Emerging Economies, Productivity Growth, and Trade with Resource-Rich Economies by 2030

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Contributed paper prepared for presentation at the
57th AARES Annual Conference, Sydney,
New South Wales, 5th-8th February, 2013

AARES
AUSTRALIAN AGRICULTURAL & RESOURCE ECONOMICS SOCIETY

Abstract

Rapid economic growth in some emerging economies in recent decades has significantly increased their global economic importance. If this rapid growth continues and is strongest in resource-poor Asian economies, the growth in global demand for imports of primary products also will continue, to the on-going benefit of natural resource-rich countries. This paper explores how global production, consumption and trade patterns might change over the next two decades in the course of economic development and structural changes under various 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 from 2007 to 2030. We first project a baseline assuming trade-related policies do not change in each region but that factor endowments and real GDP grow at exogenously-estimated rates. That baseline is compared with two alternative scenarios: one in which the growth rates of China and India are lower by one-quarter, and the other in which this slowdown in emerging economies leads to slower productivity growth in the primary sectors of all countries. Throughout the results, implications for natural resource-abundant economies including Australia and New Zealand are drawn out.

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

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

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[a] The authors are grateful for helpful interactions including with Tom Hertel, Terrie Walmsley, Dominique van der Mensbrugghe, Fan Zhai, Rob McDougall, along with participants at the 15th Annual Conference on Global Economic Analysis, Geneva, 27-29 June 2012. Thanks are also due to Papu Siameja for excellent research assistance. Funding support from the Asian Development Bank, the Australian Research Council, the Rural Industries Research and Development Corporation, and Waikato Management School is gratefully acknowledged. Views expressed are the authors' alone.

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1. Introduction

The recent slowdown in Western economies and the rapid economic growth in emerging economies are shifting the global industrial centre of gravity away from the north Atlantic and raising the importance of natural resource-poor Asian economies in world output and trade. That in turn is 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 and then by some Southeast Asian countries (Drysdale et al. 1986). Most recently it has involved far 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 primary product markets. China and India, by contrast, account for more than two-fifths of humanity and so their rapid and persistent growth 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. How markets and governments respond to these concerns could have non-trivial effects in both the emerging economies and their trading partners, especially natural resource-rich economies.

This paper focuses on the consequences for primary product markets of the prospective continuation of this latest and largest emergence 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. We briefly summarize that theory and history 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 Asian growth and global primary sector productivity growth rates. The paper concludes by drawing out key lessons and implications from the results for resource-abundant economies, including Australia and New Zealand.

2. Theory and past experience

Like Northeast Asia's earlier rapidly industrializing economies, China and India are relatively natural resource-poor and densely populated. So too are some other Asian countries. They are therefore highly complementary with relatively lightly populated economies that are well endowed with agricultural land and/or mineral resources in Australasia, Latin America, the Middle East and Africa, 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 skills and technological knowledge) per unit of available labour 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).

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 stock of produced capital (net of depreciation) per worker will put upward pressure on real wages. That will encourage, in all sectors, the use of more labour-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. That gives rise to the Rybczynski effect, of pulling mobile resources (most notably labour) out of agriculture. If there is also relatively rapid productivity growth in primary sectors (as Martin and Mitra (2001) have found to be the case historically), and especially if that productivity growth is labour-saving, this also pushes labour into non-primary sectors (Martin and Warr 1993).

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 advantage in unskilled labour-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 labour-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).

3. Modeling methodology and database

Given the interdependence between sectors of growing economies described above, an economy-wide model of the world's national markets is needed to project future trends in primary product markets. 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 (Narayanan, Aguiar and McDougall 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. The Version 8 base period of 2007 is ideal for projecting forward to 2030 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, labour (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 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. In the long-run model closure adopted here, labour and produced capital are assumed to be mobile across all uses within a country, but immobile internationally.

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. 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 follow Yu et al. (2004) in modifying these elasticities. We do so by econometrically estimating the relationship between per capita incomes and income elasticities of demand for agricultural and food products, as reflected in the full GTAP database.[1] These estimates are then used to modify the elasticities for each region by 2030, given projections of per capita income for each region.[2]

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 typical modelling practise of doubling the short-to-medium term Armington elasticities. The national balance of trade is determined by the relationship between national savings and investment, with investment allocated in response to rates of return with capital markets kept in equilibrium, for present purposes.

The GTAP Version 8 database divides the world into 129 countries/country groups, and divides each economy into 57 sectors: 26 for primary goods, 16 for manufactures and 15 for services. For most modelling tasks, 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 the database to 35 countries/country groups and to 26 sector/product groups. We then further aggregate to 15 regions and just 4 sectors for reporting of many results. We also distinguish countries that are natural resource rich (NRR) from others (denoted NRP), based on their trade specialization patterns as of 2005-09 (shown in Appendix Table A.1).[3]

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[1] We are grateful to Papu Siameja for his careful research assistance with econometrically estimating these projected income elasticities.

[2] As a form of sensitivity analysis, we also tested the impact of driving the household income elasticities close to zero for direct grain consumption in China. It turns out that dropping them from the already fairly low adjusted value of 0.2 has little further effect on overall food self-sufficiency. This is in part because elasticities for other products, including other types of foods, have to rise slightly so their weighted average is still unity. Even for grains there is little change in self-sufficiency, with intermediate usage of grains by firms increasing a little, dampening the impact of lower household direct demand for grains.

[3] The so-defined natural resource rich (NRR) countries – the first 20 in Appendix Table A.1 – accounted in 2007 for one-fifth of global GDP, one-fourth of global trade, one-third of the world's agricultural trade, two-thirds of its trade in other primary products, and just one-sixth of non-primary product exports.

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 23-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. The exogenous growth rates for GDPs, capital stocks and populations are based on estimates from the World Bank and CEPII (Fouré et al. 2012).[4] For projections of skilled and unskilled labour growth rates, we draw on Chappuis and Walmsley (2011). Historical trends in agricultural land are estimated from FAOSTAT (summarized in Deininger and Byerlee 2011) and in mineral and energy raw material reserves from BP (2012) and the US Geological Survey (2012 and earlier editions), assuming that annual rates of change in fossil fuel reserves over the past two decades continue for each country over the next two decades.[5] 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). These rates of change in natural resources are summarized in the last five columns of Appendix Table A.2.

Given those exogenous growth rates,[6] 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 manufacturing sectors, somewhat higher in most primary sectors and somewhat lower in services. 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.[7] An alternative projection in which those prices rise more is considered below. The international price consequences for the core simulation are depicted in Appendix Table A.3.[8]

[4] Some compiled using tools from Chappuis and Walmsley (2011).

[5] Past reserves data are from BP (2012). For coal, however, production data are used since reserves data are not available. Data for only a decade of exceptionally high growth were available for Vietnam's coal, oil and gas, along with Indonesia's coal; these implied implausibly high projections, therefore were modified downward.

[6] 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.

[7] We chose that calibration because it is consistent with the World Bank projections over the next four decades (see van der Mensbrugghe and Roson 2010). An alternative in which agricultural prices fall, as projected in GTAP-based projection studies in the late 20th century (e.g., Anderson et al. 1997), is considered unlikely over

4.1 Impacts on sectoral and regional GDP and trade compositions

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 very 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. The developing country 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 14 to 32 percent. Western Europe's share, meanwhile, is projected to fall from almost one-third to just above one-fifth. Economically active population shares change much less, with the developing countries' share rising from 79 to 83 percent but Developing Asia's component remaining steady between 2007 and 2030. Thus GDP per economically active person converge considerably, with the ratio of the high-income to developing country average almost halving between 2007 and 2030. In particular, the per capita income of Developing Asia is projected to rise from 25 to 57 percent of the global average over the projection period (bottom rows of Appendix Table A.4).

When global value added (based on producer expenditure) is broken down by sector, as in Table 1, 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. This is a ranking China has not held since the mid-19th

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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) and the decline in the real price of manufactures as industrialization in China and other Asian countries booms – as occurred also with the original industrial revolution in the first half of the 19th century (Williamson 2012). 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. Timilsina et al. (2010) project that by 2020 international prices will be higher in the presence vs 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.

[8] It should be noted that the extent to which productivity growth rates is higher in each primary sector than in other sectors is the same for high-income and developing countries,,with the exception of agriculture in China and India, 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, 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).

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). The NRR economies' contribution to global manufacturing GDP rises only one point (from 16 to 17 percent), while their share of overall GDP rises 2.5 points. In this core scenario the NRR share of global primary sector value added slips slightly because of the huge growth in Asia – and despite the high-income countries' share falling substantially (Table 1).

[insert Table 1 about here]

The Asian developing country share of global exports of all products nearly doubles, rising from 22 to 39 percent between 2007 and 2030. 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 the other developing-country regions in Table 2 also grow. 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. Asia's import shares also rise, although not quite so dramatically: the increase for Developing Asia is from 19 to 33 percent for all products, but the rise is much sharper for China's primary product imports – from 1.3 to 6.8 percent (Table 3).

[insert Tables 2 and 3 about here]

The consequences of continuing Asian industrialization are also evident in the sectoral shares of national trade: 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 NRR countries (Tables 4 and 5). It may seem surprising that high-income countries' comparative advantage in primary products strengthens, but recall that (a) what one part of the world imports the remaining part of the world must export to maintain global equilibrium, (b) the high-income country grouping includes Australia, Canada and New Zealand (and the US in terms of food exports) and (c) we have not allowed for possible agricultural protection growth in emerging Asia in this core scenario.

[insert Tables 4 and 5 about here]

The export composition of NRR countries strengthens a little in farm and other primary products – at the expense of manufactures and services, which suffer the Dutch disease problem associated with the strengthening of primary sector prices resulting from Asia's rapid industrialization. The share of non-farm primary products in Australia's and Brazil's exports increases significantly, more than doubling in the case of Brazil (Table 4):

while their comparative advantage strengthens somewhat in farming, it strengthens even more in mining as it weakens in non-primary goods and services. NRR's share of global exports of agricultural products is projected to rise 8 percentage points between 2007 and 2030, as those countries – especially Brazil – out-compete others in supplying the huge growth in imports of farm products by China (Table 6).

[insert Table 6 about here]

4.2 Impacts on food self-sufficiency and consumption of primary products

These changes mean that food self-sufficiency in developing countries is projected in this core scenario to fall considerably by 2030, but the source of that change is mainly China and to a smaller extent India (columns 1 and 2 of Table 7). 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, but that is not modelled here (however, see Anderson and Nelgen 2011).

[insert Table 7 about here]

Self sufficiency is a poor indicator of food security, however. A more meaningful indicator is real per capita private consumption of agricultural and processed food products by households. Table 8 reports those results, for our projection showing that between 2007 and 2030, real per capita food consumption increases by 76 percent for developing countries, and more than doubles for China and South Asia. These are major improvements in food consumption per capita. Even if income distribution were to worsen in emerging economies over the next two decades, virtually all developing country regions could expect to be much better fed by 2030, according to this baseline scenario.

[insert Table 8 about here]

Turning to global consumption shares, the rise in grain consumption is especially great in China because of their expanding demand for livestock products, most of which continue to be produced domestically in this core scenario. So even though China's share of the world's direct grain consumption by households grows little, its share of grain consumed indirectly grows from 8 to 26 percent of the global total (the differences between total and household consumption in Table 9). That promises to provide on-going growth in the market for grain (and soybean) exports to China. China's share of global consumption of fossil fuels is projected to rise by a similar proportion over this period (from 10 to 28 percent) and likewise for other minerals (from 27 to 59 percent).

[insert Table 9 about here]

4.3 Impacts on bilateral trade

In our core scenario it is the phenomenal growth in China's share of global imports of primary products that dominates the bilateral trade picture: all of the NRR regions (the last five country groups in Table 10) boost their share of exports to China. Most of the NRR countries also increase exports to other NRP Asian countries, though to a much lesser extent than China, with these increases at the expense of their primary product exports to most other regions. Among the NRR countries, Australia had the highest share of primary exports with China as of 2007, but other NRR countries are projected to move a long way towards catch up by 2030 (Table 10). That outcome probably will depend to some extent though on the intensity of Chinese investment in natural resource sectors over next two decades in Australia, South America, Sub-Saharan Africa, and elsewhere.

[insert Table 10 about here]

5. Alternative 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:

- ***One-quarter slower GDP, skilled labour and capital stock growth in China and India***, and
- ***Also one percentage point slower total factor productivity (TFP) growth in primary sectors globally,*** in response to the assumed slowdown in Asian economic growth.

The second of these alternative scenarios involves dropping the assumption that productivity growth in the primary sectors increases to nearly match the growing global demand for such products. Compared with the core projection, which is consistent with the evidence presented by Fuglie (2008), this is a plausible alternative that is more consistent with the evidence of the past two decades provided by Alston, Babcock and Pardey (2010) of a slowdown in productivity growth in agriculture in both high-income and developing countries. In this alternative case, real international prices for agricultural, mineral and energy raw material products by 2030 are much more above 2004 levels than in the core projection (see Appendix Table A.3 for details by product). Those increases are more consistent with the price projections of several international agencies (FAO/OECD 2010, IEA 2011, Nelson et al. 2010).

5.1 One-quarter slower growth in China and India

The core projection sets real GDP growth rates for China and India at about 8 and 7 percent per year, respectively, between 2007 and 2030. These are well below those economies' recent growth rates, especially when their faster growth during 2007-12 is taken into account. Yet some commentators still feel those rates are too optimistic, particularly given the recent slowdown in developed country economies and their modest prospects. Hence we re-ran our projections assuming GDP, skilled labour and capital stock growth rates in these two economies are one-quarter lower per year than in the core scenario. This causes prices of primary products to rise less (in fact to fall slightly below 2007 real levels for non-agricultural primary products – see Appendix Table A.3).

Slower growth in these two populous emerging economies certainly has a marked impact on primary product markets and trade with NRR economies. Asia's share of global agricultural imports in 2030 drops from 39 to 31 percent (Table 6), and the growth in China's share of NRR imports is dampened very substantially (Table 10). Consumption of food in those two economies also grows by about one-third less, because of their slower income growth (Table 8).

5.2 Slower growth in China and India *and* slower TFP growth in primary sectors in all countries

If slower growth in China and India were to dampen annual total factor productivity (TFP) growth in primary sectors around the world by 1 percentage point annually, this would cause international prices of farm and other primary products to be higher than in the core scenario (Appendix Table A.3). Those higher prices would compensate somewhat for the impact on primary producers in NRR countries of slower Asian growth. And because this scenario would see slower primary production growth in Asia, it would also mean a larger share of NRR countries' exports going to China than in the previous alternative scenario (Table 10).

The slowdown in farm productivity growth would result in lower food self-sufficiency ratios in Asia and even less growth in their household food consumption (Tables 7 and 8).

6. Some qualifications

As with the results from all other economy-wide projections modelling, it is necessary to keep in mind numerous qualifications. One 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 (Feenstra 1998, Baldwin and Lopez-Gonzales 2013). Our underestimate is made even larger by not accommodating endogenous foreign direct investment flows, since they tend to reinforce trade flows in manufactures within Asia (Petri 2012).

Second, 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 changes associated with production and trade growth (Krugman 2009).

Third, 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 (Rutherford and Tarr 2002), but that too is not taken into account in the above analysis.

Fourth, 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, and the references therein). Whether these policies will still be in place in 2030 is a moot point. If the expected dramatic expansion in unconventional gas production materializes (see IEA 2012), and if biofuel mandates were removed, this omission from our modelling may be inconsequential.

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, Melitz and Ottaviano 2008; Bernard et al. 2012). 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). It may also alter the political economy of protection, providing stronger opposition from new exporters and thus leading to more opening up of economies (Baldwin 2012).

7. 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. In the core projection its share of global agricultural GDP is projected to almost double also, but that is not fast enough to keep pace with the growing consumption of food. By 2030, developing Asia is projected to consume around 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 more than double between 2007 and 2030 in the core scenario – and paid for with their rapidly rising earning from exports of manufactures.

The bright export prospects for natural resource-rich economies are considerably dampened if economic growth in China and India is one-quarter slower than in that core scenario, however. And the world's food and energy security would be reduced if such a slowing of growth in emerging Asia were to lead to a slowdown in productivity growth in farm and mineral production.

Since developing Asia accounts for a large share of the world's agricultural and food output and consumption currently, and that global share will be even larger 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 (Anderson 2009, Ch. 13). 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 years – the contribution of farm policies to the global cost of goods trade barriers would become even higher.[9] Clearly such a policy development would be harmful not only to those Asian economies but also to NRR countries' farm trade interests, given the huge growth in agricultural exports to China that is projected above. It increases the stake farm-exporting countries have in the resumption and successful conclusion of the WTO's Doha Development Agenda as it relates to agricultural trade in particular.

[9] See Anderson and Nelgen (2011). Such a trend is already evident for China: its nominal rate of assistance (NRA) to farmers rose from -3 to 21 percent between 1999 and 2010 (OECD 2012). This has been sufficient to maintain self sufficiency in all key farm products except soybean (whose tariff is bound in the WTO at 3 percent and which mostly goes into livestock feed and so helps maintain apparent self sufficiency in meat and milk). In Indonesia, its agricultural NRA rose from -3 to 27 percent between 1999 and 2010 (Anderson and Nelgen 2013), and in November 2012 a new Food Law was introduced in Indonesia to make food self-sufficiency an even stronger policy goal. In India, its agricultural NRA rose from 8 to 25 percent between 1999 and 2006, before dropping back as export restrictions were introduced to reduce the rise in domestic food prices (Anderson and Nelgen 2013).

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Table 1: Regional shares of global value added by sector, 2007 and 2030 core (percent)

(a) 2007 Base

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	1.2	2.4	0.8	1.6	1.5
New Zealand	0.4	0.2	0.2	0.3	0.2
WEurope	24.2	10.8	33.5	31.9	30.9
EEurope	7.5	11.2	3.4	4.0	4.4
USC	13.7	11.7	23.6	32.1	28.7
Japan	4.4	0.7	8.0	8.6	7.9
China	13.6	9.2	11.2	4.2	6.2
East Asia	6.5	6.9	7.5	4.8	5.4
South Asia	8.5	2.6	2.1	2.4	2.7
Mexico	2.5	1.3	1.9	1.8	1.9
Argentina	0.8	0.6	0.3	0.4	0.4
Brazil	3.6	1.7	2.2	2.5	2.5
RestLA	4.5	5.2	1.7	1.9	2.2
MENA	3.6	29.0	2.7	2.3	3.6
SubSAfrica	4.9	6.5	1.0	1.2	1.6
HICS	**50.8**	**34.8**	**69.2**	**78.3**	**73.2**
Developing	**49.2**	**65.2**	**30.8**	**21.7**	**26.8**
of which Asia	28.6	18.8	20.8	11.4	14.3
NR Rich	**30.2**	**66.4**	**16.1**	**17.9**	**20.4**
NR Poor	**69.8**	**33.6**	**83.9**	**82.1**	**79.6**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	1.0	1.9	0.5	1.5	1.4
New Zealand	0.3	0.2	0.1	0.2	0.2
WEurope	14.2	6.9	20.5	23.8	21.6
EEurope	5.1	9.0	3.1	4.3	4.4
USC	9.8	6.5	17.2	28.0	23.8
Japan	2.2	0.4	4.6	6.1	5.3
China	31.7	23.8	28.9	11.1	16.2
East Asia	6.4	7.2	9.3	6.2	6.8
South Asia	11.8	5.3	4.4	6.0	6.1
Mexico	1.7	0.5	1.7	1.8	1.7
Argentina	0.8	0.4	0.3	0.5	0.5
Brazil	3.0	1.5	2.2	3.2	2.9
RestLA	3.4	5.5	1.7	2.3	2.4
MENA	3.2	19.9	3.9	3.0	4.1
SubSAfrica	5.3	10.9	1.4	2.1	2.7
HICS	**32.1**	**23.2**	**45.9**	**63.6**	**56.2**
Developing	**67.9**	**76.8**	**54.1**	**36.4**	**43.8**
of which Asia	49.9	36.3	42.6	23.3	29.0
NR Rich	**26.2**	**57.8**	**17.1**	**21.0**	**22.9**
NR Poor	**73.8**	**42.2**	**82.9**	**79.0**	**77.1**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 2: Regional and sectoral shares of global exports, 2007 and 2030 core (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	0.1	0.3	0.4	0.2	1.1
New Zealand	0.1	0.0	0.1	0.1	0.2
WEurope	2.7	1.0	28.2	9.1	40.9
EEurope	0.3	1.6	2.3	0.8	4.9
USC	0.8	0.5	8.0	2.7	12.1
Japan	0.0	0.0	4.5	0.5	5.0
China	0.2	0.1	7.4	0.6	8.3
East Asia	0.5	0.5	8.5	2.1	11.6
South Asia	0.1	0.1	1.1	0.5	1.8
Mexico	0.1	0.2	1.4	0.1	1.8
Argentina	0.2	0.0	0.2	0.1	0.4
Brazil	0.3	0.2	0.6	0.1	1.2
RestLA	0.3	0.6	0.9	0.4	2.2
MENA	0.2	3.6	1.7	0.8	6.3
SubSAfrica	0.2	1.1	0.6	0.2	2.1
HICS	**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	0.6	17.0	3.2	21.7
NR Rich	**2.1**	**8.5**	**10.6**	**3.2**	**24.4**
NR Poor	**4.0**	**1.3**	**55.2**	**15.0**	**75.6**
World	**6.1**	**9.8**	**65.8**	**18.2**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	0.2	0.6	0.2	0.1	1.1
New Zealand	0.1	0.0	0.0	0.0	0.2
WEurope	2.2	1.3	15.3	7.0	25.8
EEurope	0.3	2.3	1.9	0.6	5.1
USC	1.1	0.8	5.1	2.0	9.0
Japan	0.0	0.0	2.6	0.3	3.0
China	0.0	0.1	18.6	2.0	20.8
East Asia	0.7	0.7	10.8	2.2	14.4
South Asia	0.1	0.2	2.5	1.1	4.0
Mexico	0.1	0.0	1.4	0.2	1.8
Argentina	0.2	0.0	0.1	0.1	0.5
Brazil	0.5	0.5	0.3	0.1	1.3
RestLA	0.3	1.1	0.8	0.2	2.4
MENA	0.2	2.7	3.0	1.3	7.2
SubSAfrica	0.2	2.2	0.7	0.3	3.4
HICS	**3.9**	**4.6**	**24.9**	**10.0**	**43.4**
Developing	**2.4**	**8.1**	**38.4**	**7.7**	**56.6**
of which Asia	0.8	1.0	31.9	5.4	39.2
NR Rich	**2.6**	**10.7**	**10.8**	**3.5**	**27.7**
NR Poor	**3.7**	**1.9**	**52.5**	**14.2**	**72.3**
World	**6.3**	**12.7**	**63.3**	**17.7**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 3: Regional sectoral shares of global imports, 2007 and 2030 (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	0.1	0.1	0.8	0.2	1.1
New Zealand	0.0	0.0	0.1	0.0	0.2
WEurope	2.8	3.0	26.9	8.6	41.3
EEurope	0.4	0.4	3.3	0.7	4.8
USC	0.8	2.0	12.0	2.5	17.2
Japan	0.3	1.2	2.4	0.8	4.6
China	0.3	1.0	4.5	0.7	6.5
East Asia	0.5	1.3	6.5	1.7	10.0
South Asia	0.1	0.6	1.3	0.4	2.4
Mexico	0.1	0.0	1.3	0.1	1.6
Argentina	0.0	0.0	0.2	0.1	0.3
Brazil	0.0	0.1	0.7	0.2	1.0
RestLA	0.2	0.2	1.5	0.3	2.1
MENA	0.5	0.2	3.2	1.0	4.8
SubSAfrica	0.2	0.1	1.3	0.4	2.0
HICS	**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	12.3	2.7	18.9
NR Rich	**1.7**	**0.9**	**14.4**	**3.6**	**20.6**
NR Poor	**4.7**	**9.3**	**51.4**	**14.0**	**79.4**
World	**6.4**	**10.2**	**65.9**	**17.6**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	0.1	0.0	0.8	0.2	1.1
New Zealand	0.0	0.0	0.1	0.0	0.2
WEurope	1.8	1.6	18.6	6.4	28.3
EEurope	0.3	0.5	3.2	0.8	4.7
USC	0.6	1.4	11.0	2.4	15.4
Japan	0.2	0.6	2.1	0.6	3.5
China	1.7	5.1	7.6	1.0	15.5
East Asia	0.6	1.5	7.9	2.1	12.1
South Asia	0.3	1.7	2.2	0.7	4.9
Mexico	0.1	0.1	1.3	0.1	1.6
Argentina	0.0	0.0	0.3	0.1	0.4
Brazil	0.0	0.0	0.9	0.4	1.4
RestLA	0.2	0.1	1.6	0.4	2.3
MENA	0.4	0.3	3.4	1.0	5.1
SubSAfrica	0.3	0.2	2.2	0.7	3.4
HICS	**2.9**	**4.1**	**35.5**	**10.4**	**52.8**
Developing	**3.6**	**9.2**	**27.8**	**6.5**	**47.2**
of which Asia	2.6	8.4	17.8	3.7	32.5
NR Rich	**1.6**	**1.2**	**16.3**	**4.3**	**23.4**
NR Poor	**4.9**	**12.0**	**47.1**	**12.6**	**76.6**
World	**6.6**	**13.2**	**63.3**	**16.9**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 4: Sectoral shares of national exports, 2007 and 2030 core (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	12.5	30.4	37.0	20.1	100.0
New Zealand	42.6	3.8	31.0	22.6	100.0
WEurope	6.5	2.4	68.9	22.2	100.0
EEurope	5.5	32.6	46.4	15.5	100.0
USC	7.0	4.3	66.2	22.6	100.0
Japan	0.5	0.1	89.9	9.5	100.0
China	2.9	0.6	89.8	6.7	100.0
East Asia	4.1	4.3	73.3	18.3	100.0
South Asia	7.9	4.2	60.0	27.8	100.0
Mexico	5.5	12.0	75.3	7.3	100.0
Argentina	44.1	5.5	35.8	14.6	100.0
Brazil	23.5	14.6	49.7	12.1	100.0
RestLA	14.3	26.5	42.9	16.3	100.0
MENA	2.5	57.9	26.9	12.7	100.0
SubSAfrica	8.9	51.0	29.3	10.8	100.0
HICS	**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	2.9	78.4	14.7	100.0
NR Rich	**8.5**	**35.0**	**43.5**	**13.0**	**100.0**
NR Poor	**5.4**	**1.7**	**73.0**	**19.9**	**100.0**
World	**6.1**	**9.8**	**65.8**	**18.2**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	14.5	53.1	19.6	12.7	100.0
New Zealand	53.6	10.9	16.8	18.7	100.0
WEurope	8.5	5.0	59.3	27.1	100.0
EEurope	6.0	45.0	36.7	12.2	100.0
USC	12.5	9.3	56.4	21.8	100.0
Japan	1.2	1.1	86.9	10.8	100.0
China	0.2	0.3	89.7	9.8	100.0
East Asia	4.6	5.0	74.8	15.6	100.0
South Asia	2.9	5.8	63.1	28.2	100.0
Mexico	7.8	1.2	77.4	13.7	100.0
Argentina	48.2	8.9	30.9	11.9	100.0
Brazil	34.6	37.0	22.5	5.9	100.0
RestLA	11.5	47.0	32.3	9.2	100.0
MENA	2.8	37.7	41.2	18.4	100.0
SubSAfrica	7.1	63.5	20.5	8.9	100.0
HICS	**9.0**	**10.6**	**57.4**	**23.0**	**100.0**
Developing	**4.3**	**14.2**	**67.9**	**13.6**	**100.0**
of which Asia	2.1	2.6	81.5	13.8	100.0
NR Rich	**9.5**	**38.8**	**39.1**	**12.6**	**100.0**
NR Poor	**5.1**	**2.7**	**72.6**	**19.7**	**100.0**
World	**6.3**	**12.7**	**63.3**	**17.7**	**100.0**

Source: Derived from the authors’ GTAP Model results

Table 5: Sectoral shares of national imports, 2007 and 2030 (percent)

(a) 2007

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	4.6	4.7	72.6	18.1	100.0
New Zealand	8.1	5.2	65.7	21.0	100.0
WEurope	6.8	7.3	65.2	20.7	100.0
EEurope	7.8	9.4	68.1	14.7	100.0
USC	4.6	11.5	69.4	14.4	100.0
Japan	7.4	25.2	50.9	16.5	100.0
China	4.3	15.6	69.9	10.2	100.0
East Asia	5.4	13.2	64.8	16.7	100.0
South Asia	5.6	25.8	52.3	16.3	100.0
Mexico	7.8	1.8	81.8	8.7	100.0
Argentina	3.5	1.9	77.0	17.6	100.0
Brazil	4.1	8.8	64.6	22.5	100.0
RestLA	9.9	7.4	69.3	13.3	100.0
MENA	9.5	3.8	66.5	20.1	100.0
SubSAfrica	10.2	5.6	64.1	20.1	100.0
HICS	**6.3**	**9.7**	**65.6**	**18.4**	**100.0**
Developing	**6.5**	**11.4**	**66.4**	**15.7**	**100.0**
of which Asia	5.0	15.6	64.9	14.4	100.0
NR Rich	**8.2**	**4.4**	**70.1**	**17.3**	**100.0**
NR Poor	**5.9**	**11.7**	**64.8**	**17.6**	**100.0**
World	**6.4**	**10.2**	**65.9**	**17.6**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	4.4	3.1	72.1	20.4	100.0
New Zealand	7.8	3.8	66.0	22.4	100.0
WEurope	6.3	5.6	65.7	22.5	100.0
EEurope	6.2	9.6	66.9	17.3	100.0
USC	4.0	9.2	71.2	15.7	100.0
Japan	5.6	17.2	59.5	17.7	100.0
China	11.2	33.1	49.3	6.4	100.0
East Asia	4.8	12.8	65.4	17.0	100.0
South Asia	5.3	34.5	45.8	14.4	100.0
Mexico	5.4	4.9	83.5	6.1	100.0
Argentina	3.4	3.0	76.0	17.6	100.0
Brazil	2.3	3.1	67.4	27.2	100.0
RestLA	8.3	6.2	69.0	16.5	100.0
MENA	8.4	6.5	66.0	19.1	100.0
SubSAfrica	8.4	5.0	64.8	21.8	100.0
HICS	**5.5**	**7.7**	**67.2**	**19.6**	**100.0**
Developing	**7.7**	**19.4**	**59.0**	**13.8**	**100.0**
of which Asia	7.9	25.7	54.8	11.5	100.0
NR Rich	**6.9**	**5.1**	**69.4**	**18.5**	**100.0**
NR Poor	**6.4**	**15.7**	**61.4**	**16.4**	**100.0**
World	**6.6**	**13.2**	**63.3**	**16.9**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 6: Regional shares of world trade in agricultural and food products, 2007 base, 2030 core and 2030 alternative growth scenarios
(percent)

	Exports				Imports			
	2007	**2030 Core baseline**	**2030 slower China & India growth**	**2030 slower China & India growth + slower primary productivity growth**	**2007**	**2030 Core baseline**	**2030 slower China & India growth**	**2030 slower China & India growth + slower primary productivity growth**
Australia	2.3	2.6	2.6	2.3	0.8	0.8	0.8	0.8
New Zealand	1.6	1.6	1.7	1.7	0.3	0.2	0.2	0.2
WEurope	43.4	34.9	36.3	36.5	43.9	27.0	31.1	28.9
EEurope	4.5	4.9	4.8	5.1	5.9	4.5	5.0	4.8
USC	13.7	17.8	15.8	18.1	12.4	9.4	10.7	9.9
Japan	0.4	0.6	0.5	0.6	5.4	3.0	3.6	3.1
China	3.9	0.6	1.0	0.5	4.3	26.6	16.7	18.9
East Asia	7.8	10.5	10.3	9.0	8.5	8.8	9.9	10.1
South Asia	2.4	1.8	1.7	1.5	2.1	3.9	4.1	4.8
Mexico	1.6	2.2	2.3	2.2	1.9	1.3	1.5	1.6
Argentina	3.1	3.7	3.7	3.6	0.2	0.2	0.2	0.2
Brazil	4.7	7.4	7.8	7.2	0.6	0.5	0.5	0.6
RestLA	5.1	4.3	4.5	4.1	3.3	2.9	3.3	3.4
MENA	2.5	3.1	3.0	3.6	7.2	6.5	7.5	7.2
SubSAfrica	3.1	3.8	4.0	4.0	3.2	4.4	4.7	5.5
Totals								
HICS	**65.2**	**61.8**	**61.0**	**63.4**	**68.0**	**44.4**	**50.9**	**47.2**
Developing	**34.8**	**38.2**	**39.0**	**36.6**	**32.0**	**55.6**	**49.1**	**52.8**
of which Asia	14.1	12.9	13.0	11.0	14.9	39.3	30.7	33.8
NR Rich	**34.0**	**41.6**	**42.1**	**40.8**	**26.6**	**24.8**	**27.7**	**28.3**
NR Poor	**66.0**	**58.4**	**57.9**	**59.2**	**73.4**	**75.2**	**72.3**	**71.7**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 7: Agricultural self-sufficiency ratio,[a] 2007 base, 2030 core and 2030 alternative growth scenarios

(percent)

	2007	2030 Core baseline	2030 slower China & India growth	2030 slower China & India growth + slower primary productivity growth
Australia	124	136	131	128
New Zealand	149	167	159	167
WEurope	97	105	101	103
EEurope	98	100	99	100
USC	106	119	113	116
Japan	85	86	85	87
China	98	89	91	89
East Asia	98	103	100	98
South Asia	100	97	96	95
Mexico	94	100	98	96
Argentina	170	178	174	173
Brazil	119	138	136	134
RestLA	104	103	102	101
MENA	84	87	85	87
SubSAfrica	101	102	101	100
Totals				
HICS	**100**	**108**	**105**	**107**
Developing	**100**	**96**	**97**	**96**
of which Asia	98	92	94	92
NR Rich	**104**	**110**	**108**	**107**
NR Poor	**98**	**96**	**97**	**97**
World	**100**	**100**	**100**	**100**

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

Source: Derived from the authors’ GTAP Model results

Table 8: Changes in real household consumption per capita of agricultural and food products from 2007 base, core and alternative growth scenarios in 2030

(percent)

	2030 Core baseline	2030 slower China & India growth	2030 slower China & India growth + slower primary productivity growth
Australia	29.9	29.7	21.7
New Zealand	27.9	28.3	19.0
WEurope	30.4	30.7	23.5
EEurope	58.5	57.6	49.6
USC	34.4	35.1	26.8
Japan	28.4	29.1	22.8
China	148.1	98.4	78.3
East Asia	58.5	59.1	47.8
South Asia	100.1	74.1	59.6
Mexico	42.2	42.5	35.1
Argentina	57.9	57.8	51.3
Brazil	53.0	52.7	47.0
RestLA	40.9	40.4	34.0
MENA	43.6	41.7	33.5
SubSAfrica	61.3	59.3	52.3
HICS	**34.4**	**34.7**	**27.1**
Developing	**75.7**	**62.0**	**50.9**
of which Asia	103.3	77.0	61.7
NR Rich	**43.2**	**42.2**	**35.4**
NR Poor	**46.9**	**38.6**	**28.9**

Source: Derived from the authors' GTAP Model results

Table 9: Regional shares of global consumption of grains, fossil fuels and other minerals, 2007 and 2030 core

(percent)

	2007				2030			
	Grains	**Grains HH consm**[a]	**Fuel**	**Other minerals**	**Grains**	**Grains HH consm**[a]	**Fuel**	**Other minerals**
Australia	0.9	0.1	1.0	4.0	0.7	0.1	0.6	1.9
New Zealand	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0
WEurope	11.3	8.0	19.6	18.7	6.6	5.0	9.2	6.8
EEurope	7.9	5.9	10.1	4.1	5.5	4.3	7.1	2.2
USC	8.3	1.3	22.4	8.7	6.2	1.0	13.1	3.6
Japan	7.0	7.7	5.9	6.8	3.3	4.4	2.7	2.3
China	12.1	3.6	10.0	27.0	30.2	4.5	28.3	59.4
East Asia	14.9	15.2	9.5	10.3	12.3	14.2	10.1	7.1
South Asia	14.8	23.1	4.7	4.5	15.4	27.3	10.1	6.3
Mexico	1.5	1.0	1.2	2.6	1.2	0.8	1.1	1.0
Argentina	0.4	0.0	0.6	0.4	0.4	0.0	0.5	0.2
Brazil	2.9	3.2	1.8	2.2	2.0	2.4	1.2	1.5
RestLA	4.6	5.3	2.5	3.7	3.5	4.8	1.8	2.4
MENA	7.6	13.6	9.3	5.5	6.4	13.6	12.6	3.9
SubSAfrica	5.7	12.0	1.2	1.3	6.3	17.5	1.4	1.2
HICS	**34.6**	**21.5**	**58.0**	**41.6**	**21.8**	**13.8**	**31.8**	**16.3**
Developing	**65.4**	**78.5**	**42.0**	**58.4**	**78.2**	**86.2**	**68.2**	**83.7**
of which Asia	41.8	41.9	24.2	41.8	57.9	46.0	48.5	72.8
NR Rich	**35.6**	**46.4**	**29.5**	**27.4**	**29.9**	**49.3**	**28.6**	**16.9**
NR Poor	**64.4**	**53.6**	**70.5**	**72.6**	**70.1**	**50.7**	**71.4**	**83.1**
World	**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 10: Shares of bilateral trade in all primary products, 2007 base, 2030 core and 2030 alternative growth scenarios

(percent)

(a) 2007 base

Importer: Exporter:	HIAsia	China	ORPAsia	Eur&US	Ru&CA	OthDCs	Australia	NZ	Canada	Total
HI Asia	37.8	11.4	9.4	18.5	1.8	16.6	2.1	1.0	1.2	**100**
China	43.8	0.0	4.4	29.4	3.7	15.5	1.2	0.2	1.7	**100**
ORPAsia	14.4	20.6	8.7	25.7	1.5	26.3	1.3	0.3	1.3	**100**
Eu & US	5.2	2.3	2.1	72.1	2.6	11.2	0.5	0.1	3.9	**100**
Ru & CA	5.2	7.2	1.2	76.1	4.3	5.7	0.0	0.0	0.3	**100**
Oth DCs	23.6	9.5	10.0	42.7	0.7	11.8	0.8	0.2	0.8	**100**
Australia	44.8	22.4	7.5	14.1	0.2	8.3	0.0	1.8	0.7	**100**
NZ	18.6	6.0	6.4	30.2	1.0	26.1	9.8	0.0	2.0	**100**
Canada	7.1	2.8	1.9	80.7	0.4	6.8	0.4	0.1	0.0	**100**
Total	**16.6**	**7.4**	**6.2**	**54.4**	**1.7**	**11.2**	**0.6**	**0.2**	**1.7**	**100**

(b) 2030 core baseline

Importer: Exporter:	HIAsia	China	ORPAsia	Eur&US	Ru&CA	OthDCs	Australia	NZ	Canada	Total
HI Asia	22.6	44.3	8.9	7.8	0.8	13.1	1.2	0.6	0.6	**100**
China	44.3	0.0	5.2	31.8	5.9	11.0	0.8	0.2	0.9	**100**
ORPAsia	6.6	58.8	7.7	9.3	0.7	15.5	0.8	0.1	0.6	**100**
Eu & US	4.6	21.1	4.7	51.7	2.4	12.1	0.5	0.1	2.8	**100**
Ru & CA	8.8	48.8	3.9	26.0	2.7	9.8	0.0	0.0	0.1	**100**
Oth DCs	13.3	35.1	19.1	18.8	0.5	12.3	0.5	0.1	0.3	**100**
Australia	24.7	54.1	6.6	8.7	0.1	4.7	0.0	0.9	0.3	**100**
NZ	10.3	46.3	6.2	12.2	0.5	17.7	5.8	0.0	1.0	**100**
Canada	4.1	18.0	2.3	69.3	0.2	5.9	0.2	0.0	0.0	**100**
Total	**10.6**	**33.9**	**11.6**	**29.6**	**1.3**	**11.5**	**0.4**	**0.1**	**0.9**	**100**

(c) 2030 with slower China and India growth

Importer: Exporter:	HIAsia	China	ORPAsia	Eur&US	Ru&CA	OthDCs	Australia	NZ	Canada	Total
HI Asia	29.1	27.3	10.9	11.1	1.2	17.2	1.6	0.8	0.8	**100**
China	41.4	0.0	5.4	31.7	6.5	12.7	1.0	0.2	1.1	**100**
ORPAsia	9.3	44.5	9.1	13.6	0.9	20.4	1.0	0.2	0.9	**100**
Eu & US	5.2	10.7	4.2	59.5	2.5	14.0	0.5	0.1	3.3	**100**
Ru & CA	11.4	32.5	4.3	33.6	3.7	14.2	0.0	0.0	0.1	**100**
Oth DCs	15.9	23.9	17.5	24.9	0.7	15.9	0.6	0.1	0.4	**100**
Australia	33.5	39.7	6.5	12.3	0.2	6.4	0.0	1.1	0.4	**100**
NZ	13.8	28.8	7.7	17.2	0.7	23.1	7.5	0.0	1.4	**100**
Canada	4.9	9.3	2.6	75.5	0.2	7.2	0.2	0.0	0.0	**100**
Total	**12.9**	**21.9**	**10.8**	**36.5**	**1.6**	**14.6**	**0.6**	**0.1**	**1.1**	**100**

Table 10 (continued): Shares of bilateral trade in all primary products, 2007 base, 2030 core and 2030 alternative growth scenarios

(percent)

(d) 2030 with slower China and India economic growth and slower global primary productivity growth

Importer: Exporter:	HIAsia	China	ORPAsia	Eur&US	Ru&CA	OthDCs	Australia	NZ	Canada	Total
HI Asia	27.4	32.8	10.9	8.2	0.7	17.5	1.3	0.5	0.6	**100**
China	43.0	0.0	5.2	33.7	5.9	11.2	0.4	0.1	0.5	**100**
ORPAsia	7.7	49.3	10.2	9.1	0.6	21.5	0.8	0.1	0.6	**100**
Eu & US	5.3	14.4	4.2	54.6	2.6	15.0	0.5	0.1	3.3	**100**
Ru & CA	9.6	35.3	3.6	39.0	3.4	8.9	0.0	0.0	0.1	**100**
Oth DCs	15.9	26.0	16.2	25.8	0.5	14.6	0.6	0.1	0.4	**100**
Australia	31.2	40.3	6.7	13.2	0.1	7.0	0.0	1.2	0.3	**100**
NZ	12.5	35.8	8.0	14.7	0.6	21.4	6.0	0.0	1.1	**100**
Canada	4.5	11.3	2.6	74.8	0.2	6.4	0.2	0.0	0.0	**100**
Total	**12.6**	**24.4**	**10.2**	**36.2**	**1.4**	**13.5**	**0.5**	**0.1**	**1.1**	**100**

Source: Derived from the authors' GTAP Model results

Appendix Table A.1: Trade specialization index to distinguish natural resource-rich countries/regions from others,[a] 5-year average 2005-09

	Ag. & food (light proc.)	Fossil fuels (coal, oil, gas)	Other minerals (incl. NFM)	Forestry & fishing	All primary
RestSEAsia	0.31	0.99	0.64	0.98	0.90
CentralAsia	0.16	0.87	0.74	-0.54	0.79
Russia	-0.61	0.98	0.71	0.82	0.78
RestSSAfrica	0.09	0.92	0.78	0.85	0.77
Argentina	0.91	0.66	0.34	0.10	0.77
Australia	0.80	0.58	0.79	0.72	0.71
ME_NthAfrica	-0.57	0.93	-0.03	0.02	0.71
Peru	0.20	-0.60	0.96	0.52	0.66
Chile	0.49	-1.00	0.93	0.90	0.65
NewZealand	0.89	-0.32	0.30	0.98	0.62
PacificIslan	-0.14	0.44	0.95	0.91	0.61
RestLAmerica	0.23	0.75	0.49	0.69	0.59
Brazil	0.84	-0.18	0.70	-0.15	0.53
Vietnam	0.37	0.98	-0.60	-0.26	0.45
Indonesia	-0.31	0.56	0.62	0.84	0.45
Canada	0.36	0.48	0.40	0.34	0.43
Mexico	-0.21	0.88	0.03	0.45	0.40
SouthAfrica	0.30	-0.29	0.62	0.68	0.29
RestNEAsia	-0.60	-0.19	0.64	0.07	0.20
Malaysia	-0.62	0.51	-0.37	0.69	0.14
HongKong	-0.99	-1.00	0.43	-1.00	-0.20
WEurope	-0.07	-0.48	-0.14	-0.09	-0.26
RestSthAsia	-0.21	-0.99	-0.41	0.74	-0.34
Philippines	-0.34	-0.84	0.07	0.52	-0.36
RestEEurope	0.11	-0.84	-0.11	0.36	-0.38
Thailand	0.52	-0.87	-0.46	0.08	-0.41
Pakistan	-0.14	-1.00	-0.37	0.08	-0.49
USA	0.30	-0.92	-0.16	0.03	-0.51
India	0.45	-0.99	-0.37	-0.67	-0.55
China	-0.36	-0.84	-0.66	-0.65	-0.68
Singapore	-0.60	-0.98	-0.35	-0.40	-0.76
Bangladesh	-0.82	-0.94	-0.82	0.56	-0.81
Taiwan	-0.70	-0.94	-0.46	-0.17	-0.82
SouthKorea	-0.88	-0.99	-0.50	-0.61	-0.84
Japan	-0.97	-1.00	-0.43	-0.83	-0.85
World	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

[a] Trade specialization index for commodity j for each region is defined as $(X_j-M_j)/(X_j+M_j)$. We define the first 20 countries/regions above as natural resource-rich (NRR).

Source: Authors' calculations from the GTAP Version 8 database.

Appendix Table A.2: Average annual GDP and endowment growth rates, 2007 to 2030

	GDP growth	Population growth	Unskilled labour	Skilled labour	Produced capital	Oil	Gas	Coal	Other minerals	Agric. Land
Australia	2.35	1.11	0.29	1.91	2.28	1.54	6.52	3.56	2.07	-0.59
New Zealand	1.99	0.90	0.50	1.68	1.77	0.00	0.00	3.03	2.07	-0.40
WEurope	1.29	0.11	-1.25	1.34	1.08	2.81	0.77	-2.51	2.07	-0.28
EEurope	2.94	-0.07	-0.74	1.25	3.17	2.67	0.35	-1.97	2.07	-0.23
USC	1.96	0.80	0.09	1.56	1.39	1.11	-0.70	0.17	2.07	-0.20
Japan	0.89	-0.21	-1.53	0.77	0.70	0.00	0.00	-9.35	2.07	-1.14
China	7.95	0.42	-0.06	2.75	7.32	-0.40	4.85	5.62	2.07	-0.36
East Asia	3.94	0.84	-0.18	2.48	4.04	1.31	1.46	0.88	2.07	-0.03
South Asia	7.06	1.16	1.39	4.08	5.37	0.23	-1.18	4.84	2.07	-0.05
Mexico	2.89	0.71	0.75	3.01	2.66	-7.49	-7.34	2.52	2.07	-0.07
Argentina	3.80	0.75	0.00	3.32	3.38	2.52	-2.94	0.00	2.07	0.23
Brazil	3.48	0.58	0.44	2.85	3.18	5.66	6.29	0.50	2.07	0.50
RestLA	3.37	1.07	0.94	3.63	3.18	5.45	2.14	5.52	2.07	0.21
MENA	4.06	1.37	0.58	3.86	3.78	0.71	3.73	0.96	2.07	0.00
SubSAfrica	5.34	2.11	1.78	4.52	4.16	4.16	2.74	1.89	2.07	0.09
HICS	**1.61**	**0.26**	**-0.64**	**1.40**	**1.31**	**2.12**	**0.25**	**-0.28**	**2.07**	**-0.30**
Developing	**5.13**	**1.03**	**0.42**	**3.12**	**4.57**	**1.51**	**2.53**	**4.33**	**2.07**	**-0.09**
of which Asia	6.27	0.82	0.18	2.88	5.66	0.34	1.28	4.62	2.07	-0.16
World	**2.55**	**0.88**	**-0.37**	**1.67**	**2.36**	**1.70**	**1.44**	**2.09**	**2.07**	**-0.15**

Source: Authors' assumptions (see text for details)

Appendix Table A.3: Cumulative changes in world prices, 2007 to 2030
(relative to global average output price change across all sectors, percent)

	2030 core	2030 slower China & India growth	2030 slower China & India growth + slower primary productivity growth
Rice	4.4	0.1	16.7
Wheat	3.3	-0.1	17.3
CoarseGrains	3.1	-1.7	18.1
Fruit_Veg	15.8	7.4	33.0
Oilseeds	0.2	-2.8	9.5
Sugar	-4.7	-6.2	3.2
Cotton	6.7	2.6	22.1
OtherCrops	-1.3	-4.0	16.8
Beef_Sheep	-1.3	-3.6	6.8
Pork_Chicken	9.7	4.4	18.5
Dairy	-2.4	-3.9	6.1
OtherFood	2.8	0.2	5.2
Forest_Fish	48.9	20.8	98.3
Coal	-11.4	-12.0	1.0
Oil	-2.6	-10.3	11.6
Gas	-13.4	-11.8	7.4
OthMinerals	-7.0	-12.8	-3.0
Text_App_Lea	-0.7	-0.4	-1.1
MotorVehicle	-2.1	-1.5	-3.3
Electronics	-5.6	-4.0	-7.0
OtherLtMan	-2.1	-1.8	-2.0
HeavyManuf	-4.7	-4.9	-3.2
Utiliti_Cons	1.9	2.6	0.6
Elect_Gas	-4.8	-3.5	-3.5
Trade_transp	1.6	2.4	-0.1
Other services	1.4	2.1	-1.3
Aggregate Prices:			
Agriculture_Food	**3.6**	**0.1**	**11.5**
OtherPrimary	**1.4**	**-7.1**	**18.7**
Manufactures	**-3.7**	**-3.5**	**-3.1**
Services	**1.3**	**2.0**	**-0.8**

Source: Derived from the authors' GTAP Model result

Appendix Table A.4: Regional shares of world real GDP and GDP per economically active person, 2007 and the core projection for 2030[a] (percent)

	World GDP share		World ec. active population share		GDP per ec. active person, relative to world average	
	2007	**2030**	**2007**	**2030**	**2007**	**2030**
WEurope	32.0	21.6	8.2	6.1	390.7	353.5
Russia	2.3	2.2	2.6	1.8	90.4	123.1
RestEEurope	1.8	1.8	1.8	1.5	98.0	116.7
USA	25.2	19.8	5.3	4.7	477.0	420.9
Canada	2.6	2.0	0.6	0.5	415.0	372.4
Australia	1.5	1.3	0.4	0.4	411.6	364.3
NewZealand	0.2	0.2	0.1	0.1	324.2	279.0
Japan	7.8	4.8	2.2	1.6	353.3	306.7
China	6.3	18.3	26.0	20.9	24.0	87.6
Singapore	0.3	0.3	0.1	0.1	384.8	388.0
Indonesia	0.8	1.4	3.8	4.1	20.2	34.2
Malaysia	0.3	0.5	0.4	0.4	86.7	100.9
Philippines	0.3	0.4	1.2	1.6	21.5	23.0
Thailand	0.4	0.6	1.3	1.1	34.2	53.2
Vietnam	0.1	0.2	1.5	1.5	8.0	13.7
RestSEAsia	0.1	0.1	0.3	0.4	21.7	26.1
PacificIslan	0.1	0.1	0.1	0.2	50.4	43.8
HongKong	0.4	0.4	0.1	0.1	300.7	364.4
SouthKorea	1.9	1.8	0.8	0.7	234.6	269.6
Taiwan	0.7	1.0	0.3	0.3	203.8	320.1
RestNEAsia	0.1	0.1	0.0	0.0	145.2	192.2
India	2.2	5.5	15.5	18.0	14.2	30.8
Pakistan	0.3	0.5	1.8	2.4	13.9	20.4
Bangladesh	0.1	0.3	2.3	2.6	5.4	10.1
RestSthAsia	0.1	0.2	0.7	0.8	13.7	23.9
CentralAsia	0.4	0.4	0.6	0.5	62.1	77.1
Mexico	1.8	1.8	1.6	1.7	117.3	106.8
Argentina	0.5	0.6	0.6	0.6	74.2	89.8
Brazil	2.4	2.7	3.3	3.2	74.7	84.9
Chile	0.3	0.3	0.2	0.2	120.8	125.1
Peru	0.2	0.3	0.4	0.5	44.5	54.1
RestLAmerica	1.7	1.8	2.0	2.3	84.1	76.2
ME_NthAfrica	3.4	4.2	3.9	4.6	86.7	92.5
SouthAfrica	0.5	0.5	0.6	0.6	84.2	84.2
RestSSAfrica	1.1	2.3	9.2	13.9	11.6	16.2
High-income	73.5	53.7	21.2	16.7	347.3	322.3
Developing	**26.5**	**46.3**	**78.8**	**83.3**	**33.7**	**55.6**
of which Asia:	14.3	32.0	56.5	55.8	25.4	57.3
World	**100**	**100**	**100**	**100**	**100**	**100**

[a] 2007 prices.

Source: Derived from authors' assumptions (see text for details), with economically active population estimates drawing on Fouré et al. (2012)