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Growth in Emerging Economies:
Implications for Resource-Rich Countries by 2030

Kym Anderson,
University of Adelaide, Australian National University and CEPR
kym.anderson@adelaide.edu.au

and

Anna Strutt,
University of Waikato and University of Adelaide
astrutt@waikato.ac.nz

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Abstract

Rapid growth in recent decades has significantly increased the global economic importance of some emerging economies. If this rapid growth continues and is concentrated in resource-poor Asian economies, so too will the growth in demand for imports of primary products, to the on-going benefit of resource-rich countries. This paper explores how global trade patterns might change over the next two decades in the course of economic development and structural changes under various growth and trade reform scenarios. We employ the GTAP model and Version 8 of the GTAP database, along with supplementary data from a range of sources to support projections of the global economy to 2030. We first project a baseline from 2007 to 2030, assuming trade-related policies do not change in each region but that agricultural land, extractable mineral resources, population, skilled and unskilled labour, capital and real GDP grow at exogenously-estimated rates. Given the relatively long time-frame over which we are modelling, we modify the standard GTAP agricultural product income elasticities for rapidly growing developing countries, along with Armington elasticities, to more appropriately reflect their likely values over this time-frame. In the initial projection, the rate of total factor productivity growth is assumed to be the same in each of the non-primary sectors, and to be somewhat higher in the primary sectors. This core projection of the world economy is then compared with a number of alternative scenarios, including: slower productivity growth in primary sectors (so that real international prices for primary products rise well above 2007 levels by 2030, consistent with recent projections of international agencies such as the FAO, OECD, IFPRI and the IEA); faster grain productivity growth in China and India; and also liberalization of global trade barriers.

Keywords: Global economy-wide model projections; Asian economic growth and structural change; South-South trade; booming sector economics, food security

JEL codes: D58, F13, F15, F17, Q17

Author contact:
Kym Anderson
School of Economics
University of Adelaide
Adelaide SA 5005 Australia
Phone +61 8 8303 4712
Fax +61 8 8223 1460
kym.anderson@adelaide.edu.au

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1. Introduction

Rapid economic growth in emerging economies is shifting the global economic and industrial centre of gravity away from the north Atlantic, and globalization is causing trade to grow much faster than output, especially in Asia. Together these forces are raising the importance of natural resource-poor Asian economies in world output and trade, and are increasing the demand for exports from natural resource-rich economies. This is a continuation of a process begun in Japan in the 1950s and followed by Korea and Taiwan from the late 1960s, then by some Southeast Asian countries, but most recently by much more populous China and India. The earlier Northeast Asian group represents just 3 percent of the world's population and so its rapid industrial growth was accommodated by the rest of the world without much difficulty, including in markets for primary products. China and India, by contrast, account for more than two-fifths of humanity and so their rapid and persistent industrialization has far greater significance for primary product markets and thus for such things as food and energy security and greenhouse gas emissions regionally and globally. A boom in non-primary sectors also can exacerbate rural-urban income disparities in such fast-growing economies. How governments respond to these concerns could have non-trivial effects in both the emerging economies and those of their trading partners and competitor countries.

This paper focuses on the consequences for primary product markets, and for food and energy security, of the prospective continuation of this latest generation of Asian industrialization. There is a strong body of trade and development theory to suggest what to expect. There is also the historical experience of the two previous generations of Asia's industrializing economies and, since the 1980s, of the newest generation's first decades of rapid growth. And there are many new speculative studies about prospective economic developments, from both academics (e.g., Rodrik 2011 and Spence 2011) and major consulting firms (e.g., Citi 2011 and PwC 2011). This paper briefly summarizes that theory, history, and set of forecasts as a way of anticipating likely trends over the next two decades. Those expectations are then put to the test using a global economy-wide model for projecting

the world economy to 2030. Results that emerge from a core business-as-usual projection are compared with those generated using alternative assumptions about sectoral productivity growth rates and trade policies, so as to be able to draw out implications for national food and energy security of a range of scenarios.

The paper's core projection assumes trade policies and the trade imbalances of the United States and China continue, and that endowment and productivity growth rates are sufficient to allow global export supplies of agricultural, mineral and manufactured products to expand to almost keep pace with import demands. This ensures the prices of primary products relative to manufactures in international markets in 2030 are only modestly above 2007 levels.

That core projection is compared with two alternative growth scenarios to 2030. One involves slower productivity growth in primary sectors globally, in which case the relative price of primary products will be somewhat higher by 2030 – as forecast by some international agencies. The other growth scenario assumes faster grain productivity growth in China and India due to expanded domestic agricultural R&D aimed at slowing the rise in their foodgrain import dependence that is projected in the core scenario to otherwise occur. It also examines how the world would look if all its trade barriers were to be removed and economies had fully adjusted by 2030. The paper concludes by drawing out key lessons and implications for policies from the results.

2. Theory and past experience

China and India, like Northeast Asia's earlier rapidly industrializing economies, are relatively natural resource-poor and densely populated. So too are some other Asian countries. They are therefore highly complementary with relatively lightly populated and slower-growing economies well endowed with agricultural land and/or mineral resources in Australasia, Latin America, the Middle East and Sub-Saharan Africa (see Table 1 for crude indicators of relative factor endowments), according to the workhorse theory of comparative advantage developed in the 20th century. That theory blends the Heckscher-Ohlin-Samuelson model, which assumes all factors of production are mobile between sectors, with the Ricardo-Viner model which assumes some factors are sector-specific. Such a blend is provided by Krueger (1977) and explored further by Deardorff (1984). They consider two tradable sectors each using intersectorally mobile labour plus one sector-specific factor (natural-resource capital or

produced capital). Assuming that labour exhibits diminishing marginal product in each sector, and that there are no services or nontradables and no policy distortions, then at a given set of international prices the real wage in each economy is determined by the aggregate per worker endowment of natural-resource and produced capital. The commodity composition of a country's trade – that is, the extent to which a country is a net exporter of primary or industrial products – is determined by its endowment of natural relative to industrial capital compared with that ratio for the rest of the world.

Leamer (1987) develops this model further and relates it to paths of economic development. If the stock of natural resources is unchanged, rapid growth by one or more economies relative to others in their availability of produced capital (physical plus human stills and technological knowledge) per unit of available labor time would tend to cause those economies to strengthen their comparative advantage in non-primary products. By contrast, a discovery of minerals or energy raw materials would strengthen that country's comparative advantage in mining and weaken its comparative advantage in agricultural and other tradable products, ceteris paribus. It would also boost national income and hence the demand for nontradables, which would cause mobile resources to move into the production of nontradable goods and services, further reducing farm and industrial production (Corden 1984).[1]

Domestic or foreign savings can be invested to enhance the stock and/or improve the quality not only of a country's produced capital but also of its economically exploitable stock of natural resources. Any such increase in the net stock of produced capital per worker will put upward pressure on real wages. That will encourage, in all sectors, the use of more labor-saving techniques and the development and/or importation of better technologies that are less labour intensive. Whether it boosts industrialization more than agriculture or other primary production will depend on the relative speed of sector-specific productivity growth that such R&D investments yield. Which types of investment would expand fastest in a free-market setting depends on their expected rates of return. The more densely populated, natural resource-poor an open economy is, the greater the likelihood that the highest payoff would be in expanding stocks of capital (including technological knowledge) for non-primary sectors.

At early stages of development of a country with a relatively small stock of natural resources per worker, wages would be low and the country would have a comparative cost

[1] In fact the increased demand for nontradables (and other products) would begin as soon as expectations about future income prospects rose, which could be well before the mining export boom shows up in the trade statistics, especially in the case where the exports are preceded by FDI inflows for investments with a long lead time (Corden 1982).

advantage in unskilled labor-intensive, standard-technology manufactures. Then as the stock of industrial capital grows, there would be a gradual move toward exporting manufactures that are relatively intensive in their use of physical capital, skills and knowledge. Natural resource-abundant economies, however, would invest more in capital specific to primary production and so would not develop a comparative advantage in manufacturing until a later stage of development, at which time their industrial exports would be relatively capital intensive.

The above theory of changing comparative advantages – which can also be used to explain shocks to that pattern from discovery-driven mining booms or major terms of trade changes imposed from the rest of the world – has been used successfully to explain the evolving trade patterns of Asia's resource-poor first- and second-generation industrializing economies and their resource-rich trading partners (see, e.g., Anderson and Smith 1981). It has also explained the 20th century evolution, for early- and later-industrializing countries, of the flying geese pattern of comparative advantage and then disadvantage in unskilled labor-intensive manufactures as some rapidly growing economies expand their endowments of industrial capital per worker relative to the rest of the world – the classic example being clothing and textiles (Anderson 1992; Ozawa 2009).

Useful though the above theory has been, it is less able to explain a more recent and rapidly expanding part of Asia's international trade within individual manufacturing industries, which is in intermediate inputs. This phenomenon has been driven by the lowering of trade costs thanks to the information and communication technology revolution and the opening up to foreign direct investment, both of which have facilitated networking abroad by firms (Kozo et al. 2008). It is increasing the scope to subdivide the processes of production into ever-smaller parts that can be relocated anywhere in the world according to changes in comparative advantages over time (Jones and Kierzkowski 1997; Feenstra 1998; Arndt and Kierzkowski 2001). Its modes include sub-contracting, licensing, joint ventures, and vertical direct foreign investment by multinational corporations (Markusen et al. 1996).

The evolving pattern of a country's production and trade specialization depends on its changes not only in its comparative advantages but also in its sectoral and trade policies. If a developing economy that had been protecting its manufacturers from import competition chose to lower those barriers, there would be two sets of consequences. One is that the country would be better able to specialize in those manufacturing activities in which it had its strongest comparative advantages and to nimbly alter its product mix as those advantages evolved. The other is that its real exchange rate would depreciate, allowing other tradable

sectors such as agriculture to expand production and net exports. If the economy had been taxing exports of primary products, a lowering of them also would allow production of those goods to grow. And if a dual or multiple exchange rate system was replaced by a market-driven system, that reform would effectively remove that implicit form of trade taxation (Dervis, de Melo and Robinson 1981) and thus amplify the above effects.

According to a recent multi-country empirical study, precisely those types of policy reforms have taken place in many developing countries over the past three decades. More specifically, policy-induced distortions to the domestic prices of agricultural goods relative to other tradable product prices had discriminated heavily against many developing country farmers prior to the 1980s, but they have since been greatly reduced (Anderson 2009). According to Figure 1, this is particularly so in Asia.

That new evidence on Relative Rates of Assistance (RRAs, defined in note 1 of Figure 1) sheds light on something that has perplexed agricultural trade analysts for some time (see, e.g., Anderson and Peng 1998): why self-sufficiency in farm products in China, India and some other densely populated emerging Asian economies has fallen so little (see Table 2), despite very strong growth in production and exports of manufactures (and of certain tradable services in the case of India). The fact that the RRA is now close to zero on average for the region raises the question: will it remain close to zero, rather than keep on rising as happened in more-affluent Asian countries? If yes, then will expectations from theory now be realized in the form of declining self-sufficiency in farm products as industrialization proceeds?

3. Modeling methodology and database

Given the interdependence between sectors of growing economies, an economy-wide model of the world's national markets is needed to project future trends in agricultural trade and food security. In this study we employ the GTAP model (Hertel 1997) of the global economy and the new Version 8 of the GTAP database which is calibrated to 2007 levels of production, consumption, trade and protection (Aguiar, McDougall and Narayanan 2012). The standard GTAP model is perhaps the most widely used CGE model for economy-wide global market analysis, in part due to its robust and explicit assumptions; and its base period of 2007 is ideal because it immediately precedes the recent period of temporary spikes in food and fuel prices and the global financial crisis and recession.

In its simplest form, the model assumes perfect competition and constant returns to scale in production. The functional forms are nested constant elasticities of substitution (CES) production functions. Land and other natural resources, labor (skilled and unskilled), and produced physical capital substitute for one another in a value added aggregate, and composite intermediate inputs substitute for value-added at the next CES level in fixed proportions. Land is specific to agriculture in the GTAP database, and is mobile amongst alternative agricultural uses over this projection period, according to a relatively high Constant Elasticity of Transformation (CET) which, through a revenue function, transforms land from one use to another. In the modified version of the GTAP model we use, natural resources, including coal, oil, gas and other minerals, are specific to the sector in which they are mined. Aggregate national employment of each productive factor is fixed in the standard macro-economic closure, although we use exogenous projections to model changes in factor availability over time. Labor and produced capital are assumed to be mobile across all uses within a country, but immobile internationally, in the long-run model closure adopted.

On the demand side there is a national representative household whose expenditure is governed by a Cobb-Douglas aggregate utility function which allocates net national expenditures across private, government, and saving activities. The greatest advantage of this household representation is the unambiguous indicator of economic welfare dictated by the national utility function.[2] Government demand across composite goods is determined by a Cobb-Douglas assumption (fixed budget shares). Private household demand is represented by a Constant Difference of Elasticities (CDE) functional form, which has the virtue of capturing the non-homothetic nature of private household demands, calibrated to replicate a vector of own-price and income elasticities of demand (Hertel et al. 2008). In projecting to 2030 we modify these elasticities for developing country crops and animal products for rapidly growing economies so they more closely match the income elasticities for these products in currently higher-income countries (following Yu et al. 2004).

Bilateral international trade flows are handled through the Armington (1969) specification by which products are differentiated by country of origin. These Armington elasticities are the same across countries but are sector-specific, and the import-import elasticities have been estimated at the disaggregated GTAP commodity level (Hertel et al. 2007). For present purposes, where we are dealing with long-term changes, we follow the

[2] Altering taxes in the GTAP model does not imply a reduction in government revenue and expenditure, as government expenditures are not tied to tax revenues. A tax reduction, for example, leads to a reduction in excess burden, so regional real income increases and real expenditure – including government expenditure – may also rise.

typical modelling practise of doubling the short-to-medium term Armington elasticities. The national balance of trade is determined by the relationship between national investment and savings and investment can be allocated either in response to rates of return, with capital markets kept in equilibrium, or in fixed shares across countries so that it moves in line with global savings. For present purposes we allow savings and investment to respond to changes in rates of return.

The GTAP version 8 database divides the world into 129 countries/country groups, and divides each economy into 57 sectors: 20 for agriculture, food, beverages and tobacco, 6 for other primary goods, 16 for manufactures and 15 for services. For most modelling tasks, including this one, it is necessary for the sake of both computational speed and digestion of model outputs to restrict the number of regions and sectors. In the present study we initially aggregate to 35 countries/country groups and to 26 sector/product groups, as shown in colum 2 of Appendix Tables A.1 and A.2. We then further aggregate to 14 regions and just 4 sectors for many tables presented in this paper, as defined in column 1 of those Appendix Tables. We also aggregate countries into natural resource rich and natural resource poor regions, as indicated in column 2 of Appendix Table A.1

4. Core projection of the database to 2030

We project the GTAP database's 2007 baseline for the world economy to provide a new core baseline for 2030 by assuming the 2007 trade-related policies of each country do not change. However, over the 26-year period we assume that national real GDP, population, unskilled and skilled labor, capital, agricultural land, and extractable mineral resources (oil, gas, coal and other minerals) grow at exogenously set rates, summarized in Appendix Table A.3. The exogenous growth rates for GDP, investment and population are based on estimates from the World Bank and CEPII (Fouré et al. 2010).[3] For projections of skilled and unskilled labour growth rates, we draw on Chappuis and Walmsley (2011). We estimate historical trends in agricultural land from FAOSTAT (summarized in Deininger and Byerlee 2011) and in mineral and energy raw material reserves from BP (2010) and the US Geological Survey (2010) and assume that past annual rates of change in fossil fuel reserves since 1990 continue

[3] Compiled from Chappuis and Walmsley (2011).

for each country over the next two decades.[4] For other minerals, in the absence of country-specific data, the unweighed average of the annual rate of growth of global reserves for iron ore, copper, lead, nickel and zinc between 1995 and 2009 for all countries is used (from the US Geological Survey 2010). These rates of change in natural resources are summarized in the last five columns of Appendix Table A.3.

Given those exogenous growth rates,[5] the model is able to derive implied rates of total factor productivity and GDP per capita growth. For any one country the rate of total factor productivity growth is assumed to be the same in each of its non-primary sectors, and to be somewhat higher in its primary sectors. Higher productivity growth rates for primary activities were characteristic of the latter half of the 20th century (Martin and Mitra 2001), and are necessary in this projection if real international prices of primary products (relative to the aggregate change for all products) are to rise only modestly. We chose that calibration for our core simulation because it is consistent with the World Bank projections over the next four decades (see van der Mensbrugghe and Roson 2010). An alternative projection in which prices rise by even more is considered below. We do not consider one in which agricultural prices fall, as occurred in the latter half of the 20th century (Figure 2) and as projected in GTAP-based projection studies in the late 20th century (e.g., Anderson et al. 1997), because that seems too unlikely a scenario over the next two decades, given the slowdown in agricultural R&D investment since 1990 and its consequent delayed slowing of farm productivity growth (Alston, Babcock and Pardey 2010). It is even less likely for farm products if fossil fuel prices and biofuel mandates in the US, EU and elsewhere are maintained over the next decade.[6]

The implied TFP growth rates for all sectors are shown in the first column of Appendix Table A.4,[7] and the international price consequences for the core simulation are depicted in Appendix Table A.5.

It should be noted that the extent to which productivity growth rates are higher in each primary sector than in other sectors is the same for high-income and developing countries,[8]

[4] Past reserves data are from BP (2010). For coal, however, production data are used since reserves data are not available. The growth rates for Vietnam's oil and gas, along with Indonesia's and Thailand's coal, provided implausibly high projections for the future, so they were modified downward.

[5] There is much uncertainty in macroeconomic projections over this kind of timeframe. See, for example Garnaut (2011) for some discussion on the uncertain nature of GDP, population and energy projections.

[6] Timilsina et al. (2010) project that by 2020 international prices will be higher in the presence versus the absence of those biofuel mandates for sugar (10 percent), corn (4 percent), oilseeds (3 percent), and wheat and coarse grains (2.2 percent), while petroleum product prices will be 1.4 percent lower. On the complexity of recently introduced biofuel policies, see de Gorter (2011).

[7] In the initial core baseline, these TFP estimates are endogenously determined. However, in the subsequent simulations, it is the TFP estimates that are exogenous while GDP is endogenous.

and is the same for all crop and livestock industries within each country's farm sector. Since overall TFP growth is higher for developing than high-income countries in Appendix Table A.4, this means we are assuming agricultural TFP growth is higher for developing than high-income countries on average. That is consistent with recent (if not earlier) experience: Ludena et al. (2007, Table 2) estimate that agricultural TFP annual growth during 1981-2000 averaged 1.3 percent globally and only 0.9 percent for high-income countries (but during 1961-80 those rates were 0.6 and 1.4 percent, respectively).

4.1 Consequences for size and sectoral and regional compositions of GDP and trade

The differences across regions in rates of growth of factor endowments and total factor productivity, and the fact that sectors differ in their relative factor intensities and their share of GDP, ensure that the structures of production, consumption and trade across sectors within countries, and also between countries, is going to be different in 2030 than in 2007.

In particular, the faster-growing developing economies (especially those of Asia) will account for considerably larger shares of the projected global economy over the next two decades. Their aggregate share of world GDP (measured in 2007 US$, not PPP dollars in which developing country shares are much larger) is projected to rise from 27 percent in 2007 to 46 percent in 2030, and for just Developing Asia from 15 to 32 percent. Western Europe's share, meanwhile, is projected to fall from one-third to almost one-fifth. Population shares change much less, with the developing countries' share rising from 81 to 83 percent but Developing Asia's component falling a little, from 54 to 53 percent between 2007 and 2030. Thus per capita incomes converge considerably, with the ratio of the high-income to developing country average halving between 2007 and 2030. In particular, the per capita income of Developing Asia is projected to rise from 27 to 60 percent of the global average over the projection period (bottom rows of Appendix Table A.6).

When global value added is broken down by sector,[9] the changes are more striking. This is especially so for China: by 2030 it is projected to return to its supremacy as the world's top producing country not only of primary products but also of manufactures (Table 3). This is a ranking China has not held since the mid-19th century when first the UK and then (from 1895) the US was the top-ranked country for industrial production – see Allen (2011, Figure 2) and also Bairoch (1982) and Crafts and Venables (2003).

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[8] With the exception of China and India.
[9] Using producer expenditure on value added in each sector.

The Asian developing country share of global exports of all products nearly doubles, rising from 22 to 40 percent between 2007 and 2030 (Table 4). China's share alone grows from 8 to 21 percent. Note, however, that the growth of China's export share is entirely at the expense of high-income countries, as the export shares for all the other developing-country regions in Table 4 also grow. The group's import share also rises, although not quite so dramatically: the increase for Developing Asia is from 19 to 34 percent (Table 5).[10]

The developing country share of primary products in world exports rises slightly and its share of manufactures in world exports rises dramatically over the projection period (almost doubling, as does its services share – Table 4). The developing country share of primary products in world imports rises substantially too (Table 5), almost all of which is due to Developing Asia's expected continuing rapid industrialization. Developing Asia and other developing countries increase their share in total world imports by more than half, and nearly by half even in manufactures. The latter rise would be considerably larger if our model had been able to accommodate the on-going fragmentation of global production of manufactured goods, whereby the supply chain has many components whose production is footloose: we understate that phenomenon because of the high degree of aggregation of manufacturing industries in the version of the GTAP model we use here. It would be even larger had we accommodated endogenous foreign direct investment flows, since they tend to reinforce trade flows in manufactures within Asia (Petri 2012).

As for the sectoral shares of national trade, the consequences of continuing Asian industrialization are again evident: primary products are less important in developing country exports and considerably more important in their imports, and conversely for non-primary products, with the changes being largest in Developing Asia. The opposite is true for high-income countries (Tables 6 and 7), which may seem surprising but recall that (a) what one part of the world imports the remaining part of the world must export to maintain global equilibrium and (b) we have not allowed for possible agricultural protection growth in this core scenario (but again see Anderson and Strutt 2012a). Note also from Table 6 that services exports are far more important for India than for China or ASEAN, and that difference is projected to increase substantially by 2030. These changes occur despite little change in the share of GDP trade (Table 8).

4.2 Consequences for bilateral trade

[10] Capital flows explain the difference between each region's global export and import shares.

Turning now to bilateral trade patterns (Table 14 (a) and (b)), we find a 4 percentage point increase in the significance of natural resource rich countries in global exports between 2007 and 2030. For natural resource poor countries, their share of global exports reduces from 61 to 57 percent, despite the inclusion of China in this group, which alone increases export shares from 8 to 21 percent.

For bilateral trade in food and agricultural products, the trade pattern shift is even more striking in our projection from 2007 to 2030 (Table 15 (a) and (b)). Natural resource rich countries increase their share of global food and agricultural exports by 6 percent, while natural resource poor countries reduce their share by over 10 percent. The global import shares of these commodities remain relatively constant over the projection for natural resource rich and natural resource poor countries. , though we note that the other high income country group reduces their share of global imports by

4.3 Consequences for food self-sufficiency and consumption of agricultural products

Given the political sensitivity of farm products, regional shares of global trade in just agricultural and food products are shown in Table 9. The developing country share of exports of those goods is projected to grow by only two percentage points. However, that country group's share of global imports of farm products rises dramatically, from 32 to 58 percent (columns 6 and 7 of Table 9). Hence its self-sufficiency ratio falls considerably. The source of that change is mainly China but also South Asia (columns 1 and 2 of Table 10). It is possible that these populous countries will seek to prevent such a growth in food import dependence in practice, by erecting protectionist barriers at least for food staples (not modelled here, but see Anderson and Strutt 2012a). Looking at the commodity detail, for India and China the projected economic growth to 2030 leads to decreases in self-sufficiency in both crop and livestock products (Table 11).

Self sufficiency is a poor indicator of food security, however (Warr 2011). A more meaningful indicator is real per capita private consumption of agricultural and processed food products by households. Table 12 reports those results. It shows that between 2007 and 2030 real per capita food consumption would more than double for developing countries (a 103 percent rise). It would increase even more for China and India, by about 160 percent. These are dramatic improvements in food consumption such that, even if income distribution were

to worsen over the next two decades, virtually all groups in those economies could expect to be much better fed by 2030 according to this baseline scenario.

5. Alternative TFP growth projections to 2030

The above core projection is but one of myriad possibilities, so in this section we explore others and compare their economic consequences with those just summarized for 2030. Specifically, the following two alternative growth scenarios are considered:

- ***Slower total factor productivity (TFP) growth in primary sectors in all countries***, so that real international prices for agricultural, mineral and energy products by 2030 are much more above 2007 levels than in the core projection and thus closer to 2012 prices, and more consistent with the projections of some international agencies that specialize in those markets instead of with the World Bank's projections; and
- ***Faster total factor productivity (TFP) growth in grain cropping in China and India,*** so grain output is higher in those Asian countries.

5.1 Slower TFP growth in primary sectors in all countries

The core projection sets higher TFP growth rates for some primary product sectors than for other sectors such that average real international prices for agricultural, mineral and energy products by 2030 are around one-tenth above 2007 levels (column 1 of Appendix Table A.5). As is clear from Figure 2, that is quite different from what was experienced in the 20th century, when real primary product prices traced a long-run downward trend (apart from the 1973 and 1979 OPEC cartel-induced jumps in the price of fossil fuels). In the past decade, however, those prices have been rising, and price projections of several international agencies suggest they will be well above 2007 levels in the next decade or two (FAO/OECD 2010, Nelson et al. 2010, IEA 2010). Hence in this alternative scenario we assume the additional TFP growth of two percentage points per year for forestry and fishing is reduced to 1 percentage point. For mining, agriculture and lightly processed food the productivity differential in the core projection is smaller, but it too is reduced by 1 percentage point. These amendments lead to real international prices for farm products in 2030 to be 17 instead of 10 percent above those in 2007, and those for other primary products to be 57 instead of 7

percent above 2007 levels (see columns 1 and 2 of Appendix Table A.5 for details by product).

The higher prices more than compensate for lower farming and mining productivity such that the share of primary products in GDP is somewhat higher in this scenario than in the core projection. This does not lead to developing countries being more food self-sufficient though (Table 10), nor to much change in their share of global trade in farm products (Table 9). It does, however, raise considerably the share of GDP that is traded by each region (Table 8), due largely to the higher prices of primary products.

5.2 Faster total factor productivity (TFP) growth in grain cropping in China and India

In this next alternative scenario, the TFP growth rates for rice, wheat and coarse grains are set an extra 1 percent higher for just China and India. This could come about by boosting agricultural R&D in the region, marginal returns from which are likely to be so high as to not need to worry about modelling their up-front cost (Alston et al. 2000, 2009). Such a boost does not make a discernable difference to overall agricultural self-sufficiency rates for these countries, however, it raises self-sufficiency in grains by between 1 and 7 percent for China and India (Table 11(b) and (d)). Also it brings down the international price of grains a little (first three rows of Appendix Table A.5). This higher grain productivity does slightly increase the share of China and India in global agricultural and food exports, while reducing their share of global agricultural and food imports, particularly in the case of India (Table 9).

6. Projections to 2030 if all merchandise trade is freed

The above scenarios all assume trade policies remain unchanged between the base period and 2030. This section examines how the above core scenario for 2030 would be altered if all merchandise trade is freed by all countries of the world (global MFN). This would boost farm production and exports in developing countries more than in high-income countries (Table 9).

7. Caveats

As with the results from all other economy-wide projections modelling, it is necessary to keep in mind numerous qualifications. One is that for the core projection we have assumed

trade costs in the form of transport and communications costs do not change, even though they have been falling steadily during the current wave of globalization. Table 8 therefore understates the likely growth in the share of GDP traded.

A second assumption is that we have aggregated the model into just 26 sectors/product groups. This leads to gross underestimation of the extent to which firms can take advantage of intra-industry trade through exploiting the increasing opportunities to lower costs through fragmenting the production process into ever-more pieces whose location is footloose.

Third, we have assumed constant returns to scale and perfect competition rather than allowing firms to enjoy increasing returns and some degree of monopoly power for their differentiated products. This too leads to underestimates of the welfare gains from trade reform (Krugman 2009). The fact that opening an economy exposes monopolistic firms to greater competition generates gains from trade reform that could be quite substantial in terms of reducing firm mark-ups, according to numerous country case studies (see, e.g., Krishna and Mitra (1998) on India).

Fourth, where consumers (including firms importing intermediate inputs) value a greater variety of goods, or a greater range of qualities, intra-industry trade can grow as a result of both economic growth and trade policy reform, but that too is not taken into account in the above analysis.

Fifth, in the trade reform scenario we have not allowed domestic policies also to be reformed (apart from agricultural subsidies), even though it is typical for trade reforms – including in the context of signing regional trade agreements – to be part of a broader program of microeconomic policy reform. Recent studies show that when labor markets are freed up at the same time as trade, for example, they can have very different welfare and bilateral trade effects than if those factor markets remain inflexible (Helpman, Marin and Verdier 2008, Helpman and Itskhoki 2010). That is true also when financial market reforms are considered, not least because the inclusion of financial markets allows an additional set of influences on real exchange rates (see, e.g., McKibbin and Stegman 2005). Hoxha, Kalemli-Ozcan and Vollrath (2009) examine gains from financial integration and find that a move from autarky to full integration of financial markets globally could boost real consumption by 7.5 percent permanently, even assuming no accompanying productivity gains. National case studies of reform to services trade more generally also find gains several times those from goods trade reform (e.g., Dee, Hanslow and Pham 2003, Konan and Maskus 2006, Rutherford and Tarr 2008). However, estimating the extent of and effects of globally

removing barriers to services and factor flows between countries is far less developed than methodologies applied to trade in goods (Francois and Hoekman 2010).

Sixth, our model has not included the new biofuel policies that have been put in place in many countries but mostly since our 2004 base year. The new biofuel mandates and subsidies have had a non-trivial effect of increasing both the mean and the variance of international food prices, and are expected to become even more important over the next decade as the mandates in the United States and EU in particular increase to 2020-21 (see Hertel and Beckman 2011, Hertel and Diffenbaugh 2011, de Gorter, Drabik and Kliauga 2011, and the references therein).

Finally, the standard GTAP model used here is comparative static. It therefore does not measure the additional dynamic consequences trade reform. Dynamic effects arise in numerous ways. One of the more important is through encouragement of the more-efficient firms to take over from the less efficient in each country (Melitz 2003, Bernard et al. 2007, Melitz and Ottaviano 2008). Another way is through multinational firms sharing technologies and knowledge across countries within the firm (Markusen 2002). Offshoring is yet another mechanism through which heterogeneous firms are affected by trade liberalization, including via re-locating from small to larger nations (Baldwin and Okuba 2011). The greater competition that accompanies trade reform also can stimulate more innovation (Aghion and Griffith 2005), leading to higher rates of capital accumulation and productivity growth (Lumenga-Neso, Olarreaga and Schiff 2005).

8. Policy implications and conclusions

Should relatively rapid economic growth in Asia and to a lesser extent in other developing countries continue to characterize world economic development as suggested above, developing Asia's share of global GDP and trade will continue to rise steeply over the next two decades. Their share of global agricultural GDP is projected to almost double also, but that is not fast enough to keep pace with their growing consumption of food. Table 13 shows that, by 2030, developing Asia is projected to consume nearly half of the world's grain and fossil fuels (or even more if carbon taxes are introduced in high-income countries but not emerging economies), and three-quarters of the world's other minerals. This is possible because their shares of the world's imports of primary products are projected to treble between 2007 and 2030 in the core scenario (Figure 3).

Since Asia in total accounts for around two-fifths of all agricultural and food output and consumption currently, and that global share will be three-fifths by 2030, its food security is likely to be greatest when markets for farm products are always open, and not only regionally but globally. This is because greater openness ensures international markets are 'thicker' and thus more stable and predictable, and hence are more likely to reduce poverty through encouraging investment and boosting employment prospects and economic growth.

This basic truth seems anathema to those governments who perceive food security as a production issue rather than a consumption issue, and who thus focus on food self-sufficiency rather than on the spending capability of the poor. Such a view is understandable, though, in a world where other countries protect and insulate their domestic producers. Throughout the post-World War II era many governments, in Asia as elsewhere, have been reluctant to open their agricultural markets. True, taxes on farm trade have fallen in many countries since the 1980s, but not in Northeast Asia where government assistance to farmers remains extremely high, having risen inexorable since the 1950s. That is partly why farm policies are still by far the most welfare-reducing of the restrictions to global merchandise trade.[11] Were China and India to follow those Northeast Asian countries in raising their assistance to farmers as their per capita incomes grew – as they have been doing already in recent decades (Figure 4) – the contribution of farm policies to the global cost of goods trade barriers would become even higher.

References

Aghion, P. and R. Griffith (2005), *Competition and Growth: Reconciling Theory and Evidence*, Cambridge MA: MIT Press.

Aguiar, A., R. McDougall and B. Narayanan (eds.) (2012), *Global Trade, Assistance, and Production: The GTAP 8 Data Base*, West Lafayette: Center for Global Trade Analysis, Purdue University. www.gtap.agecon.purdue.edu/databases/v8/v8_doco.asp

Allen, B. (2011), *Global Economic History: A Very Short Introduction,* London: Oxford University Press.

[11] Martin (2006, Ch. 12 and Anderson (2009a, Ch. 13). This reluctance on the part of governments to open food trade is worst when international prices spike up or down (Anderson and Nelgen 2012) – even though the net effect of many national governments so seeking to insulate their consumers or farmers from such fluctuations has been shown to be rather ineffective and to exacerbate the spike in international food prices (Martin and Anderson 2012).

Alston, J.M., B.A. Babcock and P.G. Pardey (eds.) (2010), *The Shifting Patterns of Agricultural Production and Productivity Worldwide*, Midwest Agribusiness Trade Research and Information Center, Iowa State University, Ames IA.

Alston, J.M., J.M. Beddow and P.G. Pardey (2009), 'Agricultural Research, Productivity, and Food Prices in the Long Run', *Science* 325: 1209-10, September 4.

Alston, J.M., M.C. Marra, P.G. Pardey and T.J. Wyatt (2000), *A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem?* Washington DC: International Food Policy Research Institute.

Anderson, K. (ed.) (1992), *New Silk Roads: East Asia and World Textile Markets*, Cambridge and New York: Cambridge University Press.

Anderson, K. (ed.) (2009), *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

Anderson, K., B. Dimaranan, T. Hertel and W. Martin (1997), 'Economic Growth and Policy Reforms in the APEC Region: Trade and Welfare Implications by 2005', *Asia-Pacific Economic Review* 3(1): 1-18, April.

Anderson, K. and W. Martin (eds.) (2006), *Agricultural Trade Reform and the Doha Development Agenda***,** London: Palgrave Macmillan and Washington DC: World Bank.

Anderson, K. and S. Nelgen (2011), 'What's the Appropriate Agricultural Protection Couterfactual for Trade Analysis?', Ch. 13 in *The Doha Development Agenda***,** edited by W. Martin and A. Mattoo, London: Centre for Economic Policy Research for the World Bank.

Anderson, K. and S. Nelgen (2012), 'Trade Barrier Volatility and Agricultural Price Stabilization', *World Development* 40(1): 36-48, January.

Anderson, K. and H. Norheim (1993), 'Is World Trade Becoming More Regionalized?' *Review of International Economics* 1(2): 91-109, June.

Anderson, K. and C.Y. Peng (1998), 'Feeding and Fueling China in the 21st Century', *World Development* 26(8): 1413-29, August.

Anderson, K. and B. Smith (1981), "Changing Economic Relations Between Asian ADCs and Resource-Exporting Developed Countries", in *Trade and Growth in the Advanced Developing Countries*, edited by W. Hong and L. Krause, Seoul: Korea Development Institute Press.

Anderson, K. and A. Strutt (2012a), 'Global Food Markets in 2030: What Roles for Farm TFP Growth and Trade Policies?', Paper presented at the AARES Pre-Conference Workshop on Global Food Security, Fremantle, 7 February.

Anderson, K. and A. Strutt (2012b), 'The Changing Geography of World Trade: Projections to 2030', *Journal of Asian Economics* 23(4): 303-23, August.

Anderson K. and E. Valenzuela (2008), 'Estimates of Global Distortions to Agricultural Incentives, 1955 to 2007', World Bank, Washington DC, October, accessible at www.worldbank.org/agdistortions.

Armington, P. (1969), 'A Theory of Demand for Products Distinguished by Place of Production', *IMF Staff Papers* 16: 159-78.

Arndt, S. and H. Kierzkowski (eds.) (2001), *Fragmentation: New Production Patterns in the World Economy*, London and New York: Oxford University Press.

Bairoch, P. (1982), 'International Industrialization Levels from 1750 to 1980', *Journal of European Economic History* 11: 269-331.

Baldwin, R. and T. Okuba (2011), 'International Trade, Offshoring and Heterogeneous Firms', NBER Working Paper 16660, Cambridge MA, January.

Bernard, A.B., J.B. Jensen, S.J. Redding and P.K. Schott (2007), 'Firms in International Trade', *Journal of Economic Perspectives* 21(3): 105-30, Summer.

BP (2010), *BP Statistical Review of World Energy*, London: British Petroleum.

Chappuis, T. and T.L. Walmsley (2011), 'Projections for World CGE Model Baselines', GTAP Research Memorandum No. 22, Center for Global Trade Analysis, Purdue University, West Lafayette IN, September.

Citi (2011), *Global Growth Generators: Moving Beyond 'Emerging Markets' and 'BRIC'*, Global Economics View, Citigroup Global Markets, New York, 21 February.

Corden, W.M. (1982), "Exchange Rate Policy and the Resources Boom", *Economic Record* 58(160): 18-31, March.

Corden, W.M. (1984), "Booming Sector and Dutch Disease Economics: Survey and Consolidation", *Oxford Economic Papers* 36(3): 359-80, November.

Crafts, N. and A.J. Venables (2003), 'Globalization in Historical Perspective', pp. 323-64 in Bordo, M., Taylor, A. and J. Williamson (eds.), *Globalization in Historical Perspective* Chicago: University of Chicago Press for the NBER.

Deardorff, A.V. (1984), "An Exposition and Exploration of Krueger's Trade Model", *Canadian Journal of Economics* 5(4): 731-46.

Dee, P., Hanslow, K. and D.T. Pham (2003), 'Measuring the Cost of Barriers to Trade in Services', in T. Ito and A.O. Krueger (eds.), *Services Trade in the Asia-Pacific Region*, Chicago: University of Chicago Press for the NBER.

de Gorter, H., D. Drabik and E.M. Kliauga (2011), 'Understanding the Economics of Biofuel Policies and their Implications for WTO Rules', paper presented at the IATRC Annual Meetings, St. Petersburg FL, 11-13 December.

Deininger, K. and D. Byerlee (2011), *Rising Global Interest in Farmland: Can it Yield Sustainable and Equitable Benefits?* Washington DC: World Bank.

Dervis, K., J. de Melo and S. Robinson (1981), 'A General Equilibrium Analysis of Foreign Exchange Shortages in a Developing Country', *Economic Journal* 91: 891-906.

FAO (2003), 'Food Security: Concepts and Measurements', in *Trade Reforms and Food Security*, Rome: Food and Agriculture Organization.

FAO/OECD (2010), *FAO/OECD Agricultural Outlook 2010-2019,* Paris and Rome: OECD and FAO.

FAO and Others (2011), 'Price Volatility in Food and Agricultural Markets: Policy Responses', Policy Report for the G-20's November 2011 meeting in Paris, with contributions by FAO, IFAD, OECD, WFP, the World Bank, the WTO, UNCTAD, IFPRI and the UN HLTF), Rome, May.

Feenstra, R.C. (1998), 'Integration of Trade and Disintegration of Production in the Global Economy', *Journal of Economic Perspectives* 12(4): 31-50, Fall.

Feldstein, M.S. (2011), 'The Role of Currency Realignments in Eliminating the US andChina Current Account Imbalances', NBER Working Paper 16674, Cambridge MA, January.

Fouré J., A. Benassy-Quéré and L. Fontagné (2010), 'The World Economy in 2050: A Tentative Picture', Working Paper 2010-27, CEPII, Paris, December.

Francois, J.F. and B. Hoekman (2010), 'Services Trade and Policy', *Journal of Economic Literature* 48(3): 642-92, September.

Francois, J.F. and W. Martin (2010), 'Ex Ante Assessments of the Welfare Impacts of Trade Reforms with Numerical Models', Ch. 13 (pp. 379-434) in *New Developments in Computable General Equilibrium Analysis for Trade Policy*, edited by H. Beladi and E.K. Choi, London: Emerald Group Publishing.

Garnaut, R. (2011), *Global Emissions Trends,* Update Paper 3, Garnaut Climate Change Review Update 2011, Canberra: Commonwealth of Australia, February. www.garnautreview.org.au

Grilli, E. and M.C. Yang (1988), 'Primary Commodity Prices, Manufactured Goods Prices, and the Terms of Trade of Developing Countries', *World Bank Economic Review* 2(1): 1-48, January.

Helpman, E. and O. Itskhoki (2010), 'Labor Market Rigidities, Trade and Unemployment', *Review of Economic Studies* 77(3): 1100-37, July.

Helpman, E., D. Marin and T. Verdier (eds.) (2008), *The Organization of Firms in a Global Economy*, Cambridge MA: Harvard University Press.

Hertel, T.W. (ed.) (1997), *Global Trade Analysis: Modeling and Applications*, Cambridge and New York: Cambridge University Press.

Hertel, T.W. and J. Beckman (2011), 'Commodity Price Volatility in the Biofuel Era: An Examination of the Linkage Between Energy and Agricultural Markets', Ch. 6 (pp. 189-221) in *The Intended and Unintended Effects of U.S. Agricultural and Biotechnology Policies*, edited by J. Graff Zivin and J. Perloff, Chicago: University of Chicago Press for NBER.

Hertel T.W. and N. Differbaugh (2011), 'Implications of Climate Volatility for Agricultural Commodity Markets in the Presence of Biofuel Mandates', Presented at the 14th Annual Conference on Global Economic Analysis, Venice, 16-18 June.

Hertel T.W., D. Hummels, M. Ivanic and R. Keeney (2007), 'How Confident Can We Be in CGE-Based Assessments of Free Trade Agreements?' *Economic Modelling* 24(4): 611-635.

Hertel, T. W., R. McDougall, B.G. Narayanan, and A.H. Aguiar (2008), 'Behavioural Parameters', Ch. 14 in B.G. Narayanan and T.L. Walmsley (eds.), *Global Trade, Assistance, and Production: The GTAP 7 Data Base*, West Lafayette: Centre for Global Trade Analysis, Purdue University.

Hoxha, I., S. Kalemli-Ozcan and D. Vollrath (2009), 'How Big are the Gains from International Financial Integration?', NBER Working Paper 14636, Cambridge MA, January.

IEA (2010), *World Energy Outlook 2010,* Paris: International Energy Agency.

Jones, R.W. and H. Kierzkowski (1997), 'Globalisation and the Consequences of International Fragmentation', in *Money, Factor Mobility and Trade: Essays in Honor of Robert A. Mundell*, edited by R. Dornbusch, G. Calvo and M. Obstfeld, Cambridge MA: MIT Press.

Kawai, M. and G. Wignaraja (2010), 'Free Trade Agreements in East Asia: A Way Toward Trade Liberalization?' *ADB Briefs* No. 1, Manila, June.

Konan, D. and K. Maskus (2006), 'Quantifying the Impact of Services Liberalization in a Developing Country', *Journal of Development Economics* 81(1): 142-62.

Kozo, K., T. Matsuura, S. Urata and Y. Wei (2008), 'Reconsidering the Backward Vertical Linkages of Foreign Affiliates: Evidence from Japanese Multinationals', *World Development* 36(8): 1938-1414, August.

Krishna, P., and D. Mitra (1998), 'Trade Liberalization, Market Discipline and Productivity Growth: New Evidence from India', *Journal of Development Economics* 56: 447-62.

Krueger, A.O. (1977), *Growth, Distortions and Patterns of Trade Among Many Countries,* Princeton, NJ: International Finance Section.

Krugman, P. (2009), 'The Increasing Returns Revolution in Trade and Geography', *American Economic Review,* 99(3): 561-71, June.

Laborde, D., W. Martin and D. van der Mensbrugghe (2011), 'Measuring the Benefits of Global Trade Reform with Optimal Aggregators of Distortions', Ch. 11 in W. Martin and A. Mattoo (eds.), *The Doha Development Agenda*, London: Centre for Economic Policy Research for the World Bank.

Leamer, E.E. (1987), "Paths of Development in the Three-Factor, n-Good General Equilibrium Model", *Journal of Political Economy* 95(5): 961-99.

Ludena, C.E., T.W. Hertel, P.V. Preckel, K. Foster and A. Nin (2007), 'Productivity Growth and Convergence in Crop, Ruminant and Nonruminant Production: Measurement and Forecasts', *Agricultural Economics* 37(1): 1-17, January.

Lumenga-Neso, O., M. Olarreaga and M. Schiff (2005), 'On 'Indirect' Trade-Related R&D Spillovers', *European Economic Review* 49(7): 1785-98, October.

Markusen, J.R. (2002), *Multinational Firms and the Theory of International Trade*, Cambridge: MIT Press.

Markusen, J.R., A.J. Venables, D.B. Konan and K. Zhang (1996), 'A Unified Treatment of Horizontal Direct Investment, Vertical Direct Investment, and the Pattern of Trade in Goods and Services', NBER Working Paper 5696, Cambridge MA, August.

Martin, W. and K. Anderson (2012), 'Export Restrictions and Price Insulation During Commodity Price Booms', *American Journal of Agricultural Economics* 94(2): 422-27, January.

Martin**,** W. and D. Mitra (2001), 'Productivity Growth and Convergence in Agriculture and Manufacturing', *Economic Development and Cultural Change* 49(2): 403-22.

McKibbin W. and A. Stegman (2005) 'Asset Markets and Financial Flows in General Equilibrium Models', pp. 3-16 in *Quantitative Tools for Microeconomic Policy Analysis*, Canberra: Productivity Commission.

Melitz, M.J. (2003), 'The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity', *Econometrica* 71(6): 1692-1725.

Melitz, M.J. and G.I.P. Ottaviano (2008), 'Market Size, Trade and Productivity', *Review of Economic Studies* 75(1): 295-316, January.

Narayanan, G.B. and T.L. Walmsley (eds.) (2008), *Global Trade, Assistance, and Production: The GTAP 7 Data Base*, West Lafayette IN: Center for Global Trade Analysis, Purdue University, downloadable at www.gtap.org.

Nelson, G.C., M.W. Rosegrant, A. Palazzo, I. Gray, C. Ingersoll, R. Robertson, S. Tokgoz, T. Zhu, T.B. Sulser, C. Ringler, S. Msangi and L. You (2010), *Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options*, IFPRI Research Report, Washington DC: International Food Policy Research Institute, December.

Ozawa, T. 92009), *The Rise of Asia: The 'Flying-Geese Theory of Tandem Growth and Regional Agglomeration,* London: Edward Elgar.

Petri, P. (2012), 'The Determinants of Bilateral FDI: Is Asia Different?', *Journal of Asian Economics* 23(3): 201-209, June.

Pfaffenzeller, S., Newbolt, P. and Rayner, A. (2007), 'A Short Note on Updating the Grilli and Yang Commodity Price Index', *World Bank Economic Review* 21(1): 151-63.

PwC (2011), 'The World in 2050 -- The Accelerating Shift of Global Economic Power: Challenges and Opportunities', January (http://www.pwc.co.uk/economics).

Rodrik, D. (2011), 'The Future of Economic Convergence', NBER Working Paper 17400, Cambridge MA, September.

Rutherford, T.F. and D.G. Tarr (2008), 'Poverty Effects of Russia's WTO Accession: Modeling "Real" Households with Endogenous Productivity Effects', *Journal of International Economics* 75(1):131-50.

Sandri, D., E. Valenzuela and K. Anderson (2007), 'Economic and Trade Indicators, 1960 to 2004', Agricultural Distortions Working Paper 02, World Bank, Washington DC. Posted at www.worldbank.org/agdistortions.

Spence, M. (2011), *The Next Convergence: The Future of Economic Growth in a Multispeed World*, NewYork: Farrar, Straus and Giroux.

Timilsina, G.R., J.C. Beghin, D. van der Mensbrugghe and S. Mevel (2010), 'The Impacts of Biofuel Targets on Land-use Change and Food Supply: A Global CGE Assessment', Policy Research Working Paper 5513, World Bank, Washington DC, December.

US Geological Survey (2010), *Mineral Commodity Summaries*, accessed at http://minerals.usgs.gov/minerals/pubs/mcs/

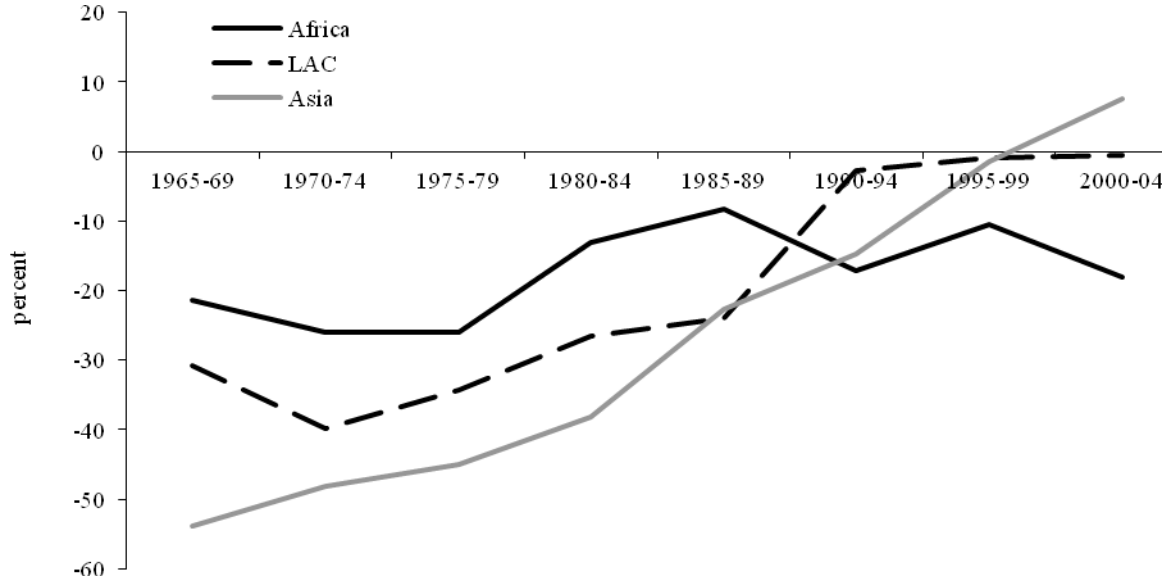
van der Mensbrugghe, D. and R. Roson (2010), 'Climate, Trade and Development', Paper presented at the 13th Global Economic Analysis Conference, Penang, 9-11 June.

Warr, P.G. (2011), 'Food Security vs. Food Self-Sufficiency: The Indonesian Case', *The Indonesia Quarterly* 39(1): 56-71.

Yu, W., T.W. Hertel, P.V. Preckel and J.S. Eales (2004), 'Projecting World Food Demand Using Alternative Demand Systems', *Economic Modelling* 21(1): 99-129, January.

Figure 1: Relative rates of assistance to agriculture,[a] Asian, African and Latin American developing countries, 1965 to 2004[b]

(percent)

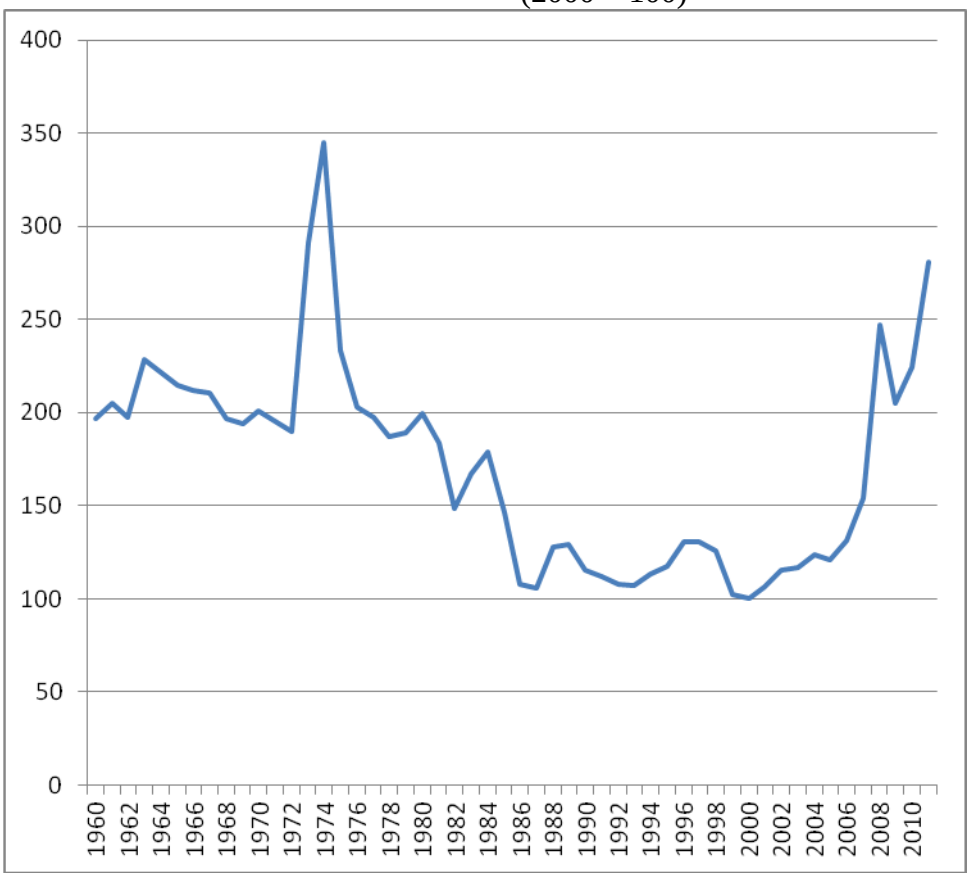


[a] The RRA is defined as 100*[(100+NRAag^t)/(100+NRAnonag^t)-1], where NRAag^t and NRAnonag^t are the percentage NRAs for the tradables parts of the agricultural and non-agricultural sectors, respectively. The 5-year weighted averages are estimated using value of production at undistorted prices as weights.

[b] Estimates for China pre-1981 are based on the assumption that the nominal rates of assistance to agriculture and other tradables in those years were the same as the average for China for 1981-84.

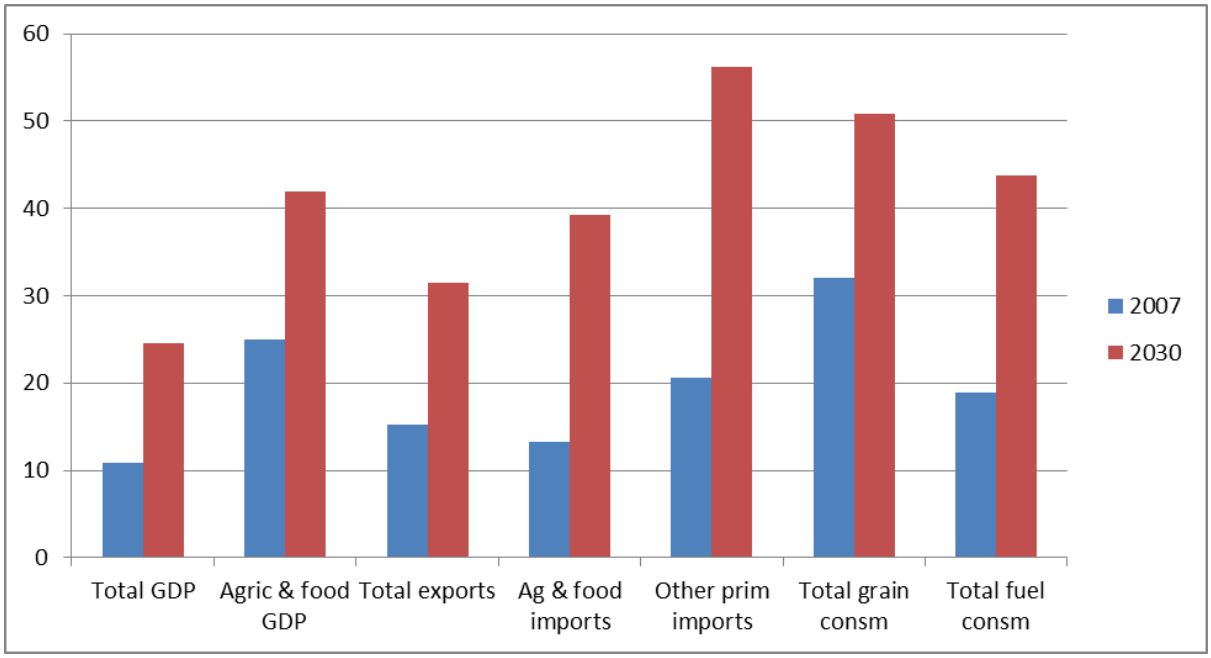
Source: Calculated from Anderson and Valenzuela (2008).

Figure 2: Real international food prices, 1960 to (July) 2011
(2000 = 100)



Source: Updated from Grilli and Yang (1988) and Pfaffenzeller, Newbolt and Rayner (2007) by the World Bank.

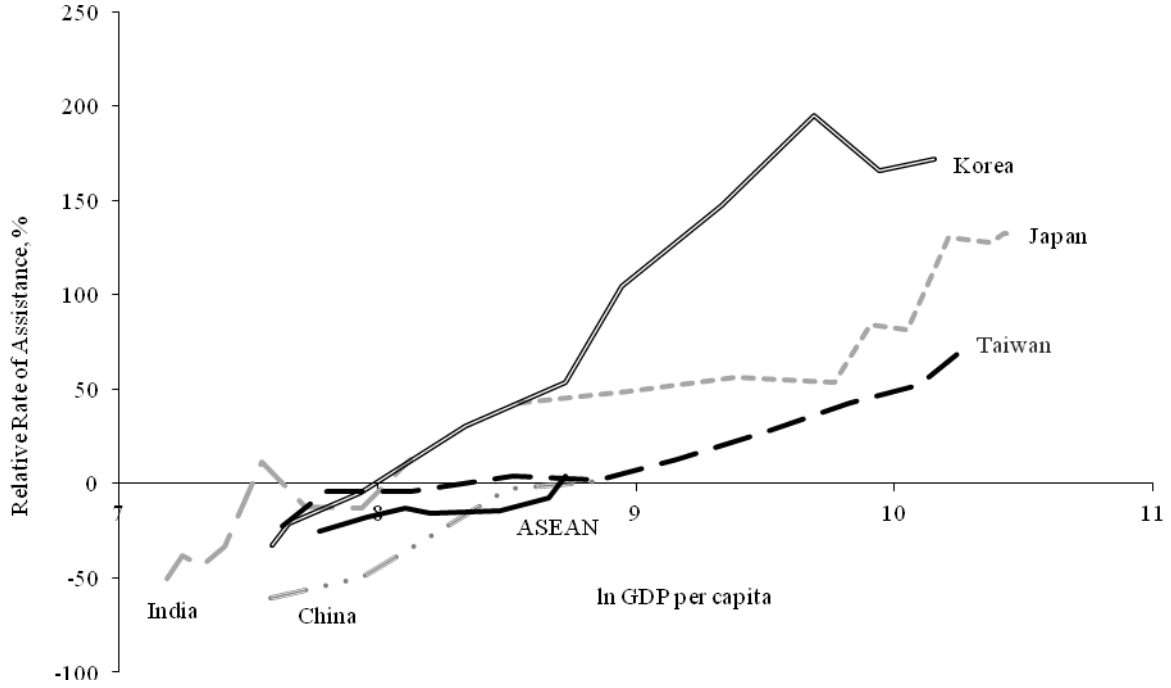
Figure 3: Shares of China, India and ASEAN in selected global markets, 2007 and 2030 core (percent)



Source: Derived from the authors' GTAP Model results

Figure 4: Relative rates of assistance to agriculture[a] and log of real per capita GDP, India and Northeast Asian economies, 1955 to 2005

(percent)



[a] The RRA is defined as $100*[(100+NRAag^t)/(100+NRAnonag^t)-1]$, where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradables parts of the agricultural and non-agricultural sectors, respectively.

Source: Adapted from Anderson (2009).

Table 1: Indicators of relative factor endowments in 2000-04

(national relative to world, world=100)

	Per capita stocks of:		
	Produced capital[a]	**Agricultural land[b]**	**Mineral reserves[c]**
W. Europe	454	46	44
E. Europe &CA	48	178	241
US & Canada	636	186	274
Australia & NZ	405	2454	1615
Japan	610	5	14
DevelopingAsia	20	34	25
NEAsian NIEs	*254*	*8*	*4*
ASEAN 5	*28*	*37*	*28*
China	*21*	*35*	*54*
India	*9*	*5*	*8*
Africa	14	148	144
Latin America	64	171	181
Total	**100**	**100**	**100**

[a] Proxied by GDP per capita.
[b] Arable land and permanent crops.
[c] Proxied crudely by total land per capita.

Source: Sandri, Valenzuela and Anderson (2007), compiled mainly from the World Bank's *World Development Indicators.*

Table 2: Self-sufficiency in primary agricultural production,[a] Asian developing economies, 1961 to 2004

(percent at undistorted prices)

	1961-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
China	99	101	100	99	98	101	101	99	98
India	98	97	99	99	99	99	100	100	100
Indonesia	na	na	106	105	104	106	104	103	102
Malaysia	293	265	215	167	152	150	122	110	104
Philippines	115	112	116	108	106	101	101	99	99
Thailand	na	na	115	125	131	135	133	130	137
Vietnam	na	na	na	na	na	103	104	110	112
Asian dev. economies[b]	**100**	**100**	**100**	**99**	**97**	**94**	**88**	**87**	**85**

[a] Agricultural production, valued at undistorted prices, as a percentage of production plus imports minus exports.

[b] Includes also Bangladesh, Pakistan, Sri Lanka, South Korea and Taiwan, China.

Source: Calculated by authors based on data in Anderson and Valenzuela (2008).

Table 3: Regional shares of global value added by sector, 2007 and 2030 core (percent)

(a) 2007 Base

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	24.2	10.8	33.5	31.9	30.9
E. Europe	7.5	11.2	3.4	4.0	4.4
US & Canada	13.7	11.7	23.6	32.1	28.7
ANZ	1.6	2.5	1.0	1.9	1.7
Japan	4.4	0.7	8.0	8.6	7.9
China	13.6	9.2	11.2	4.2	6.2
ASEAN	4.7	6.0	3.4	1.8	2.4
Rest E. Asia	1.8	0.9	4.1	3.0	3.0
India	6.7	2.2	1.8	2.0	2.2
Rest S. Asia	1.8	0.4	0.3	0.4	0.5
South America	5.4	3.5	3.1	3.3	3.4
Rest LAC	6.1	5.3	2.9	3.4	3.5
MENA	3.6	29.0	2.7	2.3	3.6
SSAfrica	4.9	6.5	1.0	1.2	1.6
High-income	**50.8**	**34.8**	**69.2**	**78.3**	**73.2**
Developing	**49.2**	**65.2**	**30.8**	**21.7**	**26.8**
of which Asia:	29.2	20.9	21.0	11.6	14.7
NResource Rich	**24.5**	**61.1**	**13.4**	**14.3**	**16.8**
NResource Poor	**43.8**	**21.4**	**57.3**	**48.0**	**48.2**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	13.4	6.5	21.3	23.8	21.4
E. Europe	4.9	10.0	3.0	4.4	4.5
US & Canada	9.6	6.8	17.0	28.5	23.6
ANZ	1.2	2.3	0.6	1.9	1.6
Japan	2.0	0.2	4.9	6.0	5.1
China	31.9	22.2	28.6	10.6	16.2
ASEAN	5.0	5.8	4.7	2.7	3.4
Rest E. Asia	1.3	0.8	4.5	3.5	3.3
India	5.0	3.6	3.8	5.0	5.1
Rest S. Asia	2.4	0.5	0.5	0.9	0.9
South America	4.6	4.0	3.3	4.1	4.0
Rest LAC	4.0	5.4	2.8	3.5	3.6
MENA	3.2	21.3	3.5	3.0	4.3
SSAfrica	5.8	10.7	1.5	2.1	2.9
High-income	**30.6**	**23.6**	**46.7**	**64.2**	**55.9**
Developing	**69.4**	**76.4**	**53.3**	**35.8**	**44.1**
of which Asia:	51.7	35.0	42.3	23.0	29.4
NResource Rich	**22.5**	**56.2**	**14.6**	**17.5**	**19.9**
NResource Poor	**48.5**	**29.3**	**59.8**	**44.1**	**46.2**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 4: Regional sectoral shares of global exports, 2007 and 2030 core (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	2.7	1.0	28.2	9.1	40.9
E. Europe	0.3	1.6	2.3	0.8	4.9
US & Canada	0.8	0.5	8.0	2.7	12.1
ANZ	0.2	0.4	0.5	0.3	1.4
Japan	0.0	0.0	4.5	0.5	5.0
China	0.2	0.1	7.4	0.6	8.3
ASEAN	0.4	0.5	4.0	0.9	5.8
Rest E. Asia	0.1	0.0	4.5	1.3	5.8
India	0.1	0.1	0.9	0.4	1.5
Rest S. Asia	0.0	0.0	0.2	0.1	0.3
South America	0.6	0.4	1.1	0.3	2.3
Rest LAC	0.3	0.6	2.0	0.4	3.4
MENA	0.2	3.6	1.7	0.8	6.3
SSAfrica	0.2	1.1	0.6	0.2	2.1
High-income	**4.0**	**3.1**	**43.3**	**13.2**	**63.6**
Developing	**2.1**	**6.7**	**22.6**	**5.0**	**36.4**
of which Asia:	0.9	1.0	17.2	3.3	22.3
NResource Rich	**1.8**	**7.8**	**9.1**	**2.8**	**21.6**
Resource Poor	**3.0**	**1.1**	**45.5**	**11.6**	**61.2**
Total	**6.1**	**9.8**	**65.8**	**18.2**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	2.3	1.3	15.8	6.2	25.7
E. Europe	0.3	2.6	1.5	0.5	5.0
US & Canada	1.3	0.9	4.7	1.7	8.6
ANZ	0.3	0.7	0.2	0.1	1.3
Japan	0.0	0.0	3.0	0.3	3.3
China	0.0	0.1	19.0	2.0	21.1
ASEAN	0.5	0.6	5.2	0.9	7.3
Rest E. Asia	0.1	0.1	4.9	1.1	6.2
India	0.1	0.3	2.1	1.1	3.5
Rest S. Asia	0.1	0.0	0.4	0.1	0.6
South America	0.8	1.0	0.8	0.2	2.8
Rest LAC	0.3	1.0	1.9	0.4	3.7
MENA	0.2	3.2	2.5	1.5	7.4
SSAfrica	0.2	2.2	0.8	0.3	3.5
High-income	**4.2**	**4.9**	**25.1**	**8.8**	**43.0**
Developing	**2.5**	**9.2**	**37.7**	**7.7**	**57.0**
of which Asia:	0.8	1.7	31.7	5.3	39.6
NResource Rich	**2.4**	**11.0**	**9.2**	**3.1**	**25.7**
NResource Poor	**2.5**	**1.4**	**43.5**	**9.8**	**57.2**
Total	**6.7**	**14.1**	**62.8**	**16.5**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 5: Regional sectoral shares of global imports of all products, 2007 and 2030 (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	2.8	3.0	26.9	8.6	41.3
E. Europe	0.4	0.4	3.3	0.7	4.8
US & Canada	0.8	2.0	12.0	2.5	17.2
ANZ	0.1	0.1	1.0	0.3	1.4
Japan	0.3	1.2	2.4	0.8	4.6
China	0.3	1.0	4.5	0.7	6.5
ASEAN	0.3	0.5	3.2	0.8	4.8
Rest E. Asia	0.3	0.8	3.2	0.9	5.2
India	0.1	0.6	0.9	0.3	1.9
Rest S. Asia	0.1	0.0	0.3	0.1	0.5
South America	0.1	0.2	1.2	0.4	1.8
Rest LAC	0.3	0.1	2.5	0.4	3.3
MENA	0.5	0.2	3.2	1.0	4.8
SSAfrica	0.2	0.1	1.3	0.4	2.0
High-income	**4.3**	**6.7**	**45.1**	**12.6**	**68.8**
Developing	**2.0**	**3.5**	**20.7**	**4.9**	**31.2**
of which Asia:	1.0	3.0	12.6	2.8	19.4
NResource rich	**1.4**	**0.9**	**12.2**	**3.3**	**17.7**
NResource poor	**3.7**	**6.2**	**37.6**	**11.1**	**58.6**
Total	**6.4**	**10.2**	**65.9**	**17.6**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	1.7	1.8	18.2	6.0	27.7
E. Europe	0.3	0.4	3.4	0.9	5.0
US & Canada	0.6	1.5	11.0	2.3	15.5
ANZ	0.1	0.0	1.0	0.3	1.4
Japan	0.2	0.7	2.0	0.6	3.5
China	2.0	5.9	7.6	0.9	16.3
ASEAN	0.4	0.7	4.1	0.9	6.1
Rest E. Asia	0.2	0.9	3.7	1.0	5.9
India	0.2	1.6	1.6	0.5	3.8
Rest S. Asia	0.2	0.1	0.6	0.1	1.0
South America	0.1	0.1	1.5	0.5	2.2
Rest LAC	0.3	0.2	2.6	0.4	3.4
MENA	0.4	0.3	3.4	0.8	5.0
SSAfrica	0.3	0.2	2.1	0.7	3.3
High-income	**2.9**	**4.5**	**35.2**	**9.8**	**52.4**
Developing	**4.0**	**10.1**	**27.5**	**5.9**	**47.6**
of which Asia:	2.9	9.3	18.0	3.6	33.8
NResource rich	**1.5**	**1.2**	**14.1**	**3.8**	**20.7**
NResource poor	**4.1**	**9.5**	**32.0**	**8.6**	**54.2**
Total	**6.9**	**14.6**	**62.8**	**15.7**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 6: Sectoral shares of national exports, 2007 and 2030 core (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	6.5	2.4	68.9	22.2	100.0
E. Europe	5.5	32.6	46.4	15.5	100.0
US & Canada	7.0	4.3	66.2	22.6	100.0
ANZ	17.5	26.0	36.0	20.5	100.0
Japan	0.5	0.1	89.9	9.5	100.0
China	2.9	0.6	89.8	6.7	100.0
ASEAN	7.4	8.0	69.7	14.9	100.0
Rest E. Asia	1.0	0.7	76.8	21.5	100.0
India	7.2	4.8	58.2	29.8	100.0
Rest S. Asia	11.6	1.4	68.2	18.8	100.0
South America	24.8	16.7	46.8	11.6	100.0
Rest LAC	9.4	18.2	59.5	12.8	100.0
MENA	2.5	57.9	26.9	12.7	100.0
SSAfrica	8.9	51.0	29.3	10.8	100.0
High-income	**6.3**	**4.8**	**68.1**	**20.8**	**100.0**
Developing	**5.9**	**18.5**	**62.0**	**13.7**	**100.0**
of which Asia:	4.0	4.6	76.8	14.6	100.0
NResource rich	**8.5**	**36.3**	**42.2**	**13.0**	**100.0**
NResource poor	**4.9**	**1.7**	**74.4**	**19.0**	**100.0**
Total	**6.1**	**9.8**	**65.8**	**18.2**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	9.2	5.0	61.7	24.2	100.0
E. Europe	6.9	52.8	30.0	10.3	100.0
US & Canada	14.9	10.5	55.2	19.5	100.0
ANZ	21.1	55.8	13.6	9.5	100.0
Japan	1.5	0.5	88.8	9.2	100.0
China	0.1	0.4	90.0	9.5	100.0
ASEAN	7.4	8.7	71.2	12.6	100.0
Rest E. Asia	1.5	1.3	79.4	17.7	100.0
India	1.9	7.1	58.8	32.3	100.0
Rest S. Asia	8.4	1.3	70.5	19.8	100.0
South America	29.6	37.0	27.0	6.4	100.0
Rest LAC	8.9	27.4	52.4	11.4	100.0
MENA	3.3	43.1	34.0	19.6	100.0
SSAfrica	6.4	63.2	21.9	8.5	100.0
High-income	**9.8**	**11.3**	**58.4**	**20.4**	**100.0**
Developing	**4.3**	**16.1**	**66.1**	**13.5**	**100.0**
of which Asia:	2.1	4.4	80.1	13.4	100.0
NResource rich	**9.4**	**42.8**	**35.8**	**12.1**	**100.0**
NResource poor	**4.4**	**2.4**	**76.0**	**17.1**	**100.0**
Total	**6.7**	**14.1**	**62.8**	**16.5**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 7: Sectoral shares of national imports, 2007 and 2030 (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	6.8	7.3	65.2	20.7	100.0
E. Europe	7.8	9.4	68.1	14.7	100.0
US & Canada	4.6	11.5	69.4	14.4	100.0
ANZ	5.2	4.8	71.5	18.6	100.0
Japan	7.4	25.2	50.9	16.5	100.0
China	4.3	15.6	69.9	10.2	100.0
ASEAN	5.9	9.9	67.7	16.4	100.0
Rest E. Asia	4.9	16.2	62.0	16.9	100.0
India	3.0	30.6	49.0	17.4	100.0
Rest S. Asia	14.7	8.8	63.9	12.5	100.0
South America	4.9	8.7	66.8	19.6	100.0
Rest LAC	9.2	3.8	76.1	10.9	100.0
MENA	9.5	3.8	66.5	20.1	100.0
SSAfrica	10.2	5.6	64.1	20.1	100.0
High-income	**6.3**	**9.7**	**65.6**	**18.4**	**100.0**
Developing	**6.5**	**11.4**	**66.4**	**15.7**	**100.0**
of which Asia:	5.1	15.3	64.9	14.7	100.0
NResource rich	**7.9**	**4.9**	**68.7**	**18.5**	**100.0**
NResource poor	**6.3**	**10.6**	**64.1**	**19.0**	**100.0**
Total	**6.4**	**10.2**	**65.9**	**17.6**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
W. Europe	6.3	6.5	65.7	21.5	100.0
E. Europe	6.2	9.0	67.5	17.3	100.0
US & Canada	4.0	9.9	71.1	15.0	100.0
ANZ	4.8	2.7	71.6	20.9	100.0
Japan	5.3	20.8	57.6	16.3	100.0
China	12.0	36.0	46.6	5.4	100.0
ASEAN	6.2	11.7	67.4	14.7	100.0
Rest E. Asia	4.1	15.7	63.0	17.2	100.0
India	4.2	42.0	41.1	12.7	100.0
Rest S. Asia	16.1	14.4	59.6	9.8	100.0
South America	3.8	5.9	68.6	21.8	100.0
Rest LAC	7.5	4.9	76.8	10.8	100.0
MENA	8.8	6.6	67.7	16.9	100.0
SSAfrica	9.9	5.9	63.9	20.3	100.0
High-income	**5.5**	**8.6**	**67.2**	**18.7**	**100.0**
Developing	**8.5**	**21.2**	**57.9**	**12.4**	**100.0**
of which Asia:	8.7	27.4	53.3	10.6	100.0
NResource rich	**7.4**	**6.0**	**68.1**	**18.5**	**100.0**
NResource poor	**7.6**	**17.5**	**59.0**	**15.9**	**100.0**
Total	**6.9**	**14.6**	**62.8**	**15.7**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 8: Exports plus imports of goods and services as a proportion of GDP, 2007 base, 2030 core and 2030 alternative growth scenarios, and trade reform

	2007	2030 core	2030 Slower prim TFP	2030 Faster Ch/India grain TFP	Full lib'n 2030
W. Europe	0.71	0.72	0.78	0.72	0.75
E. Europe	0.59	0.64	0.72	0.64	0.72
US & Canada	0.29	0.31	0.35	0.31	0.41
ANZ	0.41	0.47	0.50	0.47	0.50
Japan	0.34	0.41	0.46	0.41	0.46
China	0.64	0.67	0.89	0.67	0.98
ASEAN	1.25	1.21	1.32	1.22	1.34
Rest E. Asia	1.00	1.08	1.24	1.08	1.14
India	0.42	0.42	0.50	0.42	0.58
Rest S. Asia	0.49	0.53	0.64	0.53	0.70
South America	0.33	0.36	0.38	0.36	0.64
Rest LAC	0.51	0.59	0.65	0.59	0.67
MENA	0.89	0.89	0.98	0.89	1.03
SSAfrica	0.70	0.69	0.72	0.70	0.81
High-income	**0.49**	**0.51**	**0.56**	**0.51**	**0.57**
Developing	**0.70**	**0.70**	**0.83**	**0.70**	**0.90**
of which Asia:	0.78	0.73	0.90	0.73	0.96
NResource rich	**0.64**	**0.68**	**0.74**	**0.68**	**0.82**
NResource poor	**0.67**	**0.71**	**0.82**	**0.71**	**0.83**
Total	**0.55**	**0.59**	**0.68**	**0.59**	**0.71**

Source: Derived from the authors' GTAP Model results

Table 9: Regional shares of world trade in agricultural and food products, 2007 base, 2030 core and 2030 alternative growth scenarios, and trade reform scenarios

(percent)

(a) Baseline scenarios

	Exports					Imports				
	2007	**2030 core**	**2030 Slower prim TFP**	**2030 Faster Ch/In grain TFP**	**Full lib'n 2030**	**2007**	**2030 core**	**2030 Slower prim TFP**	**2030 Faster Ch/In grain TFP**	**Full lib'n 2030**
W. Europe	43.4	35.1	35.9	35.1	30.9	43.9	25.1	26.7	25.5	21.8
E. Europe	4.5	5.2	5.3	5.1	5.8	5.9	4.5	5.5	4.6	5.0
US & Canada	13.7	19.0	18.6	18.7	16.5	12.4	9.0	9.3	9.2	9.6
ANZ	3.9	4.0	3.3	4.0	4.2	1.1	1.0	1.0	1.0	0.8
Japan	0.4	0.7	0.7	0.7	2.1	5.4	2.6	2.8	2.7	3.5
China	3.9	0.4	0.6	0.5	0.6	4.3	28.3	20.4	27.2	27.1
ASEAN	6.9	8.1	7.1	8.0	9.5	4.5	5.5	6.6	5.6	5.7
Rest E. Asia	0.9	1.4	1.3	1.4	4.6	4.0	3.5	3.7	3.5	3.9
India	1.8	1.0	3.1	1.4	1.7	4.5	5.5	1.3	2.2	5.1
Rest S. Asia	0.6	0.8	0.7	0.7	0.8	1.2	2.4	2.5	2.4	2.3
South America	9.4	12.3	11.6	12.4	10.4	1.4	1.2	1.4	1.2	1.5
Rest LAC	5.1	4.9	4.8	4.9	5.4	4.7	3.6	4.6	3.7	3.5
MENA	2.5	3.7	4.0	3.6	3.7	7.2	6.4	7.3	6.5	5.9
SSAfrica	3.1	3.4	2.9	3.4	3.8	3.2	4.7	6.8	4.8	4.3
High-income	**65.2**	**63.3**	**63.1**	**62.9**	**58.7**	**68.0**	**41.6**	**44.4**	**42.3**	**40.1**
Developing	**34.8**	**36.7**	**36.9**	**37.1**	**41.3**	**32.0**	**58.4**	**55.6**	**57.7**	**59.9**
of which Asia:	14.7	12.5	13.6	12.8	18.0	15.6	42.6	35.4	41.5	44.7
NResource rich	**30.2**	**36.0**	**32.2**	**35.9**	**38.0**	**22.0**	**22.1**	**27.6**	**22.6**	**22.5**
NResource poor	**48.5**	**37.9**	**39.1**	**37.9**	**38.2**	**57.9**	**59.7**	**53.8**	**59.1**	**56.4**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10: Agricultural self-sufficiency ratio,[a] 2007 base, 2030 core and 2030 alternative growth scenarios, and trade reform scenarios

(percent)

	2007	2030 core	2030 Slower prim TFP	2030 Faster Ch/India grain TFP	Full lib'n 2030
W. Europe	0.96	1.07	1.03	1.06	1.08
E. Europe	0.96	0.99	0.97	0.99	1.00
US & Canada	1.05	1.21	1.17	1.20	1.23
ANZ	1.33	1.48	1.37	1.47	1.60
Japan	0.81	0.84	0.84	0.84	0.82
China	0.97	0.87	0.92	0.87	0.83
ASEAN	0.97	0.94	0.90	0.93	1.00
Rest E. Asia	0.74	0.75	0.73	0.75	0.84
India	1.02	0.97	1.03	0.98	0.94
Rest S. Asia	0.95	0.90	0.89	0.90	0.89
South America	1.20	1.36	1.31	1.36	1.43
Rest LAC	0.99	1.00	0.96	1.00	1.09
MENA	0.82	0.87	0.85	0.86	0.89
SSAfrica	1.00	0.97	0.93	0.97	1.00
High-income	**0.98**	**1.10**	**1.06**	**1.09**	**1.13**
Developing	**0.98**	**0.93**	**0.95**	**0.93**	**0.93**
of which Asia:	0.96	0.89	0.93	0.90	0.87
NResource rich	**1.02**	**1.05**	**1.00**	**1.04**	**1.12**
NResource poor	**0.93**	**0.91**	**0.94**	**0.91**	**0.89**
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

[a]Agricultural self-sufficiency ratio excludes 'other (processed) food products'

Source: Derived from the authors' GTAP Model results

Table 11: Self-sufficiency ratio for agricultural products, 2007 base and alternative 2030 scenario

(a) 2007 base

	Austr.	NZ	US Can	WE Eur	Japan	China	India	Arg.	Brazil	Chile	Peru	Rest LAm	MENA	South Africa	High Inc	Dev Asia	Rest Dev	Res rich	Res poor
Rice	1.06	0.20	1.12	0.81	0.95	1.00	1.05	1.50	0.98	0.76	0.96	0.95	0.69	0.12	**0.95**	**1.02**	**0.83**	**0.96**	**0.97**
Wheat	1.27	0.79	3.29	1.05	0.14	1.03	0.93	3.53	0.50	0.82	0.71	0.53	0.63	0.68	**1.21**	**0.88**	**0.65**	**0.92**	**0.94**
Coarse Grains	1.15	1.04	1.24	0.97	0.05	1.05	1.03	2.46	1.31	0.79	0.78	0.78	0.59	0.95	**1.05**	**0.75**	**0.89**	**0.97**	**0.75**
Fruit & Veg	1.08	1.36	0.88	0.86	0.89	1.01	0.97	1.75	1.09	3.30	1.18	1.19	1.00	1.53	**0.88**	**0.99**	**1.10**	**1.01**	**0.93**
Oilseeds	1.05	0.68	1.66	0.80	0.12	0.51	1.03	1.39	1.85	0.46	0.94	1.21	0.57	0.84	**1.05**	**0.73**	**1.20**	**1.18**	**0.57**
Sugar	1.47	0.96	0.93	0.92	0.81	0.94	1.05	1.27	1.26	0.89	0.97	1.08	0.66	1.09	**0.93**	**0.97**	**1.02**	**0.98**	**0.90**
Cotton	1.62	0.92	3.22	0.88	0.58	0.66	1.14	0.88	1.13	0.58	0.71	0.89	1.03	0.82	**1.15**	**0.82**	**1.08**	**1.10**	**0.65**
Other Crops	0.98	1.49	0.78	0.87	0.80	1.28	1.03	1.29	1.24	1.13	1.14	1.55	0.48	0.75	**0.85**	**1.04**	**1.25**	**1.17**	**0.88**
Beef & Sheep	1.49	1.64	1.00	0.95	0.82	0.92	1.05	1.16	1.10	0.87	0.98	1.02	0.87	0.97	**0.99**	**0.93**	**1.00**	**1.05**	**0.92**
Pork & Chicken	1.07	1.34	1.06	0.98	0.68	1.00	1.00	1.22	1.31	1.17	1.05	0.97	0.91	0.97	**0.99**	**0.98**	**1.02**	**1.03**	**0.97**
Dairy	1.14	1.68	0.99	1.01	0.91	0.97	1.00	1.13	1.00	1.05	0.98	0.95	0.86	0.97	**1.01**	**0.96**	**0.93**	**0.97**	**1.00**
Other Food	0.99	1.11	0.95	0.99	0.91	1.01	0.96	1.87	1.08	1.42	1.11	0.97	0.80	1.01	**0.97**	**1.01**	**1.00**	**1.02**	**0.98**

(b) 2030 core sim

	Austr.	NZ	US Can	WE Eur	Japan	China	India	Arg.	Brazil	Chile	Peru	Rest LAm	MENA	South Africa	High Inc	Dev Asia	Rest Dev	Res rich	Res poor
Rice	1.28	0.23	1.23	1.04	1.00	0.94	1.04	1.41	1.01	0.74	0.97	0.97	0.80	0.21	**1.04**	**0.99**	**0.84**	**0.98**	**0.96**
Wheat	1.30	0.79	3.77	1.22	0.21	0.94	0.89	3.11	0.65	0.81	0.64	0.55	0.67	0.88	**1.44**	**0.85**	**0.65**	**0.88**	**0.99**
Coarse Grains	1.37	1.02	1.27	1.00	0.05	0.98	1.03	2.12	1.34	0.74	0.78	0.78	0.59	1.10	**1.10**	**0.86**	**0.91**	**0.97**	**0.84**
Fruit & Veg	1.21	1.68	1.05	0.93	0.95	0.96	0.93	1.47	1.19	3.41	1.18	1.18	1.03	1.85	**0.98**	**0.96**	**1.08**	**1.05**	**0.95**
Oilseeds	1.07	1.13	2.27	0.92	0.16	0.23	0.99	1.66	3.18	0.44	0.90	1.41	0.57	0.91	**1.40**	**0.58**	**1.54**	**1.33**	**0.37**
Sugar	1.38	0.97	0.91	0.95	0.83	0.79	1.02	1.24	1.35	0.87	0.98	1.13	0.71	1.23	**0.95**	**0.94**	**1.03**	**0.97**	**0.88**
Cotton	2.07	0.98	7.07	1.03	0.66	0.53	0.94	0.88	2.05	0.58	0.73	1.06	1.26	2.61	**1.65**	**0.70**	**1.36**	**1.31**	**0.56**
Other Crops	0.90	1.57	0.82	0.98	0.88	0.31	0.95	1.02	1.56	0.88	1.04	1.37	0.50	1.30	**0.95**	**0.89**	**1.23**	**1.12**	**0.92**
Beef & Sheep	1.64	1.96	1.02	1.03	0.88	0.70	0.97	1.10	1.15	0.93	0.99	1.02	0.94	1.20	**1.07**	**0.80**	**1.03**	**1.08**	**0.85**
Pork & Chicken	1.42	2.42	1.45	1.17	0.73	0.85	0.95	1.51	1.63	1.21	1.05	0.98	0.93	1.22	**1.26**	**0.86**	**1.09**	**1.09**	**0.91**
Dairy	1.03	1.68	1.00	1.04	0.93	0.88	0.99	1.09	1.02	1.02	0.99	0.93	0.91	1.01	**1.04**	**0.95**	**0.93**	**0.95**	**1.01**
Other Food	0.91	1.24	0.95	1.03	0.94	0.92	0.91	2.02	1.08	1.43	1.28	0.94	0.90	1.07	**1.00**	**0.95**	**1.02**	**1.05**	**0.96**

Table 11 (continued): Self-sufficiency ratio for agricultural products, 2007 base and alternative 2030 scenario

(c) 2030 slower primary productivity growth

	Austr.	NZ	US Can	WE Eur	Japan	China	India	Arg.	Brazil	Chile	Peru	Rest LAm	MENA	South Africa	High Inc	Dev Asia	Rest Dev	Res rich	Res poor
Rice	1.19	0.33	1.24	0.87	0.97	0.98	1.14	1.43	1.00	0.70	0.95	0.91	0.63	0.25	**0.99**	**1.02**	**0.72**	**0.89**	**0.98**
Wheat	1.40	0.83	3.37	1.20	0.19	0.99	0.97	3.12	0.59	0.85	0.53	0.54	0.64	0.92	**1.40**	**0.91**	**0.62**	**0.84**	**1.04**
Coarse Grains	1.28	1.07	1.28	0.99	0.05	0.99	1.06	2.31	1.34	0.81	0.75	0.76	0.58	1.13	**1.10**	**0.86**	**0.90**	**0.97**	**0.84**
Fruit & Veg	1.12	1.73	0.94	0.91	0.92	0.98	0.99	1.46	1.20	3.09	1.10	1.15	1.02	1.81	**0.93**	**0.98**	**1.05**	**1.00**	**0.97**
Oilseeds	1.06	2.13	2.03	0.91	0.14	0.34	1.06	1.64	2.96	0.49	0.84	1.36	0.55	0.91	**1.31**	**0.62**	**1.47**	**1.29**	**0.46**
Sugar	1.20	0.98	0.92	0.91	0.82	0.88	1.07	1.29	1.31	0.88	0.96	1.04	0.70	1.34	**0.92**	**0.98**	**0.99**	**0.94**	**0.89**
Cotton	2.09	1.09	5.99	1.08	1.14	0.63	1.07	0.93	1.82	0.58	0.69	1.00	1.14	2.66	**1.63**	**0.76**	**1.23**	**1.13**	**0.65**
Other Crops	0.94	3.09	0.72	1.00	0.87	0.55	1.02	1.00	1.54	0.98	1.01	1.28	0.47	0.97	**0.94**	**0.92**	**1.16**	**1.09**	**0.94**
Beef & Sheep	1.39	2.01	1.03	1.00	0.89	0.82	1.04	1.08	1.13	0.91	0.97	0.95	0.94	1.29	**1.05**	**0.88**	**1.00**	**1.03**	**0.91**
Pork & Chicken	1.16	2.18	1.35	1.05	0.74	0.92	0.98	1.20	1.39	1.11	1.00	0.93	0.91	1.21	**1.15**	**0.92**	**1.00**	**0.98**	**0.95**
Dairy	1.01	1.66	1.00	1.03	0.93	0.96	1.00	1.14	1.02	1.04	0.96	0.89	0.92	1.26	**1.03**	**0.97**	**0.90**	**0.92**	**1.03**
Other Food	0.93	0.92	0.98	1.06	0.94	0.91	0.96	1.90	1.07	1.32	1.28	0.89	0.91	1.14	**1.02**	**0.94**	**0.99**	**0.99**	**0.97**

(d) 2030 higher China and India grain productivity growth

	Austr.	NZ	US Can	WE Eur	Japan	China	India	Arg.	Brazil	Chile	Peru	Rest LAm	MENA	South Africa	High Inc	Dev Asia	Rest Dev	Res rich	Res poor
Rice	1.10	0.21	1.15	0.95	0.98	0.98	1.09	1.38	1.00	0.73	0.97	0.95	0.71	0.24	**1.00**	**1.01**	**0.79**	**0.93**	**0.98**
Wheat	1.27	0.78	3.70	1.19	0.21	0.98	0.96	3.06	0.63	0.80	0.64	0.54	0.66	0.85	**1.40**	**0.88**	**0.64**	**0.86**	**1.01**
Coarse Grains	1.26	1.02	1.27	0.99	0.05	0.99	1.05	2.10	1.34	0.74	0.78	0.78	0.58	1.09	**1.09**	**0.85**	**0.90**	**0.97**	**0.83**
Fruit & Veg	1.22	1.68	1.05	0.93	0.95	0.96	0.93	1.47	1.19	3.41	1.18	1.18	1.03	1.85	**0.98**	**0.96**	**1.08**	**1.05**	**0.95**
Oilseeds	1.07	1.13	2.29	0.92	0.16	0.23	0.99	1.67	3.19	0.44	0.90	1.41	0.57	0.91	**1.41**	**0.58**	**1.55**	**1.34**	**0.37**
Sugar	1.38	0.97	0.91	0.95	0.83	0.81	1.01	1.25	1.34	0.87	0.98	1.12	0.72	1.22	**0.95**	**0.94**	**1.03**	**0.97**	**0.88**
Cotton	2.10	0.98	7.15	1.03	0.66	0.53	0.94	0.89	2.05	0.58	0.73	1.06	1.26	2.58	**1.65**	**0.70**	**1.36**	**1.31**	**0.56**
Other Crops	0.90	1.56	0.82	0.98	0.88	0.31	0.96	1.03	1.56	0.89	1.04	1.37	0.50	1.30	**0.94**	**0.89**	**1.23**	**1.12**	**0.91**
Beef & Sheep	1.64	1.96	1.02	1.02	0.87	0.71	0.97	1.10	1.15	0.92	0.99	1.02	0.94	1.19	**1.07**	**0.81**	**1.03**	**1.08**	**0.85**
Pork & Chicken	1.40	2.35	1.42	1.15	0.72	0.86	0.95	1.50	1.61	1.20	1.05	0.98	0.93	1.20	**1.24**	**0.87**	**1.08**	**1.09**	**0.92**
Dairy	1.03	1.68	1.00	1.04	0.93	0.89	0.99	1.09	1.02	1.02	0.99	0.93	0.91	1.01	**1.03**	**0.95**	**0.93**	**0.95**	**1.01**
Other Food	0.91	1.24	0.95	1.03	0.94	0.92	0.93	2.00	1.08	1.42	1.27	0.94	0.90	1.07	**0.99**	**0.95**	**1.02**	**1.05**	**0.96**

Table 12: Changes in real household consumption per capita of agricultural and food products from 2007 base, core and alternative growth scenarios in 2030, and variations from that core base due to trade reforms

(percent)

	2030 core	2030 Lower primary productivity growth	2030 higher China and India grain productivity growth
W. Europe	25	18	25
E. Europe	53	47	53
US & Canada	33	22	33
ANZ	34	26	35
Japan	22	14	22
China	165	142	167
ASEAN	88	73	88
Pacific Islands	50	54	51
Rest E. Asia	57	41	57
India	159	144	161
South Asia	146	111	146
Central Asia	86	93	86
Latin America	50	43	50
M.E. & Africa	85	78	85
High-income	**31**	**23**	**31**
Developing	**103**	**90**	**104**
of which Asia:	132	114	133
Total	**55**	**44**	**55**

Source: Derived from the authors' GTAP Model results

Table 13: Regional shares of global consumption of grains and fossil fuels, 2007 and 2030 core

(percent)

	2007				2030			
	Grains	Grains HH cons[a]	Fuel	Other minerals	Grains	Grains HH cons[a]	Fuel	Other minerals
W. Europe	11.3	8.0	19.6	18.7	6.3	4.6	10.1	6.1
E. Europe	7.0	4.4	8.9	3.2	4.7	3.1	5.8	1.3
US & Canada	8.3	1.3	22.4	8.7	5.9	0.9	13.3	3.1
ANZ	1.0	0.1	1.2	4.2	0.7	0.1	0.5	1.7
Japan	7.0	7.7	5.9	6.8	3.0	3.8	3.1	2.2
China	12.1	3.6	10.0	27.0	30.7	5.4	28.9	63.8
ASEAN	9.5	10.9	4.6	3.5	8.8	11.3	5.6	2.9
Pacific Islands	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Rest E. Asia	5.4	4.3	4.8	6.6	3.6	2.6	4.5	3.8
India	10.5	16.8	4.2	4.2	11.5	21.5	9.1	5.2
Rest S. Asia	4.3	6.3	0.5	0.3	4.3	7.1	0.9	0.3
Central Asia	0.9	1.5	1.2	0.9	0.6	1.1	0.8	0.4
Latin America	9.5	9.5	6.1	8.9	6.7	7.4	4.6	4.5
M.E. & Africa	13.3	25.6	10.4	6.8	13.1	31.0	12.7	4.5
High-income	**34.6**	**21.5**	**58.0**	**41.6**	**20.6**	**12.5**	**32.8**	**14.6**
Developing	**65.4**	**78.5**	**42.0**	**58.4**	**79.4**	**87.5**	**67.2**	**85.4**
of which Asia:	42.7	43.3	25.4	42.7	59.6	49.1	49.9	76.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

[a] Private household and government consumption (excluding use by firms)

Source: Derived from the authors' GTAP Model results

Table 14: Shares of bilateral trade in global trade in all goods and services, 2007 base, 2030 core and 2030 alternative growth scenarios

(percent)

(a) 2007 base

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	3.6	10.9	5.3	1.8	**21.6**
Nat Res Poor	9.3	40.4	8.7	2.7	**61.2**
Other HICs	3.6	5.4	0.3	1.6	**11.0**
Other DCs	1.1	2.1	2.5	0.5	**6.3**
Total	**17.5**	**59.0**	**16.9**	**6.6**	**100.0**

(b) 2030 core baseline

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	4.6	14.1	3.9	3.1	**25.7**
Nat Res Poor	11.6	32.9	8.8	4.0	**57.2**
Other HICs	2.6	3.8	0.3	1.3	**7.9**
Other DCs	1.9	3.6	2.8	0.8	**9.1**
Total	**20.6**	**54.4**	**15.8**	**9.3**	**100.0**

(c) 2030 with slower primary TFP growth

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	3.8	16.0	3.7	2.8	**26.3**
Nat Res Poor	12.3	31.6	8.4	4.4	**56.8**
Other HICs	2.6	3.7	0.2	1.3	**7.8**
Other DCs	1.8	3.7	2.9	0.7	**9.1**
Total	**20.5**	**55.0**	**15.3**	**9.3**	**100.0**

(d) 2030 with faster China and India grain TFP growth

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	4.6	14.1	3.9	3.1	**25.8**
Nat Res Poor	11.5	32.9	8.7	4.0	**57.2**
Other HICs	2.6	3.8	0.3	1.3	**7.9**
Other DCs	1.9	3.6	2.8	0.8	**9.1**
Total	**20.6**	**54.4**	**15.8**	**9.3**	**100.0**

Table 15: Shares of bilateral trade in agricultural and food products, 2007 base, 2030 core and 2030 alternative growth scenarios

(percent)

(a) 2007 base

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	9.4	12.8	4.9	3.1	**30.2**
Nat Res Poor	5.8	38.1	3.7	0.9	**48.5**
Other HICs	4.3	5.3	0.6	2.5	**12.7**
Other DCs	2.1	2.7	2.6	1.2	**8.6**
Total	**21.5**	**58.9**	**11.8**	**7.8**	**100.0**

(b) 2030 core baseline

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	9.4	19.0	3.2	4.4	**36.0**
Nat Res Poor	6.1	28.0	2.6	1.2	**37.9**
Other HICs	4.2	10.9	0.5	2.4	**18.0**
Other DCs	2.0	2.4	2.4	1.3	**8.1**
Total	**21.8**	**60.3**	**8.6**	**9.3**	**100.0**

(c) 2030 with slower primary TFP growth

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	10.1	15.4	3.1	3.7	**32.2**
Nat Res Poor	8.1	27.2	2.6	1.2	**39.1**
Other HICs	5.5	9.3	0.6	2.9	**18.3**
Other DCs	3.6	2.5	2.6	1.6	**10.4**
Total	**27.3**	**54.4**	**8.9**	**9.4**	**100.0**

(d) 2030 with faster China and India grain TFP growth

Importer: / ***Exporter:***	**Nat Res Rich**	**Nat Res Poor**	**Other HICs**	**Other DCs**	**Total**
Nat Res Rich	9.6	18.7	3.2	4.3	**35.9**
Nat Res Poor	6.1	28.0	2.6	1.2	**37.9**
Other HICs	4.3	10.6	0.5	2.4	**17.8**
Other DCs	2.2	2.5	2.5	1.3	**8.5**
Total	**22.2**	**59.8**	**8.8**	**9.2**	**100.0**

Appendix Table A.1: Aggregations of regions in the GTAP Model[a]

Aggregations for reporting	Modelled regions	Description	Original GTAP regions
W. Europe	*WesternEurope	EU27 and EFTA	AUT BEL CYP CZE DNK EST FIN FRA DEU GRC HUN IRL ITA LVA LTU LUX MLT NLD POL PRT SVK SVN ESP SWE GBR CHE NOR XEF BGR ROU
E. Europe	#Russia	Russia	RUS
	RestEEurope	Other Europe	ALB BLR HRV UKR XEE XER TUR
	#CentralAsia	Arm Azeb Geo Kaz Kyr Taj Tkm Uzbek	KAZ KGZ XSU ARM AZE GEO
US & Canada	USA	USA	USA
	#Canada	Canada	CAN
Australia&NZ	#Australia	Australia	AUS
	#NewZealand	New Zealand	NZL
Japan	*Japan	Japan	JPN
China	*China	China	CHN
ASEAN	*Singapore	Singapore	SGP
	#Indonesia	Indonesia	IDN
	#Malaysia	Malaysia	MYS
	Philippines	Philippines	PHL
	#Thailand	Thailand	THA
	#Vietnam	Vietnam	VNM
	#RestSEAsia	Cambodia, Laos, Brunei, Myanmar, Timor Leste	KHM LAO XSE
Rest E. Asia	*HongKong	Hong Kong	HKG
	*SouthKorea	South Korea	KOR
	*Taipei,China	Taipei,China	TWN
	#RestNEAsia	North Korea, Macau, Mongolia	XEA
	#PacificIslands	Pacific Countries	XOC
India	India	India	IND
R. South Asia	Pakistan	Pakistan	PAK
	Bangladesh	Bangladesh	BGD
	RestSAsia	Afghanistan Bhutan Maldives, Nepal, Sri Lanka	LKA XSA
South America	#Argentina	Argentina	ARG
	#Brazil	Brazil	BRA
	#Chile	Chile	CHL
	#Peru	Peru	PER
Rest LAC	RestLatAmer	Other Latin America	XNA BOL COL ECU PRY URY VEN XSM CRI GTM NIC PAN XCA XCB
	Mexico	Mexico	MEX
MENA	#ME_NAfrica	Middle East and North Africa	IRN XWS EGY MAR TUN XNF
SubSAfrica	SthAfrica	South Africa	ZAF
	#RestSSAfrica	Sub-Saharan Africa	NGA SEN XWF XCF XAC ETH MDG MWI MUS MOZ TZA UGA ZMB ZWE XEC BWA XSC

[a] High-income countries (the 'North') are defined as the first five country groups in the table (i.e. W.Europe, E.Europe, US&Canada, Australia&NZ, and Japan, with the exclusion of Central Asia). The rest are defined as developing countries (the 'South'), of which China, ASEAN, Pacific Islands, Rest E. Asia, India, Rest S. Asia, and Central Asia make up 'Developing Asia'. Regions marked # are classified as 'natural resource rich' and * are classified as 'natural resource poor' for reporting aggregate results.

Source: Authors' compilation from www.gtap.org

Appendix Table A.2: Aggregations of sectors in the GTAP Model

Aggregations of commodities	Modelled commodities	Description	Original GTAP sectors
Agric. & Food	Rice	Paddy and processed rice	pdr pcr
	Wheat	Wheat	wht
	Fruit_Veg	Vegetables, fruit, nuts	v_f
	Oilseeds	Oil seeds	osd
	Sugar	Raw and processed sugar	c_b sgr
	Cotton	Plant-based fibres	pfb
	Grains	Other cereal grains	gro
	OtherCrops	Other crops	ocr
	Beef_Sheep	Beef & sheep	ctl wol cmt
	Pork_Chicken	Pork & chicken	oap omt
	Dairy	Dairy products	rmk mil
	OtherFood	Other processed food	vol ofd b_t
Other Primary	Fish_Forest	Forestry and fishing	frs fsh
	Coal	Coal	coa
	Oil	Oil	oil
	Gas	Gas	gas
	OthMinerals	Other minerals	omn
Manufactures	Text_App_Lea	Textiles, apparel & leather	tex wap lea
	MotorVehicle	Motor vehicles & parts	mvh
	Electronics	Electronic equipment	ele
	OtherLtMan	Other light manufacturing	lum ppp fmp otn omf
	HeavyManuf	Heavy manufacturing	p_c crp nmm i_s nfm ome
Services	Utiliti_Cons	Utilities and construction	wtr cns
	Elect_Gas	Electricity & gas distribution	ely gdt
	Trade_transp	Trade & transport	trd otp wtp atp
	OthServices	Other Services	cmn ofi isr obs ros osg dwe

Source: Authors' compilation from www.gtap.org

Appendix Table A.3: Average annual GDP and endowment growth rates, 2007 to 2030

	GDP growth	Population growth	Unskilled labour	Skilled labour	Produced capital	Agric. land	Oil	Gas	Coal	Other minerals
W. Europe	1.29	0.11	-1.25	1.34	1.19	-0.28	2.81	0.77	-2.51	2.07
E. Europe	2.88	0.02	-0.75	1.30	2.77	-0.22	2.64	0.12	-1.90	2.07
US & Canada	1.96	0.80	0.08	1.55	0.96	-0.20	1.11	-0.70	0.17	2.07
Australia & NZ	2.30	1.07	0.31	1.88	1.71	-0.56	1.40	6.07	3.55	2.07
Japan	0.89	-0.21	-1.53	0.77	0.93	-1.14	0.00	0.00	-9.35	2.07
China	7.95	0.42	-0.06	2.75	7.40	-0.36	-0.40	4.85	5.62	2.07
ASEAN	4.73	0.93	0.07	3.60	4.49	0.22	1.32	1.48	1.17	2.07
Pacific Islands	3.87	1.67	2.31	1.71	3.59	0.19	1.54	1.21	0.15	2.07
Rest E. Asia	3.33	0.28	-0.53	2.10	2.87	-0.84	0.00	0.00	-1.64	2.07
India	7.25	1.06	1.28	3.92	4.86	-0.04	0.24	0.00	4.93	2.07
Rest S. Asia	6.16	1.43	1.95	4.72	5.03	-0.10	0.12	-2.04	1.18	2.07
Central Asia	3.68	-0.45	-0.82	0.92	2.54	-0.29	2.81	0.77	-2.51	2.07
Latin America	3.31	0.82	0.63	3.18	3.44	0.23	3.50	-0.05	5.05	2.07
ME & Africa	4.47	1.88	0.82	4.32	4.33	0.06	1.28	3.64	1.88	2.07
High-income	1.61	0.26	-0.60	1.38	1.22	-0.30	2.12	0.25	-0.28	2.07
Developing	5.13	1.03	0.36	3.21	4.66	-0.09	1.51	2.53	4.33	2.07
of which Asia:	6.21	0.79	0.08	2.95	5.39	-0.17	0.93	1.11	4.47	2.07
Total	2.55	0.88	-0.45	1.84	2.33	-0.15	1.70	1.44	2.94	2.07

Source: Authors' assumptions (see text for details)

Appendix Table A.4: Implied annual growth in total factor productivity for the various sectors,[a] 2007 to 2030

(percent, using 2007 national GDP values as weights)

	2030 core			2030 slower primary TFP				2030 higher China/India grain productivity growth			
	A	B	C	A	B	C	D	A	B	C	E
W Europe	0.8	1.8	2.8	0.8	0.8	1.8	-0.2	0.8	1.8	2.8	1.8
E Europe	1.3	2.3	3.3	1.3	1.3	2.3	0.3	1.3	2.3	3.3	2.3
US & Canada	1.1	2.1	3.2	1.1	1.1	2.1	0.1	1.1	2.1	3.2	2.1
Australia & NZ	0.9	1.9	2.9	0.9	0.9	1.9	-0.1	0.9	1.9	2.9	1.9
Japan	0.8	1.9	2.9	0.8	0.8	1.9	-0.2	0.8	1.9	2.9	1.9
China	4.1	4.1	6.2	4.1	4.1	4.1	3.1	4.1	4.1	6.2	5.1
ASEAN	1.7	2.7	3.7	1.7	1.7	2.7	0.7	1.7	2.7	3.7	2.7
Pacific Islands	1.0	2.0	3.0	1.0	1.0	2.0	0.0	1.0	2.0	3.0	2.0
Rest E. Asia	1.7	2.8	3.8	1.7	1.7	2.8	0.7	1.7	2.8	3.8	2.8
India	4.0	4.0	6.1	4.0	4.0	4.0	3.0	4.0	4.0	6.1	5.0
Rest S. Asia	2.5	3.5	4.6	2.5	2.5	3.5	1.5	2.5	3.5	4.6	3.5
Central Asia	2.4	3.4	4.4	2.4	2.4	3.4	1.4	2.4	3.4	4.4	3.4
Latin America	0.6	1.4	2.3	0.6	0.6	1.4	-0.1	0.6	1.4	2.3	1.4
ME & Africa	1.0	2.1	3.1	1.0	1.0	2.1	0.0	1.0	2.1	3.1	2.1
High Income	1.0	2.0	3.0	1.0	1.0	2.0	0.0	1.0	2.0	3.0	2.0
Total Developing	2.3	2.8	4.3	2.3	2.3	2.8	1.4	2.3	2.8	4.3	3.3
Developing Asia	3.2	3.6	5.3	3.2	3.2	3.6	2.3	3.2	3.6	5.3	4.3
Total World	1.4	2.2	3.4	1.4	1.4	2.2	0.4	1.4	2.2	3.4	2.4

[a] The above TFP growth rates are those implied for the non-primary sectors by the GDP and factor growth rates in Appendix Table A.3, based on the following assumptions about primary sector TFP growth. Primary sector TFP rates were exogenously set higher than those for the non-primary sectors to the following extent in the core projection for all countries, with the aim of ensuring only modest growth in international relative prices for those products (shown in Appendix Table A.5): 1% for agriculture, lightly processed food and other minerals (except in the case of China and India), 0% for fossil fuels, and 2% for the forestry and fishing sector. In the slower primary TFP growth scenario, the increment for all primary sectors is assumed to be 1 percentage point lower than in non-primary sectors. For the higher China and India grain productivity scenario, the increment is increased in rice, wheat and coarse grains by 1 percent for China and India. For the trade reform scenarios, the core projection's TFP growth assumptions are maintained.

Column heading letters refer to:

A: non-primary sectors
B: agriculture, lightly processed food and other minerals
C: forestry and fishing
D: fossil fuel sectors (coal, oil and gas)
E: rice, wheat and other coarse grains in the higher China/India productivity growth scenario

Source: Derived from the GTAP Model, based on authors' assumptions (see text for details)

Appendix Table A.5: Cumulative changes in international prices, 2007 to 2030
(price relative to global average output price change across all sectors, percent)

	2030 core	2030 Lower primary productivity growth	2030 higher China/India grain productivity growth
Rice	13.4	17.9	5.8
Wheat	12.0	25.3	7.1
CoarseGrains	15.0	32.3	10.0
Fruit_Veg	32.5	40.0	31.9
Oilseeds	15.0	34.6	14.6
Sugar	-1.0	4.0	-1.1
Cotton	18.0	32.1	17.6
OtherCrops	9.2	25.9	8.8
Beef_Sheep	3.2	11.4	3.0
Pork_Chicken	16.7	20.9	15.9
Dairy	2.1	8.8	2.0
OtherFood	6.0	10.4	5.7
Forest_Fish	7.9	153.1	8.3
Coal	-7.6	15.5	-7.4
Oil	10.8	60.2	11.0
Gas	-7.5	8.4	-7.4
OthMinerals	8.2	25.6	8.3
Text_App_Lea	2.1	-2.2	2.0
MotorVehicle	-0.2	-2.6	-0.1
Electronics	-4.2	-8.7	-4.1
OtherLtMan	-1.0	-0.2	-0.9
HeavyManuf	-0.9	3.4	-0.8
Utiliti_Cons	0.7	-1.4	0.8
Elect_Gas	-5.2	-5.1	-5.1
Trade_transp	-0.5	-4.0	-0.5
Other services	-1.5	-6.5	-1.4
Aggregate Prices:			
Agriculture_Food	**10.1**	**16.7**	**9.2**
OtherPrimary	**6.8**	**57.1**	**7.0**
Manufactures	**-0.9**	**0.7**	**-0.8**
Services	**-1.1**	**-5.2**	**-1.1**

Source: Derived from the authors' GTAP Model results

Appendix Table A.6: Regional shares of world real GDP and population, and GDP per capita relative to world average, 2007 and the core projection for 2030,[a] percent

	World GDP share		World population share		GDP per capita relative to world average	
	2007	**2030**	**2007**	**2030**	**2007**	**2030**
WEurope	32.0	21.6	7.7	6.4	415.9	338.4
Russia	2.3	2.2	2.1	1.6	108.5	134.2
RestEEurope	1.8	1.8	2.3	2.0	76.7	88.6
USA	25.2	19.8	4.6	4.4	553.4	449.5
Canada	2.6	2.0	0.5	0.5	512.1	405.1
Australia	1.5	1.3	0.3	0.3	482.1	397.0
NewZealand	0.2	0.2	0.1	0.1	387.9	309.2
Japan	7.8	4.8	1.9	1.5	406.3	325.0
China	6.3	18.3	19.9	17.7	31.4	103.2
Singapore	0.3	0.3	0.1	0.1	456.8	448.6
Indonesia	0.8	1.4	3.4	3.3	22.8	42.4
Malaysia	0.3	0.5	0.4	0.4	83.3	105.0
Philippines	0.3	0.4	1.3	1.5	19.3	23.5
Thailand	0.4	0.6	1.0	0.9	43.7	67.3
Vietnam	0.1	0.2	1.3	1.3	9.5	16.1
RestSEAsia	0.1	0.1	1.1	1.1	6.9	10.0
PacificIslan	0.1	0.1	0.1	0.2	40.0	40.7
HongKong	0.4	0.4	0.1	0.1	354.5	357.1
SouthKorea	1.9	1.8	0.7	0.6	256.8	304.1
Taiwan	0.7	1.0	0.3	0.3	204.1	320.5
RestNEAsia	0.1	0.1	0.4	0.4	16.3	25.9
India	2.2	5.5	17.0	17.5	13.0	31.7
Pakistan	0.3	0.5	2.5	3.0	10.4	16.1
Bangladesh	0.1	0.3	2.4	2.5	5.1	10.5
RestSthAsia	0.1	0.2	1.2	1.2	8.4	16.2
CentralAsia	0.4	0.4	1.1	0.8	31.5	49.8
Mexico	1.8	1.8	1.6	1.5	115.5	117.5
Argentina	0.5	0.6	0.6	0.6	78.3	96.6
Brazil	2.4	2.7	2.9	2.7	85.2	101.9
Chile	0.3	0.3	0.3	0.2	117.1	124.8
Peru	0.2	0.3	0.4	0.4	44.7	59.6
RestLAmerica	1.7	1.8	2.8	2.9	58.9	59.9
ME_NthAfrica	3.4	4.2	5.5	6.0	61.7	70.1
SouthAfrica	0.5	0.5	0.7	0.7	70.9	78.6
RestSSAfrica	1.1	2.3	11.4	15.2	9.3	14.8
High-income	**73.5**	**53.7**	**19.5**	**16.8**	**376.1**	**319.5**
Developing	**26.5**	**46.3**	**80.5**	**83.2**	**33.0**	**55.7**
of which Asia:	14.7	32.0	54.3	52.9	27.1	60.4
World	**100**	**100**	**100**	**100**	**100**	**100**

[a] 2007 prices.

Source: Derived from the authors' GTAP Model results