GATT/WTO) membership as well. Country pairs in which a member has joined the

[2] The growth rates we report are nominal. The U.S. producer price index for manufacturing industries grew by 21.4 percent from 1995 to 2005.

GATT/WTO during the sample period have more overall trade growth as well as more extensive margin growth than country pairs without a country that has had a change in status. Lastly, the differences between country pairs that began a regional trade agreement during the period, and those that did not, are relatively small.

How is extensive margin growth related to total trade growth? The last column of table 1 computes the ratio of the median growth rate of the least-traded goods to the median growth rate of total trade. There is some variation across the different subsamples, but the ratio is typically between 3.5 and 5.0. In figure 2 we plot the components of this ratio. The relationship between growth in trade and growth in the extensive margin is striking. To quantify the relationship between extensive margin growth and total trade growth, we regress the growth rate of the least-traded goods between countries n and m, $\hat{x}^{mn}$, on the growth rate of total trade, x^{mn},

$$\Delta_{1995,t_0+k}\left(\hat{x}^{mn}\right) = \alpha_1 \Delta_{1995,t_0+k} x^{mn} + \varepsilon_{mn}, \quad k = 1,\ldots,10 . \tag{1}$$

Before turning to the results of these regressions, we should stress that we are not attaching causality to the estimated coefficients, but rather using them as a means to further summarize a large set of data.

Our estimates of (1) are reported in table 2. Each row of the table reports the coefficient on total trade growth over the period $1995 - 1995 + k$. Over the entire sample ($k = 10$), the coefficient on total trade growth is 3.59, meaning that a 10 percent increase in total trade is accompanied by a 35.9 percent increase in the extensive margin. This coefficient is precisely estimated; robust standard errors are reported in parentheses. As a robustness check, we also estimate (1) using six-digit Harmonized System data for the same period. These data are available for fewer country pairs, but the result is similar. A 10 percent increase in total trade is accompanied by a 42.9 percent increase in the value of the least-traded goods.

The coincidence of growth in total trade and growth on the extensive margin is a robust feature of the data. Growth in trade, which can come from a variety of sources — falling tariffs, industrial policy, technological development — is accompanied by growth in the extensive margin. This result is a time-series analogue to the cross-sectional finding in Hummels and Klenow (2005) that countries that export more do so by exporting a wider set of goods.

3.2. Extensive margin growth in the long and the short run

To highlight the importance of the extensive margin over different time horizons, we estimate (1) using several sample lengths and report the results in table 2. The coefficients at the one- and two-year horizons are small, but some of this result is an artifact from sorting the goods by the average trade over the first three years of the sample. At the three-year horizon (1995–1998) the coefficient is 2.0 and the r-squared of the regression is 0.43. The coefficient increases — not quite monotonically — to 3.6 for the 10-year sample and the r-squared grows to 0.72. Our results are not dependent on the system of classification. While we lose some country pairs, we can repeat our estimation using six-digit Harmonized System data. The pattern is similar if we use the HS data: the coefficient rises from 1.9 at the 3-year horizon to 4.3 at the 10-year horizon.

The coefficients reported in table 2 suggest that the extensive margin is more important over longer time frames. This pattern is consistent with dynamic firm-level models of exporting in which sunk entry costs into foreign markets play a significant role. As shown in Ruhl (2008), in these models, a firm is more likely to enter an export market in response to a permanent change in export profitability than it would if faced with a transitory shock of the same magnitude. The estimates from the longer time horizons are likely picking up changes in exporting conditions that are more permanent in nature than those in the shorter time horizon samples. We present further evidence consistent with sunk cost models in the following sections. When we focus on country pairs that were not undergoing long-term structural change or changes in trade policy, we find very little change in the composition of goods that are traded compared with countries that are undergoing structural changes or changes in trade policy. The large set of countries is useful for documenting the general patterns regarding the behavior of the extensive margin. In the remainder of this section, we study the data from particular country pairs to shed light on the situations in which the extensive margin is important — and on those in which it is not.

3.3. Trade liberalization episodes

In our analysis of North American trade liberalization, we consider the Canada-U.S. FTA and the NAFTA together as one episode of liberalization. Data issues prevent this experiment from being as clean as we would like, however. In particular, the adoption of the Harmonized

System creates a break in the data at 1988–1989 that we cannot ignore. (We provide an analysis of this discontinuity in the data in the appendix.) The Canada-U.S. FTA was implemented in 1989, one year after Canada switched to the HS classification and the same year that the United States switched. Since we cannot compare data from before the adoption of the HS classification to data from after, we have a short pre-liberalization sample.

The Mexico-U.S. trade relationship suffers from a similar problem. Mexico started liberalizing its trade policy unilaterally in the mid-1980s, acceding to the GATT in 1986. Kehoe (1995) provides a chronicle of Mexican trade policy from 1982 to 1994, and General Agreement on Tariffs and Trade (1993) provides detailed data and documentation. In the early 1980s, import licenses, rather than tariffs, were the main instrument of trade policy. Between 1983 and 1992, the share of imports restricted by licenses fell from 100 percent to 11 percent. Early in the liberalization period, tariffs actually rose, as they replaced licenses, as required by accession to the GATT. Later they fell. Ideally, we would like to study U.S.-Mexican trade throughout the 1980s and 1990s — a time period of significant adjustment — but we cannot incorporate this period as a continuous episode into our analysis.

In light of these issues, we use Canadian-collected data to study the Canada-U.S. relationship, as this strategy allows for an extra year at the beginning of the sample. For the Mexico-U.S. relationship there is little we can do, so we begin the sample in 1989 using U.S.-collected data. We also report, separately, U.S.-Mexico trade for the period 1980–1988, but there is no sense in which these two series can be spliced together. The Canada-Mexico liberalization is a complete experiment. The trade barriers between Canada and Mexico were significantly impacted by the NAFTA's implementation in the mid- and late 1990s, and this period is fully captured in our data sample.

As can be seen in figures 1 and 3, there is significant extensive margin growth between Canada and Mexico during the NAFTA period. The 1,747.6 least-traded Canadian goods to Mexico went from 10 percent of total exports to Mexico in 1989 to 30.3 percent of exports in 1999. The 1,773.1 least-traded Mexican goods to Canada increased their share from 10 percent to 25.3 percent of total exports to Canada over the same period. (In figure 3, the good in the 0.8–0.9 set that drives the large increase in trade share is passenger motor cars, SITC 78100.) Figure 4 shows the timing of these changes: the increases coincide with the implementation of the NAFTA in 1994. Table 3 summarizes the results for the North American free trade episode.

Reported in the table is the end-of-period share of the least-traded goods in total exports for the country pair. The Canada-Mexico relationship had significant changes in the extensive margin, while Canada and Mexico realized smaller extensive margin gains in exports to the United States. It is likely that these gains would be larger if we had been able to account properly for the late 1980s: growth in the least-traded goods between Mexico and the United States in 1980–1988 was similar to that between Canada and Mexico in the later period. The United States appears to have made only small adjustments on the extensive margin in its exports to Canada and Mexico over this period. Our findings regarding the NAFTA are broadly consistent with Romalis (2007), who finds that the NAFTA had the largest impact on trade between Mexico and Canada. Additionally, Romalis (2007) finds that the goods with the largest increases in trade tend to be the goods that received the largest tariff reductions. It will be interesting to study how tariff preferences interact with the extensive margin. How many of the least-traded goods received cuts in their tariff rates? Do tariff reductions influence the extensive margin in multilateral liberalizations — like China joining the WTO — in the same way that they do in regional trade agreements — like the NAFTA? We leave these questions to our future research.

The extensive margin growth we have found in the North American trade liberalization experience is not unique. Following the methodology outlined here, Mukerji (2009) finds that, during unilateral trade liberalization in India, the least-traded goods grew from 10 percent to 33.8 percent of total imports over the period 1988–1999 and from 10 percent to 26.5 percent of total exports. In another study, also using our methodology, Sandrey and van Seventer (2004) find that, during liberalization of Australia–New Zealand trade, New Zealand's least-traded exports to Australia grew from 10 percent of exports in 1988 to 29.5 percent in 2003, while the least-traded exports from Australia to New Zealand grew from 10 percent to 21.9 percent over the same period. Using a different methodology, Arkolakis et al. (2008) study Costa Rica's trade liberalization and find significant growth in the number of varieties imported as tariffs fell.

3.4. Structural change episodes

Besides changes in trade policy, changes in the efficiency with which goods can be produced are likely to lead to changes in the composition of goods that a country exports and imports. These changes are constantly occurring; firms enter and exit production, new products are created and old ones are retired, and better ways of producing existing goods are

continuously developed. In most countries, these changes seem to cancel themselves out and do not have an aggregate impact on the composition of trade, a topic that we address below. In cases of significant structural change, however, this is not the case. These episodes are accompanied by a significant restructuring of the composition of a country's trade.

Recently, China has been undergoing a dramatic transition from a centrally planned economy to a free market economy. An important part of this transition has been opening the country to foreign trade and investment, culminating in China's accession to the World Trade Organization in 2001. The period 1995–2005 was one of rapid growth in Chinese exports and imports. Exports of goods grew from 19.7 percent of GDP in 1995 to 34.1 percent of GDP in 2005, even though GDP itself was growing very rapidly. Over this same period, imports of goods grew from 17.4 percent of GDP to 29.5 percent of GDP. Figures 5 and 6 show the effect this restructuring has had on the extensive margin in both U.S. exports to China and China's exports to the United States. The least-traded goods in China's exports to the United States increase from 10 percent of exports in 1995 to 25.7 percent in 2005. In U.S. exports to China, the exports of least-traded goods grow to 21.2 percent of exports over the same period. Figure 7 provides interesting detail regarding the timing of the extensive margin growth. It appears that the structural reforms of the early 1990s had a larger effect on the extensive margin for U.S. exports to China, whereas China's membership in the WTO, which took effect in 2001, seems to have had an effect on the extensive margin for both countries' exports.

Even more striking patterns emerge for other growth episodes, such as Korea's rapid growth and development in the 1970s and 1980s. As shown in table 4, the least-traded Korean exports to the United States grew to 65.8 percent of exports in 1985, from only 10 percent in 1975. This extraordinary change in the extensive margin reflects Korea's shift from exporting very specific light manufactured goods in the 1970s to exporting a far more diversified set of goods in the 1980s; 26.4 percent of Korean exports to the United States in 1975 consisted of leather-soled footwear (code 85102), and, although footwear was still the top export in 1985, it accounted for only 10.7 percent of exports. Of the top 10 exports from Korea to the United States in 1985, 6 were in the least-traded set of goods in 1975. These new exports include Korea's second-largest export in 1985, electronic microcircuits (code 77640), as well as electro-thermic domestic appliances (code 77586). This evidence suggests that Korean industrial policy played a role in shaping the mix of exports. A model-based analysis of the connection between

Korea's economic policy and its production structure is undertaken in Connolly and Yi (2009). Notice that, as Korea restructured, the composition of its imports from the United States changed as well. In particular, the least-traded imports from the United States went from 10 percent of imports in 1975 to 56.0 percent in 1985.

Chile's transition to a free market economy also brought about significant changes along the extensive margin. Chile's least-traded exports to the United States grew from 10 percent of exports in 1975 to 34.6 percent in 1985. The United States had an even larger change in the composition of its exports to Chile; the least-traded goods grew to be 70.7 percent of total exports to Chile over the same period.

The dramatic growth in the extensive margin during these episodes suggests that these are periods of important structural change, much of which involved trade liberalization. These episodes, however, are not clean policy experiments, as were the trade liberalization episodes considered above. The reforms in China, Korea, and Chile touched many aspects of the economy: labor, capital, and international markets were all reformed to some extent in these transition economies. It will be difficult to disentangle the effects of the different policies on the composition of exports and imports for these countries, but incorporating the changing extensive margin into models of trade and development, as in Romer (1994), will make them more consistent with the empirical evidence and perhaps provide further insights into the development process.

It is worth pointing out that, in some of the cases we have studied, the growth in trade on the extensive margin increases significantly as we lengthen the time period studied. Figure 8 shows the evolution of the extensive margin in trade between Canada and Mexico and trade between China and the United States over the period 1989–2006. Notice that the fraction of Canadian exports to Mexico accounted for by the least-traded goods increases as we lengthen the time period, going from 30.3 percent in 1999 to 41.5 percent in 2006. The fraction of Mexican exports to Canada accounted for by the least-traded goods shows a more modest increase, however, going from 25.2 percent in 1999 to 29.2 percent in 2006. Notice that the growth on the extensive margin for both exports from China to the United States and exports from the United States to China increases as we lengthen the time period. Now both increase from 10 percent of trade to approximately 30 percent of trade. The increase in the extensive margin for U.S. exports

to China occurs mostly in the 1990s, while the increase for Chinese exports to the United States occurs after 2000.

3.5. Business cycle episodes

The episodes we have studied so far have been times of structural change. The changes in policy that occurred during these episodes represent departures from the environment in which the agents of the countries operated. We can also study country pairs that have not had significant structural changes in order to study the effects of the normal fluctuations in their economies on the extensive margin. A plausible hypothesis is that country pairs continually change the mix of goods that they trade in such a way that the extensive margin always increases after a decade or so. We now argue that this is not the case; in periods of policy stability, the growth in the extensive margin is relatively small. We also argue that normal business cycle fluctuations cause only small fluctuations in the extensive margin.

To see how the extensive margin changes over the business cycle, we compute the same measures of extensive margin growth for the United States and three of its trading partners: Japan, Germany, and the United Kingdom. Of the top seven trading partners of the United States in 2000, these three have had no major trade reform with the United States, nor were they part of a structural transformation episode over the sample period. We have already examined the extensive margin for the other four major trading partners of the United States: Canada, Mexico, China, and Korea.

As can be seen in table 5, none of these relationships is characterized by the large growth in the extensive margin that we saw in tables 3 and 4. The average share of total exports in these six trade flows is 12.9 percent in 1999, and the trade flow with the largest growth — U.S. exports to the United Kingdom — grew from 10 percent of trade to 14.8 percent of trade over this period.

Figures 9 and 10 further demonstrate how little the trade patterns have changed between these countries. These figures show the composition of trade between the United States and the United Kingdom, which are representative of the country pairs studied in this subsection. As can be seen, there is very little change in the mix of goods traded between these two countries over the sample period. Further, figure 11 shows that there were no large variations in the share of exports accounted for by the least-traded goods over this period, although there is an upward

drift in the share of U.S. exports to the United Kingdom. The small changes in the extensive margin that we find over the business cycle are consistent with our findings in section 3.2, where we found a weaker extensive margin effect over short time periods relative to longer time periods.

The lack of change in the extensive margin over the business cycle suggests that exporting decisions are not trivial matters. Why, for example, would a U.S. firm not stop exporting goods when prices of traded goods in the United Kingdom were low compared with those in the United States in 1993–1994, and begin exporting when prices of traded goods in the United Kingdom were high compared to those in the United States in 1998–1999? One explanation for this behavior would be that firms face large sunk costs in order to set up an export operation, as in Melitz (2003). In an environment such as this, a firm may not find it worthwhile to make (or abandon) large sunk investments in response to temporary changes. Large permanent changes, such as the structural changes considered in the previous two sections, may, however, induce firms to enter or exit the export market. Ruhl (2008) constructs a model in which firms face sunk exporting costs and uncertainty over profits in a quantitative general equilibrium framework, and finds that much of the difference in the response of exports to business cycles versus trade liberalization can be accounted for by these factors.

4. Decomposing trade growth

To further explore the importance of the extensive margin, we decompose the growth in total trade into its extensive and intensive margins. Our decomposition is based on Feenstra (1994) and is the time-series analogue of Hummels and Klenow (2005). Consider a pair of countries, m and n, and two periods, t_0 and t_1. Define the set of goods that are exported from m to n in period $t \in \{t_0, t_1\}$ as I_t. Define the set of goods traded in both periods as $I = I_{t_0} \cap I_{t_1}$. The intensive margin growth rate between these two countries, γ_{IM}^{mn}, is

$$\frac{\sum_{i \in I} x_{i,t_1}^{mn}}{\sum_{i \in I} x_{i,t_0}^{mn}} = 1 + \gamma_{IM}^{mn}, \qquad (2)$$

where the value of exports of good i from country m to country n at time t is denoted $x_{i,t}^{mn}$. The intensive margin growth rate is the growth in trade of the goods that are traded in both years. The extensive margin growth rate between the two countries, γ_{EM}^{mn}, is then defined as

$$\frac{\sum_{i \in I_{t_1}} x_{i,t_1}^{mn}}{\sum_{i \in I_{t_0}} x_{i,t_0}^{mn}} / \frac{\sum_{i \in I} x_{i,t_1}^{mn}}{\sum_{i \in I} x_{i,t_0}^{mn}} = 1 + \gamma_{EM}^{mn} . \qquad (3)$$

The numerator in the left-hand side of this expression is the growth rate of total exports from m to n, and the denominator is the growth rate of all the goods that are traded in both periods — the intensive margin. This measure of the extensive margin is the reciprocal of the "lambda ratio" in proposition 1 of Feenstra (1994). Multiplying the intensive margin growth rate by the extensive margin growth rate returns the growth rate of total trade from m to n, γ^{mn}. Taking logarithms, we have

$$\gamma^{mn} \cong \gamma_{EM}^{mn} + \gamma_{IM}^{mn} , \qquad (4)$$

which decomposes the growth rate of total trade into that accounted for by the extensive and intensive margins.

To compute (2) and (4), we use our concept of the least-traded goods to create the set of traded goods, I_{t_0}. We define the traded threshold, $\overline{x}^{mn}$, to be the three-year average value of trade of the first good that would not be included in the set of least-traded goods. The set of traded goods in t_0 is the set of all goods with three-year average trade greater than the threshold value, $I_{t_0} = \left\{ i : 1/3 (x_{i,t_0}^{mn} + x_{i,t_0+1}^{mn} + x_{i,t_0+2}^{mn}) \geq \overline{x}^{mn} \right\}$. Given this definition, the set of traded goods in the base year is simply the complement of the set of least-traded goods. The set of traded goods in the ending year is made up of all the goods whose trade is greater than the cutoff value, $I_{t_1} = \left\{ i : x_{i,t_1}^{mn} \geq \overline{x}^{mn} \right\}$. In section 5, we discuss the sensitivity of our findings to different traded thresholds.

We report the results of this decomposition in table 6. Columns 3 and 4 report the growth rate of the extensive and intensive margins. Beneath each growth rate is the contribution of that margin to total trade growth. For example, total exports from Canada to Mexico grew by 71.6

percent over 1989–1999. The extensive margin accounted for 16.7 percent of the growth in total trade, and the intensive margin accounted for the other 83.3 percent.

The patterns we have found in the previous sections are borne out in the decompositions as well: the extensive margin is a significant contributor to trade growth during trade liberalization or periods of structural change, but is not very important for country pairs with stable policy. On average, the extensive margin is responsible for 9.9 percent of total trade growth for the NAFTA country pairs. The extensive margin accounts for 26.0 percent of trade growth in the structural change episodes we have identified, though there is more variation: the extensive margin is responsible for 84.6 percent of the growth in U.S. exports to Chile, but −8.6 percent of total trade growth to China. In the set of country pairs without any significant changes in policy, the extensive margin accounts for only 2.4 percent of total trade growth.

5. Robustness checks

As we noted earlier, the nonuniform "width" of an SITC code may have an impact on the extent to which a good appears to be traded. It therefore may be useful to normalize a good's trade by total output of that good or the world trade of that good before we sort the goods in the base period. In this section, we report on the analysis in which we do such sorting for the country pairs we studied in section 3. We find that the results do not change in a significant way. We also ask how our characterization of the extensive margin differs from those of Evenett and Venables (2002), Hummels and Klenow (2005), and Broda and Weinstein (2006). We find that our characterization differs significantly from those of other researchers.

5.1. Sorting codes relative to world trade

In determining the tradedness of a good, we ranked goods according to the values of their trade in a base year. This ordering could potentially be dependent on the way that the SITC is constructed. Some SITC codes, such as automobile parts (SITC 78490), are broad and may encompass many products, while others, such as natural honey (SITC 06160), are narrower. Narrow codes would be less likely to be ranked as a traded good, while broader categories would more likely be ranked as traded. Armenter and Koren (2010) discuss the nonuniform distribution of trade categories in detail and demonstrate that this feature can affect the interpretation of trade data, particularly when a researcher is interested in goods with zero trade. To help normalize the

SITC codes, we could rank goods by their trade-to-output ratio or by their trade-to-world-trade ratio in the base year. To compute the trade-output ratios, we require gross output data by five-digit SITC code. These data are not generally available, as output data are collected according to classification schemes that tend to classify goods according to how they are produced — such as the International Standard Industrial Classification (ISIC) — while the SITC tends to classify goods according to the type of material from which the good is made. There is also a significant difference in detail: the four-digit ISIC classification contains only 92 codes, compared with the 1,836 codes in the five-digit SITC.

Rather than attempt to bridge the ISIC and SITC data, we check the sensitivity of our results to an alternative sorting procedure in which we order goods by their trade relative to total world trade of the same good. Besides being much simpler to implement than sorting by trade-output ratios, normalizing the trade of a good to the world trade of that good is similar to the procedure used in Hummels and Klenow (2005).

Consider the flow of Canadian exports to Mexico, in which the set of least-traded goods tripled its share of total trade from 10 percent to 30.3 percent from 1989 to 1999. As an alternative to our baseline method, we sort the goods by their average export value to world trade ratios for the years 1989–1991. Once we have sorted the goods, we build the set of least-traded goods as we have before: no other part of the procedure changes. In figure 12, we plot the results of the alternative ordering. As a comparison, we also plot the results from the baseline method. There are some differences across the categories, but the share of the least-traded set of goods is not very different across the two methods: it is 34.1 when the trade value of a good is normalized by the value of world trade in that good. The alternative ordering also slightly increases the importance of the extensive margin for Mexican exports to Canada. In figure 13, we plot the results for Mexican exports to Canada. In this case, the least-traded goods' share in total trade grows to 25.3 in the baseline method and 26.2 under the alternative method.

Generally, normalizing a good by the amount of world trade in that good slightly increases the importance of the extensive margin. For the NAFTA country pairs, the average increase in the share of the least-traded goods is 2.2 percentage points. For the countries with stable policy — the ones in table 5 — the average increase in the share of the least-traded goods across the two methods is 3.6 percentage points.

5.2. What is a traded good

Our measure of the extensive margin uses a relative cutoff value — one that is based on the size of the overall trade flow between a pair of countries — to categorize a good as being traded or not traded. This generates a country pair specific cutoff value. An alternative way of measuring the extensive margin uses a country-invariant cutoff value. Feenstra (1994), Hummels and Klenow (2005), and Broda and Weinstein (2006) consider a good to be nontraded if the trade flow is 0; Evenett and Venables (2002) consider any good with less than 50,000 dollars of trade to be nontraded. In this section, we use the decomposition developed in section 4 to reexamine the trade relationships in table 3 and to bring out the important differences that arise from the definition of a nontraded good.

In table 7 we report the results of the decomposition in (4) for various traded good thresholds. For each country pair, the three rows report the results of (4) for three cutoffs: 0 dollars, 50,000 dollars, and the cutoff implied by our methodology. In the last case, we take as the cutoff value the amount of trade in the first good that would not be included in the set of least-traded goods, the $\bar{x}^{mn}$ from section 4. In contrast to the other cutoffs, this value varies across country pairs. The first column of the table reports the growth in total trade between the country pair. Note that the growth rate of total trade differs slightly across the different cutoffs because a good that falls below the cutoff in both periods will not be reported in total trade.

Columns 2 and 3 report the growth rates of the intensive and extensive margins. The two decompositions in table 7 that employ country-invariant cutoffs are similar; they both find very little extensive margin growth for the NAFTA pairs, and some trade relationships even have negative extensive margin growth rates. This finding reflects that many country pairs trade more than 50,000 dollars in almost every good: there are no nontraded goods! The 50,000 dollar cutoff allows for some nontraded goods between Canada and Mexico, and this is where we find differences in the extensive margin growth across the two cutoffs.

We are interested in capturing the change in the composition of goods that are traded between two countries. Fixed dollar cutoffs imply that most goods are traded in large trading relationships, which rules out growth in the extensive margin, even if the types of goods that are traded are dramatically changing. One solution would be to increase the cutoff value. If this value is country invariant, then this leads to problems in small trade relationships. For example, our relative cutoff implies that any good exported from Canada to the United States at less than

40.9 million dollars is nontraded. The total flow of exports from Canada to the United States is very large, however, so a good exported in the amount of 40.9 million dollars accounts for only 0.05 percent of the total trade flow. This good would be considered heavily traded by the country-invariant cutoffs in table 7. If we were to force these goods to be classified as nontraded under a fixed dollar measure, we would need to increase the cutoff value. If this cutoff is constant across country pairs, we create problems measuring nontraded goods in other relationships. For example, total exports from Canada to Mexico are small compared with those to the United States: 508 million dollars to Mexico compared with 80 billion dollars to the United States in 1989. The cutoff value of 40.9 million dollars would imply that a good valued at 8.1 percent of total Canadian exports to Mexico would be considered a nontraded good!

By restricting the focus to goods with zero trade, measures of the extensive margin based on absolute-value cutoffs miss the dramatic changes that occur in goods that were initially traded only in small amounts. For example, as reported in table 7, the absolute-value definition of tradedness implies that the extensive margin is negative for trade between Canada and Mexico: the extensive margins actually shrink. While there may be times in which a zero-based measure is appropriate, in this case it completely misses the dramatic change in the Canada-Mexico trade pattern. The least-traded goods from Canada to Mexico grow to make up 30.3 percent of total trade, and the least-traded goods from Mexico to Canada grow to make up 25.3 percent of total trade, after only 10 years. A country-specific definition, such as the one presented in this paper, will capture the changing composition of trade.

This is not to say that absolute-value cutoffs are never useful measures. Fixed costs associated with trading may impart a natural discreteness to trade flows. Armenter and Koren (2010), using U.S. trade data, document that low-value goods tend to be exported in remarkably equal-sized shipments. They attribute this discreteness to the economics of modern ocean transportation: it is not profitable to ship a half-full intermodal freight container. This discreteness is the driving force in models like Melitz (2003) and is used to explain why the majority of firms do not export. In models like this, country size matters, as larger destination markets are more likely to generate profits large enough to overcome the fixed costs of exporting. If the size of the exporting fixed cost is independent of country size, the extensive margin would become less important as the size of the destination country increased. In the firm-level data, these zero-trade measures are important for identifying these fixed costs.

6. Conclusions and the future of international trade models

A new generation of models has made significant progress in addressing long-standing questions regarding the pattern of trade and the effects of trade policy. The key to their results is the idea that the mix of goods a country trades — the extensive margin — changes in response to changes in the economic environment. In this paper, we have looked at the data from several episodes in which these models predict changes in the extensive margin, and we have found that in many of them, the changes in the extensive margin are large and important. We have also found that the extensive margin does not change much over the business cycle. In our analysis, we develop a methodology for studying changes in bilateral trade due to countries exporting goods that they did not export previously, or exported only in small quantities. Our work, which analyzes exports by the type of good, is complementary to both the work that uses the industry as a unit of observation and the firm-level analysis as exemplified by Eaton, Kortum, and Kramarz (2011). Our approach differs fundamentally from previous studies, such as Hummels and Klenow (2005), in that we judge a good to be traded (or not) based on a relationship-specific cutoff rather than a cutoff that is invariant across bilateral relationships.

We document several empirical regularities that will be useful in evaluating and developing models of international trade. That we find a significant expansion along the extensive margin in response to trade policy is in line with the predictions of models where heterogeneous firms face fixed entry costs of exporting to a foreign country (Melitz 2003; Bernard et al. 2003; Eaton, Kortum, and Kramarz 2011). That we do not see the extensive margin change over the business cycle suggests that the sunk nature of these costs may be important, but models with uncertainty are needed (Alessandria and Choi 2007; Ruhl 2008). As we discuss in section 5.2, our approach captures the significant trade growth not only in goods that had zero previous trade but also in goods that had positive but small amounts of trade. It will be difficult for fixed-cost models of trade to account for this fact, but models like Arkolakis (2010) are able to generate this pattern.

The importance of the extensive margin in international trade is problematic for models with a fixed production structure. Kehoe (2005) shows that multisectoral applied general equilibrium models built to analyze the NAFTA did a poor job in predicting the impact of trade liberalization on different sectors. These models are incapable of generating growth in exports on the extensive margin. More research is needed to develop models capable of predicting the sectoral

impact of episodes like the NAFTA. We speculate that successfully modeling the increase in trade on the extensive margin will be the key element in this model development.

References

Alessandria, George, and Horag Choi. 2007. "Do Sunk Costs of Exporting Matter for Net Export Dynamics?" *Quarterly Journal of Economics* 122 (February): 289–336.

Alessandria, George, Joseph P. Kaboski, and Virgiliu Midrigan. 2010. "Inventories, Lumpy Trade, and Large Devaluations." *American Economic Review* 100 (December): 2304–39.

Arkolakis, Costas. 2010. "Market Penetration Costs and the New Consumers Margin in International Trade." *Journal of Political Economy* 118 (December): 1151–99.

Arkolakis, Costas, Svetlana Demidova, Peter J. Klenow, and Andrés Rodríguez-Clare. 2008. "Endogenous Variety and the Gains from Trade." *American Economic Review* 98 (May): 444–50.

Armenter, Roc, and Miklos Koren. 2010. "A Balls-and-Bins Model of Trade." Manuscript, Department of Economics, Central European University.

Bernard, Andrew B., Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum. 2003. "Plants and Productivity in International Trade." *American Economic Review* 93 (September): 1268–90.

Broda, Christian, and David E. Weinstein. 2006. "Globalization and the Gains from Variety." *Quarterly Journal of Economics* 121 (May): 541–85.

Connolly, Michelle P., and Kei-Mu Yi. 2009. "How Much of South Korea's Growth Miracle Can Be Explained by Trade Policy?" Working Paper no. 09-19 (June), Federal Reserve Bank of Philadelphia, Philadelphia, PA.

Eaton, Jonathan, Samuel Kortum, and Francis Kramarz. 2011. "An Anatomy of International Trade: Evidence from French Firms." *Econometrica* 79 (September): 1453–98.

Evenett, Simon J., and Anthony J. Venables. 2002. "Export Growth in Developing Countries: Market Entry and Bilateral Trade Flows." Manuscript, Department of Economics, Oxford University.

Feenstra, Robert C. 1994. "New Product Varieties and the Measurement of International Prices." *American Economic Review* 84 (March): 157–77.

General Agreement on Tariffs and Trade (GATT). 1993. *Trade Policy Review: Mexico 1993*. Two vols. Geneva: GATT Publication Services.

Hillberry, Russell H., and Christine A. McDaniel. 2002. "A Decomposition of North American Trade Growth since NAFTA." Working Paper no. 2002-12-A (July), U.S. International Trade Commission, Washington, D.C.

Hummels, David, and Peter J. Klenow. 2005. "The Variety and Quality of a Nation's Exports." *American Economic Review* 95 (June): 704–23.

Kehoe, Timothy J. 1995. "A Review of Mexico's Trade Policy from 1982 to 1994." *World Economy* 18 (July): 135–51.

Kehoe, Timothy J. 2005. "An Evaluation of the Performance of Applied General Equilibrium Models of the Impact of NAFTA." In *Frontiers in Applied General Equilibrium Modeling: Essays in Honor of Herbert Scarf*, edited by Timothy J. Kehoe, Thirukodikaval N. Srinivasan, and John Whalley, 341–77. New York: Cambridge University Press.

Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71 (November): 1695–1725.

Mukerji, Purba. 2009. "Trade Liberalization and the Extensive Margin." *Scottish Journal of Political Economy* 56 (May): 141–66.

Romalis, John. 2007. "NAFTA's and CUSFTA's Impact on International Trade." *Review of Economics and Statistics* 89 (August): 416–35.

Romer, Paul. 1994. "New Goods, Old Theory, and the Welfare Costs of Trade Restrictions." *Journal of Development Economics* 43 (February): 5–38.

Ruhl, Kim J. 2008. "The International Elasticity Puzzle." Manuscript, Department of Economics, Stern School of Business, New York University.

Sandrey, Ron, and Dirk van Seventer. 2004. "Has the New Zealand/Australian Closer Economic Relationship (CER) Been Trade Widening or Deepening?" Forum Paper 2004 (October), African Development and Poverty Reduction: The Macro-Micro Linkage, Somerset West, South Africa.

Yi, Kei-Mu. 2003. "Can Vertical Specialization Explain the Growth of World Trade?" *Journal of Political Economy* 111 (February): 52–102.

Appendix

Data quality and the switch to the Harmonized System

In addition to the usual concerns that arise when working with trade data, our focus on newly traded goods means that we must be careful that changes in the way goods are classified do not appear as newly traded goods. Unfortunately, the adoption of the Harmonized System — which took place in many countries in 1988 and in the United States in 1989 — was accompanied by a significant change in the codes that are reported as traded. This problem creates a discontinuity in the data that forces us to restrict our sample periods to preclude the year in which a country transitioned to the Harmonized System. In this appendix, we discuss the extent of this problem.

Prior to 1988, data were collected by individual nations according to their own classifications and converted into the SITC for reporting purposes. In 1988, many nations adopted the Harmonized System as the classification used to collect data and assess tariffs. This change is a step forward in the collection of trade data, as it standardizes the classification of goods across countries, making the data more consistent and comparable. This change, however, has created an inconsistency in the data at the year of adoption that has a large impact on measuring the changes in the extensive margin.

The problem with the change in nomenclature lies in the mapping of the old system of classification to the new system. The United States, for example, had been using the Tariff Schedule for the United States, Annotated (TSUSA) to classify import data prior to 1989 and mapping the TSUSA codes to the SITC. With the adoption of the HS in 1989, the trade flows were reported under the new classification and mapped to the SITC. If, for some good, the map between its TSUSA code and the SITC, and the map between its HS code and the SITC, differ, the SITC data may show one code surging in value while another one shrinks. If the change

affects an SITC code in the set of least-traded goods, our measures would find a change in the extensive margin.

The COMTRADE data allow us to study the same trade flow measured by two different countries. This feature of the data, combined with the fact that different countries adopted the HS in different years, allows us to identify the changes caused by the switch in nomenclature. Consider the flow of goods from Canada to the United States, measured both by Canada (as exports) and by the United States (as imports). An important difference between these two countries is that Canada adopted the HS in 1988, while the United States adopted the HS in 1989. If the switch in classification system systematically created discontinuities in the data, then we would expect to see the discontinuities in 1988 in Canadian-collected data and 1989 in the U.S.-collected data.

The problem can be clearly seen when inspecting individual codes. Figure A1 plots the value of Canadian transmission parts (SITC 74930) exported to the United States, reported by both the United States and Canada. Notice the timing of the large jumps in the two series. The Canadian-measured series jumps between 1987 and 1988, while the U.S.-measured series jumps between 1988 and 1989. The timing of the change in trade values coincides exactly with the two countries' adoption of the HS.

How prevalent is this problem? As a simple measure of this discontinuity, consider the amount of code turnover in the data. Define an SITC code death, in period t, as a code that has a value greater than 10,000 U.S. dollars in year $t-1$ and less than 10,000 U.S. dollars in year t. Analogously, a code birth, in period t, occurs when a code has a value less than 10,000 U.S. dollars in year t and a value greater than 10,000 U.S. dollars in year t. Code turnover is the sum of code births and deaths. The number of total codes is constant throughout the sample at 1,836.

Turnover in the data displays the pattern consistent with a poor concordance between the nomenclatures. Table A1 reports data on code birth and death for trade between Canada and the United States. The left panel presents statistics about Canadian exports to the United States. For data collected by Canada, the code turnover is highest in 1988, but for the U.S.-collected data, turnover is highest in 1989. In the Canadian-collected data, 1,007 of 1,836 codes were turned over in 1988. The high turnover is driven by the 996 new codes put into service in 1988, which is more than 450 times larger than the average number of births in the years prior. The U.S.-collected data on this same trade flow have 364 new codes being traded in 1989, more than 20

times the average births in the prior years. The right panel in table A1 reports statistics for exports from the United States to Canada, and it displays the same pattern: code turnover is highest in the U.S.-collected data in 1989 and highest in the Canadian-collected data in 1988. It is worth noting that for both trade flows, the importing country seems to be less affected by the change in classification. This is consistent with the idea that import data are more carefully collected than export data. In our analysis above, we have used data collected as imports whenever possible.

The problem that we are discussing seems to be systematic. Looking at exports from Italy to Switzerland and exports from Switzerland to Italy, we see what looks like large increases on the extensive margin for both countries in 1988, the year that both countries switched to the HS. The benefit of focusing on the United States and Canada is that these two countries switched to the HS in different years, which makes explanations for the increases in the extensive margin, other than problems with the concordances between the pre-HS system and the SITC and the HS and the SITC, less plausible.

Are there ways to fix the problem we highlight here? The answer to this question depends crucially on the intended use of the data. These problems seem less severe at more aggregate classifications; analysis at the two-digit level, which is common in the multisectoral applied general equilibrium literature, may not be severely affected. For questions specifically about code turnover, it seems that the problems are too severe, and the prudent choice is to remove the transition year from the sample period, as we have done in this paper.

Table 1

Summary Statistics

		Growth in total trade			Growth in least-traded goods			Ratio
	N	mean	std	p50	mean	std	p50	
All country pairs	1913	158	284	80	703	1185	334	4.2
OECD importer, OECD exporter	421	155	207	89	650	1174	302	3.4
OECD exporter, non-OECD importer	639	96	179	42	483	818	215	5.1
Non-OECD exporter, OECD importer	405	206	338	113	877	1396	428	3.8
Non-OECD exporter, non-OECD importer	448	207	381	106	911	1360	516	4.9
Fast-growing exporter, slow-growing importer	203	347	435	221	1501	1894	957	4.3
Fast-growing exporter, fast-growing importer	33	695	619	521	2725	2593	1999	3.8
Slow-growing exporter, fast-growing importer	175	310	435	220	1108	1298	800	3.6
Slow-growing exporter, slow-growing importer	1502	103	174	56	504	855	254	4.6
Exporter joined GATT/WTO	121	472	587	309	1979	2460	1067	3.4
Importer joined GATT/WTO	157	356	531	239	1354	1533	948	4.0
No change in GATT/WTO membership	1899	155	276	79	688	1145	331	4.2
New RTA	313	192	239	105	914	1143	492	4.7
No new RTA	1600	152	291	76	662	1189	304	4.0

Notes: Growth rates are computed over 1995–2005. The column Ratio reports the median growth rate of the least-traded goods divided by the median growth rate of total trade.

Table 2

Least-traded goods and total trade growth

Horizon	SITC2		HS 92	
(years)	Coefficient	R-squared	Coefficient	R-squared
1	0.299**	0.215	0.498***	0.413
	(0.119)		(0.053)	
2	0.493***	0.403	0.704***	0.595
	(0.044)		(0.041)	
3	2.016***	0.430	1.885***	0.525
	(0.192)		(0.151)	
4	2.246***	0.468	2.439***	0.497
	(0.129)		(0.123)	
5	2.836***	0.503	2.735***	0.566
	(0.232)		(0.220)	
6	2.425***	0.517	2.829***	0.564
	(0.381)		(0.245)	
7	3.108***	0.663	3.205***	0.686
	(0.234)		(0.323)	
8	3.752***	0.682	4.241***	0.791
	(0.385)		(0.426)	
9	3.599***	0.725	3.647***	0.757
	(0.330)		(0.387)	
10	3.591***	0.717	4.288***	0.837
	(0.402)		(0.243)	
Observations	1,913		1,277	

Notes: Ordinary least squares estimates of (1). Each row reports the coefficient and r-squared for a specification of (1) where the growth rates are taken over the number of years listed in the column Horizon. An observation is an exporter-importer pair. Robust standard errors are reported in parentheses. Levels of significance are denoted $^{***}\ p < 0.01$ and $^{**}\ p < 0.05$.

Table 3

Share of least-traded goods: Trade liberalization

period	trade flow	share of total exports
1989–1999	Canada to Mexico	0.303
1989–1999	Mexico to Canada	0.253
1988–1998	Canada to United States	0.166
1988–1998	United States to Canada	0.121
1989–1999	Mexico to United States	0.180
1980–1988	Mexico to United States	0.357
1989–1999	United States to Mexico	0.137
1980–1988	United States to Mexico	0.223

Table 4

Share of least-traded goods: Structural transformation

period	trade flow	share of total exports
1975–1985	Chile to United States	0.346
1975–1985	United States to Chile	0.707
1995–2005	China to United States	0.257
1995–2005	United States to China	0.212
1975–1985	Korea to United States	0.658
1975–1985	United States to Korea	0.560

Table 5

Share of least-traded goods: Business cycle fluctuations

period	trade flow	share of total exports
1989–1999	Germany to United States	0.139
1989–1999	United States to Germany	0.123
1989–1999	Japan to United States	0.118
1989–1999	United States to Japan	0.126
1989–1999	United Kingdom to United States	0.120
1989–1999	United States to United Kingdom	0.148

Table 6

Decomposing total trade growth

		log difference [contribution to total]		
		total trade	extensive margin	intensive margin
1989–1999	Canada-Mexico	0.716	0.120 [16.7]	0.597 [83.3]
1989–1999	Mexico-Canada	1.565	0.097 [6.2]	1.468 [93.8]
1988–1998	Canada-U.S.	0.788	0.092 [11.7]	0.696 [88.3]
1988–1998	U.S.-Canada	0.706	0.061 [8.7]	0.645 [91.3]
1989–1999	Mexico-U.S.	1.486	0.136 [9.2]	1.350 [90.8]
1989–1999	U.S.-Mexico	1.310	0.088 [6.7]	1.222 [93.3]
1975–1985	Chile-U.S.	1.962	0.033 [1.7]	1.929 [98.3]
1975–1985	U.S.-Chile	0.987	0.834 [84.6]	0.152 [15.4]
1995–2005	China-U.S.	1.683	0.258 [15.4]	1.424 [84.6]
1995–2005	U.S.-China	1.308	–0.113 [–8.6]	1.421 [108.6]
1975–1985	Korea-U.S.	3.157	1.015 [32.1]	2.143 [67.9]
1975–1985	U.S.-Korea	1.892	0.580 [30.7]	1.312 [69.3]
1989–1999	Germany-U.S.	0.842	0.086 [10.2]	0.756 [89.8]
1989–1999	U.S.-Germany	0.741	–0.017 [–2.3]	0.759 [102.3]
1989–1999	Japan-U.S.	0.342	0.002 [0.6]	0.340 [99.4]
1989–1999	U.S.-Japan	0.375	0.003 [0.8]	0.373 [99.2]
1989–1999	U.K.-U.S.	0.788	0.022 [2.8]	0.765 [97.2]
1989–1999	U.S.-U.K.	0.659	0.015 [2.2]	0.644 [97.8]

Table 7
Decomposition of trade growth under different cutoff values

	log difference [contribution to total]			
	total trade	extensive margin	intensive margin	cutoff value (thousand USD)
Canada-Mexico 1989–1999	0.642	–0.049 [–7.7]	0.691 [107.7]	0
	0.648	–0.038 [–5.9]	0.686 [105.9]	50
	0.716	0.120 [16.7]	0.597 [83.3]	481
Mexico-Canada 1989–1999	1.502	–0.077 [–5.2]	1.579 [105.2]	0
	1.504	-0.019 [–1.3]	1.523 [101.3]	50
	1.565	0.097 [6.2]	1.468 [93.8]	2,529
Canada-U.S. 1988–1998	0.742	0.001 [0.2]	0.740 [99.8]	0
	0.742	0.001 [0.1]	0.741 [99.9]	50
	0.788	0.092 [11.7]	0.696 [88.3]	40,932
U.S.-Canada 1988–1998	0.656	0.007 [1.1]	0.649 [98.9]	0
	0.656	0.008 [1.2]	0.649 [98.8]	50
	0.706	0.061 [8.7]	0.645 [91.3]	26,322
Mexico-U.S. 1989–1999	1.412	0.062 [4.4]	1.350 [95.6]	0
	1.412	0.065 [4.6]	1.348 [95.4]	50
	1.486	0.136 [9.2]	1.350 [90.8]	19,634
U.S.-Mexico 1989–1999	1.234	0.028 [2.3]	1.207 [97.7]	0
	1.235	0.027 [2.2]	1.207 [97.8]	50
	1.310	0.088 [6.7]	1.222 [93.3]	8,838

Table A1
Code turnover

	U.S. imports from Canada				U.S. exports to Canada			
	U.S.-collected		Canada-collected		U.S.-collected		Canada-collected	
	births	deaths	births	deaths	births	deaths	births	deaths
1982	0	4	4	2	41	43	5	2
1983	3	4	4	2	43	38	4	4
1984	5	13	2	0	49	20	3	0
1985	87	36	1	2	70	74	1	2
1986	4	23	0	1	36	26	0	1
1987	8	9	2	1	34	40	2	1
1988	13	6	996	11	43	32	116	16
1989	364	105	117	78	325	152	132	96
1990	5	15	76	32	38	49	91	36
1991	122	15	26	29	152	66	28	37
1992	4	17	28	26	52	39	36	32
1993	13	6	29	27	38	45	34	33
1994	7	8	28	31	48	48	35	41
1995	9	9	29	28	48	38	40	33
1996	11	6	29	22	42	35	36	27
1997	5	7	29	22	36	34	34	25
1998	7	10	24	21	40	35	28	30
1999	6	5	22	34	38	46	29	40
2000	6	11	29	27	37	57	33	34
2001	4	6	17	20	39	36	23	22
Average	17.1	13.6	2.2	1.3	45.1	39	2.5	1.7

Notes: Average is the average for that column over the years preceding the transition year, which is 1988 for Canada and 1989 for the United States.

Figure 1

Composition of exports: Canada to Mexico

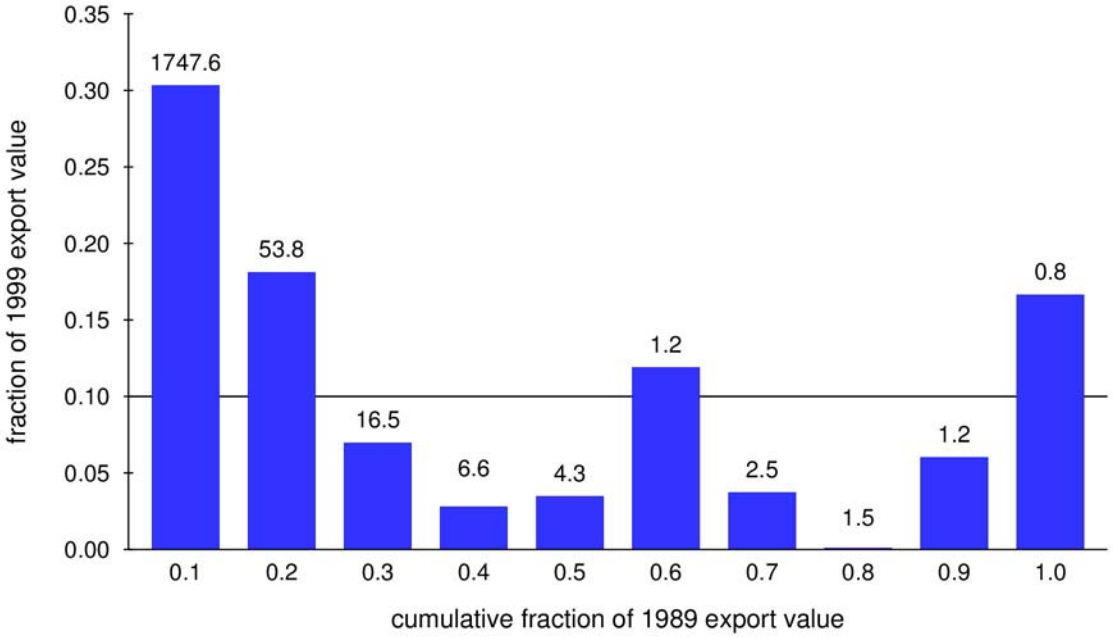

Figure 2

Least-traded goods and total trade growth for all country pairs

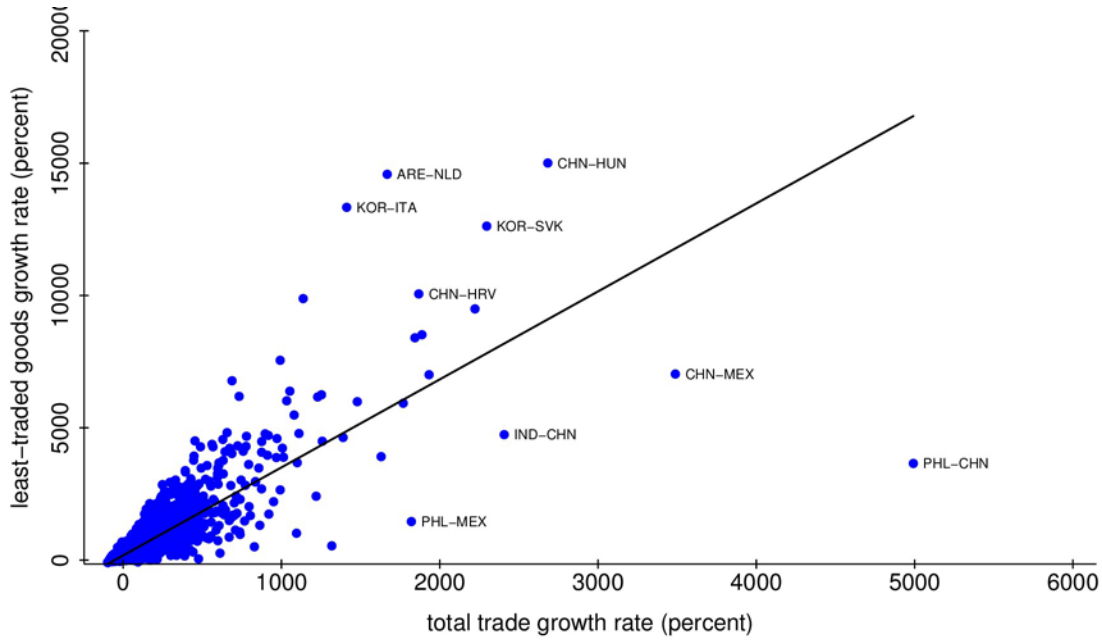

Figure 3

Composition of exports: Mexico to Canada

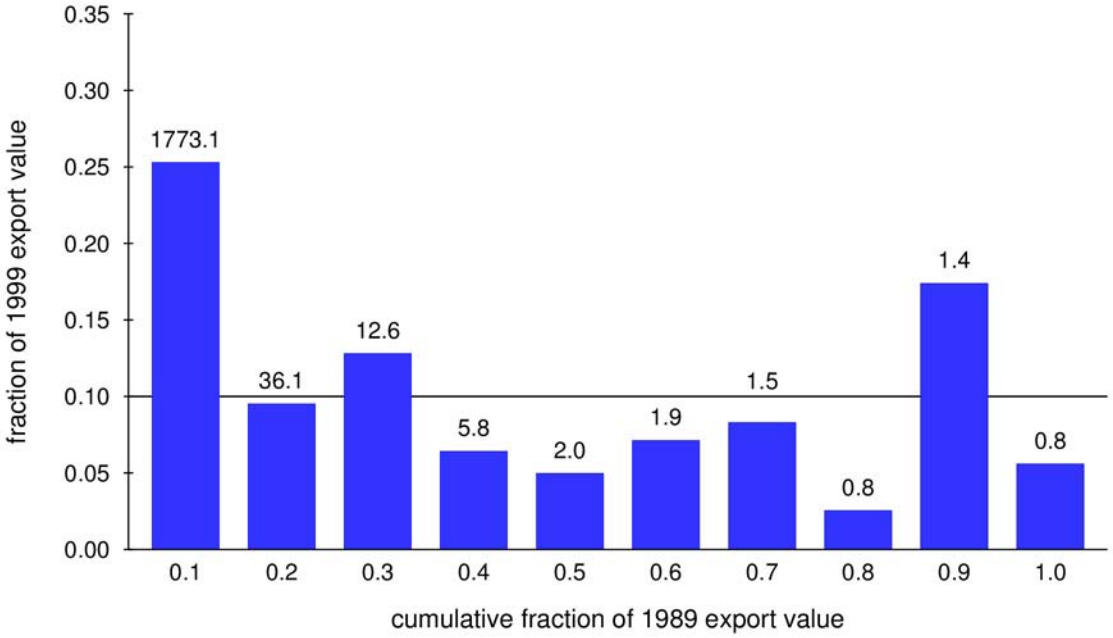

Figure 4

Least-traded goods: Mexico to Canada

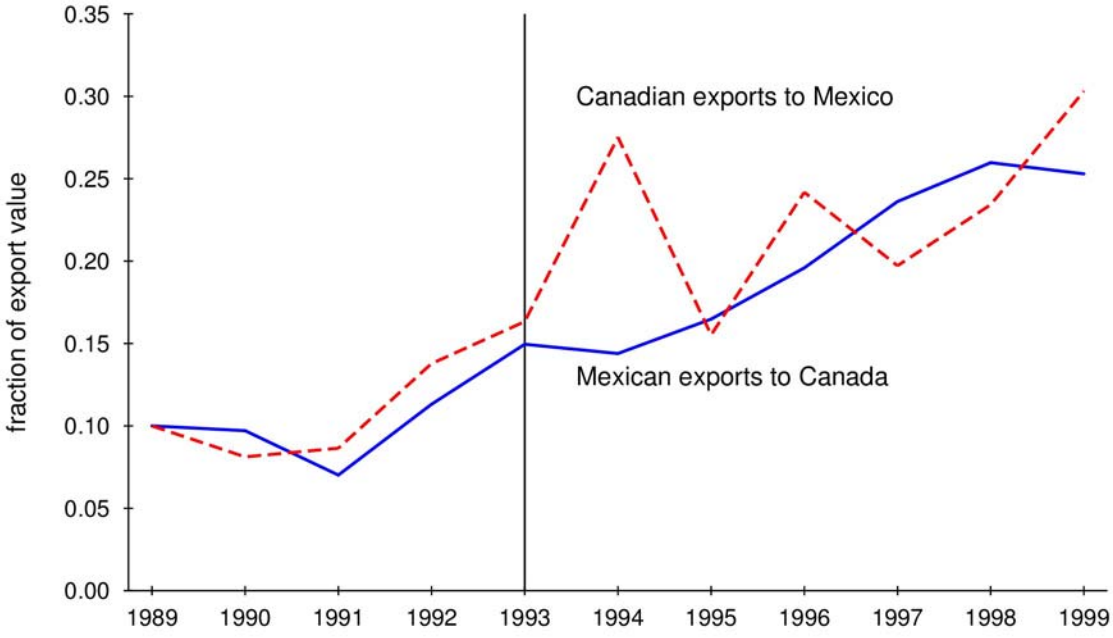

Figure 5

Composition of exports: China to United States

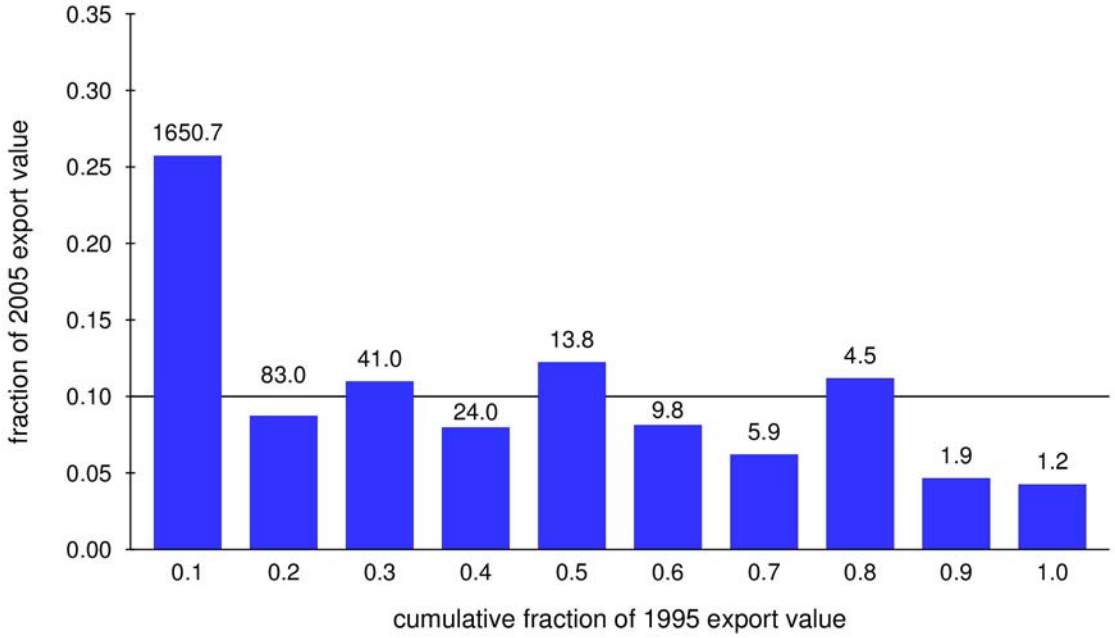

Figure 6

Composition of exports: United States to China

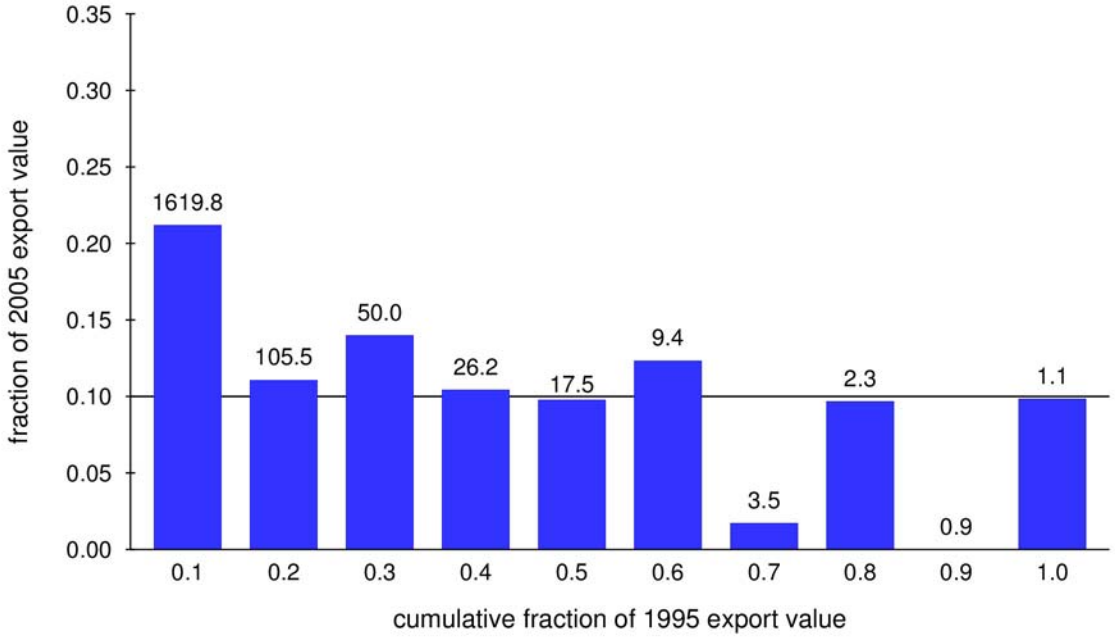

Figure 7

Least-traded goods: China and United States

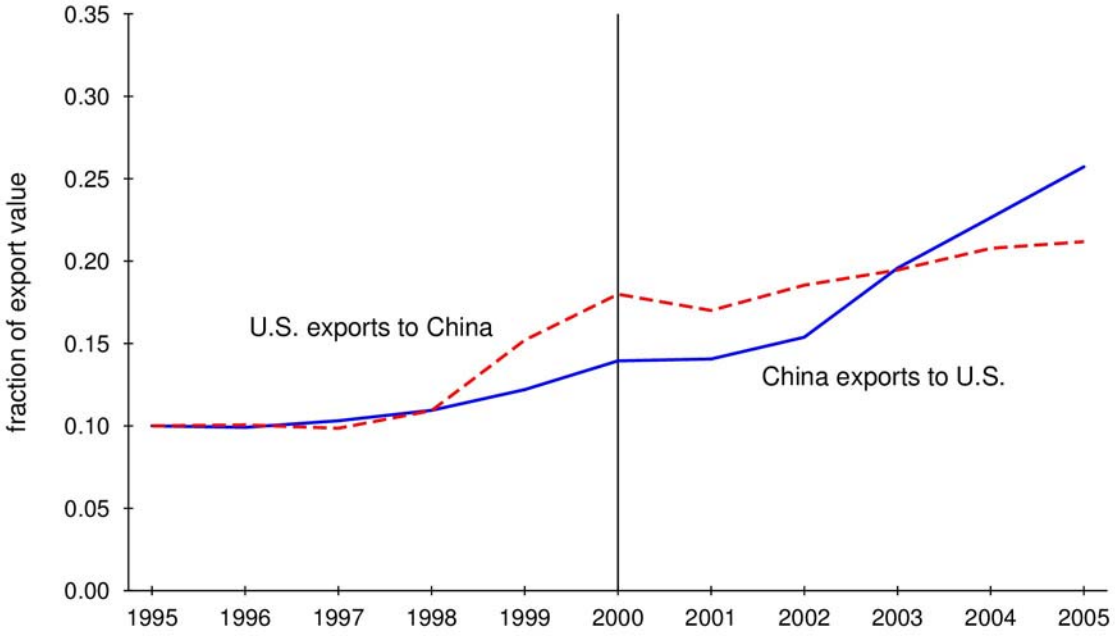

Figure 8

Least-traded goods growth over longer time horizon

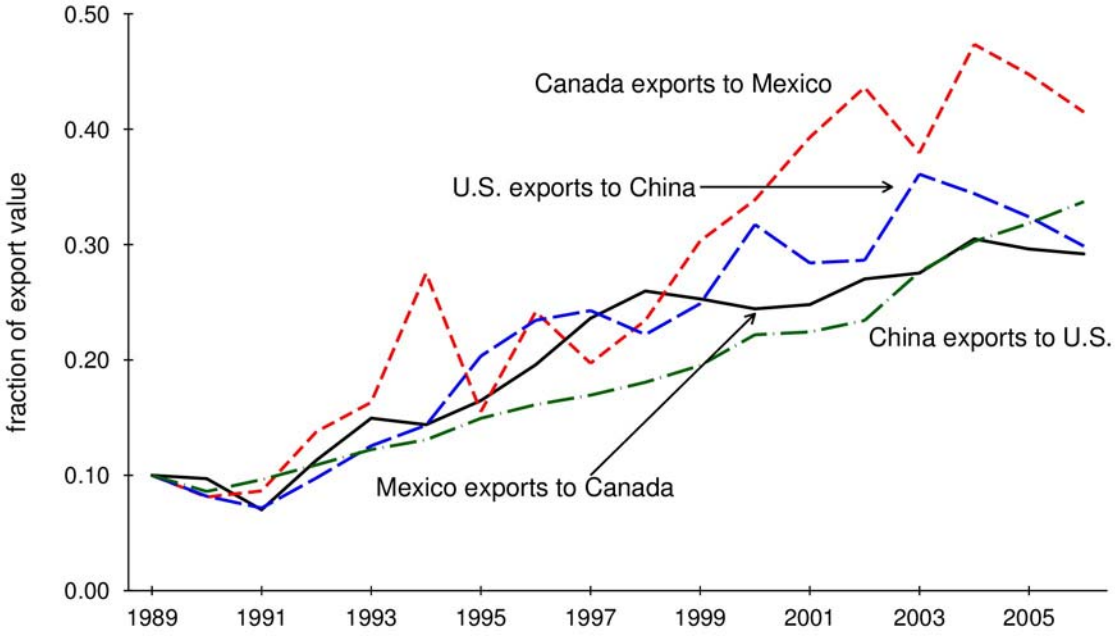

Figure 9

Composition of exports: United Kingdom to United States

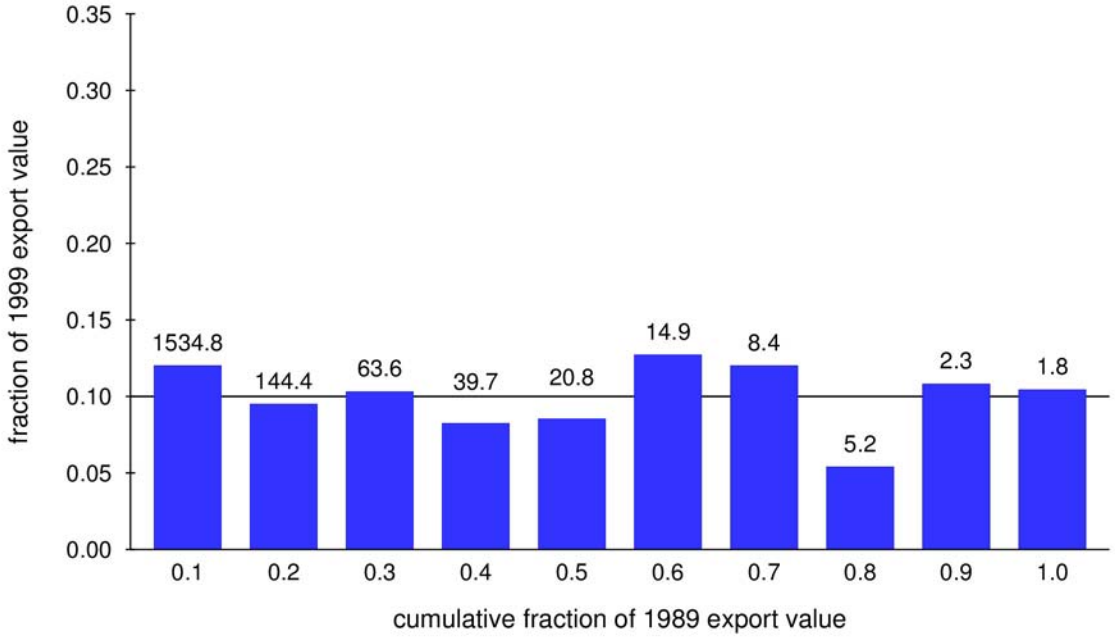

Figure 10

Composition of exports: United States to United Kingdom

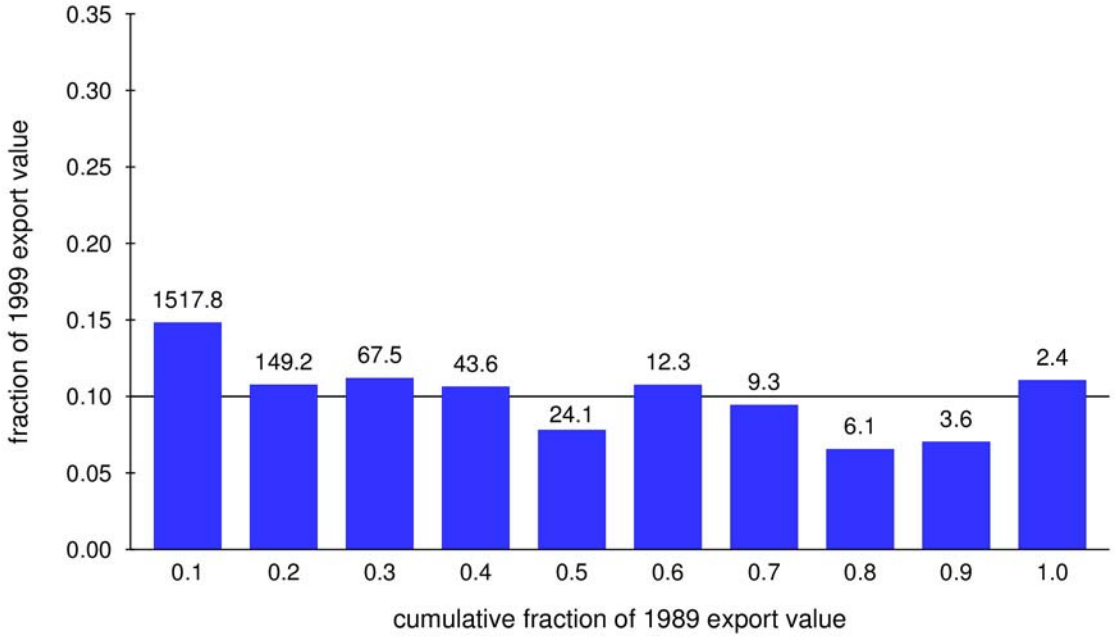

Figure 11

Least-traded goods: United States to United Kingdom

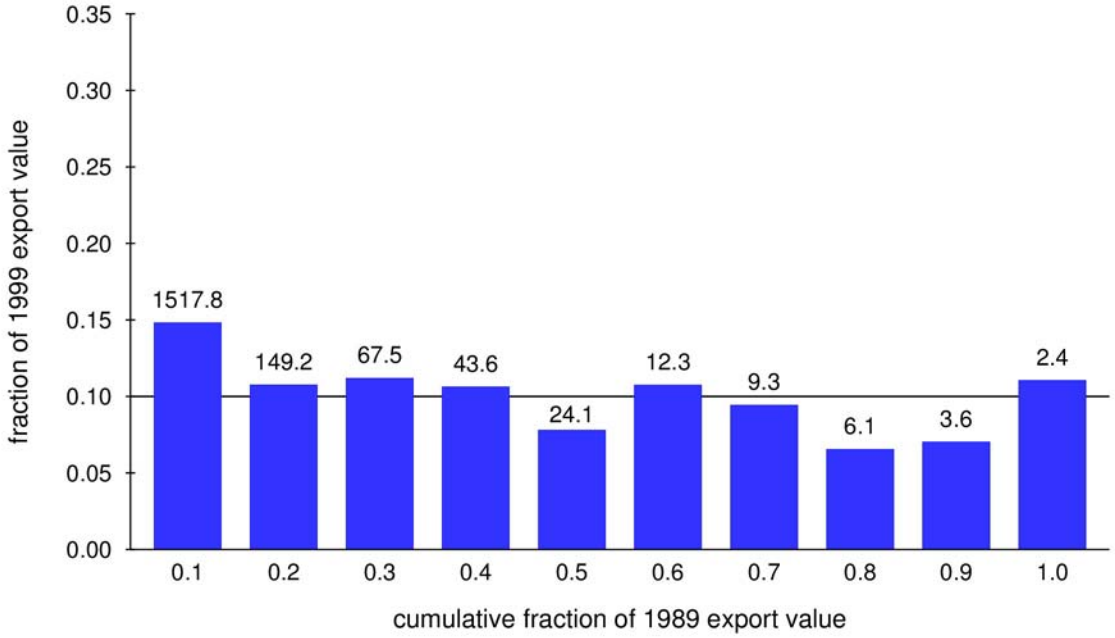

Figure 12

Canada to Mexico: Alternative sorting procedure

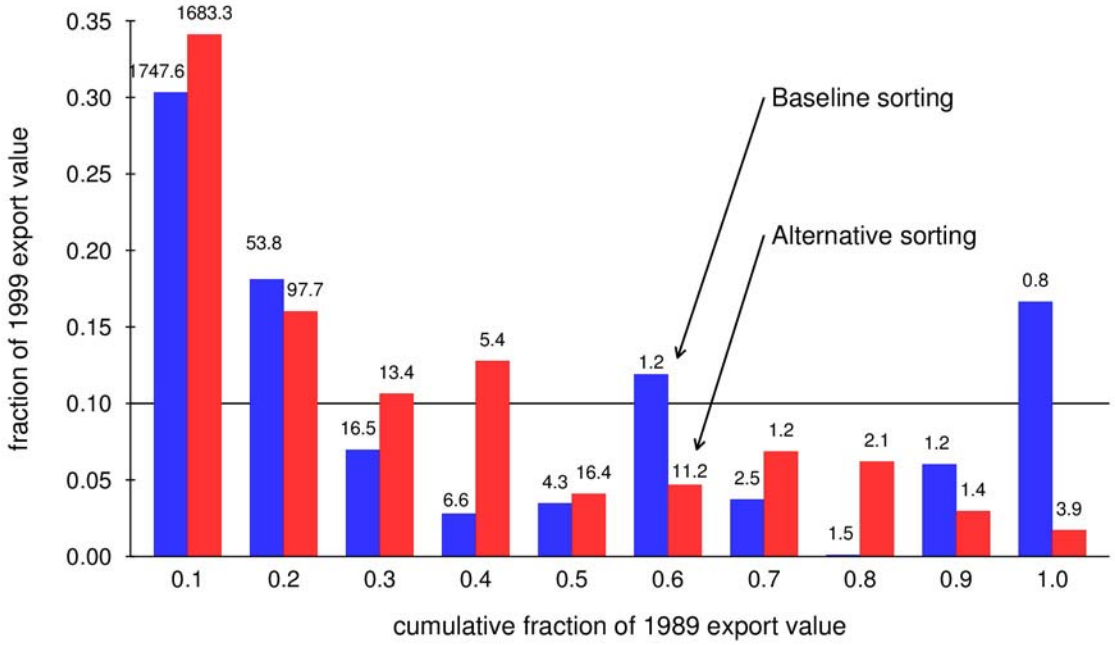

Figure 13

Mexico to Canada: Alternative sorting procedure

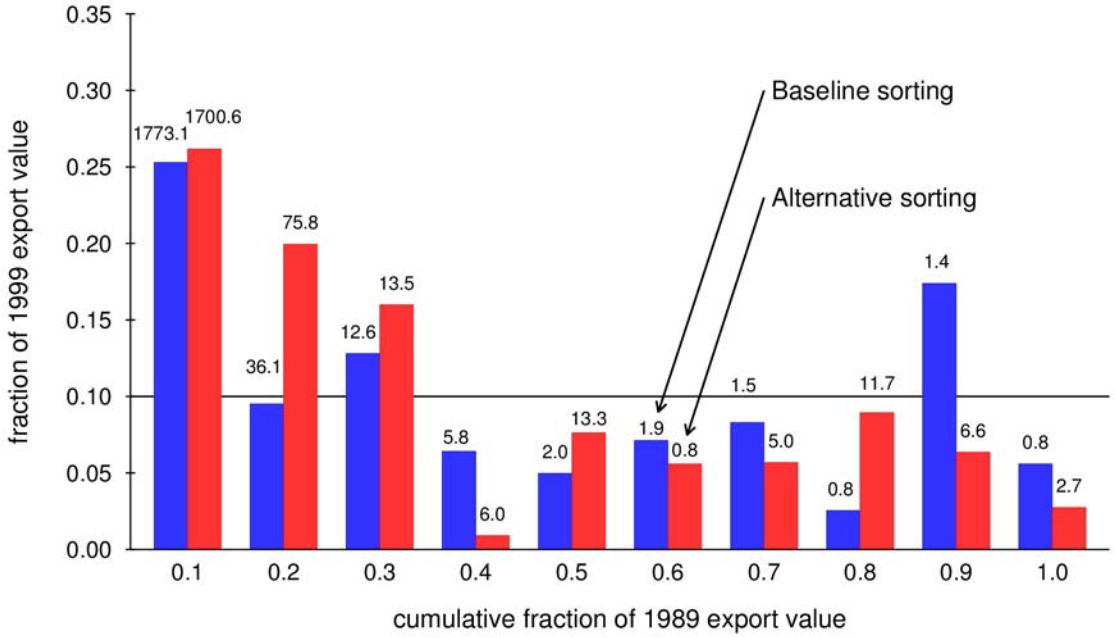

Figure A1

SITC 74930 Transmission shafts, cranks, bearing housings