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ABSTRACT

Asia-Pacific Food Markets and Trade in 2005: A Global, Economy-wide Perspective*

Rapid industrialization in East Asia, particularly China, is raising questions about who will feed the region in the next century and how Asia will pay for its food imports. The paper addresses this question by first reviewing existing food sector projections and then taking an economy-wide perspective using projections to 2005, based on the global CGE model known as GTAP. After showing the impact of implementing the Uruguay Round, the paper explores the effects of slower global agricultural productivity growth and of slower economic growth in China. Several policy shocks are also examined. They include the entry of China (and hence Taiwan) into the World Trade Organization (WTO), and the failure to fully abolish the bilateral quotas on textiles and clothing trade as promised under the Uruguay Round. A slow-down in farm productivity growth could be very costly to the world economy, as could slower economic growth in China. Failure to honour Uruguay Round obligations to open textile and clothing markets in OECD countries is shown to reduce East Asia's industrialization and thereby slow its net imports of food. On the other hand, the trade reform that is likely to accompany China's WTO membership would greatly benefit the economies of China and the world. It would boost exports of manufactures and strengthen food import demand, not only by China, but also its densely populated neighbours with whom its intra- and inter-industry trade in manufactures would intensify.

JEL Classification: F13, F17, O53, Q17, R13
Keywords: Asia-Pacific, global CGE modelling, food and agriculture markets, economic projections

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NON-TECHNICAL SUMMARY

The past year has seen a dramatic rise in international grain prices and a drop in *per capita* world grain stocks to near-record low levels. That, together with concerns about the erosion of agriculture's resource base, and in particular projections by the Worldwatch Institute suggesting massive grain imports by China in the twenty-first century, has called into question the long-term prospects for the world food situation. By contrast, other recent studies suggest food will continue to be abundantly available for the foreseeable future so long as investments in agricultural research are maintained. Which of these sets of projections is more likely? What if the global slow-down in agricultural research investments during the past decade lowers farm productivity growth? What do these projections imply about food production, consumption, and self-sufficiency levels in rapidly industrializing East Asia and elsewhere? Who will supply the food-deficit countries? How will the latter pay for their food imports?

The present paper addresses these questions by first reviewing existing food sector projections and then taking an economy-wide perspective using projections to 2005, based on the global CGE model known as GTAP. After showing the impact of implementing the Uruguay Round, we explore the effects of slower global agricultural productivity growth and of slower GDP growth in China. Several policy shocks are also examined. They include the entry of China (and hence Taiwan) into the World Trade Organization (WTO), and the failure to fully abolish the bilateral quotas on textiles and clothing trade as promised under the Uruguay Round. A slow-down in farm productivity growth could be very costly to the world economy, as could slower economic growth in China. Failure to honour Uruguay Round obligations to open textile and clothing markets in OECD countries is shown to reduce East Asia's industrialization and thereby slow its net imports of food. On the other hand, the trade reform that is likely to accompany China's WTO membership would greatly benefit the economies of China and the world. It would boost exports of manufactures and strengthen food import demand, not only by China, but also its densely populated neighbours with whom its intra- and inter-industry trade in manufactures would intensify.

The concluding section draws out several trade and policy implications. The first relates to China's grain trade. In our base case projection, China's annual net imports of grains increase by 33 million metric tons between 1992 and 2005. When measured in value terms, however, this pales next to the projected increases in imports of other crops, livestock products and processed foods; grains account for only one-eighth of China's total net food

imports in our 2005 projection, assuming no policy changes in China. Of course, if China were to increase barriers to imports of livestock products, the latter would be lower, but grain imports would have to be greater to feed China's larger number of animals.

A second point relates to the commonality of interest between farm and food producers in North America and elsewhere on the one hand, and manufacturers in East Asia on the other. We show that measures such as the Multifibre Agreement (MFA), which restrict the OECD's imports of manufactures, indirectly penalize OECD exports of food and agricultural products. Trade is a two-way street, and obstacles to industrial exports from Asia will necessarily reduce agricultual and other exports to that region.

A third point is that slower economic growth in China has an adverse impact on all of China's main trading partners in the Asia-Pacific region – including its natural competitors. This is because slower growth in China means higher prices for Chinese products and lower demand for China's imports. The trade impact of halving the GDP growth rate in China is smaller than the opposite impact of China's accession to the WTO, however.

Lastly, all but one of these alternative scenarios have little impact on national grain self-sufficiency levels in 2005. Certainly, there are some changes to be expected between 1992 and 2005 as the Uruguay Round agreements are implemented and as East Asia's industrialization continues at a rapid pace. But grain self-sufficiency ratios vary little with the shocks considered (with one exception), suggesting that world food markets are quite capable of handling even substantial shocks of the kind considered in this paper. The one scenario considered where grain self sufficiency does change significantly is the case of slower GDP growth in China. Consistent with earlier studies, the latter is shown to raise China's grain self sufficiency – mainly because livestock product demand grows less rapidly, hence there is less need for imported feedgrains.

Asia-Pacific Food Markets and Trade in 2005: A Global, Economy-Wide Perspective

The past year has seen a dramatic rise in international grain prices and a drop in per capita world grain stocks to near-record low levels. That, together with concerns about the erosion of agriculture's resource base, and in particular the projections by the Worldwatch Institute suggesting massive grain imports by China in the 21st century, have called into question the long-term prospects for the world food situation. By contrast, a soon-to-be-published study by Mitchell, Ingco, and Duncan suggests grain will be abundantly available for the foreseeable future so long as investments in agricultural research are maintained. In between these extremes are studies by the OECD and the FAO which take into account the impact of the Uruguay Round agreement. They suggest modest increases in grain prices in the medium term, as subsidies are reduced. Which of these sets of price projections is most likely? What do they imply about food production, consumption, and self-sufficiency levels in the Asia-Pacific and elsewhere? Who will supply the food-deficit countries? How will the latter pay for their food imports?

This paper first reviews some answers to these questions in so far as they are provided in available studies. It then provides a new set of projections for the next decade, based not on a sectoral model of food markets but rather on an integrated economy-wide model of national and international markets for all products. The advantages of the latter approach are many: it identifies the sources of economic growth that cause the expected expansion in the demand for and supply of food and other products; it ensures countries can import only what they can pay for through exporting or borrowing (leaving aside food aid); and it includes in the base scenario the inter-sectoral structural adjustments and policy changes that normally accompany economic development. As well, this new set of projections incorporates the agricultural and other results of the Uruguay Round to be implemented over the next decade ("other" being as important for food markets as the agricultural agreement itself).

The Global Trade Analysis Project (GTAP) Model used to generate the new projections divides the world economy up into 37 sectors (11 are agricultural or processed food) and 30 countries or country groups (including the 16 major PBEC economies). In order to keep the present analysis and presentation of results tractable, this data base is aggregated up to the level of 13 commodities and 15 regions. This aggregation reflects the focus of this paper on issues related to food and agriculture in the Asia-Pacific region. Changes in the structure of production, trade, and self-sufficiency in these product groups between 1992 and 2005 are provided, as well as projected changes in international prices for each product group.

Furthermore, the GTAP model is used to explore different growth assumptions and to simulate policy shocks. The results of several alternative growth scenarios are presented in the paper: loss of agricultural land due to urbanization, slower growth in agricultural productivity worldwide, and slower economic growth in China. The policy shocks considered are: China and Taiwan's entry into the World Trade Organization, and the failure to fully abolish the bilateral quotas on textiles and clothing trade as promised under the Uruguay Round.

All but one of these scenarios is shown to have important implications for East Asian food markets. For example, failure to liberalize textiles and clothing trade will lessen the incentive for resources to shift from the food sector to other manufacturing activities and will translate into slower growth in overall trade in the region—particularly slower growth in food imports. On the other hand, the greater opening up of the Chinese economy associated with its accession to the WTO will have important implications for food and other trade in the region, generating increased manufacturing exports from that country and stronger food import demand.

The paper concludes by drawing out the trade and policy implications for PBEC countries, particularly with respect to trade in food and non-food products in the region, and the priority issues requiring further study. Specifically, it makes the following points:

* Continued technical progress in agriculture is essential if we are to feed the increasing world population with limited natural resources, while keeping prices from rising.

* While recent work on the future of food and agriculture in the Pacific Rim especially China has focused attention on grains production and trade, we project that grains will account for only 13% of the value of the increased food deficit for China in the coming decade.

* Trade is a two-way street: if North America and Europe continue to block increased imports of manufactured goods from newly industrializing economies (NIEs), it will be more difficult to export food products to these NIEs.

* Rapid growth in China benefits all of the APEC region. However, the beneficial impact of its growth would be greater following WTO accession, as would the prospects for rapid growth in China continuing well into the 21st century.

Review of past trends and available projections of world food markets

The simplest trends and projections to report are those based on World Bank data, since they are in the summary form of real international prices. Figure 1 suggests that throughout this century the price of food relative to industrial products has been on a downward trend, declining at about 0.5% per year. This is a remarkable achievement, implying that the global capacity to supply food has grown slightly more rapidly than global demand while population and incomes have expanded, diets have been upgraded, and resources have been withdrawn to support dramatic expansion in the industrial and services sectors.[1]

Will this broadly balanced growth continue in the future? The latest projections by the World Bank for staple food and manufactured goods prices suggest so, because its projections for real prices to 2005 are lower than those prevailing in the first half of the 1990s (Figure 2).

However, a recent book by Lester Brown (1995) created major headlines by suggesting a very pessimistic outlook.[2] Specifically, he focused on China and pointed to declines he expected in land and water availability for grain production there, which led him to project China needing more than 200 million metric tons of grain imports per year by 2030. That volume roughly equals the current volume of global international trade in grain, and implies China would be relying on imports for as much as half its grain consumption by

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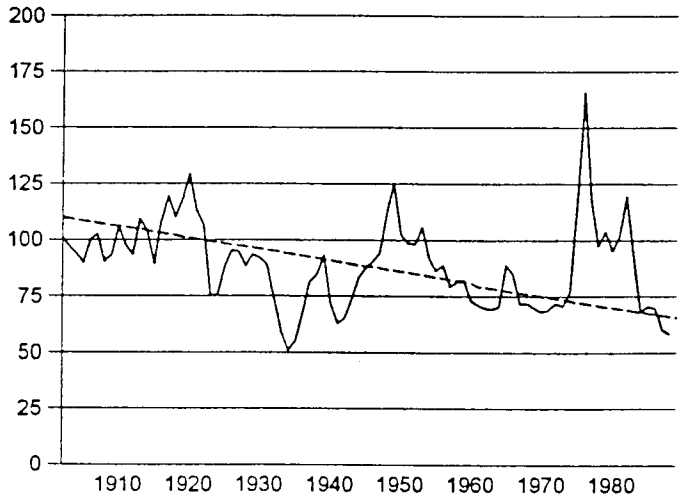
[1] The decline may be to some degree a consequence of a failure to adjust for the effects of quality changes as much in constructing the price index for manufactures as for the price index for primary commodities. A more careful adjustment for this effect in a recent study suggests a lesser decline and possibly even a slight increase in the price of food relative to manufactures (Lipsey 1994).

[2] His Worldwatch Institute's earlier studies, including a recent one on population growth, carry similar Malthusian warnings (Brown and Kane 1994).

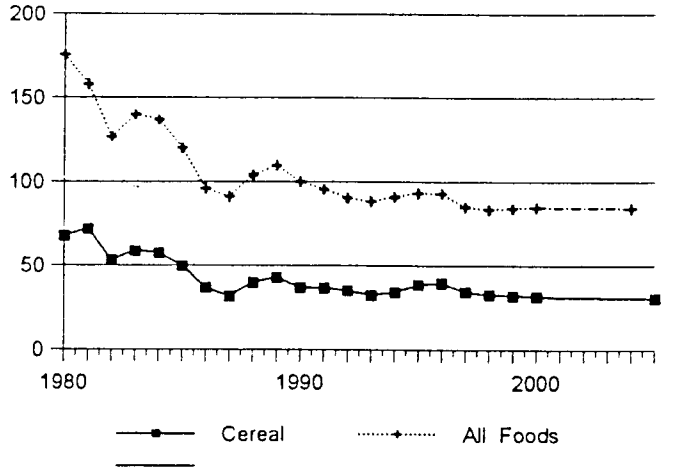
Figure 1. Real International Food Prices, 1900 to 1987.[a]



[a] An index of export prices in US dollars for cereals, meats, dairy products, and sugar, deflated by the US producer price index for industrial products, with weights based on the importance of each product in global exports, 1977-79.

Source: Tyers and Anderson (1992), based mainly on price series maded available by the World Bank's Economic Analysis and Project Department (see Grilli and Yang 1988).

Figure 2. World Bank Projections of Real International Food Prices to 2005.[a]



[a] Food prices relative to unit value in US dollar terms of manufactures exported from industrial countries to developing countries.

Source: World Bank (1996).

then.[3] Because he believes the rest of the world is incapable of satisfying that demand growth, Brown expects significant upward pressure on international grain prices over the next few decades, other things equal. These projections are based on simple arithmetic rather than a formal economic model, and take no account of behavioral responses to the price changes that would occur should his projections of supply and demand changes in China and elsewhere materialize.

By contrast, a forthcoming book by Mitchell, Ingco, and Duncan (1996) argues that there is good reason to assume real prices of grains will continue to decline. Using their econometric model of world grain markets that was detailed in an earlier World Bank study (Mitchell and Ingco 1993), they project the real price of wheat and rice to decline by almost a third and of maize by a fifth between 1992 and 2010 (compared with declines of about 40% in the 1980s). This projection assumes, though, that agricultural research continues to deliver sizeable increases in food production. This World Bank study, a summary of which appears in Mitchell and Ingco (1995), accepts the caution in Crosson and Anderson (1992) that the global quantity of quality-adjusted cropland may be near its limits, not least because of the distaste for further widespread deforestation. It nonetheless concludes that Malthus must wait beyond the foreseeable future.

Another modelling exercise, undertaken by the International Food Policy Research Institute (IFPRI), uses a global model that includes not only grain but also soybean and livestock product markets (Agcaoili and Rosegrant 1995). That study projects declines in real prices in international markets for all those products by 2010, some by as much as 15% compared with the late 1980s. In a related study looking even further ahead, IFPRI projects the price of grain to be on average 20% lower in 2020 than 1990 in real terms, and the price of livestock products to average 10% less. This does not imply abundant production in all regions though. In grains, for example, IFPRI projects advanced economies in 2010 to be exporting 24% of their grain production (compared with 28% in 1989-91), Eastern Europe and the former Soviet Union to become slight net exporters because of little growth in consumption compared with production there,[4] and developing economies becoming slightly more dependent on food imports, most notably in Sub-Saharan Africa.

The IFPRI projections are in most respects very similar to those produced by the FAO using yet another model of world agricultural markets (Alexandratos 1995a,b). That FAO model, like the Mitchell, *et al.* World Bank model, projects South Asia and the Middle East/North Africa rather than Sub-Saharan Africa as the regions with the biggest declines in grain self sufficiency (Table 1). The FAO anticipates the various developing country regions will enjoy annual increases in consumption of agricultural products during the next 15 years of between 2.4% (Latin America) and 3.3% (Sub-Saharan Africa), with East Asia at the developing country average of 2.8% (which compares with an average of 3.6% in the 1970-90 period).

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[3] This projection contrasts markedly with Chinese studies. Mei (1995), for example, projects faster consumption growth but much faster growth in grain output than Brown, leading to imports providing less than 3% of China's projected grain consumption during the first two decades of next century. Other analysts project import dependence between these two extremes. An IFPRI study projects import dependence to be just under 10% by 2020 (Huang, Rozelle and Rosegrant 1995), the OECD (1995) suggests 5% by 2000 and 21% by 2010, and Garnaut and Ma (1992) suggest as much as 15% as early as the year 2000. Brown is far more pessimistic than the other authors on China's supply capacity in part because he believes soil degradation is accelerating for which at least one careful historical study finds no supporting evidence (Lindert, Lu and Wu 1995).

[4] The same direction of trade effect from these transforming economies, but with even larger export surpluses, is projected in another detailed food modelling exercise reported in Tyers (1994).

Table 1. Grain Self Sufficiency, Various Regions, Actual 1989-91 and Projected 2010.

	Actual 1989-91	Projected 2010 World Bank	Projected 2010 IFPRI	Projected 2010 FAO
			(percent)	
Advanced economies	128	136	124	128
Eastern Europe and former Soviet Union	88	105	102	102
All developing economies	91	86	88	89
East Asia	94	91	94	95
South Asia	100	90	97	97
Latin America	87	84	92	86
Sub-Saharan Africa	86	86	73	85
Middle East and North Africa	67	57	64	62

Sources: World Bank from Mitchell and Ingco (1995), FAO from Alexandratos (1995b), and IFPRI from Agcaoili and Rosegrant (1995).

All three studies project large increases in both production and consumption of food in all parts of the tropics and in China. The small projected changes in grain self sufficiency to 2010 mask the fact that large increases in the size of those markets and hence in trade volumes are anticipated. Taking the average of the three sets of projections, they suggest developing countries as a group (including China) would be importing around 180 MMT of grain from advanced industrial economies in 2010, double the volume of the early 1990s. East Asia would account for 25% of that, and the Middle East/North Africa for about 40% (Table 2).

Do these three modelling exercises take into account the concerns of Lester Brown and others that farm land is being degraded, that it is being lost to non-agricultural uses, and that there may be limits to the expansion of irrigation (which rose from 11% to 18% of arable land globally during the past 35 years)? The answer is that they do. The World Bank study incorporated the lessons from Crosson and Anderson's 1992 review of the issues; IFPRI drew on its own extensive experience in examining them (see IFPRI 1995 and in particular Rosegrant 1995 regarding water resources); and the FAO devoted several chapters to exactly these issues in its lengthy study (Alexandratos 1995a). These careful background analyses simply are far less pessimistic than the Worldwatch Institute in their expectations of the capacity of people (producers, consumers, *and* policy makers) to respond appropriately to resource and environmental challenges. In the case of land use, for example, the FAO estimates that the current cropped area in developing countries (excluding China) is less than one-third of the land with rainfed crop production potential. It projects that crop area will expand only by one-eighth by 2010 and that human settlement areas will absorb no more than 4% of that potential by 2010 (Alexandratos 1995a, Tables 4.1 and 4.3), which will leave most of it in its present form. Currently 45% of that potential crop land is forested and 12% is in protected areas. In the case of China, Brown may also have understated its potential for increasing yields. Coyle (1996) notes that historical underreporting of crop area in China means that historical yields have been overstated, that considerable scope exists for application of high yielding varieties and improved management practices in China's interior provinces, and that more multiple cropping is possible in the Southern provinces of China.

Table 2. Grain Production, Consumption and Net Exports, Various Regions, Actual 1989-91 and Projected 2010 (in million tons).

	Actual 1989-91	Projected 2010 World Bank	Projected 2010 IFPRI	Projected 2010 FAO
Advanced economies				
production	598	735	785	710
total use	468	540	634	553
net exports	130	195	151	157
Eastern Europe and former Soviet Union				
production	266	324	389	306
total use	302	309	381	301
net exports	-36	15	8	5
All developing economies				
production	863	1253	1232	1318
total use	953	1463	1393	1480
net exports	-90	-210	-161	-162
East Asia				
production	431	626	579	638
total use	459	685	616	673
net exports	-28	-59	-37	-34
South Asia				
production	203	282	297	292
total use	203	313	307	302
net exports	-0	-31	-10	-10
Latin America				
production	97	144	152	159
total use	111	172	165	185
net exports	-14	-28	-13	-26
Sub-Saharan Africa				
production	55	83	86	110
total use	64	97	118	129
net exports	-9	-14	-32	-19
Middle East and North Africa				
production	77	97	118	119
total use	114	170	183	191
net exports	-37	-73	-65	-72

Source: Islam (1995, Appendix to Part II).

Trends in agricultural policies are contributing to and reinforcing the above food price and trade trends. Implementation of the Uruguay Round agreement on agriculture during the remainder of this decade will cause only minor reductions in agricultural protection growth in developed economies (Martin and Winters 1995). Meanwhile, many developing countries and the former COMECON countries are reducing implicit and explicit subsidies to food consumers and raising their historically low producer prices up towards levels in international markets. In China's case, domestic prices of numerous farm products appear to be now close to border prices, and there are signs that the gradual change from taxing to subsidizing agriculture relative to manufacturing that occurred in Western Europe, Japan and then Korea and Taiwan (Anderson and Hayami 1986) may well be copied in China. Hence the importance of examining the implications of China acceding to the World Trade Organization (see below).

None of the models referred to above includes the non-agricultural sectors of these economies. That means they do not have explicit constraints on a country's resource use (no more than the aggregate available), on its spending (no more than is earned plus borrowings) and on its imports (no more than is earned from exports plus net inflows of financial capital, which in turn have to come from other similarly constrained countries). Furthermore, the above studies have no direct means of ascertaining the impact of developments in the non-farm economy on trade in farm and food products. As we will see below, the dynamic nature of manufacturing production and trade in the Asia-Pacific region can have important implications for trade in food products. To gain more insights, we turn now to an economy-wide global model that not only includes nonfarm sectors but has the additional feature of separately identifying the major APEC/PBEC member countries.

Overview of the GTAP framework

In this paper we employ a modified version of an applied general equilibrium model, known as GTAP (Global Trade Analysis Project) (Hertel and Tsigas 1996). The GTAP model is a relatively standard, multiregion model which is currently in use by over one hundred researchers in 30 countries on five continents. The data base builds on contributions from many of these individuals, as well as the ten national and international agencies represented on the GTAP advisory board. Unlike most such models, GTAP utilizes a sophisticated representation of consumer demands which allows for differences in both the price and income responsiveness of demand in different regions depending upon both the level of development of the region and the particular consumption patterns observed in that region. In the simulations presented below, many of the East Asian economies are projected to continue to experience extremely rapid growth rates, so that the income elasticities of demand play an important role in the model.

With the exception of China, income elasticities of demand are drawn from the FAO data base, and are therefore comparable to those used in the study of Alexandratos (1995a). Non-food income elasticities of demand are also required, due to the economy-wide nature of the model. These are obtained from international, cross-section studies conducted by Theil, Chung, and Seale (1989). In the case of China, we obtain the income elasticities of demand from Zhi and Kinsey (1994) and Fan, Wailes, and Cramer (1995). A complete listing of the values used in this study is provided in Appendix Table 1.

On the supply-side, differences in relative rates of factor accumulation interact with different sectoral factor intensities to drive changes in the sectoral composition of output. The GTAP production system distinguishes sectors by their intensities in four primary factors of production: agricultural land, labor, physical capital, and human capital. Thus in a region where physical capital is accumulating rapidly, relative to other factors, we expect the capital intensive sectors to expand at the expense of labor intensive sectors such as

agriculture in East Asia. These Rybczynski effects are not present in the partial equilibrium models reviewed above. However, they have been found to be important determinants of structural change in rapidly developing economies (Krueger 1977; Leamer 1987; Martin and Warr 1993).

Unlike the agricultural commodity-oriented projections presented above, the GTAP framework is built on a complete set of economic accounts for each of the APEC economies, based on the year 1992. In particular, our model incorporates an exhaustive description of inter-industry linkages at the 37 sector level. (In this paper we work with a 13 sector/15 region aggregation of the GTAP data base see Tables 3 and 4 below.) In addition to differences in intermediate input intensities, import intensities are also permitted to vary across uses. Since much of the farm and food trade in the Pacific region represents trade in intermediate inputs, the distinction between sales to final consumers and sales to other firms can be quite important. Lowering the cost of imported food to consumers is quite different from lowering the cost of intermediate inputs to domestic firms which in turn may be competing with imports in the product market.

Another important distinction between the framework used here and the approach used in the partial equilibrium studies of food demand cited above is the treatment of product differentiation and interindustry trade. In the IFPRI, FAO and World Bank studies cited above, individual products are assumed to be homogeneous and perfectly substitutable for one another. In reality, this is rarely the case. One need only refer to the current crisis in the British beef industry to verify that beef is not a homogeneous product. Of course, the same point applies to non-agricultural products as well.

An alternative approach, and the one adopted in this study, involves treating British beef as a different product from US beef, which is in turn differentiated from Japanese beef. The linkage between their prices is typically quite strong, but will depend on the degree of substitutability in consumption. In addition to matching up more effectively with reality, this approach has the advantage of permitting us to track *bilateral* trade, as opposed to simply reporting net total trade. However, one implication of these differing prices is that it makes less sense to aggregate physical commodities across regions in terms of metric tons, so we measure trade volumes for all products in terms of constant dollars.

Throughout the analysis, we have used the standard GTAP parameters as documented in chapter four of Hertel (ed.) (1996), with two exceptions. First, we have upgraded the income elasticities of demand for farm and food products. (Our revised estimates are provided in the appendix.) Secondly, we have employed larger values for the Armington elasticities of substitution used to specify the extent to which similar products from different countries (e.g., meats) substitute for one another. In his analysis of changing trade shares in the Asia-Pacific region over the decade of the 1980, Gehlhar (1995) found that the standard GTAP trade elasticities were too small to accurately predict changes in trade shares over this 10 year period. By increasing these parameters he obtained a better prediction of historical changes in export shares in the region. Accordingly, we have doubled the standard parameter values in the 13 year projections reported here.

Region and commodity aggregation in GTAP

Since it is cumbersome to conduct projections with the full 37-sector, 30-region GTAP data base, we have aggregated up to a level which highlights sectors and countries of interest for this particular study. The regional aggregation presented in the left margin of Table 3 allows us to identify most of the APEC/PBEC members, while keeping the overall dimensions manageable. (NAFTA comprises Canada, Mexico, and USA). We have also broken out Western Europe due to its importance in world trade. The former Soviet Union is

Table 3. Assumptions Used in the Projections: Cumulative Percentage Growth Rates Over the Period 1992-2005 (Annual rate of change in parentheses).

Regions	Population (1)	Labor Force (2)	Capital Stock (3)	Human Capital (4)	Real GDP (5)
China	12 (0.9)	16 (1.1)	303 (11.3)	57 (3.5)	167 (7.8)
Indonesia	19 (1.3)	30 (2.0)	152 (7.4)	242 (9.9)	129 (6.6)
Philippines	33 (2.2)	40 (2.6)	92 (5.1)	109 (5.8)	76 (4.4)
Thailand	18 (1.3)	26 (1.8)	265 (10.5)	150 (7.3)	173 (8.0)
Malaysia	28 (1.9)	41 (2.7)	214 (9.2)	257 (10.3)	174 (8.1)
Korea	11 (0.8)	12 (0.9)	209 (9.1)	119 (6.2)	131 (6.7)
Taiwan	11 (0.8)	18 (1.3)	211 (9.1)	119 (6.2)	115 (6.1)
Hong Kong/Singapore	11 (0.8)	13 (0.9)	158 (7.6)	83 (4.8)	117 (6.1)
Japan	3 (0.2)	-2 (-0.2)	69 (4.1)	81 (4.7)	44 (2.8)
Australia/New Zealand	15 (1.1)	16 (1.1)	46 (3.0)	155 (7.5)	54 (3.4)
NAFTA	15 (1.1)	18 (1.3)	56 (3.5)	95 (5.3)	40 (2.6)
Western Europe	2 (0.2)	1 (0.1)	36 (2.4)	217 (9.3)	37 (2.5)
Former Soviet Union	6 (0.4)	8 (0.6)	10 (0.7)	10 (0.7)	10 (0.7)
India	24 (1.7)	31 (2.1)	98 (5.4)	107 (5.6)	94 (5.2)
Rest of the World	32 (2.2)	28 (2.6)	50 (3.2)	133 (6.7)	57 (3.5)

Source: Authors' modifications of World Bank projections.

also disaggregated since the emergence of this region as a net exporter over the coming decades is an important part of our base case. Finally, the potential impact of rapid growth in India on world food markets led us to show that country separately as well.

Table 4 displays the 13 aggregated sectors employed for this analysis, and their relationship to the 37 sectors available in the GTAP database. We have retained greater detail in the farm and food sectors, because of the focus of this study. Rice is left disaggregated due to its economic and political importance in Asia. The disaggregation of rice and wheat from coarse grains and the breakout of meat and livestock products seeks to accommodate the potential upgrading of diets in Asia over this period. As per capita incomes rise in countries like China, history suggests that meat consumption per capita will rise rapidly, thereby requiring more feedgrains. Wealthier consumers also suggest an increase in the demand for more highly processed food products. Hence the disaggregation of this category. Note that, in contrast with the partial equilibrium studies cited above, the six farm and food products in Table 4 exhaust *all* food output.

The non-agricultural detail in Table 4 is designed to capture several important aspects of economic growth and trade in the Asia-Pacific region over the coming decade. As noted above, textiles and wearing apparel are important, and more so because of the agreed reforms under the Uruguay Round. One of the scenarios below considers less-complete reform of trade in these products. We have also disaggregated light and heavy manufacturing, which have very different primary factor intensities. Transportation equipment and machinery represent about 40% of global trade, and this commodity category is an especially important component of rapid growth in the Asia-Pacific region. When combined with services, these sectors exhaust all economic activity.

Base case projections in GTAP

Assumptions about economic growth: The projections from 1992 to 2005 presented in this paper are based on a relatively small number of exogenous shocks. Specifically, we utilize exogenous projections of each region's endowments of agricultural land, physical capital, human capital, the state of technology, population and the labor force. These are based on combinations of historical data and World Bank projections of the growth in population, labor force, real GDP and investment with minor adjustments[5] to obtain the shocks presented in Table 3. Capital stock projections were generated by adding investment in each year and subtracting depreciation using the methodology of Nehru and Dhareshwar (1994). The human capital projections were based on projections of the growth in the stock of tertiary educated labor in each developing country (Ahuja and Filmer 1995) and historical growth rates in developed countries to provide an indication of changes in the stock of those qualified for employment as professional and technical workers. The stock of agricultural land is held constant in the base case, but it is varied in one of the subsequent "scenarios." Finally, base case estimates of non-agricultural, neutral total factor productivity (TFP) growth rates for each of the 15 regions were obtained by subtracting the growth in total factor inputs from the real, non-agricultural GDP projections. (Agricultural TFP growth rates are discussed below.)

From the estimates in Table 3 it can be seen that the structure of the world economy will change in a number of important ways over the coming decade. Firstly, given the substantial differential between the growth rates of developed and developing countries, the developing countries will constitute a considerably

[5] In particular, the rate of nonagricultural total factor productivity growth was set at 3.0 percent for China, broadly consistent with the evidence provided by Jefferson, Rawski and Zheng (1996).

Table 4. Commodity Aggregation in the GTAP Model.

Aggregated Commodity	GTAP Commodity	Aggregated Commodity	GTAP Commodity
Rice	paddy rice processed rice	Textiles	textiles
Wheat	wheat	WearApp	wearing apparels
Crsgrns	other grains	LightMnfc	leather, etc. lumber fabricated metal products other manufacturing
OthCrops	non-grain crops	TMEq	transport industries machinery and equipment
LstkProd	meat products milk products other livestock products wool	HeavyMnfc	chemicals, rubber, and plastic primary ferrous metals nonferrous metals fabricated metal products pulp paper, etc. petroleum and coal nonmetallic minerals
ProcFood	other food products beverages and tobacco fisheries	Services	electricity water and gas construction trade and transport other services (private) other services (government) ownership of dwellings
NatRes	forestry coal oil gas other minerals		

Source: Authors' model disaggregation of each category. Note that, in contrast with the partial equilibrium studies cited above, the six farm and food products in Table 4 exhaust *all* food output.

larger share of the global economy in 2005. Furthermore, given the particularly high rates of savings and investment in East Asia, the capital-labor ratios of these economies are expected to increase, creating supply-side pressures for changes in the composition of output in these economies (Krueger 1977; Leamer 1987). The relatively high rates of accumulation of human capital in developing economies also are likely to contribute to pressures for structural change as developing countries upgrade the skill-intensity of their product mix.

Assumptions about agricultural markets: One of the tradeoffs associated with providing economywide coverage in these projections is that we are inevitably forced to sacrifice some detail in the agricultural sectors. For example, we do not build in detailed projections of agricultural research expenditures and their likely impact on different crop yields. For this reason, we are not well-placed to project commodity-specific total factor productivity growth for agricultural products. Instead, we calibrate our base case to IFPRI's world price projections (Rosegrant, *et al.* 1995, Table 2) over this period and let TFP growth for agricultural products adjust endogenously. Having ascertained the rates of TFP growth implied by these projections, we then fix them exogenously in all of the subsequent scenarios. Differences between the rates of total factor productivity growth in the agricultural and non-agricultural sectors have important implications for inter-sectoral competitiveness.

The first column in Table 5 reports the 1992-2005 cumulative changes in world price for rice, wheat, coarse grains, and meats implied by annualizing and then cumulating IFPRI's most recent projections. As noted above, these prices are expected to continue their long term decline in real terms, with the largest cumulative declines over this period occurring for rice (-10%) and wheat (-11%).

Another area in which the GTAP model (and probably all formal, quantitative models) is currently deficient is in the treatment of agricultural activity in the former Soviet Union. This is a region where it is very difficult to assemble consistent data for the early 1990s and even harder to anticipate how the market reforms currently underway will be implemented, and what impact they will have on the production, marketing and consumption of food in the former Soviet Union. Staff at IFPRI have devoted considerable effort to the task of understanding the implications of developments in this region for world food markets (including commissioning a study by Tyers 1994), and we draw on their work in formulating our base case projections.

A special feature of this base case scenario is the transformation of the agricultural sector in the former Soviet Union. Demand is projected to decline from very high per capita levels of consumption, while effective domestic supply is expected eventually to increase with improvements in productivity both on-farm and

Table 5. Key Base Case Assumptions (absent the Uruguay Round agreement) About World Prices and former Soviet Union Net Exports From 1992-2005 Implied by IFPRI's 2020 Projections (cumulative changes).

Commodity	Price (%)	Former Soviet Union Net Exports (1992 $US mill.)
Rice	-10.03	-31
Wheat	-6.98	1378
Coarse grains	-11.02	425
Meats	-4.10	1412

Source: Authors' modification of projections in Rosegrant, Agcaoili-Sombilla and Perez (1995).

particularly in the marketing and handling system. A key factor underlying this change is liberalization of grain markets, a liberalization that is expected to increase the cost of grains to consumers and raise its profitability to producers. As a consequence, this region is expected to become a slight net exporter of grains. The second column in Table 5 reports IFPRI's estimates of the change in former Soviet Union net exports for rice, wheat, coarse grains, and meats over our projections period (Rosegrant, *et al.* 1995, Table 10. We have simply prorated their 1990-2020 estimates to come up with these 1992-2005 figures.) The net trade changes are imposed on our base case GTAP simulation by endogenizing domestic policy interventions.

Trade policy assumptions: IFPRI's detailed agricultural commodity projections referenced above do not reflect the final results of the Uruguay Round agreement. Yet this agreement has important implications for agriculture. Of particular importance are the reductions in agricultural export subsidies, and the increased import access for farm and food products in East Asia. Because we draw so heavily on the IFPRI work in establishing our initial base case, we implement this base case *without the Uruguay Round* first. This permits us to use their world price changes and net trade changes for the former Soviet Union, as reported in Table 5. Having established the base case settings for worldwide TFP growth and policies in the former Soviet Union, we then *add the Uruguay Round* to establish our modified base case. An advantage of this approach is that we can also report summary information about the expected impact of the Uruguay Round on world markets in 2005.

Implications of the Uruguay Round: In order to add the effect of the Uruguay Round, we specify the associated cuts in tariffs, tariff equivalents of nontariff import restrictions, import access commitments for rice, and export subsidies. The nonagricultural information was obtained largely from the WTO's Integrated Data Base, and the agricultural cuts are based on work conducted at the World Bank. (For more details on the nature of these cuts, the reader is referred to Martin and Winters 1995.) Note that while these offers do not include protection cuts in China and Taiwan (since they were not yet WTO members), in one of our scenarios below we consider the implications of China joining the WTO. (Otherwise we assume China's and Taiwan's policies are unchanged from 1992 to 2005.) Reform of the system of textile and apparel quotas is an important part of the Uruguay Round, so we also incorporate the elimination of these quotas under the Agreement on Textiles and Clothing. Despite being only indirectly related to agriculture, we find that this reform will have important implications for farm and food trade in the Asia-Pacific region.

Table 6 summarizes the expected impact of the Uruguay Round on average world prices and trade by the year 2005 (as compared with the initial base case for 2005 if there were no Uruguay Round.) The combination of reduced export subsidies and improved market access for farm products translates into higher prices, with the largest increase being for wheat (more than 5%). Nevertheless, these increases are not enough to offset the structural decline in agricultural prices built into the pre-Round base case (Table 5). Therefore, our post-Round base case still has agricultural prices declining, albeit by a lesser amount. The most striking thing about the 2005 non-agricultural price effects of the Uruguay Round is the strong impact on average world prices of textile and wearing apparel products. This follows from the removal of bilateral quotas on the export of these products (except in the cases of China and Taiwan, which are assumed to continue being subject to VERs until they accede to the WTO).

As expected, the Uruguay Round also gives a significant boost to world trade in agricultural products. Table 6 shows rice exports being 147% higher and processed food exports being 53% higher than they would have been without the Round. Wheat exports increase by far less, due to the trade-reducing effect of cutting export subsidies. Textile and wearing apparel trade also increases significantly with the removal of bilateral quotas on exports into North America and Europe.

Table 6. Impact of the Uruguay Round on World Prices and Trade Volume by 2005 (percentage changes).

	World			Trade Volume		Welfare	
Commodity	Price	Volume	Region	Exports	Imports	% Δ	US $
							(1992 bill.)
Rice	2.1	147	China	2	2	0.2	2.1
Wheat	5.2	8	Indonesia	38	30	4.5	11.1
Crsgrns	2.3	32	Philippines	28	19	1.8	1.4
OthCrops	2.5	13	Thailand	23	18	2.8	6.5
LstkProd	4.1	25	Malaysia	22	18	7.2	10.4
ProcFood	-0.4	53	R. of Korea	23	20	1.7	9.5
NatRes	0.7	0	Taiwan, China	3	4	0.9	3.5
Textiles	-2.7	29	HK/Singapore	2	1	-0.3	-0.5
WearApp	-10.3	80	Japan	8	9	0.5	19.9
LightMnfc	0.6	6	Australia/NZ	8	8	0.4	1.9
TMEq	0.5	6	North America	7	8	0.4	31.8
HeavyMnfc	0.6	7	Western Europe	6	8	0.4	38.6
Services	0.7	4	Former Soviet Union	1	1	0.0	-0.2
			India	72	54	1.5	5.9
			Rest of the World	17	15	0.7	21.1
			WORLD	10	10		163.0

Source: Authors' model results.

The second set of columns in Table 6 report the percentage changes in regional exports and imports as a result of the Uruguay Round. These increases are largest for the East Asian economies making the deepest cuts (see also, Hertel, *et al.* 1995, Table 1). Asia also benefits greatly from elimination of the Multifibre Agreement (MFA). Trade increases for the other major economies, but more modestly.

Analysis of the base case (incorporating the Uruguay Round)

What are the implications of our modified base case (incorporating the Uruguay Round) for the world and especially the Asia-Pacific economy over the period 1992-2005? (All of this discussion is based on the simulations which include the Uruguay Round agreement.) Table 7 reports the projected change in composition of the world economy over this period. (We have aggregated some country groups in order to reduce the dimensions of this and subsequent tables.) Entries in each row refer to the percentage change in the relative importance of each sector in the real GDP of each region between 1992 and 2005. For example, from the first column, we see that the projection implies massive structural change in China over the coming decade. The share of farm and food activity in GDP is projected to decline rapidly (e.g., -44% for rice), in favor of growth in the relative importance of manufacturing and services (e.g., 97% for transport machinery and equipment). The non-farm exceptions are textiles and apparel. Due to their assumed exclusion from the Uruguay Round,

Table 7. Cumulative Percentage Change in Composition of Real GDP, 1992-2005 (Modified base case incorporating the Uruguay Round).

	China	ASEAN-4	NIEs	Japan	Aus/NZ	NAFTA	WEurope	ROW
Rice	-44	-29	-39	-22	-9	3	-14	-16
Wheat	-54	-33	-50	-41	2	15	-31	-11
Crsgrns	-46	-24	-79	-57	0	1	-27	-20
OthCrops	-42	-28	-37	-9	-7	13	-13	-9
LstkProd	-33	-34	-32	-34	2	-2	-14	-2
ProcFood	-31	8	5	-13	-11	-7	-15	-7
NatRes	18	-38	-1	23	-2	1	-2	-2
Textiles	-16	95	29	-9	-29	-27	-27	7
WearApp	-6	295	-39	-23	-62	-77	-80	48
LightMnfc	30	-17	15	-0	-11	-5	-7	-0
TMEq	97	-12	2	1	-8	6	8	-19
HeavyMnfc	38	-12	15	2	-8	-2	-1	-5
Services	14	-0	-0	0	2	0	2	2

[a] Includes Thailand, Malaysia, Indonesia, and the Philippines.

[b] Includes Hong Kong, Singapore, Korea, and Taiwan.

[c] Includes Australia and New Zealand.

[d] Includes Canada, Mexico and USA.

Source: Authors' model results.

Chinese exporters of these products do not benefit from elimination of the MFA. Rather, they are displaced by other exporters to developed country markets.[6]

The other Asian economies also shift resources out of agriculture, although the ASEAN-4 and the NIEs become more competitive in processed food production, due to cheaper agricultural imports in the wake of Uruguay Round cuts. Overall, only Australia/New Zealand and NAFTA see increases in the relative importance of agriculture in their economies over this period, fueled by the Uruguay Round liberalization in other countries, and by generally higher rates of productivity growth in their agriculture relative to their nonagricultural sectors. For the world as a whole, we expect the relative economic importance of farming to continue to decline, as a consequence of the relatively low income elasticities of demand for primary agricultural products together with continuing relatively rapid farm productivity growth.

Table 7 also portends a massive relocation of global production of wearing apparel, and to a lesser extent textiles, from the OECD countries to the developing economies of Asia. Owing to its assumed exclusion from the MFA reforms, China is not able to participate in this growth. Resources in that region are therefore diverted to other manufacturing activities, particularly transport equipment and machinery, heavy

[6] In our earlier study of the Uruguay Round (Hertel, *et al.* 1995) we assumed that Chinese quotas were eliminated. A comparison of the two studies shows that this makes a big difference in the pattern of expansion of the Chinese economy over this period, and hence that this is a potentially large source of gain from China acceding to the WTO (see below).

manufacturing and light manufacturing. Also, owing to China's exclusion, the growth of the textile and wearing apparel sectors in ASEAN is extremely rapid.

Table 8 shows the effect of combining the production-side changes enumerated in Table 7 with consumption-side changes. Here, regional trade balances are reported, by commodity. Once again, columns refer to countries or country-groupings while rows refer to commodities. The final column shows the difference between fob and cif values for merchandise commodities, while for services it shows total exports of international trade and transport services. Column sums give the change in trade balance for each individual region. We have held each country's trade balance constant (by assumption) in these projections, which is why the column sums are all zero.

To guide the reader in interpreting these numbers, consider the first column of Table 8, which relates to the most dynamic economy in the region—namely China. The first entry in this column shows the difference in the grains trade balance in 2005 relative to 1992, in billions of constant (1992) US dollars. At -$4.9 billion, this indicates that China is expected to be a significant net importer of grain in 2005. When converted to physical units, this amounts to imports (net of exports) of about 33 million metric tons (China is 100% self-sufficient in grains in our initial data base for 1992 but drops to 96% in 2005 under our modified base case—see Table 16.) This figure is comparable to the projected increases in net imports reported in several other studies (e.g., IFPRI and ERS/USDA, as summarized by Coyle (1996, Figure 12)).

Much more significant (in value terms) are the increases in China's net imports of non-grain crops ($13.7 billion) and meat products ($15.6 billion). Processed food imports also increase more rapidly than exports in this period, under the base case assumptions. Indeed, as the "All Food" row in Table 8 indicates, China's net imports of all farm and food products are $39 billion higher in the year 2005 than in the base year of 1992. Grains account for only 13% of this increase in China's food trade deficit.

How does China pay for this massive increase in farm and food imports? It does so by expanding net exports of manufactures. Here, a critical point relates to China's potential entry to the WTO. As discussed in more detail below, until that accession occurs, China is assumed to be excluded from the liberalization of textiles and wearing apparel trade. This is why the combined trade balance on these product categories in Table 8 does not increase as in Asia's other developing countries. Instead, the increase in Chinese net exports is concentrated in other light manufactures.

Moving beyond China to the other columns in Table 8, note that the NIEs, Japan, and Western Europe all move into increased deficits with respect to grains and other crops. This is offset by increased net exports from ASEAN-4, Australia/New Zealand, North America and the rest of the world. With respect to processed food, which is a heterogeneous category, we see negative net trade changes for Japan and Western Europe and smaller ones for the other regions outside Southeast Asia. In ASEAN-4 and NIEs, cheaper raw materials, owing to Uruguay Round tariff cuts, result in a far more competitive food processing sector. In the case of ASEAN-4, this effect dominates the negative numbers for primary agriculture and the base case predicts that the value of total food exports will increase much more rapidly than that of imports over this period. However, the largest change of all for the ASEAN-4 region is the boost in wearing apparel net exports ($128 billion more than in 1992), owing to the abolition of quotas affecting its exports to North America and Europe.

Table 8. Change in Trade Balance, by Commodity and Region, 1992-2005, in billions of 1992 $US.
(Modified base case incorporating the Uruguay Round).

	China	ASEAN-4	NIEs	Japan	Aus/NZ	NAFTA	WEurope	ROW	WORLD[a]
Grains	-4.9	0.3	-5.4	-5.6	0.8	11.4	-3.2	4.5	-2.0
OthCrops	-13.7	-10.7	-8.1	-0.9	1.1	22.4	-2.9	5.5	-7.3
LstkProd	-15.6	0.8	-7.1	-10.1	9.3	15.9	-6.7	8.5	-5.1
ProcFood	-4.7	38.5	18.5	-14.3	-0.5	-2.8	-42.9	-7.9	-16.1
AllFood	-38.9	29.0	-2.1	-30.8	10.6	47.0	-55.8	10.6	-30.4
NatRes	-4.5	-7.8	-57.7	-23.9	11.4	-5.8	-28.5	102.5	-14.3
Textiles	-11.6	-29.4	40.8	4.1	-1.1	-4.5	-17.7	5.8	-13.6
WearApp	19.5	128.4	2.7	-15.3	-2.5	-71.2	-93.8	14.6	-17.7
LightMnfc	35.4	3.8	44.4	1.3	-3.9	-41.1	-60.6	-0.5	-21.1
TMEq	5.3	-57.2	-39.0	24.8	-10.8	0.9	124.0	-91.7	-43.7
HeavyMnfc	-1.3	-50.3	7.5	41.4	-5.4	0.6	24.5	-48.4	-31.5
Services	-3.8	-16.4	3.4	-1.6	1.7	74.1	107.9	7.1	172.3
Total[b]	0	0	0	0	0	0	0	0	0

[a] Row totals for merchandise commodities equal the difference between *fob* and *cif* value for services, the row total equals total trade and transport service exports.

[b] Column totals equal zero due to our assumption of a fixed trade balance over the projection period.

Source: Authors' model results.

Alternative scenarios for the Asia Pacific region

The base case presented above is a projection of the world economy based on myriad assumptions. How does the projection change as these assumptions are altered? In this section we seek to identify and examine some of the key forces shaping farm and food trade in the Pacific Rim in the next decade. We do so by exploring five alternative scenarios, each designed to highlight a different feature of this complex topic. The first two scenarios involve less optimistic assumptions concerning agricultural production: a greater loss of farm land to non-farm uses, and slower technical change in agriculture. The second pair of scenarios relate to China. In the first of these we examine the impact of slower growth in China. The second involves China and Taiwan's accession to the WTO. Finally, we consider the impact of the failure to abolish the quotas on trade in textiles and wearing apparel.

Scenario 1. A loss of agricultural land

Lester Brown's study drew attention to the potential loss of agricultural land resulting from increasing urbanization and infrastructure needs in China. Assuming that urban uses require a standard 0.05 hectare per person worldwide, Crosson and Anderson (1992) conclude that urbanization in land-scarce East Asia could press relatively heavily on the available land supplies in that region. However, given the vast differences in urban population densities observed within East Asia, it seems inappropriate for our analysis to assume a standard urban density across countries.

To make an initial assessment of the magnitude of the demand for land for urban uses, we began with projections of the change in the urban population for each country during the 1992-2005 period (United Nations 1994). These are reported in the first two columns of Table 9. We multiplied these changes by the average amount of land used per person in the largest urban agglomeration in the region to obtain an initial indication of the underlying demand for land for urban uses. We then expressed this change in land demand as a fraction of the area of arable and permanent cropland in the region (World Bank Economic and Social Database, 15 April 1996). We recognize that using land use in the largest city probably understates demand for urban land demand since some expansion will take place in less densely populated urban areas. However, this underestimation is offset by the implicit overestimation resulting from (a) assuming that all urban demand reduces one for one the arable land base and (b) ignoring the fact that the new urban population would have required rural (and potentially more land intensive) housing and infrastructure had they not moved to urban areas. The resulting estimates of the percentage reduction in the arable land base are presented in the last column of Table 9 as a very rough indicator of the potential reduction in the arable land base associated with increasing urbanization. These reductions are well below 1% in most regions and average only 0.26% globally. Only in the cases of Korea, Taiwan and Hong Kong do they amount to as much as 3 or 4% over the 13-year period from 1992-2005.

From these numbers, it is obvious that the impact of urban demand on the arable land base will be relatively small in virtually all countries/regions. The impact on agricultural output will be even smaller, since the reduction in available land will typically be offset by more intensive use of other productive factors and inputs such as fertilizer on the remaining land. Because of this small effect, we do not devote scarce table space to this simulation. Suffice it to report that altering the land area by the amounts shown in the final column of Table 9 changed the world price of rice by only 0.4% and all other prices by much less. Output changes were even smaller. However, based on this analysis, our interim conclusion is that this is a minor

Table 9. Estimated Percentage Reduction in Arable Land Resulting from Urbanization, 1992-2005.

	Urban Population[a] 1992	Urban Population[a] 2005	Urban Density[a]	Arable Land[b]	Change in Arable Land
	(thousands)		(pop/ha.)	(thousand ha.)	(%)
China	329411	518609	331.55	95426	-0.60
Indonesia	61551	102572	412.62	33051	-0.30
Philippines	32440	51478	174.26	9190	-1.19
Thailand	10960	15734	189.19	20800	-0.12
Malaysia	9671	14866	189.19	4880	-0.56
Korea	33624	43907	154.27	2070	-3.22
Taiwan	15808	20643	155.28	876	-3.55
Hong Kong	5451	5789	1045.37	7	-4.62
Japan	96041	101046	90.18	4515	-1.23
Australia/NZ	18154	20698	38.79	51161	-0.13
NAFTA	279921	339229	44.24	23736	-0.57
W. Europe	262015	275603	41.71	89683	-0.36
Former Soviet Union	110366	114998	100.58	132283	-0.03
India	230602	341932	411.99	169650	-0.16
Rest of the World	904238	1132847	228.25	607952	-0.31
World	2400252	3299951	241.37	1458780	-0.26

[a] Source: United Nations (1994).
[b] Source: World Bank Economic and Social Data Base (1996).

issue from the point of view of global food availability in the coming decade. This leads us to the question of how much output can be achieved on the existing land base, or, in more general economic terms, what rate of technical change is possible (bearing in mind the possibilities for land degradation and the limitations on expanding the proportion of crop land that is irrigated)?

Scenario 2. Technical change in agriculture

A key influence on world food markets is the rate of technical change in agriculture. While this is commonly equated with growth in yield per hectare, technical progress can be much broader than this, encompassing advances in the productivity of all factors. Further, such partial productivity measures inevitably confound productivity changes with changes in the quantities of capital and land per worker. For simplicity, we assume that technical change raises the productivity of all the factors used in agricultural production. Such technical change has two impacts on output. Firstly, it increases the volume of output associated with any given level of factor use. Secondly, it makes the activities that benefit from this technical change more competitive and allows them to draw factors away from other sectors.

There has been considerable concern expressed recently to the effect that productivity growth in agriculture may be diminishing. If the rapid advances in agricultural productivity observed over the past 30 years have reflected, in part, the adoption of a one-off improvement in technology associated with the "green revolution," then it seems plausible that these gains might be close to exhaustion in Asia, where adoption rates of these technologies are now very high in many suitable areas. Consistent with this, Crosson and Anderson

(1992, p.105) conclude that future productivity growth must come primarily from the generation of new knowledge, rather than from increased application of existing techniques.

Clearly, reliance on new knowledge accentuates the importance of maintaining high levels of research inputs. A wide range of studies has found a strong link between investments in agricultural research and rapid agricultural productivity growth. Further, these studies have typically found that such research has a very high economic rate of return. This seems likely to continue to be the case in the period under review. Despite this, there is considerable unease about the willingness of national and international agencies to continue providing the levels of support to agricultural research and development that have been forthcoming in the past.

To explore the potential impact of reductions in research and development spending on agricultural trade and prices, we evaluate the impact of a one-half percent per year decline in total factor productivity (TFP) in grain production worldwide. This reduction represents about one-fifth of the historical growth rate of agricultural productivity growth (Bernard and Jones 1996) and it cumulates over 13 years to a 6.7% decline in grain productivity.

The results from this adverse TFP shock for grains are reported in Tables 10 to 12. From Table 10 we see that there is a significant effect on world grain prices (a rise of 6.3% for rice, 4.8% for wheat and 5% for coarse grains). There is also a modest spillover onto the prices of meat and livestock products and of processed food. As shown in Table 11, the trade impact of this scenario is very modest. The welfare consequences of slower technical progress in grains are adverse, by definition. The world as a whole would lose $28 billion/yr. by 2005 if such a slowdown were to occur (Table 12, column 1). And, with the exception of Australia/New Zealand, welfare in the APEC region falls. Due to its substantial export position in grains, only Australia/New Zealand, among the country groups shown, benefit more from the higher prices than it loses from the assumed slowdown in its own grain productivity growth.

Scenario 3. China's growth slows

One of the major uncertainties associated with our base case projections pertains to the rate of Chinese GDP growth over this period. We assume an annual growth rate of 7.8%. Even though China has achieved and surpassed that rate of growth over the past 15 years, the agriculturally focused projections studies cited above have assumed slower growth rates. For example, the IFPRI study (Rosegrant, *et al.* 1995) uses an estimate of 6%/yr, while Rozelle *et al.* (1996) use a figure of a bit more than 4%/yr. When cumulated over the 13 year period in question, these differences can be quite substantial. In order to explore the implications of slower growth for patterns of trade and production, we consider one alternative scenario in which total factor productivity growth in the non-agricultural sectors is slower. In the base case that TFP growth rate is 3%/yr. In this alternative scenario, we set this equal to only 1%/yr., which in turn lowers savings, investment, and hence capital stock accumulation (-1.4%/yr.) over this period. The combined effect amounts to a slowdown in real GDP growth in China over this 13 year period of 1.5 percentage points per year (6.3 percent instead of 7.8 percent). Moreover, the decline in non-agricultural productivity growth, relative to agricultural productivity growth, reduces the ability of the non-agricultural sector to attract resources away from agriculture.

The second set of columns in Tables 10 to 12 report the differences in world trade and welfare in the year 2005 which result from the slowdown in China. From Table 11 we can see that the effect on trade volume is concentrated in China itself. Slower growth in China means lower levels of imports and exports for China in 2005. This is obvious. Less clear is the distribution of this decline in trade across other regions. The numbers in Table 11 indicate that the impact on export volume from other regions is spread fairly evenly. On the import side, Hong Kong/Singapore and Australia/New Zealand are more significantly affected, but the total changes are relatively small.

Table 10. Impact of Alternative Scenarios on International Prices and Exports of Different Products in the Year 2005 (percentage change).

	Grain TFP Slowdown		China Slowdown		China in WTO		MFA Snapback	
Commodity	Prices	Exports	Prices	Exports	Prices	Exports	Prices	Exports
Rice	6.3	-0.3	-2.6	-0.4	0.1	0.7	-1.6	0.8
Wheat	4.8	3.2	-2.7	-10.3	0.0	0.1	-1.3	-1.2
Crsgrns	5.0	1.9	-5.0	-0.8	0.5	1.1	-1.3	-0.3
OthCrops	0.3	-0.3	-2.7	-5.8	0.1	2.4	-1.4	-2.3
LstkProd	0.5	0.3	-1.5	-7.7	0.3	11.6	-0.9	-1.8
ProcFood	0.3	-0.4	-0.4	-0.1	0.1	3.7	-0.9	0.8
NatRes	-0.1	-0.1	0.1	-0.4	0.4	1.0	-0.8	0.0
Textiles	0.0	-0.1	-0.3	-2.3	-1.1	7.8	2.3	-11.9
WearApp	0.0	-0.1	-0.2	-0.3	-2.6	8.6	11.0	-30.7
LightMnfc	-0.1	-0.1	0.0	-1.4	0.2	4.3	-0.8	1.4
TMEq	-0.1	-0.1	0.2	-0.8	0.3	2.8	-0.8	0.2
HeavyMnfc	-0.1	-0.1	0.1	-1.2	0.3	1.5	-0.8	-0.2
Services	-0.1	-0.1	0.0	-1.3	0.3	2.6	-0.7	-1.4

Source: Authors' model results.

Table 11. Impact of Alternative Scenarios on Regional Export and Import Volumes in the Year 2005 (percentage change).

	Grain TFP Slowdown		China Slowdown		China and Taiwan in WTO		MFA Snapback	
Region	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
WORLD	-0.1	-0.1	-1.2	-1.2	3.0	3.0	-2.0	-2.0
China	-0.1	-0.2	-23.1	-20.7	39.6	54.8	-8.4	-3.1
Indonesia	-0.2	-0.3	0.1	0.0	-5.9	-9.0	-19.7	-15.8
Philippines	0.1	0.0	0.4	0.2	-1.8	-5.5	-8.0	-3.4
Thailand	-0.5	-0.1	0.4	0.2	-0.8	-3.0	-4.3	-1.4
Malaysia	0.0	0.0	0.3	0.3	-0.4	-1.8	-2.4	-1.3
R. of Korea	-0.1	-0.1	-0.2	-0.2	0.6	0.1	-1.0	-0.6
Taiwan, China	0.0	0.0	-0.3	-0.5	6.0	7.7	-0.5	-0.4
HK/Singapore	0.0	0.0	-0.7	-1.4	1.1	2.8	0.1	0.9
Japan	0.1	-0.1	-0.2	-0.2	3.6	2.6	0.3	0.3
Australia/NZ	-0.1	0.1	-0.5	-1.2	0.8	-0.1	-0.1	-0.2
North America	-0.1	0.0	-0.3	-0.4	1.6	0.9	-2.2	-3.7
Western Europe	-0.1	-0.1	-0.1	-0.1	1.6	1.0	-1.6	-3.2
Former Soviet Union	0.0	-0.2	-0.7	-0.8	2.5	1.1	0.2	0.2
India	-0.5	-0.5	0.1	0.0	-1.6	-6.2	-12.9	-6.7
Rest of the World	-0.1	-0.1	-0.1	-0.2	0.5	-0.3	0.4	0.9

Source: Authors' model results.

Table 12. Annual Welfare Effect (Equivalent Variation in Income) from Various Scenarios in 2005 (US$ 1992 billion).

	Grain TFP Slowdown	China Slowdown	China and Taiwan Join WTO	MFA Snapback
World	-27.6	-199.6	50.5	-44.8
China	-6.5	-184.3	42.1	5.5
Indonesia	-0.9	-0.4	-6.6	-7.4
Philippines	-0.3	-0.1	-1.3	0.6
Thailand	-0.1	-0.6	-4.4	0.8
Malaysia	-0.4	-0.1	-2.2	-0.8
R. of Korea	-1.6	-0.6	-0.2	0.8
Taiwan, China	-0.4	-0.8	2.2	0.1
HK/Singapore	0.0	-2.5	4.1	2.8
Japan	-2.9	-2.5	6.0	1.5
Australia/NZ	0.1	-1.3	0.0	0.0
North America	-2.1	-2.1	5.9	-28.5
Western Europe	-3.2	-2.0	10.2	-29.9
Former Soviet Union	-1.1	-0.1	0.4	0.1
India	-2.1	-0.3	-4.2	0.1
Rest of the World	-6.0	-1.9	-1.7	9.5

Source: Authors' model results.

Looking at the impact of slower growth in China on international commodity markets (Table 10), we find that the effects are concentrated in the farm and food sectors. In particular, wheat, other crops and meat/livestock products experience sharp reductions in their global trade. World exports of meat, for example, are estimated to be 8% lower in 2005 if China's non-farm TFP grows at one percent as opposed to the base case assumption of 3%/yr. In sum, China's industrial growth rate is more important for world food markets than it is for non-farm sectors.

Tables 13-15 report the changes in bilateral trade volumes for crops, meat and livestock products and processed food. Columns in these tables correspond to importers and rows correspond to exporters. Entries correspond to the change in trade volume along a particular route, measure in millions of 1992 $US, at constant prices. Table 13 provides bilateral trade volume changes estimated to arise in the year 2005, from slower growth in China. The impact of this slowdown on food exports varies by type of product. NAFTA experiences by far the largest decline in the case of crop exports to China ($5.8 billion). However, in the case of livestock products, it is Australia/New Zealand where the export slowdown is largest ($3.8 billion).

So much for trade but what about welfare? Are there some regions which benefit from a slowdown in China? We might think that those countries competing with China in the global marketplace might be pleased to see a slowdown in Chinese growth. However, the results in Table 12 indicate that all other regions would lose from slower growth in China. Hertel, *et al.* (1996) have examined this phenomenon in considerable detail, and find that competitor regions, such as India and Indonesia, do indeed benefit from the changes in *average* world prices resulting from China's slower growth, but those gains are more than offset by increases in the prices of Chinese exports to them (relative to the world average), and decreases in demand for their exports to China. For the world as a whole, welfare would be about $200 billion lower in 2005 under the lower growth rate assumption in China.

Table 13. Changes in Volume of Bilateral Farm and Food Exports in the Year 2005 Owing to a Slowdown in China's GDP Growth ($US million at constant 1992 prices).

	China	ASEAN-4	NIEs	Japan	Aus/NZ	NAFTA	WEurope	ROW	WORLD
China									
crop[a]	0	703	1384	435	8	35	109	318	2992
lvstk[b]	0	173	194	98	1	13	90	184	752
prfd[c]	0	487	475	789	23	263	547	743	3327
ASEAN-4									
crop	-923	-60	-22	42	0	16	80	71	-795
lvstk	-359	-13	-79	36	-2	0	6	1	-410
prfd	-439	-56	-191	-17	-12	97	211	268	-140
NIEs									
crop	-169	7	-13	-4	0	2	6	51	-120
lvstk	-257	0	2	7	0	0	1	2	-245
prfd	-448	-20	-1	233	3	91	231	184	272
Japan									
crop	-133	-10	-30	0	-1	-3	-1	-2	-182
lvstk	-193	-7	-23	0	-1	-1	0	-1	-226
prfd	-125	-48	-65	0	-5	-10	-5	-11	-270
Aus/NZ									
crop	-277	62	38	45	2	6	40	76	-8
lvstk	-3806	49	338	221	-1	279	282	355	-2286
prfd	-52	9	3	63	4	23	31	11	92
NAFTA									
crop	-5820	-173	-1049	-247	-10	-40	122	20	-7197
lvstk	-1767	-32	-249	-172	-13	-145	-5	-55	-2437
prfd	-188	-72	-91	-119	-26	-111	-64	-161	-832
WEurope									
crop	-233	-20	-28	-17	-7	-31	-89	-149	-573
lvstk	-802	-24	-54	-28	-18	-26	-76	-181	-1209
prfd	-189	-89	-120	-105	-42	-116	-202	-557	-1421
Rest of the World									
crop	-1754	-407	-163	-118	-13	-83	62	-253	-2729
lvstk	-1157	-125	-34	-5	-3	-18	17	-133	-1458
prfd	-810	-87	-53	-81	-17	-34	27	-194	-1249
WORLD									
crop	-9309	102	117	136	-22	-98	329	133	-8612
lvstk	-8342	20	94	157	-37	103	315	171	-7519
prfd	-2253	123	-43	762	-71	203	777	282	-221

[a] crop = rice, wheat, coarse grains and other crops. [b] lvstk = meat and livestock products. [c] prfd = other food products (processed).

Source: Authors' model results.

Scenario 4. China and Taiwan enter the WTO

The offers that China has made in seeking entry to the WTO involve very substantial tops-down reductions in its protection rates (Bach, Martin and Stevens 1996). Assuming that tariffs are cut only when the tariff binding offered to WTO is below the applied rate, the latest offer involves a fall in the weighted average rate of protection in China from 30% in 1992 to 16%. This reduction will be complemented by a substantial reduction in the coverage of nontariff barriers. In this paper, we have used the reductions in the trade-weighted bilateral tariffs as documented in Bach (1996) to give us an indication of the impact of the offer[7]. Based on this offer, the drop in average import prices for food products will range from a low of 0% for rice and wheat, to 5-7% for other crops and livestock products, and 15% for processed foods. Manufacturing import price cuts as a result of the offer range from 10-22%.

Since China's accession to the WTO will surely be followed immediately by Taiwan's accession, we have combined these two events into one scenario. Unfortunately, our data base on Taiwanese protection outside of agriculture is very limited. We assume that non-agricultural tariffs are cut by 36%, while agricultural cuts are assumed to be only half as deep (18%). The latter assumption is consistent with the tendency for trade-weighted protection cuts in the sensitive agricultural area to be reduced by the way that the initial tariff equivalents were set, or by the use of the ceiling binding option in developing countries (Hathaway and Ingco 1995).

Admission to the WTO will confer an additional important benefit on China (and Taiwan to a lesser degree) by bringing into effect the provisions of the Uruguay Round Agreement on Textiles and Clothing (ATC). If China enters during the implementation period of the Round, it will benefit from increases in the growth rates of its quotas, and the progressive reintegration of some export categories under GATT disciplines.[8] In the baseline simulation for this paper, we have assumed that China and Taiwan will not benefit from the ATC provisions. As a consequence, their exports of textiles and clothing grow *relatively* slowly. Given this background, it is perhaps not surprising that an important effect of WTO accession on China's trade and output pattern is an expansion of textiles and apparel. Such large relative changes in textiles and clothing would not be expected if China joins the WTO during, rather than at the end of this period. If we combined the sectoral output growth in the baseline with that resulting from the WTO offer, we would observe a more balanced pattern of output expansion, with textiles and apparel growing at a rate in the same order of magnitude as other light manufacturing sectors, instead of being artificially constrained.

WTO entry results in a substantial increase in China's overall trade volume, with imports in 2005 being 55% greater and exports 40% greater[9] (Table 11). Imports of most industrial products rise substantially

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[7] This specification omits two important, but partially offsetting, features of the situation. The neglect of the current system of tariff exemptions tends to overstate the impact. The omission of NTB abolition tends to underestimate the effect. Dealing with the tariff exemptions will clearly change the specific results, but does not appear to change the broad conclusions (Bach, Martin, and Stevens 1996).

[8] Our results for China/Taiwan accession to the WTO hinge crucially on the timing of their entry. Most quota rents accociated with the bilateral restrictions on textiles and wearing apparel are expected to grow over the period of implementation (Hertel *et al.*, 1995). However, once these quotas have been abolished for all other exporters, quota rents for China and Taiwan are greatly reduced. In the analysis of China/Taiwan accession reported here, we work from a modified base case for 2005, in which quota rents are held at their 1992 level. This contrasts with the results reported in Bach, Martin and Stevens, in which initial quota rents are at the 2005 level predicted *in the absence of the Uruguay Round agreement.*

[9] An important byproduct of China's accession into the WTO is the reduction in cost of investment goods arising from the tariff cuts. As a result, investment in China becomes more attractive. In order to permit this investment flow to take place, we relax the fixed trade balance restriction in this simulation. As a result of the capital inflow following accession, exports do not increase as rapidly as do imports. This blunts the adverse terms of trade effect associated with China's liberalization.

because of the large reductions in protection rates on these goods. Amongst the crops, by contrast, there are very small reductions in protection. China's imports of wheat and rice actually fall as consumers substitute towards the goods whose prices have fallen. Imports of meats and processed foods, however, grow substantially as their non-food average price cuts are much larger.

Following WTO entry, China's exports of all agricultural products increase substantially, despite the modest declines in the output of these sectors. The key reason is the fall in domestic food consumption as consumers shift towards other, now cheaper nonfarm goods. The strikingly large increases in China's exports of textiles and wearing apparel follow from elimination of the MFA restrictions on exports to North America and Europe. This causes reductions in exports from its most direct competitors in these market, especially Indonesia, the Philippines, Thailand and Malaysia, where output falls. Wearing apparel exports from these countries are diverted to the MFA markets (North America and Western Europe) to the other high income markets of Japan and Australia/New Zealand.

Table 14 reports the change in bilateral farm and food trade volumes when China and Taiwan enter the WTO. Large increases in sales to China arise in processed food from the NIEs, NAFTA, and Western Europe. NAFTA increases its exports of livestock products to China by $6.8 billion, while Western Europe and the rest of the world supply an added $3.4 billion of these products to China. These regions achieve these increases in part by diverting exports from other destinations. This is not the case with the ASEAN-4, which increases its total volume of farm and food exports by almost $9.3 billion as a result of China's entry into the WTO.

Turning to the welfare results, Table 12 shows that the trade liberalization resulting from China and Taiwan joining the WTO increases world welfare by a total of $50 billion per year in 2005. This figure is substantial, when compared to the $163 billion Uruguay Round gains associated with all other countries offers combined (Table 6). The main gainers are Western Europe, Japan, North America, and Hong Kong/ Singapore. Indonesia, the Philippines, Thailand, and Malaysia experience a combined loss of $14.5 billion. These losses appear to be primarily the result of the expansion of China's exports of textiles and clothing associated with the abolition of the MFA quotas. As noted above, this shock needs to be interpreted carefully; it is an artifact of the suppression of China's textile and clothing sector resulting from its assumed exclusion from the MFA phase-out in the base case.

In concluding this section, one final caveat needs to be kept in mind. We have assumed in the base case that China would not alter its policies between 1992 and 2005. In fact, however, the decline in grain self-sufficiency over that period (see Table 16) might prompt China to raise domestic food prices above international levels (Tyers and Anderson 1992, Ch. 8). Under such circumstances, acceding to the WTO, thereby preventing increased protection in agriculture, becomes even more significant.

Scenario 5. Failure to abolish the MFA

Elimination of the bilateral quotas associated with the MFA under the Uruguay Round is designed to occur gradually. The first step involves increases in the growth rates of MFA quotas under the Agreement on Textiles and Clothing during the ten year transition period to 2005, followed by a progressive integration of textile and clothing items into the GATT system, at which point the quotas are abolished altogether. The tariff lines to be integrated under GATT are selected by the importing countries, and it appears that few commodities subject to binding quotas will be integrated until near the end of the transition period (Sanjoy Bagchi, International Textiles and Clothing Bureau, personal communication). Therefore the real liberalization of trade in these products is heavily loaded at the end of the period (2005).

Table 14. Changes in Volume of Bilateral Farm and Food Exports in the Year 2005 Owing to China and Taiwan Joining the WTO ($US million at constant 1992 prices).

	China	ASEAN-4	NIEs	Japan	Aus/NZ	NAFTA	WEurope	ROW	WORLD
China									
crop	0	-45	-80	-21	0	-2	-4	-16	-168
lvstk	0	-15	-13	-6	0	-1	-5	-14	-54
prfd	0	-234	-173	-276	-9	-92	-185	-266	-1236
ASEAN-4									
crop	376	60	191	78	4	57	63	87	916
lvstk	578	7	210	305	2	9	31	11	1152
prfd	30	318	719	1181	136	1283	1988	1569	7223
NIEs									
crop	94	-18	37	10	0	0	-2	-58	64
lvstk	371	-55	20	177	0	1	0	-25	489
prfd	2396	-205	-136	-67	-25	4	-132	-673	1162
Japan									
crop	20	-15	14	0	-1	-2	-2	-6	9
lvstk	875	-4	-33	0	0	0	0	-1	837
prfd	459	-98	-57	0	-6	-24	-16	-26	232
Aus/NZ									
crop	94	-43	58	19	0	3	11	-10	132
lvstk	-980	-71	296	35	-2	123	66	-8	-540
prfd	-68	-45	47	10	-5	-2	-2	-5	-69
NAFTA									
crop	238	-426	482	-79	-9	-32	-117	-327	-269
lvstk	6847	-37	-140	-299	-5	17	-27	-128	6228
prfd	2641	-201	74	-77	-26	-271	-259	-358	1523
WEurope									
crop	110	-18	3	-1	-2	0	-36	-76	-19
lvstk	1322	-45	41	-20	-6	5	-44	-157	1095
prfd	2827	-179	165	-50	-33	-147	-315	-923	1345
Rest of the World									
crop	2272	-192	99	36	2	111	141	-289	2179
lvstk	2156	-58	-4	1	-1	36	95	-18	2208
prfd	-190	110	-5	124	1	97	511	178	825
WORLD									
crop	3204	-697	804	43	-7	136	55	-694	2845
lvstk	11169	-278	376	194	-13	190	116	-339	11414
prfd	8095	-535	634	844	33	847	1589	-503	11006

[a] crop = rice, wheat, coarse grains and other crops. [b] lvstk = meat and livestock products. [c] prfd = other food products (processed).

Source: Authors' model results.

Based on our earlier analysis (Hertel, *et al.* 1995), we conclude that the degree of quota acceleration under the Agreement on Textiles and Clothing is not sufficient to reduce the quota rents for most of the bilateral flows. Therefore, we expect abolition of the quotas to remain a contentious issue, even though the agreement cannot be extended, and developing countries are sure to resist any artifice that would continue such protection.

Failure to fully eliminate the trade-restricting effect of the MFA would substantially reduce the export opportunities for the high-performing East Asian economies. Clearly, this will reduce the ability of these economies to earn the foreign exchange required to import goods such as agricultural products from their industrialized trading partners. Within the East Asian economies, failure to abolish the MFA would constrain the movement of resources out of agriculture and into industry. Thus, from the supply side, this scenario can be expected to lead to increased agricultural output and reduced imports in Asia.

We explore the quantitative implications of this scenario by permitting the MFA quotas to "snap-back" to the same level of restrictiveness observed in our initial (1992) data set. In other words, we conduct a simulation in which the bilateral quotas on textiles and wearing apparel are reintroduced and tightened to the point where they generate the same quota rent per unit of sales as in 1992. While this may seem extreme in light of the quota acceleration built into the Agreement on Textiles and Clothing, such is not the case. Hertel, *et al.* (1995) find that even with the ATC growth rates in place, quota rents are expected to increase over the period 1992-2005 for 37 of the 44 bilateral flows examined. Given that finding, our MFA snapback scenario may be more modest than the true consequences of failing to abolish these quotas in 2005.

The results stemming from the MFA snapback scenario are reported in the fourth set of columns in Tables 10 to 12. (Since this snapback also involves China and Taiwan, we begin from the 2005 data base in which they have joined the WTO.) The most striking impact of this scenario is the very large reduction of world trade in textiles and wearing apparel (12% and 31%, respectively—see Table 10). This is large enough to cause a 2% contraction in total global trade (Table 11). The trade impact of this scenario is felt most severely by Indonesia, India and the Philippines—countries which benefited significantly from the removal of the quotas in our base case. Since we have constrained all regions to retain a fixed trade balance, this export reduction means that imports are also reduced. Indeed, from Table 10 we see that Indonesia's total imports fall by 16%, followed by India (-7%) and the Philippines (-3%). These import reductions are spread across the board and have important ramifications for those regions seeking to expand farm and food exports to Asia.

From Table 15 it can be seen that there is a close link between farm and food exports from the MFA-importers (North America and Western Europe), and imports by the most competitive MFA exporters affected by the snapback (ASEAN-4). For example, by examining the entries in the NAFTA row and ASEAN-4 column, we see that the volume of crops exports falls by $US 733 million. This is followed by the drop in bilateral processed food sales ($US 217 million) and livestock products ($US 47 million).

Ironically, the reduction in ASEAN-4 exports of textiles and wearing apparel is accompanied by higher levels of farm and food exports—much of this to the MFA-importers! From the last column we see that the total increase in all food exports from ASEAN-4 equals $9.5 billion. This increase is a reflection of the fact that when the ASEAN-4 countries are stymied in one export market, they are likely to move into other ones. In practical terms, what this means is that the shift of resources out of food and agriculture which was foreseen in our base case (Table 7) will be slowed if the MFA is less fully reformed. As a result, the bilateral balance in food trade (at constant prices) between NAFTA and ASEAN-4 deteriorates by a total of about $2.4 billion, relative to the 2005 base. Overall, NAFTA's food exports fall by $5.6 billion in this scenario.

In sum, by refusing to *import* additional textiles and wearing apparel from East Asia, North America indirectly limits the ability of domestic farm and food producers to *export* to Asia, and meanwhile indirectly stimulating additional net food exports from that region. As Hertel (1996) points out: "trade is a two-way street," and obstructions in one direction inevitably spill over and slow the flow of traffic in the other direction.

Table 15. Changes in Volume of Bilateral Farm and Food Exports in the Year 2005 Owing to MFA Snapback ($US million at constant 1992 prices).

	China	ASEAN-4	NIEs	Japan	Aus/NZ	NAFTA	WEurope	ROW	WORLD
China									
crop	0	12	44	10	0	1	3	7	76
lvstk	0	-2	1	2	0	0	2	0	3
prfd	0	-18	5	57	2	27	54	73	201
ASEAN-4									
crop	49	78	155	93	7	89	120	176	766
lvstk	59	20	151	262	2	10	41	19	565
prfd	153	447	528	1036	140	1288	2462	2091	8146
NIEs									
crop	-14	-7	-10	2	0	1	3	-5	-29
lvstk	-36	-17	-2	37	0	1	1	-23	-40
prfd	-65	-272	-114	-159	-8	32	51	-237	-772
Japan									
crop	-12	-15	-19	0	0	0	1	-4	-48
lvstk	-72	-3	-10	0	0	0	1	0	-84
prfd	-21	-80	-55	0	-3	1	0	-1	-158
Aus/NZ									
crop	-6	-145	-11	17	1	3	23	2	-117
lvstk	-228	-102	-32	22	1	116	102	39	-82
prfd	-1	-40	-16	-25	-4	8	9	3	-65
NAFTA									
crop	-501	-733	-583	-163	-9	-92	47	-176	-2210
lvstk	-820	-47	-263	-341	-4	-1	2	-91	-1565
prfd	-177	-217	-152	-251	-40	-337	-342	-355	-1872
WEurope									
crop	-26	-29	-18	-8	-4	-13	3	-65	-159
lvstk	-205	-56	-46	-23	-4	3	24	-58	-366
prfd	-162	-190	-163	-138	-44	-133	-304	-757	-1891
Rest of the World									
crop	-306	-474	-90	-42	0	11	250	-313	-964
lvstk	-299	-85	-36	-13	-1	2	36	-57	-453
prfd	-62	180	-34	-70	-21	-203	-736	-146	-1092
WORLD									
crop	-816	-1312	-533	-91	-6	0	449	-377	-2686
lvstk	-1602	-293	-237	-54	-6	132	209	-171	-2022
prfd	-334	-190	0	452	22	684	1194	669	2497

[a] These changes are relative to the 2005 data base in which both China and Taiwan have entered the WTO. [b] crop = rice, wheat, coarse grains and other crops. [c] lvstk = meat and livestock products. [d] prfd = other food products (processed).

Source: Authors' model results

In addition to limiting trade within the APEC region, the MFA-snapback is an adverse development for overall global welfare. Table 12 reports the impact of this scenario on *annual* real income, in billions of $US1992. (The present value of these welfare changes—assuming they persist forever— can be obtained by multiplying by 10 in the case of a 10% discount rate.) The annual global loss is equal to $45 billion. Not all regions lose from the MFA-snapback scenario. Indeed, the transfer of quota rents back to the restricted exporters is beneficial in many cases. However, as Trela and Whalley (1995) have shown, the mechanisms for allocating these quotas in many developing countries are highly inefficient, so that the gains which we report here may in fact be illusory.

Summary and conclusions

A major objective of this paper has been to place the future prospects for Asia-Pacific food markets in an economywide perspective. We have done so by utilizing the GTAP data base and model in order to construct a consistent set of projections for the year 2005. Key inputs include macroeconomic projections, projections for the labor force, physical capital and human capital, by region, world price projections for food products from IFPRI, and Uruguay Round liberalization measures from the WTO's Integrated Data Base. We recognize that all of these inputs are subject to considerable uncertainty, and potential revision. However, we believe that our analysis makes a number of important points which will prove robust to variation in these assumptions.

First of all, we find that concerns over loss of land due to urbanization are unwarranted. Estimates of these losses based on current urban densities are quite small and have a negligible impact on world prices over the 1992-2005 projection period. More important is the rate of technical progress which is achievable in agriculture. As emphasized by other authors, this is a key variable in determining whether food prices will rise in the face of increasing populations and a diminishing natural resource base (soil degradation, a slowdown in irrigation developments, etc.). Our sensitivity analysis shows that even a modest slowdown of about one fifth (half a percentage point per year) in the growth rate of agricultural productivity, could have a substantial impact on food prices by the year 2005.

Our second conclusion relates to grains. In our base case projections, annual net imports of grains increase by 33 million metric tons between 1992 and 2005. However, when measured in *value terms*, this pales next to the projected increases in other crops, livestock products and processed foods. In fact, grains only account for 13% of total net food imports in our 2005 projections for China. Of course, if China were to increase barriers to imports of livestock products, grain imports would increase to feed the larger number of animals in China.

A third point relates to the commonality of interest between farm and food producers in North America, on the one hand, and manufacturers in East Asia on the other. We show that measures such as the Multifibre Agreement (MFA), which restrict imports of manufactures (textiles and clothing in the case of the MFA) into North America, indirectly penalize NAFTA's exports of food and agricultural products. Specifically, we estimate that failure to fully reform the MFA will force more labor and capital into the food and agriculture sectors in ASEAN-4 (Thailand, Malaysia, Indonesia and the Philippines), resulting in a $7.7 billion increase in net exports of food products from that region by the year 2005. Meanwhile, food exports from NAFTA to ASEAN-4 are projected to fall by nearly one billion dollars if the MFA is not abolished. *Trade is a two-way street*, and obstacles to exports from Asia will come back to haunt those sectors seeking to export to this region.

We also consider the impact of two China-specific scenarios. In the first, we look at the impact of slower economic growth in China. This has an adverse impact on all of China's trading partners in APEC —even its natural competitors. This is because slower growth in China means higher prices for Chinese products and lower demand for China's imports from other members of APEC. However, the trade impact of reducing the growth rate in China is smaller than the impact of China's accession to the WTO. This serves to demonstrate

the strong impact of trade liberalization on trade volumes. In addition to this large boost to exports to China from other countries in the region, accession to the WTO helps to ensure that China's high rate of growth will be sustainable. In short, the two scenarios are natural partners: the latter (WTO accession) will reduce the probability of the former (slower GDP growth).

Finally, none of these scenarios have much impact on grain self sufficiency in 2005. Certainly there are some changes to be expected between 1992 and 2005 as the Uruguay Round agreements are implemented and as China's industrialization continues at a rapid pace. But Table 16 shows that those grain self sufficiency ratios vary little with the shocks considered, with one exception, namely, the case of slower growth in China. This causes its grain self sufficiency to increase, consistent with earlier studies (e.g., Tyers and Anderson 1992, Ch. 8). The key reason is that livestock product demand growth slows, hence there is less need for imported feedgrains (leading to a drop in the share of North American grain that is exported). The clear conclusion that can be drawn from this table is that the ability of world grain markets to handle changes is not likely to be threatened even by substantial shocks of the sort considered in this paper.

Table 16. Grain Self-Sufficiency[a] in 1992 and in 2005 Under Various Scenarios (percent).

	1992	2005				
	Initial Data	Modified Base Case	Grain TFP Slowdown	China Slowdown	China in WTO	MFA Snapback
China	100	96	96	99	96	96
Indonesia	98	97	97	96	97	97
Philippines	85	89	89	89	89	89
Thailand	112	136	135	136	135	134
Malaysia	69	65	65	66	65	65
R. of Korea	81	78	79	79	78	78
Taiwan, China	68	65	65	65	65	66
HK and Singapore	6	9	8	9	8	8
Japan	84	81	81	81	81	81
Australia/NZ	187	199	197	198	204	204
North America	126	140	144	135	139	139
Western Europe	113	99	99	99	99	99
Former Soviet Union	87	93	92	93	93	93
India	100	101	100	100	101	102
Rest of the World	92	96	95	95	96	96
World	100	100	100	100	100	100

[a] Aggregation across different grain types is based on value weights not physical volumes.

Source: Authors' model results.

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Appendix Table 1. Income Elasticities of Demand Used in the Simulations.

	CHN	IDN	PHL	THA	MYS	KOR	TWN	HKS	JPN	ANZ	NAFTA	WEU	CIS I	IDI	ROW
Rice	0.22	0.11	0.19	0.20	0.17	0.37	0.32	0.46	0.34	0.43	0.37	0.46	0.32	0.30	0.20
Wheat	0.36	0.91	0.47	0.49	0.26	0.44	0.40	0.49	0.34	0.31	0.23	0.36	0.16	0.47	0.35
CrsGrns	0.09	0.10	0.19	0.20	0.14	0.37	0.32	0.32	0.34	0.31	0.23	0.36	0.16	0.09	0.12
OthCrops	0.75	0.66	0.62	0.62	0.52	0.68	0.65	0.47	0.60	0.43	0.38	0.54	0.70	0.72	0.56
MeatLstk	1.11	0.79	0.60	0.44	0.32	0.70	0.66	0.60	0.77	0.39	0.29	0.49	0.60	0.67	0.46
ProcFood	0.99	0.94	0.87	0.82	0.81	0.82	0.83	0.75	0.70	0.71	0.58	0.70	0.91	0.87	0.74
NatRes	1.06	1.44	1.34	1.25	1.21	1.22	1.21	1.11	1.10	1.11	1.11	1.11	1.49	1.78	1.33
Textiles	1.07	0.87	0.90	0.82	0.79	0.91	0.89	0.93	0.91	0.92	0.89	0.92	1.13	0.91	0.90
WearApp	1.07	0.87	0.90	0.82	0.79	0.91	0.89	0.92	0.91	0.92	0.89	0.92	1.13	0.91	0.89
LightMnfc	1.41	1.38	1.29	1.24	1.21	1.17	1.17	1.09	1.08	1.10	1.08	1.09	1.45	1.40	1.25
TMEq	1.55	1.15	1.15	1.24	1.20	1.10	1.08	1.06	1.04	1.05	1.04	1.06	1.36	1.24	1.17
HeavyMnfc	1.49	1.44	1.34	1.25	1.21	1.22	1.21	1.13	1.10	1.11	1.10	1.11	1.49	1.78	1.29
Services	1.29	1.34	1.24	1.19	1.15	1.14	1.12	1.09	1.07	1.06	1.06	1.07	1.38	1.40	1.20

Source: Authors' model.