UNDERSTANDING THE DETERMINANTS OF STRUCTURAL CHANGE IN WORLD FOOD MARKETS*

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Introduction

World agricultural trade has witnessed striking structural changes during the last two decades. From 1980 to 1995, world food and agricultural imports increased 5.3 percent annually, however, growth rates differed greatly among commodity groups. Among the four broad commodity categories--bulk, livestock, horticulture, and other processed--other processed product trade increased the most, 8.3 percent annually. This was followed by livestock and horticulture product trade at 6.9 and 6.6 percent. Growth in trade of bulk commodities was much slower (2.1 percent). As a result, the share of bulk commodities declined from 50 percent in 1980 to 32 percent in 1995, while the shares of non-bulk products increased from 50 percent to 68 percent (figure 1).

This change in the structure of trade appears to be closely related to growth in income. In affluent markets, like the EU, North America, and Japan, consumer-ready processed goods make up a large and rising share of their food and agricultural imports. While in developing countries, imports are still dominated by bulk and intermediate products, consumer-ready products are also beginning to make inroads. As per capita income grows, people tend to prefer a more diverse diet, and expenditures on some food items such as meats, beverages, and fruit tend to grow faster than for food staples such as cereals and legumes.

Another potential force driving the observed structural change in world food markets derives from the supply side. It is based on the fact that agriculture land is fixed and that land usage differs by country. Land scarce countries tend to use their land more intensively such as for horticulture and some livestock products. There is a tendency for rapidly growing economies to shift the composition of their outputs in favor of those factors which are accumulating most rapidly. This was clearly observed in the East Asian economies where rapid accumulation of physical and human capital led to an expansion in manufacturing activity at the expense of agriculture.

In addition to these fundamental demand and supply side forces, there are other factors which have played an important role in the changing structure of world food trade. For example, transport costs for bulk and non-bulk agricultural commodities have been differentially affected by the shift to containerized shipping technology. The shift in the composition of food and agricultural trade is also related to changes in trade and domestic policies that support or regulate agriculture and food consumption in various countries. Historically, agriculture has been protected by many more developed economies and the degree of protection for grains has been larger than for other food products. This may partially explain the relatively slow growth of world grain import demand in recent years. In addition, bilateral agreements with East Asia, NAFTA, and the evolution of the CAP, have all had important impacts on the structure of world food and agricultural trade.

The objective of this paper is to assess the relative role of each of the major forces--consumer demand, factor accumulation, transport costs, and policy change--in driving changes in the composition of world food trade in 1980-1995. To do so, we employ a modified version of the Global Trade Analysis Project (GTAP) model of world trade which permits us to isolate the contribution of each of these related factors to the changing composition of world food trade in a general equilibrium context.

We evaluate the relative role of each of these factors by simulating the model backwards in time, from 1995 to 1980 under different assumptions. This general approach, termed "backcasting" (i.e. backwards forecasting), takes as exogenous the basic drivers of change and attempts to explain the resulting change in food trade composition. The model-produced changes in the composition of agricultural and food trade are compared with historical trade data, to determine the relative importance of each factor on the changing composition of food trade. Given limited space, our focus will be on explaining the changes in the global composition of food and agriculture trade. A natural follow-on effort would target specific markets in more detail.

This type of backcasting approach was first employed by Gehlhar (1997) who sought to explain the shift in exports of primary commodities to manufactures in East Asia in the 1980's. He calibrated the GTAP model to 1992 data, then implemented shocks to factor endowments and economywide total factor productivity (TFP) in order to force each economy back to its 1982 levels of population, land, labor, human capital, physical capital and technology. By comparing actual and predicted changes in export shares in this period, he found human capital accumulation played a key role in explaining the change in the aggregate composition of East Asian exports. Gehlhar, Hertel and Martin (1994) built on this work in an effort to predict future changes in the pattern of agricultural trade from 1992-2002. They also emphasized the importance of supply-side determinants of agricultural trade.

In this paper, we go beyond this earlier work in a number of ways. First, we focus on the composition of agricultural exports, rather than simply looking at the share of agriculture in total trade. Secondly, we incorporate the Cranfield *et al.* estimates of Rimmer and Powell's recently developed, implicitly directly additive demand system (nicknamed AIDADS) into the GTAP model. This permits us to better capture the impact of demand-side changes on the pattern of global trade. Thirdly, we incorporate new and improved estimates of the factor shares driving the supply side of the story (Liu et al., 1998). Finally, we bring in estimates of historical changes in the costs of trading, due either to changes in protection or innovation in global shipping.

Determinants of Structural Change in World Food Trade

Income Growth and Changes in Income Elasticities in 1980-95

As has been amply developed in the companion paper for this session, the level and composition of food demand varies in a systematic way with per capita income levels and associated changes in income elasticities over time. Table 1 reports these income elasticities as estimated by Cranfield *et al.* These are based on mappings from individual countries in their study to the aggregated GTAP regions shown in Table 1.[1] The entries in this table correspond to the GTAP model's base year (1995) and an historical year (1980). The latter is derived *via* a backcasting exercise in which prices are held constant and real expenditure is reduced.

Boldface entries in Table 1 are the larger of the two year's elasticities. It can be seen that the expenditure elasticities of demand for grains are larger in 1980 than in 1995 for all regions. In some cases, the decline from 1980-95 is quite sharp. For example, the expenditure elasticity of demand for grains in the Asian NICs falls from 0.44 to 0.08. This means that the impact of economic growth on the demand for grains in 1980 was much larger than in 1995.

The expenditure elasticity of demand for livestock products also falls somewhat over this period for the lower income economies. For example, in the case of ASEAN, it falls from 0.77 to 0.68. For China, the model predicts an expenditure elasticity of demand for food of 1.08 in 1980 versus 0.96 in 1995. However, in the wealthier economies (Australia, Canada, Japan, USA), the expenditure elasticity of demand for livestock products is marginally higher in 1995 than 1980. The same pattern is true for horticultural products and other food products. Given this pattern of change, the impact of global economic growth on the incremental demand for the higher-value food products is ambiguous, and depends on the composition of economic growth worldwide.
However, when compared to grains, it seems clear that economic growth willhave a greater relative stimulus on livestock products and other value-added goods.

Differential factor accumulation

Another source of structural change in food and agriculture trade comes from the supply side as a consequence of differential rates of production factor accumulation over time. The Rybczynski theorem in trade theory predicts that, when the endowment of one factor increases faster than others, the sectors that use this resource most intensively increase their output faster than other sectors. In the early stages of development, this shifts economic activity away from agriculture to manufactures, and from labor-intensive manufactures to capital intensive industries. In later stages of development, this involves a shift from manufactures to more skill-intensive service sectors, as additional supplies of physical and human capital are accumulated over time. As shown by Bowen (1994), differential growth in factor supplies also offers an explanation for differential export performance in developing countries.

Table 2 presents the average growth rates of production factors and total changes of world factor supply across major regions of the world from 1980 to 1995. Among the five production factors distinguished here, skilled labor (embodied with human capital) grew the fastest on a worldwide basis, achieving an average rate of growth 3.6 percent per year (see final column of Table

2). This was followed by growth in the global stock of physical capital, at 2.9 percent per annum, and then by growth in unskilled labor. There was almost no aggregate growth in the global stock of land employed in agriculture over this period. The overall increase in world supply is 70 percent for skilled labor, 54 percent for capital, 40 percent for unskilled labor, 21 percent for rural labor, and only 3 percent for agricultural land.

The accumulation rate of production factors, however, varies significantly across regions. For example, agricultural land declined in Japan, the Asia NICs, China, Western Europe, United States and Economies in Transition, but increased in other regions, especially some developing countries such as MERCOSUR, ASEAN, and Mexico. Physical capital accumulated at a very high rate in Asian countries during this period. It increased almost four-fold in China and in the three Asian NICs and three-fold in ASEAN (Table 2, third panel).

Agricultural land intensity (hectares per worker) declined in every region across the world as a result of world labor force growth rates which were much higher than those for agricultural land. However, the ranking of relative abundance of agricultural land to labor force stayed the same during this period. In contrast, capital intensity measured by physical capital per worker increased in all regions. While the relative ranking of the five capital rich OECD countries (Japan, USA, Western Europe, AUS/NZ, Canada) stayed the same, we observe considerable catch-up in the countries with lower physical capital endowments.

Another change over the 1980-95 period occurred in the skill composition of the labor force. The share of rural labor declined in every region. While the share of unskilled labor decreased in most OECD counties except Japan, it increased in all developing countries, inducing an upgrading of the industrial structure in different regions. The economies in the OECD countries became more service-oriented as their labor force became more skilled, while most developing countries expanded their manufacturing sectors drawing more of their labor force from rural to urban areas. This further concentrated the global stock of rural labor in the three low-income developing countries.

Change in Transportation Technology and Costs

The changing structure of world food trade has been accompanied by global changes in demand for ocean transportation services. Different agriculture products require different ocean shipping services. Grains and oilseeds, for example, are primarily shipped in bulk form in the holds of large ocean-going vessels. Processed products are packaged, requiring more handling, and are shipped primarily in standardized 20 or 40 foot containers. Perishable products require the most service and are shipped in refrigerated containers or in refrigerated bulk vessels.

Differences in transportation costs between the bulk and non-bulk agricultural commodities could arise from changing market conditions in shipping subsectors. The demand for containerized shipping has grown faster than bulk shipping in the last two decades. If the supply of container shipping services were constrained by lack of competition this could lead to higher costs for the sector, lending a bias against non-bulk trade. On the other hand, greater innovation in container shipping could reduce costs, thus favoring non-bulk trade over bulk commodities. In the long-run, under competitive conditions with constant returns to scale, we would expect transportation to have a neutral effect on the composition of trade.

There are many new technologies that have been adopted in global shipping. Transit times have been reduced, along with growth in integrated logistics. Climate and temperature control and packaging techniques have reduced spoilage and extended shelf life for horticulture and livestock products. Large container ships have reduced costs through scale economies. Some markets are not able to take full advantage of these advances because of undeveloped port and marketing infrastructure.

In order to assess the effect of changes in transportation on the structure of food and agriculture trade, we measure changes in transportation costs over the 1980-95 period. Table 3 displays changes in transportation margins for the five aggregate agriculture sectors used in the model. The change is expressed as a percentage change from 1995 base period margins in order to fit with our "backcasting" mode of analysis. These are calculated by holding the price constant at 1995 levels and allowing transportation costs to vary over time. Transportation margins in the grain and bulk sector have changed sporadically over time. Bulk margins in 1990 were higher than 1995, but 1985 margins were actually lower. These fluctuations reflect the volatile world market for grain trade. Over-capacity in dry bulk shipping services depressed rates in the mid 1980's. In contrast, the non-bulk transportation margins show a downward trend throughout the period. The only exception is processed food products, where the transportation margin actually rose from 1980 to 1985.

Policy as a Determinant of Structural Change

Policy changes can affect the composition of trade by having differential impacts on protection levels and thereby on an economy's output and the structure of its trade. For example, if protection levels for livestock products are reduced at a faster rate than for feedgrains, then meat imports are likely to grow faster than feedgrain imports.

International institutions have struggled for some time to measure the extent of policy intervention in markets. Thus far no comprehensive measure has been developed. In *Indicators of Tariff and Non-tariff Trade Barriers*, eleven measures of an economy's tariff structure and eight for the incidence of NTBs are defined. Each has its conceptual limitations, not to mention measurement problems. The PSE/CSE (OECD) probably comes closest as a single indicator in accounting for a range of government interventions from budgetary programs like deficiency payments to border measures like import quotas. The PSE measure, however, is not comprehensive, applying only to some agriculture sectors and the most up-to-date information (1996) applies only to the OECD countries. Furthermore, as an indicator of protection it does not always show a clear trend during the 1980-95 period for important markets like Japan and the EU. Consider the Japanese beef PSE. We know the Japanese beef market has become more open, with market-opening agreements in 1984 and 1988 and the substitution of tariffs for import quotas in 1991. Nevertheless, the PSE for Japanese beef shows no downward trend. This contradiction appears to be due to fluctuations in the Yen's value which, in turn, affects the size of the measured price wedge used in computing the PSE for Japanese beef.

As shown in table 4, tariff protection in the OECD countries has generally risen over this time period, with the exception of the United States and Oceania.[2] This result is due in part to the replacement of NTBs by tariffs through the tariffication process agreed to in the Uruguay Round. This could raise trade-weighted tariff levels, but would still represent a move toward a more liberal trade regime. In contrast to the OECD pattern, tariff levels for agriculture imports in developing countries generally have declined (table 5).

Higher tariffs in the OECD may reflect a reduced role for NTBs. According to table 4, almost all OECD countries experienced a decrease in the incidence of NTB's for agricultural products as measured by import-weighted NTB coverage ratios.[3] NTB coverage ratios were typically higher for agriculture than non-agriculture sectors in the EU, Canada, Japan and Mexico. In most sectors across the OECD, the share of imports covered by NTB's declined. Big drops were seen for livestock products relative to grain in the United States and Canada among developed markets. Declines were also observed in MERCOSUR, the Asian NICs, China, and ASEAN. In order to compute a single rate of change in market protection, we apply a hybrid measure in the simulations that combines changes in applied tariff rates with changes in NTB coverage ratios.[4]

Analysis of the Determinants of Structural Change

Experimental Design

Table 6 outlines the design of the five simulation experiments used to test the relative importance of different factors in the changing composition of world food trade over the past 15 years. In experiments E1-E3, we replace the AIADS demand system with a homothetic demand system derived from a Cobb-Douglas utility function. Therefore, these three simulations exclude the Engel effects on the structure of food demand and hence world trade. Instead they focus on other dimensions. In experiment E1, we shock the aggregate factor endowments in each region based on the data in Table 2. Experiment E2 introduces the shock on international transport costs based on percentage change of c.i.f / f.o.b ratios estimated in table 3. Experiment E3 adds the reduction in import protection based on a linear combination of changes in tariffs and NTB import coverage ratios. Finally, experiment E4 brings this demand side force into play.

Results and Analysis

Table 7 presents the changes in trade volumes resulting from the simulation experiments. These figures represent percentage changes in global trade volume, by 13 aggregated GTAP commodity categories. Since the simulations are performed in backcasting mode, they represent the percentage change necessary to take us from the 1995 data base backwards in time to 1990, 1985 and 1980. The one exception is the case of the policy shocks where only one set of shocks was used. These correspond roughly to policy changes which occurred from the mid-1980's to the early to mid-1990's (see Tables 4 and 5 for more details).

The first set of experiments involve shocks to the endowments of land, labor (both skilled and unskilled) and capital. Economywide TFP growth is permitted to adjust to hit the observed changes in real GDP. The reader will recall that the main impact of these shocks on the composition of trade comes through their interaction with differential factor intensities by sector. Because grains and bulk products are heavily dependent on agricultural land, which is not accumulating appreciably over this period, they benefit relatively less from these supply side shocks. In contrast, food processing is more responsive to the accumulation of labor and capital, since it is not directly constrained by land, and can import raw materials, if necessary. In addition, agriculture production is most affected in regions where land represents an important constraint. Agriculture in land-scarce countries tends to produce a larger share of horticulture and livestock products, sectors which are increasingly constrained with economic growth. These constraints stimulate imports for these commodities from land-abundant countries. Therefore, by the end of the backcasting period (1980) the change in trade volume for processed food products is -31.8% vs. only -18.0% for grains. Livestock products fall in between (-23.6%). From this we conclude that supply side forces may have indeed played a role in the relatively rapid increase in trade in value-added food products.

The second set of experiments in Table 7 report the impact of improvements in transport efficiency over the backcasting period. The shocks applied are those described in Table 3. Here, the evidence is mixed. Over the 1995-90 period, the model predicts that observed changes in margins would have stimulated grains trade relatively more (larger negative change in backcasting experiment). However, when this is taken back to 1985 and 1980, the situation changes, with relatively stronger impacts on trade in horticultural, livestock and processed foods. Overall, when compared to the supply side shocks, these changes are relatively small. This may be because of the relatively specialized nature of the transport innovations. For certain products, these innovations may have been critical in boosting trade. However, when averaged over all food products, the impact on trade volume growth is quite modest. In addition, innovations such that facilitate faster delivery of higher quality products may not lower unit transportation costs but they may nevertheless stimulate trade. Unfortunately our model does not capture this effect.

The third experiment introduces the policy shocks. As noted in section II above, the impact of observed changes in NTBs and tariffs on the mix of food trade over the last decade is uncertain. In some countries liberalization in processed products has been relatively more rapid, while in other cases the big changes have occurred in the grains sector. Experiment E3 aims to sort out the aggregate impact on global trade. Our results show that the impact, among food products, has been strongest on grains trade. This is followed by horticultural products, livestock and then processed foods. On this basis we are inclined to rule out policy reforms as the explanatory variable for the dramatic change in the composition of global food trade over the past decade. Of course, this finding must be qualified by the observation that we had great difficulty measuring changes in protection over this period.

The final determinant which we bring to bear in our analysis is that of consumer preferences. The previous experiments all assume fixed expenditure shares on food products. However, as has been emphasized previously in this paper, as well as in the companion paper by Cranfield et al., consumer demand for food is a dynamic phenomenon. We have seen that increasing incomes lead to lower expenditure elasticities of demand for grains in all of the regions considered in this analysis. In contrast, the responsiveness of processed food demand to income growth increases over the projections period in many regions. This generates a tendency towards increased consumption and trade in the latter products, as may be observed in the results reported under E4 in Table 7. Once again, these results are cast in terms of backwards changes. We see that the impact of 1995-80 income reductions on grains demand is very modest, whereas the impact on processed food demand is six times as large. Livestock demand follows in importance, and then horticultural products.

In summary, experiments E1 - E4 permit us to order the relative contribution of these four factors as determinants of the changing mix to world food trade. We find that consumer preferences rank at the top of the list. They are followed by differential factor accumulation and the supply side forces. Changes in transport efficiency rank a distant third in terms of explanatory power for changes in the composition of these broad groups of commodities. Finally, we find that changes in trade policy tended to bolster grains trade, relative to trade in value-added products, over the past decade.

The final experiment combines the shocks for which we have an explicit time dimension-- namely supply, demand and transport costs -- into a single backcasting experiment. Not surprisingly, this leads to the sharpest difference in trade volume between the bulk and processed food products, with grains remaining very stable (-3.8%) and processed food trade dropping by nearly 29 %, followed by livestock (-23%), horticultural products (-17%) and non-grain bulk products (-15%).

We have been unable to construct an historical time series of pure trade volume changes appropriate for comparison with the percentage changes reviewed above. Therefore, we compare instead the changes in value-based shares of world trade predicted by the model, with those observed in reality. Information on the model predictions for the bulk share in world food trade is shown in the last two rows of Table 7. This share was 32.4% in 1995, whereas it was much higher (50%) in 1980 (see also Figure 1). This contrasts with the model-based predictions under the combined shocks scenario provided by experiment E5 which raises the 32.4% share to 40% in 1980. Most of this increase is driven by the increase in the grains trade share. Going across the last row in Table 7, we see that about 40 percent of the increase comes from demand side forces, with 30 percent attributable to supply side factors. Less than five percent is due to transportation efficiency and 25 percent due to the joint effect of supply and demand.

Summary and Conclusions

We have used a modified version of the GTAP model to analyze the relative role of different forces underlying the compositional changes in world agriculture and food trade in the last 15 years. We attempted to isolate the effects of supply and demand factors as well as changes in transportation costs and trade policy. Our primary finding is that the fundamental supply and demand factors are most important in explaining the 15-year shift in global trade composition from bulk to non-bulk commodities (livestock, horticulture, and other processed foods). The demand side, driven by rising incomes and associated changes in income elasticities of demand, is the most important factor. Differential accumulation of production factors ranks a close second. Declining transportation costs falls a distant third. Finally, while extremely difficult to measure, it appears that changes in trade policy did not contribute to the observed shift away from trade in bulk products.

This study is the first to attempt a systematic explanation of the dramatic shift in composition of agricultural trade over the last two decades. As such, it is perhaps not surprising that the overall explanatory power of the experiments is rather low, accounting for less than half of the change in the global composition of food and agriculture trade. Future work in this area could usefully focus on two potential problems with the current study. First of all, we have had considerable difficulty measuring some of the key drivers of change, particularly in the case of transportation and trade policy. For example, the transportation margins are derived from trade data, not actual transportation costs. Furthermore the data are representative of only a few commodities and trade routes. The policy data used in this study — import-weighted applied tariffs and NTB coverage ratios — likely do not adequately reflect the market liberalization that has actually occurred in recent years. In addition, there are a host of other changes which occurred over this period which we have not captured in these experiments.

Secondly, the economic model used in this study is a stylized simplification of the world economy. One area in particular stands out in our minds. The import demand functions used in the model are of the Armington variety, in which food products are differentiated by country of origin. Grains from the US are permitted to substitute for grains from Canada, but only imperfectly. This means that price differences for very similar products can persist over time, thereby dampening shifts in trade flows, and most importantly, limiting market penetration of imports. While this approach may be satisfactory in the short- to medium run, we believe that it may be too rigid in the longer run, thereby limiting the responsiveness of trade to changing comparative advantage and demand conditions (see also Gehlhar, 1997.) Future research should attempt to improve our understanding of why such models tend to underpredict historical changes in trade shares.

Endnotes:

1. There were two main challenges which we faced in bridging the ICP and GTAP frameworks. The first involved bridging the two disparate price concepts used for consumer demand in the two models. The AIADS demand system is estimated using consumer survey data, and so reflects consumer prices. However, the GTAP framework is implemented using producer prices. Thus food prices reflect producer prices, less any subsidies, plus consumer taxes. They do not include wholesale, retail or transportation margins. In order to bridge the two frameworks, we introduce a margins sector into the model and calibrate the margins to observed differences in expenditure shares. This wholesale/retail sector also builds in the transition matrix which link the 12 product GTAP aggregations and the 7 product ICP commodity groupings. The second challenge in linking the consumer demand and trade frameworks derives from the incomplete country coverage of the ICP sample. In some cases (Australia, Japan, Canada, USA), the countries in the GTAP aggregation were also available in the ICP data base. For those we had only to update the demand system to 1995 by increasing expenditures and assuming unchanged prices. When the country in question was not in the ICP sample, we chose a country at a similar stage of development (in 1985) and updated their demand system to the appropriate level of 1995 expenditure. This led us to apply the India demand system in the case of China, for example. A third case was where the GTAP aggregation in our study involved a regional grouping, with multiple countries. Here, we generally used the most dominant ICP country in the grouping. For example, Germany was used as a proxy for the EU, Poland for Economies in Transition, Korea for the NICs, and Thailand for the ASEAN-6. A complete summary of these mappings is available in appendix Table A1.

2. The authors acknowledge the invaluable assistance of Darina Batkova of ERS in the development of Tables 4 and 5.

3. The import coverage ratio indicates the share of a country's imports subjected to NTB's. See OECD (1997).

4. We use the following formula to calculate the changes in protection level in the model $100*((1+t_0)/(1+t_1)-1)$, where t_0 is the protection level in the earlier year, and t_1 is the protection level in most recent year. The shocks applied in our model are a linear combination of tariffs (70%) and NTBs (30%). The resulting numbers are presented in Appendix Table A2.

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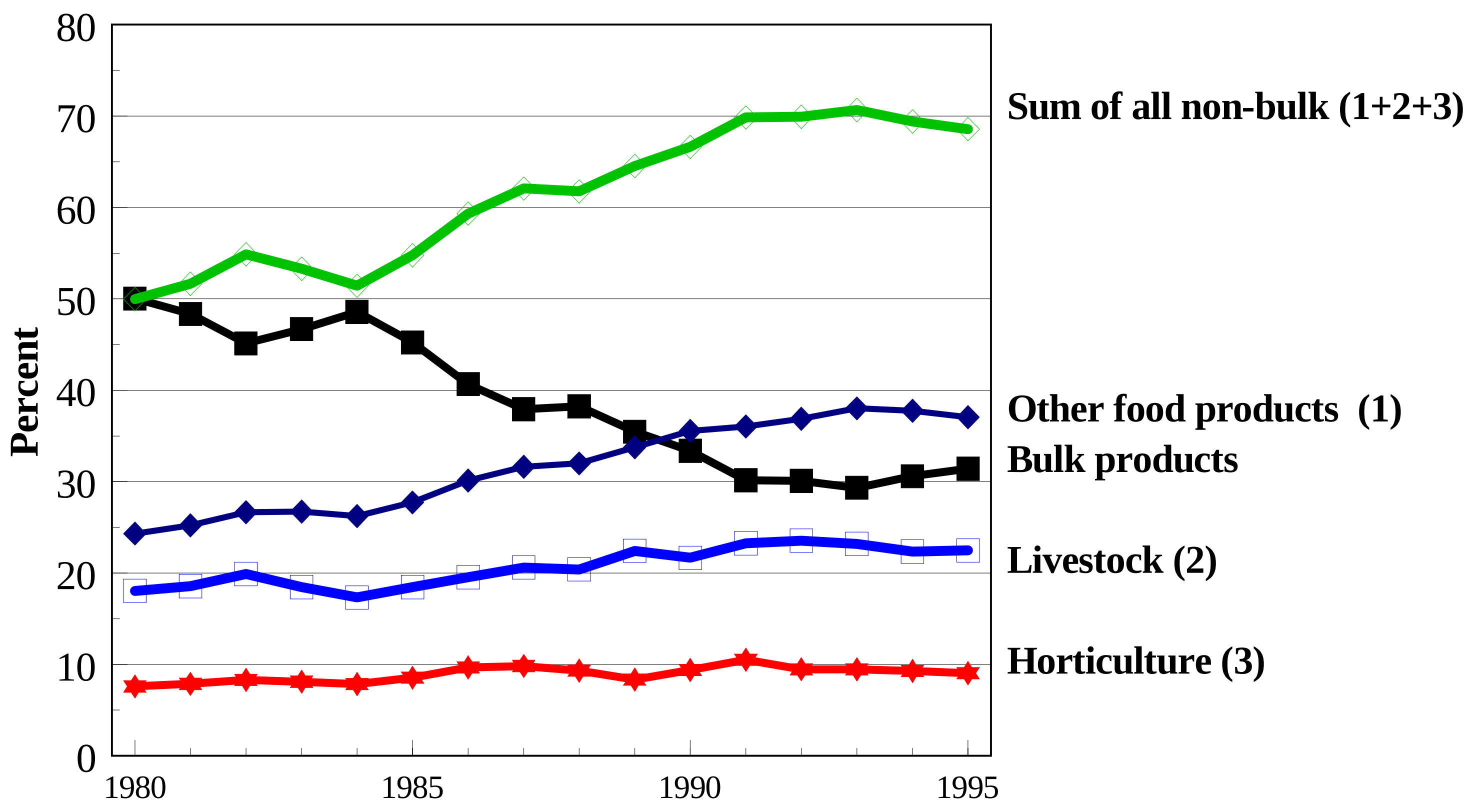
Figure 1--World Trade in Non-bulk Commodities Rising in Relative Importance



Data source: Authors aggregation from United Nations COMTRADE database.

Table 1 -- Income Elasticities Estimated from AIDADS by Model Regions 1980 (1995)

	Grains	Livestock	Horticulture	Other Food	Non-durables	Services	Durables
Australia	**0.103**(0.057)	0.696(**0.76**)	0.419(**0.478**)	0.524(**0.594**)	**1.039**(1.028)	**1.158**(1.103)	**1.176**(1.118)
Japan	**0.082**(0.032)	0.652(**0.727**)	0.368(**0.428**)	0.474(**0.55**)	**1.046**(1.032)	1.204(**1.127**)	**1.221**(1.141)
Asian NICs	**0.439**(0.084)	**0.685**(0.663)	**0.538**(0.376)	**0.589**(0.486)	**1.064**(1.045)	**1.374**(1.194)	**1.408**(1.212)
ASEAN	**0.597**(0.307)	**0.769**(0.677)	**0.661**(0.468)	**0.702**(0.545)	1.053(**1.054**)	**1.317**(1.255)	**1.35**(1.277)
China	**0.938**(0.757)	**1.079**(0.959)	**0.985**(0.826)	**1.074**(0.925)	1.025(**1.054**)	0.937(**1.179**)	**0.904**(1.158)
Canada	**0.048**(0.025)	0.716(**0.776**)	0.425(**0.493**)	0.54(**0.613**)	**1.034**(1.025)	**1.136**(1.093)	**1.149**(1.105)
Unites States	**0.022**(0.01)	0.754(**0.814**)	0.465(**0.547**)	0.583(**0.665**)	**1.027**(1.02)	**1.107**(1.071)	**1.118**(1.081)
Mexico	**0.184**(0.142)	0.662(**0.68**)	**0.409**(0.408)	0.504(**0.513**)	**1.053**(1.047)	**1.219**(1.186)	**1.235**(1.2)
MERCOSUR	**0.19**(0.122)	0.633(**0.651**)	**0.39**(0.377)	0.478(**0.481**)	**1.058**(1.05)	**1.271**(1.218)	**1.297**(1.24)
Western Europe	**0.098**(0.065)	0.694(**0.738**)	0.415(**0.452**)	0.522(**0.568**)	**1.04**(1.032)	**1.158**(1.118)	**1.178**(1.136)
Economies in Transition	**0.337**(0.335)	**0.686**(0.685)	**0.479**(0.478)	**0.561**(0.56)	1.066(1.066)	**1.256**(1.255)	**1.289**(1.288)
Mideast and North Africa	**0.439**(0.404)	**0.714**(0.704)	**0.55**(0.528)	**0.613**(0.595)	**1.06**(1.059)	**1.284**(1.275)	**1.323**(1.312)
Rest of the World	**0.812**(0.739)	**0.982**(0.936)	**0.871**(0.808)	**0.958**(0.899)	1.045(**1.055**)	1.14(**1.204**)	1.119(**1.187**)

Notes: a. Numbers outside parentheses are elasticities for 1980; numbers inside are for 1995, the base year;
b. Numbers in bold are the larger in the pair.

Data Source:

Table 2 -- Changes of Relative Abundance of World Production Factor Supply, 1980-1995

	United States	Canada	Mexico	MERCOSUR	Western Europe	Australia & New Zealand	Japan	Asia NICs	China	ASEAN	Economies in Transition	Mideast & North Africa	Rest of the World	World Total
Growth rate of Population, GDP and Trade Flows							*Percent*							
Population	1.0	1.2	2.0	1.7	0.3	1.3	0.5	1.2	1.3	1.9	0.6	2.9	2.3	1.7
GDP	2.5	2.4	1.3	1.8	2.0	2.9	3.2	7.7	10.1	6.2	0.0	0.7	2.5	2.6
Exports	5.5	6.5	7.5	6.3	3.9	6.4	4.9	11.7	13.8	5.8	4.1	2.0	2.3	5.1
Imports	7.2	6.5	2.4	5.0	3.5	5.5	4.7	12.1	10.9	6.9	2.9	1.4	0.4	5.0
Average growth rate of regional factor endowments							*Percent*							
Agricultural land	-0.1	0.0	0.7	1.2	-0.3	0.5	-0.7	-0.6	-0.3	1.0	-0.2	0.7	0.4	0.2
Rural labor	-0.5	-4.9	0.4	-1.5	-3.2	0.0	-3.5	-3.9	1.6	1.8	-1.3	0.8	1.5	1.3
Unskilled labor	0.9	0.9	4.3	3.8	0.3	1.4	1.1	3.3	2.6	3.9	0.3	4.8	3.5	2.3
Skilled labor	2.5	4.6	4.6	3.7	3.6	4.3	2.7	7.0	2.8	3.3	2.6	5.5	6.0	3.6
Total labor	1.3	1.7	3.2	2.5	0.7	2.0	1.0	2.2	1.9	2.7	0.3	3.2	2.3	1.9
Physical capital	2.4	3.9	3.2	1.8	2.0	2.5	4.6	9.4	9.2	8.3	2.1	3.7	2.9	2.9
Total growth of regional factor endowments							*1980 as 1.0*							
Land	0.99	1.00	1.11	1.20	0.96	1.08	0.90	0.92	0.96	1.16	0.97	1.11	1.06	1.03
Rural labor	0.93	0.47	1.06	0.80	0.61	1.00	0.58	0.55	1.27	1.31	0.82	1.13	1.24	1.21
Unskilled labor	1.15	1.14	1.88	1.74	1.04	1.23	1.18	1.62	1.46	1.77	1.04	2.02	1.68	1.40
Rural & unskilled labor	1.14	1.09	1.56	1.42	0.99	1.21	1.11	1.29	1.31	1.47	0.99	1.54	1.38	1.29
Skilled labor	1.44	1.96	1.96	1.72	1.70	1.88	1.49	2.76	1.51	1.64	1.47	2.24	2.40	1.70
Physical capital	1.42	1.78	1.59	1.31	1.34	1.45	1.97	3.82	3.76	3.29	1.37	1.71	1.54	1.54
Land and capital intensities							*Hectares per worker*							
1980	1.70	3.75	1.10	1.29	0.57	5.96	0.09	0.13	0.18	0.48	1.47	1.08	0.64	0.69
1995	1.37	2.92	0.77	1.07	0.49	4.79	0.07	0.08	0.13	0.37	1.36	0.75	0.48	0.54
							Constant 1987 US$ 1,000 per worker							
1980	93.1	63.1	14.2	16.6	87.7	85.6	100.5	13.2	0.6	2.6	15.0	17.4	2.8	19.5
1995	108.8	88.0	14.2	15.1	105.7	92.2	171.9	36.6	1.8	5.8	19.5	18.6	3.1	22.7
Skill distribution of regional labor force							*Percent*							
Rural Labor														
1980	3.52	6.66	36.28	31.37	9.40	7.27	10.95	28.71	74.24	61.25	22.73	49.22	67.22	52
1995	2.69	2.47	24.19	17.35	5.17	5.43	5.54	11.49	71.30	54.14	17.74	34.66	59.21	47
Unskilled labor														
1980	70.61	71.55	54.56	60.04	73.66	72.68	76.81	65.29	19.64	33.90	63.59	41.67	29.45	39.76
1995	66.65	64.08	64.55	72.43	68.91	66.46	78.60	76.50	21.72	40.51	63.14	52.62	35.12	42.04
Skilled labor														
1980	25.87	21.79	9.16	8.59	16.94	20.05	12.24	6.00	6.12	4.84	13.68	9.11	3.32	8.29
1995	30.66	33.46	11.26	10.22	25.91	28.11	15.85	12.01	6.98	5.35	19.12	12.72	5.67	10.65

Data sources:

Data on agricultural Land, population, rural and total labor (economically active population) were downloaded from the FAO Web Site (www.fao.org) for about 200 countries across the world.

The disaggregation between skilled and unskilled labor was based on employment by occupation data for over 150 countries from the International Labor Office, Labor Statistical Database.

Additional data on Taiwan were downloaded from the Web Site (www.dgbasey.gov.tw) and China's data from 1990 and 1995 population census from the Development Research Center at the State Council of P.R. Chi

Skilled labor are professionals that include ILO occupation ground group 0-2, (professional, technical and related workers; administrative and managerial workers); production laborers are the aggregation of ILO occupation ground group 3-5, (clerical and related workers; sales workers; service workers) and 7-9, (production and related workers, transport equipment operators and laborers).

Physical capital stock data in 1987 constant US dollars for 134 counties were obtained from the Development Economics Analytical Database (DAD) at the World Bank.

Table 3 -- Percentage Change in Transportation Margins (c.i.f./f.o.b)

	1990	1985	1980
	Percent change from 1995		
Grains	9.1	-7.6	2.5
Bulk	1.0	-2.0	1.9
Horticulture	2.5	9.3	10.4
Livestock	8.4	10.6	11.1
Food Products	3.3	9.1	6.3

Data Source: Authors estimation from U.S. Department of Commerce, Bureau of Census -Foreign Trade Statistics, and United Nations COMTRADE.

Note: Transportation margin are aggregated from reported customs trade statistics. For U.S. trade these margins are based on the difference between the c.i.f unit value and the customs import unit value. For United Nations trade statistics, they are based on the difference between the c.i.f unit value and the f.o.b unit value. Reliable trade statistics are not available on a global basis. Selected importing and exporting countries were used to best represent changes in the ocean shipping cost. Importing countries include Japan, U.S. and the United Kingdom. Exporting countries include Australia, Canada, Chile, Colombia, Brazil, France, New Zealand, and the United States. Canada-U.S. trade was not used for estimating transportation margins. Detailed commodity data were obtained at the 4 and 5 digit Standard International Trade Classification (SITC).

There are a number of problems encountered in measuring changes in transportation margins over time. Margins for individual commodities within each aggregated sector can vary considerably. For example, the cif/fob for grapes is 1.31 while the margin for nuts is only 1.04. First is the aggregation problem. Aggregate margins calculated at different points in time may vary significantly due to changes in the commodity composition of the aggregate, not necessarily from changes in transportation costs. Second, for most agricultural commodities, freight constitutes the largest portion of transportation cost, while it is often unit weight-based. Therefore, differential fluctuations in cif and fob prices would also affect the cif/fob ratio. To make changes in the aggregate cif/fob ratio solely represent changes in transportation cost, we calculate the cif/fob margin based on selected representative sets of commodities for each of the five aggregate agricultural sectors, and use 1995 prices through out the calculation to isolate the price effect.

Table 4 -- OECD countries: Import-weighted applied tariffs and core NTB coverage ratios

	United States			Canada			Western Europe			Japan			Australia & New Zealand			Mexico			
Sectors	88	93	96	88	93	96	88	93	96	88	93	96	88	93	96	84-87	88	93	96
Applied tariffs																			
Grain	3.8	3.7	3.3	16.2	16.0	26.0	15.8	7.1	87.3	10.9	7.8	29.4	1.0	0.0	0.0	3.2	5.7	7.6	115.3
Other food - bulk	6.8	10.1	8.2	3.2	3.2	4.1	11.4	10.9	17.3	5.9	5.1	9.9	5.6	4.7	12.4	5.8	5.9	8.3	23.2
Horticulture	5.7	5.7	5.2	4.6	4.6	3.2	11.5	11.1	17.0	11.5	11.2	11.4	2.1	1.4	0.5	8.5	17.4	17.7	43.7
Other food - high value	7.4	7.7	8.2	10.8	9.3	15.9	17.8	16.3	23.6	20.9	19.7	24.0	11.1	6.5	2.3	8.5	10.7	12.0	55.4
Meat and livestock products	5.8	4.7	4.8	7.3	7.3	37.8	9.0	9.4	61.2	13.4	20.7	19.8	3.2	1.9	1.7	8.5	8.2	15.4	70.1
Agriculture	6.3	7.0	6.5	7.7	7.3	15.5	12.6	11.8	33.8	12.1	13.9	18.0	4.9	3.1	3.6	7.1	8.5	11.5	59.5
Non-agriculture	2.0	1.7	1.6	3.8	3.2	2.6	5.8	5.8	5.1	4.3	4.3	3.8	7.4	5.3	2.9	9.1	11.7	12.8	25.9
Fishing	0.5	0.5	0.5	0.7	0.7	0.6	10.1	10.2	10.0	5.5	5.7	5.1	0.1	0.1	0.0	8.5	19.9	19.7	39.5
Resource intensive products	0.4	0.4	0.2	1.3	1.3	0.3	1.0	1.0	0.8	0.4	0.4	0.3	2.4	1.2	0.2	4.2	6.6	8.3	16.3
Labor intensive non-durable	8.0	5.6	5.7	8.9	8.3	7.6	4.8	4.6	4.0	3.6	4.4	4.0	8.6	7.3	4.7	9.5	10.0	10.8	23.6
Labor intensive durable	1.2	1.2	1.1	3.0	2.0	1.5	2.9	2.7	1.6	3.3	3.1	2.7	8.7	5.1	2.1	18.9	13.2	13.7	27.3
Skill intensive durable	3.0	3.1	2.5	9.8	9.7	8.0	6.1	6.5	6.0	3.2	3.1	2.4	11.5	6.1	1.9	10.3	11.7	13.9	26.6
Average	4.9	5.4	5.0	6.7	6.3	12.2	11.3	10.6	28.3	8.6	9.6	11.6	5.6	3.8	3.3	8.3	9.0	11.7	54.4
Core NTB import coverage ratios																			
Grain	11.8	11.8	11.8	1.7	0.1	0.0	97.0	97.0	7.6	31.6	31.6	0.1	1.8	0.0	0.0	68.8	97.5	96.4	
Other food - bulk	11.7	3.6	9.6	20.0	0.0	0.0	18.8	18.4	1.2	3.1	3.0	2.4	2.7	0.8	0.0	53.0	51.5	38.3	0.0
Horticulture	0.4	1.0	1.1	5.9	12.2	9.9	41.0	23.5	8.2	7.2	2.4	0.2	1.2	1.4	1.5	47.9	20.7	11.1	
Other food - high value	16.4	4.3	2.8	19.6	8.8	1.0	36.4	35.3	15.0	13.3	6.5	1.0	2.8	6.6	0.9	47.9	39.4	41.2	
Meat and livestock products	33.1	36.3	6.7	51.8	17.2	0.0	60.5	58.1	0.8	48.3	37.1	25.8	1.3	13.6	11.9	47.9	11.6	11.5	11.1
Agriculture	16.0	11.5	6.3	20.2	7.4	2.1	41.4	37.7	6.0	24.0	18.5	9.8	1.9	7.4	5.5	50.6	44.7	40.4	2.6
Non-agriculture	7.3	5.0	4.2	7.7	3.8	2.5	6.8	6.1	5.2	6.1	7.5	5.3	6.5	0.0	0.0	25.4	0.3	0.3	1.8
Fishing	2.4	1.6	1.5	29.9	0.0	0.0	11.5	10.1	9.5	9.6	12.8	7.9	0.0	0.0	0.0	47.9	5.7	5.7	
Resource intensive products	24.2	20.8	18.3	0.0	0.0	0.0	0.1	1.2	0.7	11.0	12.2	11.0	0.6	0.0	0.0	54.6	0.0	0.0	
Labor intensive non-durable	61.1	41.2	34.2	14.1	17.1	15.8	17.4	17.8	14.1	23.6	23.6	22.6	11.4	0.0	0.0	17.8	0.0	0.0	5.0
Labor intensive durable	0.0	0.0	0.0	0.2	3.6	2.0	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	0.0	0.0	
Skill intensive durable	2.8	2.7	2.4	0.0	1.7	0.0	0.9	1.0	0.0	1.1	1.1	1.1	11.7	0.0	0.0	9.3	0.1	0.1	0.3
Average	13.3	9.5	5.6	17.0	6.5	2.2	34.7	31.7	5.8	15.9	13.5	7.8	3.3	5.2	3.8	35.2	38.0	34.3	2.5

Source: Authors' aggregations based on *OECD, Indicators of Tariff and Non-tariff Trade Barriers, Paris, 1997. Tariffs and NTB import coverage ratio are weighted by 1995 imports.*

Table 5 -- Developing countries: Import-weighted applied tariffs and NTM

	MERCOSUR			Asian NICs			China			ASEAN			Mid East and North Africa			Economies in Transition		Rest of the World		
	84-87	88-90	91-93	84-87	88-90	91-93	84-87	88-90	91-93	84-87	88-90	91-93	84-87	88-90	91-93	84-87	88-90	84-87	88-90	91-93
Applied tariffs																				
Grain	24.6	19.5	7.7	6.9	3.8	3.5	0.4	0.4	0.4	2.1	8.5	1.2	3.7	3.4	3.5	6.4	6.3	8.1	11.9	9.0
Other food - bulk	34.3	16.3	9.0	9.8	6.7	6.2	23.1	22.1	20.8	8.3	11.4	10.0	16.7	12.8	7.6	7.6	7.0	36.1	25.0	15.9
Horticulture	35.3	23.7	9.2	9.1	6.4	6.0	33.3	34.4	32.5	10.9	14.1	12.4	19.9	17.6	7.3	9.0	8.9	31.4	29.0	18.9
Other food - high value	35.3	23.7	9.2	9.1	6.4	6.0	33.3	34.4	32.5	10.9	14.1	12.4	19.9	17.6	7.3	9.0	8.9	31.4	29.0	18.9
Meat and livestock products	35.3	23.7	9.2	9.1	6.4	6.0	33.3	34.4	32.5	10.9	14.1	12.4	19.9	17.6	7.3	9.0	8.9	31.4	29.0	18.9
Agriculture	34.5	19.1	9.0	9.5	6.6	6.1	25.4	25.2	23.7	9.2	12.4	10.8	17.8	14.8	7.3	8.1	7.8	33.7	26.1	16.8
Non-agriculture	32.3	19.0	11.8	7.9	4.9	4.3	29.2	29.9	30.0	10.7	13.3	12.4	15.0	12.5	8.8	9.5	9.2	39.5	27.2	18.4
Fishing	39.6	23.8	9.2	9.1	6.4	6.0	33.3	34.4	32.5	10.9	14.1	12.4	19.9	17.6	7.3	9.0	8.9	31.4	29.0	18.9
Resource intensive products	30.1	10.5	9.2	8.4	6.1	5.6	18.6	17.0	15.7	6.1	10.3	9.2	14.6	10.0	7.9	6.9	6.1	39.5	22.5	14.1
Labor intensive non-durable	39.5	18.3	11.4	3.9	1.9	1.6	56.7	57.0	52.1	16.9	20.5	18.7	17.8	14.9	12.7	12.3	12.1	32.5	30.2	20.5
Labor intensive durable	49.7	19.4	10.5	13.8	7.0	5.6	29.7	32.8	30.8	7.8	11.5	11.2	14.5	15.3	9.4	13.1	13.3	28.2	27.6	9.7
Skill intensive durable	36.1	25.4	14.1	8.9	5.1	4.4	26.1	27.7	29.8	12.3	14.0	13.4	13.6	12.4	9.0	11.9	12.0	42.3	32.1	23.3
Average	33.0	19.0	10.9	8.4	5.4	4.9	28.2	28.6	28.3	10.3	13.1	12.0	16.2	13.5	8.2	8.9	8.6	37.3	26.8	17.8
NTMs																				
Grain	34.5	22.4	0.0	1.9	2.2	2.2	49.2	44.8	0.0	54.6	27.7	22.3	65.5	44.4	5.5	88.7	81.0	87.0	77.2	32.1
Other food - bulk	36.5	46.3	22.6	21.0	22.7	7.0	27.0	57.4	32.9	31.8	8.3	7.0	48.1	37.3	3.4	69.3	53.1	78.9	58.2	34.1
Horticulture	19.3	30.8	1.3	18.0	13.7	10.6	38.9	41.6	6.5	35.9	13.1	11.7	44.6	33.7	3.5	68.7	59.1	73.1	54.7	16.6
Other food - high value	19.3	30.8	1.3	18.0	13.7	10.6	38.9	41.6	6.5	35.9	13.1	11.7	44.6	33.7	3.5	68.7	59.1	73.1	54.7	16.6
Meat and livestock products	19.3	30.8	1.3	18.0	13.7	10.6	38.9	41.6	6.5	35.9	13.1	11.7	44.6	33.7	3.5	68.7	59.1	73.1	54.7	16.6
Agriculture	30.0	40.2	14.3	19.5	18.8	8.4	32.1	51.4	22.4	33.8	10.4	9.1	47.0	35.8	3.5	69.3	55.9	77.0	57.5	27.7
Non-agriculture	35.2	29.5	17.1	9.9	9.9	2.1	15.3	39.1	25.5	26.2	5.1	3.8	46.7	39.9	3.5	51.2	39.7	67.7	49.6	29.0
Fishing	19.3	30.8	1.3	18.0	13.7	10.6	38.9	41.6	6.5	35.9	13.1	11.7	44.6	33.7	3.5	68.7	59.1	73.1	54.7	16.6
Resource intensive products	53.9	61.8	42.0	17.6	29.8	4.5	14.9	57.7	42.3	27.2	6.1	5.0	53.7	42.3	3.5	68.2	44.7	81.7	60.7	46.2
Labor intensive non-durable	49.6	18.8	0.1	1.6	0.3	0.1	16.7	43.5	36.9	27.7	4.3	0.7	44.1	36.9	11.0	51.2	52.9	53.4	42.3	10.2
Labor intensive durable	22.0	0.0	0.0	0.0	0.0	0.0	0.0	43.8	51.8	22.8	0.0	0.0	17.1	15.2	1.2	0.0	5.6	36.9	27.9	1.7
Skill intensive durable	21.8	6.3	2.3	7.3	0.3	0.2	13.6	30.2	16.9	24.6	4.0	2.8	43.3	40.6	2.0	27.0	25.8	52.1	36.1	13.3
Average	33.5	33.0	16.1	12.9	12.6	4.0	19.9	42.5	24.7	28.4	6.7	5.4	43.3	43.3	43.3	58.5	46.2	71.2	52.5	28.5

Source: Authors' aggregations based on *UNCTAD, Directory of Import Regimes, Part I Monitoring Import Regimes, New York*, 1994. Tariffs and NTMs are weighted by 1992 imports.

Table 6 -- Experimental Design

Experiment	Exogenous variables to be shocked	Instruments
E1: Supply-side forces	real gdp consumption shares land, labor, capital endowments population	regional tfp Cobb Douglas utility function
E2[a]: International transportation	international transport efficiency	
E3: Trade policy	linear combination of tariffs and non-tariff barrier coverage ratios	
E4: Demand-side forces	real private consumption	real income
	population	
	primary factor prices (fixed)	supply of endowments
E5: Combined simulation	regional tfp population land, labor, capital endowments tariffs/NTBs transport efficiency	

Note:

a. The GTAP model explicitly represents bilateral transport margins in terms of a cif/fob margins by individual trade route and sector. These transportation margins are exogenous in the model and the associated technical coefficients (services per unit of merchandise transported) are ‘shocked’ to simulate changes in efficiency in transportation.

Table 7 -- Simulation Results: Global Trade Volume Changes from 1995 by Commodity

	E1: Supply			E2: Transport			E3: Policy	E4: Demand			E5 = E1+E2+E4	
	1980	1985	1990	1980	1985	1990		1980	1985	1990	1980	Actual
							Percent change from 1995					
Grain	-18.0	-15.1	-5.8	-0.7	1.9	-2.6	-18.4	-4.9	-2.6	-5.5	-3.8	na
Other food - bulk	-18.8	-15.4	-4.3	-0.4	0.4	-0.2	-12.1	-17.3	-12.5	-6.9	-14.5	na
Other food - high value	-31.8	-23.5	-7.4	-1.1	-1.6	-0.5	-13.2	-27.3	-19.7	-5.4	-29.4	na
Horticulture	-17.2	-14.0	-3.0	-2.5	-2.2	-0.6	-15.8	-17.2	-12.5	-4.4	-16.5	na
Meat and livestock products	-23.6	-17.4	-4.4	-1.2	-1.2	-0.9	-14.6	-23.5	-17.0	-5.7	-22.8	na
Fishing	-30.2	-21.6	-6.3	0.0	0.0	-0.1	-5.4	-27.6	-19.6	-7.3	-22.5	na
Resource intensive products	-28.8	-21.8	-8.4	0.0	0.0	0.0	-6.8	-27.7	-20.4	-7.6	-28.5	na
Labor intensive non-durable	-33.0	-25.0	-10.3	-0.1	-0.1	0.0	-21.6	-29.5	-21.4	-7.4	-32.9	na
Labor intensive durable	-31.0	-22.9	-8.0	0.0	0.0	0.0	-3.4	-24.8	-18.2	-6.4	-30.9	na
Skill intensive durable	-33.6	-25.0	-10.5	0.0	0.0	0.0	-6.4	-25.2	-18.6	-7.1	-33.3	na
Housing and utility	-28.6	-21.1	-5.4	0.0	0.0	0.0	0.1	-26.7	-19.8	-5.9	-27.7	na
Other services	-33.4	-24.8	-9.4	0.2	0.1	0.1	-2.1	-28.4	-21.0	-7.4	-31.1	na
							Bulk trade as share of total food and agricultural trade					
Value share of bulk/total food	34.7	33.6	32.7	32.6	33.0	32.4	32.5	35.5	34.5	32.3	39.9	32.5
Difference with 1995 base	2.3	1.2	0.3	0.1	0.5	0.0	0.0	3.0	2.1	-0.2	7.5	(50.0) 17.5

Note:

a. There are two major channels that the differential accumulation of factors may affect the composition of food and agricultural trade. First, when dramatic accumulation of phy and human capital drives economic structure from agriculture to manufacture, and then to services, the mix of intermediate demand for food and agricultural products of produ changes. In the meantime, more capital brings higher household income which compounds the Engel effect on the composition of food trade. Therefore, there are joint effects from supply and demand factors on the composition of food trade.

Table A1. Commodity/Region Aggregations used in Study

ICP Commodities	GTAP Commodities	GTAP Regions
Grain	grn: Grains	AUS: Australia and New Zealand
Livestock	blk: other food-bulk	JPN: Japan
Horticulture	ofd: other food-high value	NIC: Asia NIC (Korea, Taiwan, HongKong)
Other food	hor: Vegetables, fruit, nuts	AS6: ASEAN including Viet Nam
Other non-durables	liv: livestock	CHN: China
Services	fsh: fishery	CAN: Canada
Durables	rsp: resource intensive products	USA : USA
	lnd: labor-intensive non-durables	MEX: Mexico
	ldp: labor-intensive durables	MER : MERCOSUR(Argentina, Brazil, Chile, Uruguay)
	skp: skill-intensive manufactures	WEU: West Europe
	egw: house and utilities	EIT: Central European Association and Former Soviet Union
	sev: other services	MAN: Middle east and North Africa
		ROW: Rest of World

Appendix Table A2-Factor endowments and relative size of model

	United States	Canada	Mexico	MERCOSUR	Western Europe	Australia & New Zealand	Japan	Asia NICs
Population						*Million persons*		
Population	271	29	91	211	385	21	125	72
GDP and trade flows						*Billion 1995 U.S. dollars*		
GDP	7169	572	277	1045	8680	401	5076	839
Exports	711	197	82	77	826	67	477	310
Imports	840	183	72	96	816	83	449	333
Relative size in the world						*Percent*		
Population	4.8	0.5	1.6	3.7	6.8	0.4	2.2	1.3
GDP	25.3	2.0	1.0	3.7	30.7	1.4	17.9	3.0
Exports	18.5	5.1	2.1	2.0	21.5	1.8	12.4	8.1
Imports	20.7	4.5	1.8	2.4	20.1	2.0	11.0	8.2
Trade dependence						*Percent*		
Exports/Out	9.9	34.5	29.7	7.4	9.5	16.8	9.4	37.0
Imports/Abs	11.7	31.9	26.2	9.2	9.4	20.7	8.9	39.8
Share in world factor endowment						*Percent*		
Land								
1980	13.35	3.20	1.72	5.74	6.46	3.34	0.34	0.22
1995	12.72	3.08	1.85	6.65	6.00	3.49	0.30	0.19
Rural Labor								
1980	0.37	0.08	0.76	1.87	1.43	0.05	0.59	0.66
1995	0.28	0.03	0.67	1.23	0.72	0.05	0.28	0.30
Unskilled labor								
1980	9.70	1.07	1.49	4.67	14.66	0.71	5.38	1.97
1995	7.94	0.87	2.00	5.62	11.31	0.60	4.51	2.24
Skilled labor								
1980	17.02	1.55	1.20	3.20	16.12	0.94	4.10	0.86
1995	14.42	1.79	1.38	3.22	16.06	1.04	3.60	1.40
Total labor								
1980	5.46	0.59	1.08	3.09	7.89	0.39	2.78	1.20
1995	5.01	0.57	1.30	3.36	6.60	0.39	2.42	1.24
Capital								
1980	25.98	1.91	0.79	2.63	35.41	1.70	14.29	0.81
1995	23.97	2.20	0.81	2.23	30.66	1.59	18.26	2.00

Data Source: Calculated from the 1995 multi-regional SAM estimated by the author from Version 4 GTAP datal
Data on agricultural Land, population, rural and total labor (economically active population) were
The disaggregation between skilled and unskilled labor was based on employment by occupation da
Physical capital stock data in 1987 constant US dollars for 134 counties were obtained from the De
Additional data on Taiwan were download from the Web Site (www.dgbasey.gov.tw) and China's d
GDP and other national account data in 1987 constant US dollars were obtained from the Economi

regions, 1995

China	ASEAN	Economies in Transition	Mideast & North Africa	Rest of the World	World Total
1220	422	391	348	2120	5437
708	600	785	841	1323	28314
212	283	164	210	221	3839
175	326	172	241	281	4067
21.4	7.4	6.9	6.1	37.2	100
2.5	2.1	2.8	3.0	4.7	100
5.5	7.4	4.3	5.5	5.8	100
4.3	8.0	4.2	5.9	6.9	100
30.0	47.1	20.9	25.0	16.7	13.6
24.7	54.3	21.9	28.7	21.3	14.4
7.02	4.51	19.02	5.78	29.30	100.0
6.49	5.05	17.91	6.21	30.07	100.0
38.03	7.73	3.93	3.51	41.00	100.0
39.95	8.38	2.67	3.28	42.16	100.0
13.17	5.44	14.37	3.86	23.51	100.0
13.69	6.90	10.70	5.54	28.11	100.0
19.63	3.83	14.80	4.07	12.69	100.0
17.37	3.68	12.78	5.34	17.92	100.0
26.61	6.56	8.97	3.71	31.68	100.0
26.51	7.33	7.12	4.47	33.68	100.0
0.85	0.88	6.90	3.30	4.57	100.0
2.08	1.87	6.10	3.66	4.56	100.0

base (Hertel, 1997) and additional factor endowment and historical data collected and aggregated by the authors.
download from the FAO Web Site (www.fao.org) for about 200 countries across the world.
ata for over 150 countries from International Labor Office Labor Statistical Database.
evelopment Economics Analytical Database (DAD) at the World Bank.
data from 1990 and 1995 Population census from Development Research Center at the State Council of P.R. China
c and Social Database EBSD data base at the World Bank (BESD).

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Appendix Table A3 --Changes of GDP and other major macro vari

	United States	Canada	Mexico	MERCOSUR	Western Europe	Australia & New Zealand	Japan	Asia NICs
Real GDP						*1995 as 1.0*		
1980	0.688	0.698	0.820	0.762	0.743	0.648	0.626	0.326
1985	0.782	0.805	0.903	0.767	0.804	0.752	0.752	0.460
1990	0.897	0.927	0.970	0.837	0.940	0.855	0.936	0.718
Population								
1980	0.86	0.84	0.74	0.78	0.95	0.83	0.93	0.84
1985	0.91	0.88	0.83	0.86	0.96	0.88	0.97	0.91
1990	0.95	0.95	0.91	0.93	0.98	0.95	0.99	0.95
						Percent		
Gross investment as percent of Real GDP								
1980	15.21	20.28	32.88	27.81	21.89	24.99	28.98	29.30
1985	16.74	19.89	22.19	19.20	19.53	24.94	27.10	24.94
1990	15.29	22.12	22.71	18.87	22.23	22.55	33.08	30.59
1995	17.34	21.62	18.15	23.72	19.10	23.40	30.76	34.00
GTAP4	16.80	17.90	14.20	19.10	19.20	21.50	28.60	32.00
National saving as percent real GDP								
1980	14.78	21.77	28.77	25.47	20.96	23.40	28.48	26.16
1985	13.88	22.13	28.98	23.55	20.31	22.09	29.22	31.00
1990	13.90	21.72	21.04	22.52	21.92	22.62	33.75	33.75
1995	15.54	24.41	22.17	22.10	21.45	23.94	32.76	33.18
GTAP4								
Balance of trade as percent of real GDP								
1980	0.55	0.84	-11.82	-3.86	0.30	-2.68	1.60	-0.29
1985	-3.12	2.45	2.98	4.30	2.07	-2.29	4.67	7.90
1990	-1.29	-1.04	-4.31	4.28	-0.60	-1.24	1.76	1.60
1995	-2.68	1.76	0.67	-3.58	2.13	-0.66	2.23	-4.11
GTAP4	-1.23	3.76	5.03	-1.52	0.90	-2.17	1.00	-1.28
Government expenditure as percent of real GDP								
1980	18.52	20.84	7.63	9.36	18.21	17.32	10.07	13.52
1985	18.84	20.09	8.61	9.62	18.65	17.56	9.64	12.19
1990	18.49	20.15	8.17	12.88	17.78	17.72	8.62	11.41
1995	16.43	18.96	8.35	10.80	17.07	17.04	8.91	10.04
GTAP4	15.80	19.00	9.30	14.30	19.30	17.20	9.80	11.60

Data Source: GDP and other national account data in 1987 constant US dollars were obtained from EBSD data b

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China	ASEAN	Economies in Transition	Mideast & North Africa	Rest of the World	World Total
0.237	0.407	0.993	0.900	0.688	0.681
0.385	0.492	1.095	0.928	0.800	0.772
0.565	0.696	1.500	0.907	0.957	0.917
0.82	0.75	0.92	0.65	0.71	0.78
0.88	0.84	0.95	0.77	0.80	0.85
0.95	0.92	0.99	0.89	0.90	0.93
35.16	25.61	6.95	17.70	25.45	
37.86	26.82	8.60	17.74	21.54	
34.72	32.69	9.27	19.16	18.98	
36.68	41.63	10.48	20.71	20.30	
34.80	35.60	19.80	22.50	18.70	
34.05	30.21	5.62	20.98	24.87	
31.03	28.00	4.92	17.82	21.51	
37.02	31.67	4.17	16.40	19.20	
38.93	34.43	5.51	17.88	18.43	
-3.67	1.95	-0.65	-2.28	-5.30	
-8.54	-1.44	0.17	-3.76	-1.92	
1.90	-1.18	0.30	-2.28	0.55	
1.46	-4.70	0.26	-1.46	0.45	
6.07	-3.93	0.31	-1.95	-3.48	
14.71	11.30	1.99	10.70	10.98	
14.51	11.63	2.70	12.10	11.74	
11.88	9.96	3.79	10.50	12.03	
8.76	8.83	4.09	11.18	11.10	
12.10	10.00	18.20	19.70	11.60	

ase at the World Bank. Population data were download from the FAO Web Site.

Appendix Table A4 Simulation Design: Shocks on Factor Supply a

	Australia & New Zealand	Japan	Asia NICs	ASEAN	China	Canada	United States	Mexico
							Percent change from 199	
Land								
1980	-7.50	11.50	8.60	-13.60	4.60	0.40	1.50	-10.10
1985	-1.50	8.70	6.10	-8.40	2.00	1.20	1.10	-9.50
1990	0.70	5.00	4.90	0.60	0.80	1.00	0.00	-9.50
Rural and Unskilled labor								
1980	-17.20	-9.60	-22.50	-32.10	-23.60	-8.00	-12.20	-35.70
1985	-11.70	-4.90	-13.30	-21.50	-15.40	-6.20	-7.00	-24.50
1990	-4.60	-2.20	-6.20	-10.60	-5.30	-0.80	-3.20	-13.30
Skilled labor								
1980	-46.90	-33.10	-63.80	-38.90	-33.70	-49.00	-30.70	-48.90
1985	-31.30	-22.90	-49.40	-31.40	-22.60	-32.20	-23.80	-36.10
1990	-12.50	-6.60	-28.30	-10.50	-9.70	-15.20	-11.20	-9.90
Capital								
1980	-30.90	-49.30	-73.80	-69.60	-73.40	-43.90	-29.80	-37.20
1985	-20.60	-36.60	-59.90	-53.50	-60.60	-31.60	-21.40	-20.50
1990	-9.50	-18.90	-37.60	-35.20	-39.70	-14.60	-11.50	-12.70
GDP								
1980	-35.20	-37.40	-67.40	-59.30	-76.30	-30.20	-31.20	-18.00
1985	-24.80	-24.80	-54.00	-50.80	-61.50	-19.50	-21.80	-9.70
1990	-14.50	-6.40	-28.20	-30.40	-43.50	-7.30	-10.30	-3.00
Population								
1980	-17.50	-6.60	-15.70	-24.90	-18.10	-16.40	-13.80	-25.90
1985	-11.90	-3.40	-9.40	-16.50	-12.30	-11.80	-9.50	-17.20
1990	-5.50	-1.20	-4.70	-8.10	-5.30	-5.50	-4.90	-8.70
Government spending								
1980	-34.00	-29.00	-56.00	-48.00	-60.00	-23.00	-22.00	-25.00
1985	-22.00	-19.00	-44.00	-35.00	-36.00	-15.00	-10.00	-7.00
1990	-11.00	-9.00	-18.00	-22.00	-23.00	-2.00	1.00	-5.00
Gross Investment								
1980	-30.75	-41.05	-71.87	-74.94	-77.32	-34.53	-39.62	48.54
1985	-19.80	-33.79	-66.29	-68.31	-60.25	-25.97	-24.50	10.44
1990	-17.65	0.67	-35.40	-45.38	-46.55	-5.14	-20.93	21.42
National Savings								
1980	-37.00	-46.00	-74.00	-64.00	-79.00	-38.00	-35.00	6.00
1985	-31.00	-33.00	-57.00	-60.00	-69.00	-27.00	-30.00	18.00
1990	-19.00	-4.00	-27.00	-36.00	-46.00	-18.00	-20.00	-8.00

Data source: Authors' calculation from Tables A2 and A3. All macro shocks are calculated as the differences of s

ınd Macro Variables

MERCOSUR	Western Europe	Economies in Transition	Mideast & North Africa	Rest of the World
95				
-16.50	4.20	2.70	-9.90	-5.80
-13.30	3.70	2.70	-7.10	-4.10
-9.00	3.00	1.40	-2.00	-1.90
-29.40	1.00	1.40	-34.90	-27.30
-18.70	0.40	-5.20	-24.90	-19.20
-7.80	1.60	-4.40	-12.40	-10.50
-41.70	-41.10	-32.00	-55.30	-58.40
-33.30	-28.60	3.60	-33.70	-43.40
-13.70	-15.40	6.60	-22.30	-20.60
-23.80	-25.20	-26.80	-41.60	-35.10
-16.60	-18.10	-12.50	-19.60	-23.70
-8.70	-8.70	0.50	-10.40	-13.80
-23.80	-25.70	-0.70	-10.00	-31.20
-23.30	-19.60	9.50	-7.20	-20.00
-16.30	-6.00	50.00	-9.30	-4.30
-22.40	-4.60	-8.40	-34.60	-28.70
-14.50	-3.60	-4.80	-23.30	-19.80
-6.80	-1.80	-1.30	-11.20	-10.00
-34.00	-21.00	-52.00	-14.00	-32.00
-32.00	-12.00	-28.00	0.00	-15.00
0.00	-2.00	39.00	-15.00	4.00
-10.62	-14.88	-34.15	-23.08	-13.70
-37.97	-17.76	-10.11	-20.49	-15.11
-33.43	9.36	32.61	-16.08	-10.54
-12.00	-27.00	1.00	6.00	-7.00
-18.00	-24.00	-2.00	-8.00	-7.00
-15.00	-4.00	13.00	-17.00	0.00

share of GDP multiply the GDP data in version 4 GTAP database (1995).

Appendix Table A5 Simulation Design: Shocks on Import Protecti

	Australia & New Zealand	Japan	Asia NICs	ASEAN	China	Canada	United States	Mexico
							Percent change from 199	
Shocks on import protection								
Grain	1.87	3.97	6.56	8.56	9.84	0.00	11.42	8.45
Other food -	3.55	0.00	2.64	5.33	2.73	7.54	3.02	12.17
Horticulture	1.66	2.88	1.96	4.50	8.93	0.00	1.02	5.09
Other food -	15.58	3.37	2.17	4.50	21.04	4.69	8.47	12.11
Meat and liv	0.00	3.93	8.87	4.50	11.04	7.43	17.78	0.00
Fishing	0.28	0.87	10.32	4.50	2.38	12.02	0.90	0.00
Resource int	3.20	0.01	1.93	4.07	3.26	0.64	4.88	0.00
Labor intens	27.60	0.11	17.32	3.86	24.01	0.07	41.39	0.00
Labor intens	9.09	0.39	0.36	0.00	8.44	0.16	0.01	0.00
Skill intensi	19.63	0.47	4.84	9.54	7.72	0.99	3.47	0.00
Import weighted applied Tariff								
Grain	1.85	-14.33	3.09	0.42	0.00	-7.72	-0.02	-50.92
Other food -	-3.93	-3.65	3.57	-3.48	1.99	-0.78	1.91	-14.06
Horticulture	3.14	0.11	2.53	-4.19	0.60	1.34	-0.62	-18.31
Other food -	22.20	-2.54	2.53	-4.19	0.60	-4.46	13.25	-28.76
Meat and liv	3.73	-5.36	2.53	-4.19	0.60	-22.12	24.72	-36.41
Fishing	0.46	0.40	2.53	-4.19	0.60	0.08	0.91	-14.00
Resource int	4.32	0.02	2.85	-4.28	4.33	1.07	4.99	-8.34
Labor intens	8.22	-0.35	3.44	-6.60	-7.70	1.13	20.05	-11.02
Labor intens	15.15	0.65	0.60	-6.84	-0.84	1.45	0.02	-11.09
Skill intensi	18.59	0.79	6.96	-1.12	-4.07	1.64	0.44	-11.75
Import weighted NTB coverage Ratios								
Grain	1.89	31.43	11.76	20.78	49.20	1.67	28.57	97.50
Other food -	14.77	0.64	1.25	18.54	-4.62	20.03	4.67	51.51
Horticulture	-0.57	7.04	1.10	17.55	30.42	-3.56	3.48	20.70
Other food -	5.65	12.24	1.64	17.55	30.42	18.43	1.31	39.35
Meat and liv	-14.64	17.87	18.38	17.55	30.42	51.76	7.38	0.40
Fishing	0.00	1.58	22.00	17.55	30.42	29.93	0.89	5.69
Resource int	1.51	0.00	0.55	16.58	-17.11	0.00	4.71	0.00
Labor intens	56.69	0.79	38.14	19.55	-11.33	-1.52	73.40	-4.80
Labor intens	0.00	0.00	0.00	4.39	-34.12	-1.76	0.00	0.00
Skill intensi	21.20	0.00	1.66	25.52	-3.17	0.00	8.01	-0.17

Data source: Authors' calculation from Tables 4 and 5. Additional data for China from Research Development C
All numbers are calculated as percentage change of one plus protection rates from the available data
weighted average of tariff and NTB import coverage ration (60% tariff, 40 percent NTB), all negati

ion

MERCOSUR	Western Europe	Economies in Transition	Mideast & North Africa	Rest of the World
95				
30.06	10.34	1.76	19.73	15.01
21.45	3.93	4.52	22.99	20.89
24.84	9.33	2.47	22.93	27.59
24.84	4.62	2.47	22.93	27.59
24.84	4.28	2.47	22.93	27.59
24.84	0.81	0.00	22.93	27.59
16.67	0.00	0.00	22.44	16.29
26.68	1.63	0.00	8.12	25.15
25.19	1.14	0.00	7.15	22.81
20.06	0.41	2.47	17.81	22.46
17.59	-38.16	0.09	-1.03	6.24
25.37	-5.08	0.47	6.30	18.65
27.75	-4.70	0.09	8.31	18.57
27.75	-4.70	0.09	8.31	18.57
27.75	-32.39	0.09	8.31	18.57
27.75	0.16	0.00	8.31	18.57
19.13	0.27	0.00	4.42	17.21
25.25	0.80	0.00	0.34	13.43
35.55	1.28	0.00	2.74	20.09
19.30	0.07	0.09	1.70	17.14
48.77	83.08	4.25	50.87	28.17
15.55	17.44	10.61	48.02	24.25
20.47	30.38	6.03	44.85	41.11
20.47	18.62	6.03	44.85	41.11
20.47	59.28	6.03	44.85	41.11
20.47	1.78	0.00	44.85	41.11
12.98	-0.59	0.00	49.48	14.90
28.84	2.89	0.00	19.80	42.74
9.65	0.93	0.00	13.78	26.90
21.20	0.91	6.03	41.96	30.43

enter at State Council for China are used for China. Both UNCTAD and OECD data are used for Mexico.
a of latest year to the earliest year. In calculating the shocks to the model,
ive number are replaced by zero, assuming no protection reduction in that sector during last decades.