Working Papers in
Trade and Development

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

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November 2013
Working Paper No. 2013/17

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Revised November 2013

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The authors are grateful for helpful referee comments and interactions with Tom Hertel, Terrie Walmsley, Dominique van der Mensbrugghe, Fan Zhai, Rob McDougall and participants at the 15th Annual Conference on Global Economic Analysis, Geneva, 27-29 June 2012. Funding support from the Asian Development Bank, Australian Research Council, Rural Industries Research and Development Corporation and Waikato Management School is gratefully acknowledged. Views expressed are the authors' alone. Forthcoming in the *Australian Journal of Agricultural and Resource Economics* Vol. 58, 2014.

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 8.1 of the GTAP database with a base year of 2007, along with supplementary data from a range of sources, to support projections of the global economy 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 are drawn out for natural resource-abundant economies, including Australia and New Zealand.

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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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. 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, hence 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. Their rapid and persistent growth thus has far greater significance for primary product markets and for such things as food and energy security and greenhouse gas emissions nationally, 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

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. According to the workhorse theory of comparative cost advantage (Krueger 1977; Deardorff 1984; Leamer 1987), that means their industrialization will make them 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. This is because the commodity composition of each country's trade – that is, the extent to which it is a net exporter of primary or industrial products – is largely determined by its endowment of natural relative to industrial capital compared with that ratio for the rest of the world.

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 increase in the stock of capital (net of depreciation) per worker will put upward pressure on real wages. Whether such investment 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.

Trade patterns are also affected by growth in domestic demands, insofar as preferences are non-homothetic (Markusen 2013). Food has an income elasticity of demand of less than one, for example. While this may dampen somewhat the decline in comparative advantage in farm products in resource-poor emerging economies, it does not do so initially when consumers switch from staples to higher-valued foods, including intensively fed livestock. By contrast, at early stages of industrialization and urbanization the requirements of minerals and energy raw materials for producing such essentials as steel and electricity are quite high, before they decline as the economy matures. This adds to the decline in comparative advantage of the mining sector in Asia's rapidly industrializing economies.

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 latest available Version 8.1 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 8.1 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 all 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 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. 2012). In projecting to 2030 we acknowledge the theory point made by Markusen (2013) and 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 food crops, as reflected in the full GTAP database.[1] These estimates are then used to alter the income elasticities of demand for foods in each region by 2030, given projections of per capita income for each region.

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. Investment in our model is allocated in response to rates of return with capital markets kept in equilibrium. Expected rates of return are assumed to be relatively sensitive to investment, helping to ensure that the model-generated changes in regional investment are comparable to the exogenous increases in capital stocks assumed in our projection.

The GTAP Version 8.1 database divides the world into 134 countries/country groups, and each economy into 57 sectors. For the sake of both computational speed and digestion of model outputs, we initially aggregate the number of regions and sectors to 35 countries/country groups and to 34 sector/product groups. We then further aggregate to 10 regions and just 4 sectors for reporting 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).[2]

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 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,

[1] Elasticities are modified for rice (paddy and processed), wheat, coarse grains, fruit and vegetables, oilseeds, sugarcane and other crops. We are grateful to Papu Siameja for his excellent research assistance with econometrically estimating these projected income elasticities.

[2] The so-defined natural resource rich (NRR) countries 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 global exports of non-primary products.

capital stocks and populations are based mainly on estimates from the World Bank and CEPII (Fouré et al. 2012). For projections of skilled and unskilled labour growth rates, we draw on Chappuis and Walmsley (2011). Historical trends over the past two decades in agricultural land from FAOSTAT and in mineral and energy raw material reserves from BP (2012) and the US Geological Survey (2012 and earlier editions), are assumed to continue for each country over the next two decades. These rates of change in natural resources are summarized in the last five columns of Appendix Table A.2.

Given those exogenous endowment and GDP growth rates, 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 primary sectors (in the light of findings by Martin and Mitra 2001) and somewhat lower in services (following Roson and van der Mensbrugghe 2012). Our core calibration is consistent with the World Bank projections over the next four decades provided by Roson and van der Mensbrugghe (2012). It differs a little from GTAP-based projection studies in the late 20th century (e.g., Anderson et al. 1997) in which agricultural prices were projected to fall to 2005. We believe further falls to 2030 are unlikely given the slower growth in agricultural R&D investment since 1990 (Fuglie 2008) and the decline in the real price of manufactures thanks to Asia's industrialization – as occurred also with the original industrial revolution in the first half of the 19th century (Williamson 2012).[3] Our core projection has real international prices in 2030 differing from 2007 levels by just 2 percent for farm products, -5 percent for other primary products, -1 percent for manufactures and 4 percent for services.

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, Asia's faster-growing developing economies will account for considerably larger

[3] It is even less likely that farm product prices will fall 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 percent).

shares of the projected global economy over the next two decades. Based on the exogenous GDP growth assumptions we use, 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. Europe's share, meanwhile, is projected to fall from over one-third to just above one-quarter. Thus GDP per economically active person converges considerably between 2007 and 2030. In particular, Appendix Table A.3 shows that the per capita income of Developing Asia is projected to rise from 25 to 57 percent of the global average over the projection period.

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 century when first the UK and then (from 1895) the US was the top-ranked country for industrial production (Allen 2011, Figure 2). The NRR economies' contribution to global GDP rises 3 percentage points, even though their share of the 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 40 percent between 2007 and 2030. China's share alone grows from 8 to 21 percent. The growth of China's 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 32 percent for all products, but the rise is much sharper for China's primary product imports – from 1.3 to 6.5 percent (Table 3).

[insert Table 2 and 3 about here]

The consequences of continuing Asian industrialization are also evident in the sectoral shares of national trade, which can be derived from Table 2 and 3: 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 to 2030 being largest in Developing Asia. The opposite is true for NRR countries.

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 product demands resulting from Asia's rapid industrialization. The shares of non-farm primary products in Australia's and Latin America's exports increase significantly: 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 out-compete others in supplying the huge growth in imports of farm products by China (Table 4).

[insert Table 4 about here]

4.2 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, with all regions significantly increasing the proportion of their exports of primary products going to China (Table 5). The Other Developing Country grouping, which comprises the natural resource rich countries of Latin America, the Middle East and Africa, significantly increases the share of their primary exports going to China and maintains the share going to other Asian economies. Among the NRR countries, Australia had the highest share of primary exports with China as of 2007, but other NRR countries, especially New Zealand, are projected to move a long way towards catching up by 2030 (Table 5).

[insert Table 5 about here]

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

These changes mean that food self-sufficiency is projected in this core scenario to fall considerably by 2030 in China (from 97 to 87 percent) and South Asia (from 100 to 95 percent). 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).

A more meaningful indicator of food security than self-sufficiency is real per capita private consumption of agricultural and processed food products by households. Table 6 shows that between 2007 and 2030, real per capita food consumption is projected to increase

by 79 percent for developing countries as a group, and to more than double in 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 core scenario.

[insert Table 6 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 substantially, leading to an increase in overall grain usage in China from 12 to 32 percent of the global total (Table 7). 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 25 percent) and likewise for other minerals (from 27 to 61 percent).

[insert Table 7 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 annual total factor productivity (TFP) growth in primary sectors globally,*** in response to the assumed growth slowdown in China and India.

The core projection sets real GDP growth rates between 2007 and 2030 for China and India well below those economies' actual growth rates during 2007-12, implying growth rates of around 7 percent per year for China and 6 percent for India for the remainder of the projection period (2013-30). Some commentators feel those rates are too optimistic, particularly given their slowdown in 2013 as a result of slow growth since 2008 in developed

country economies.[4] Hence our first alternative scenario re-runs the projections assuming that annual GDP, skilled labour and capital stock growth rates in China and India are one-quarter lower per year than in the core scenario. This causes international prices of primary products on average to fall by 7 percent, compared with 2 percent in the core scenario.

The second of our alternative scenarios involves dropping the assumption that productivity growth in the primary sectors increases to nearly match the growing global demand for such products. This is a plausible alternative to the core projection 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, and of the price projections of several international agencies (FAO/OECD 2010, IEA 2011, Nelson et al. 2010). In this second alternative case, real international prices for primary products on average are 10 percent above 2007 levels by 2030, compared with 2 percent below in the core projection.

Slower growth in these two populous emerging economies has a marked impact on primary product markets and trade with NRR economies. Developing Asia's share of global agricultural imports in 2030 drops from 43 to 33 percent (Table 4), and the growth in China's share of exports from the various regions is dampened substantially (Table 5). Consumption of food in those two economies also grows much less, because of their slower income growth (Table 6).

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, by 9 and 14 percentage points respectively. 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 slightly larger share of primary exports going to China than in the previous alternative scenario (Table 5). The slowdown in farm productivity growth would result in 1-2 percent lower food self-sufficiency rates in Asia and a further one-quarter less growth in their household food consumption (Table 6).

[4] Though such a slowdown may be less likely than some observers fear. According to one of China's most prominent economists and former Senior Vice-President of the World Bank, "China can maintain an 8 percent annual GDP growth rate for many years to come. … China's per capita GDP in 2008 was 21 percent of per capita GDP in the United States. That is roughly the same gap that existed between the United States and Japan in 1951, Singapore in 1967, Taiwan in 1975, and South Korea in 1977. … Japan's average annual growth rate soared to 9.2 percent over the subsequent 20 years, compared to 8.6 percent in Singapore, 8.3 percent in Taiwan, and 7.6 percent in South Korea" (Lin 2013).

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 34 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).

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 2007 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 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 and drives down fossil fuel prices (see IEA 2012), and if biofuel mandates were removed, this omission from our modelling of 2030 may be inconsequential.

Finally, the standard GTAP model used here is comparative static and will not capture all of the dynamic impacts of global change.

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 increase significantly also, but that is not fast enough to keep pace with the growing consumption of food. By 2030, developing Asia is projected to consume almost 60 percent of the world's grain, 45 percent of the world's 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 share 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. Over this period real per capita food consumption is projected to increase by about four-fifths for developing countries as a group, and to more than double in China and South Asia. These represent substantial increases in global 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 if high Asian economic growth continues.

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 global slowdown in productivity growth in farm and mineral production. Furthermore, were China and India to follow Northeast Asian economies in raising their protection of farmers as their per capita incomes grew – as they have been doing already in recent years – that 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 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.

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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	2.3	0.8	1.6	1.5
New Zealand	0.4	0.2	0.2	0.2	0.2
Europe	31.5	21.8	36.9	35.8	35.1
USC	13.7	11.7	23.8	32.0	28.6
China	14.4	9.4	11.7	4.3	6.4
Rest East Asia	10.4	7.4	14.6	13.7	13.4
South Asia	8.5	2.6	2.1	2.4	2.7
Latin America	10.9	9.0	6.1	6.7	6.9
MENA	3.6	29.0	2.8	2.3	3.6
SubSAfrica	5.4	6.5	1.0	1.1	1.6
HICs	**50.2**	**34.4**	**68.7**	**78.2**	**73.1**
Developing	**49.8**	**65.6**	**31.3**	**21.8**	**26.9**
of which Asia	29.3	18.9	21.3	11.4	14.5
NR Rich	**30.1**	**66.6**	**16.3**	**17.8**	**20.4**
NR Poor	**69.9**	**33.4**	**83.7**	**82.2**	**79.6**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

(b) 2030 core

	Agric. & Food	Other Primary	Manufactures	Services	Total
Australia	0.8	2.0	0.5	1.5	1.3
New Zealand	0.3	0.2	0.1	0.2	0.2
Europe	17.6	15.6	22.7	28.2	25.8
USC	9.3	6.6	17.0	27.6	23.3
China	33.1	24.9	29.9	11.2	16.6
Rest East Asia	8.1	7.6	13.2	12.6	12.1
South Asia	14.0	5.3	4.7	5.8	6.2
Latin America	8.0	8.1	6.0	7.8	7.6
MENA	3.0	18.9	4.4	3.0	4.1
SubSAfrica	5.9	10.7	1.4	2.0	2.7
HICs	**29.3**	**23.0**	**44.2**	**63.5**	**55.6**
Developing	**70.7**	**77.0**	**55.8**	**36.5**	**44.4**
of which Asia	53.3	37.6	43.9	23.3	29.7
NR Rich	**25.2**	**56.6**	**17.6**	**21.0**	**22.8**
NR Poor	**74.8**	**43.4**	**82.4**	**79.0**	**77.2**
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 base

	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
Europe	2.9	2.6	30.5	9.8	45.8
USC	0.8	0.5	8.0	2.7	12.1
China	0.2	0.1	7.4	0.6	8.3
Rest East Asia	0.5	0.5	13.0	2.6	16.6
South Asia	0.1	0.1	1.1	0.5	1.8
Latin America	0.9	1.0	3.1	0.7	5.7
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	0.1	0.6	0.2	0.1	1.1
New Zealand	0.1	0.0	0.0	0.0	0.2
Europe	2.7	3.3	16.5	7.7	30.2
USC	1.4	0.8	5.3	2.2	9.6
China	0.0	0.1	19.2	2.0	21.3
Rest East Asia	0.8	0.7	12.9	2.4	16.9
South Asia	0.1	0.2	3.0	1.3	4.6
Latin America	1.2	1.5	2.5	0.6	5.7
MENA	0.2	2.7	2.9	1.1	6.9
SubSAfrica	0.3	2.1	0.7	0.3	3.5
HICs	**4.3**	**4.2**	**24.4**	**10.3**	**43.2**
Developing	**2.6**	**7.7**	**39.0**	**7.5**	**56.8**
of which Asia	0.9	1.0	32.7	5.4	39.9
NR Rich	**2.9**	**10.1**	**10.7**	**3.3**	**27.1**
NR Poor	**4.0**	**1.8**	**52.6**	**14.4**	**72.9**
World	**6.9**	**12.0**	**63.3**	**17.8**	**100.0**

Source: Derived from the authors' GTAP Model results

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

(a) 2007 base

	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
Europe	3.2	3.5	30.2	9.3	46.1
USC	0.8	2.0	12.0	2.5	17.2
China	0.3	1.0	4.5	0.7	6.5
Rest East Asia	0.9	2.5	8.8	2.4	14.6
South Asia	0.1	0.6	1.3	0.4	2.4
Latin America	0.4	0.3	3.7	0.7	5.1
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	1.2
New Zealand	0.0	0.0	0.1	0.0	0.2
Europe	2.1	2.2	22.2	7.3	33.8
USC	0.6	1.6	10.7	2.3	15.3
China	2.0	4.5	7.4	1.0	14.9
Rest East Asia	0.9	2.1	10.2	2.8	15.9
South Asia	0.4	1.4	2.0	0.7	4.5
Latin America	0.3	0.2	4.2	0.9	5.6
MENA	0.5	0.3	3.5	1.1	5.3
SubSAfrica	0.3	0.2	2.1	0.7	3.2
HICs	**2.9**	**4.5**	**35.6**	**10.3**	**53.4**
Developing	**4.2**	**8.1**	**27.7**	**6.6**	**46.6**
of which Asia	3.1	7.4	17.6	3.8	31.8
NR Rich	**1.7**	**1.1**	**16.5**	**4.4**	**23.7**
NR Poor	**5.4**	**11.5**	**46.8**	**12.6**	**76.3**
World	**7.1**	**12.6**	**63.3**	**16.9**	**100.0**

Source: Derived from the authors' GTAP Model results

Table 4: 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 global primary TFP growth**	**2007**	**2030 Core baseline**	**2030 slower China & India growth**	**2030 slower China & India growth + slower global primary TFP growth**
Australia	2.3	2.0	2.1	1.9	0.8	0.8	0.8	0.8
New Zealand	1.6	1.3	1.5	1.3	0.3	0.2	0.2	0.2
Europe	47.8	38.9	40.6	42.2	49.8	29.1	34.6	31.3
USC	13.7	19.7	17.3	19.4	12.4	8.7	10.0	9.5
China	3.9	0.4	0.8	0.4	4.3	28.6	17.8	20.2
Rest East Asia	8.2	11.3	10.8	9.5	13.9	11.9	13.6	13.7
South Asia	2.4	1.5	1.5	1.2	2.1	5.5	5.5	6.2
Latin America	14.5	16.9	17.8	16.1	6.1	4.7	5.4	5.6
MENA	2.5	3.2	3.1	3.4	7.2	6.4	7.5	7.5
SubSAfrica	3.1	4.7	4.6	4.6	3.2	4.1	4.6	5.1
Totals								
HICS	**65.2**	**61.8**	**61.1**	**64.6**	**68.0**	**41.0**	**48.4**	**44.0**
Developing	**34.8**	**38.2**	**38.9**	**35.4**	**32.0**	**59.0**	**51.6**	**56.0**
of which Asia	14.1	12.6	12.6	10.4	14.9	43.3	33.5	37.2
NR Rich	**34.0**	**41.9**	**42.4**	**40.0**	**26.6**	**24.0**	**27.1**	**28.1**
NR Poor	**66.0**	**58.1**	**57.6**	**60.0**	**73.4**	**76.0**	**72.9**	**71.9**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Soure: Derived from the authors' GTAP Model results

Table 5: Shares of bilateral trade in all primary products, 2007 base, 2030 core and 2030 alternative growth scenarios (percent)

(a) 2007 base

Importer: / Exporter:	Australia	New Zealand	Europe & NA	China	Rest Asia	Other DCs	Total
Australia	0.0	1.8	15.1	22.4	56.6	4.1	**100**
New Zealand	9.8	0.0	33.2	6.0	33.9	17.2	**100**
Europe & NA	0.3	0.1	79.4	3.5	7.8	8.9	**100**
China	1.2	0.2	34.9	0.0	56.4	7.3	**100**
Rest Asia	4.6	0.5	20.1	14.4	51.6	8.9	**100**
Other DCs	0.1	0.1	47.3	9.2	32.4	10.8	**100**
Total	**0.6**	**0.2**	**57.8**	**7.4**	**24.4**	**9.6**	**100**

(b) 2030 core baseline

Importer: / Exporter:	Australia	New Zealand	Europe & NA	China	Rest Asia	Other DCs	Total
Australia	0.0	0.9	9.3	54.5	33.0	2.4	**100**
New Zealand	6.4	0.0	12.8	47.3	24.3	9.3	**100**
Europe & NA	0.4	0.1	51.7	26.8	11.5	9.5	**100**
China	0.8	0.1	39.7	0.0	54.2	5.1	**100**
Rest Asia	2.8	0.2	7.5	46.2	38.9	4.4	**100**
Other DCs	0.1	0.1	24.9	32.5	32.5	10.0	**100**
Total	**0.5**	**0.1**	**34.1**	**32.2**	**24.2**	**8.9**	**100**

(c) 2030 with slower China and India growth

Importer: / Exporter:	Australia	New Zealand	Europe & NA	China	Rest Asia	Other DCs	Total
Australia	0.0	1.1	13.3	39.3	43.0	3.4	**100**
New Zealand	8.1	0.0	18.2	29.3	31.5	13.0	**100**
Europe & NA	0.4	0.1	60.6	15.8	12.2	11.0	**100**
China	1.0	0.2	39.5	0.0	53.2	6.2	**100**
Rest Asia	3.4	0.3	11.3	32.3	46.5	6.2	**100**
Other DCs	0.1	0.1	32.2	22.3	33.1	12.2	**100**
Total	**0.6**	**0.1**	**41.6**	**21.0**	**25.9**	**10.8**	**100**

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

Importer: / Exporter:	Australia	New Zealand	Europe & NA	China	Rest Asia	Other DCs	Total
Australia	0.0	1.1	13.1	39.3	43.0	3.4	**100**
New Zealand	7.2	0.0	14.8	34.9	32.0	11.1	**100**
Europe & NA	0.4	0.1	56.9	18.4	12.5	11.8	**100**
China	0.4	0.1	40.7	0.0	52.0	6.9	**100**
Rest Asia	3.5	0.3	8.4	34.8	47.9	5.0	**100**
Other DCs	0.1	0.1	30.7	23.7	33.5	11.8	**100**
Total	**0.6**	**0.1**	**39.8**	**22.7**	**25.9**	**10.9**	**100**

Source: Derived from the authors' GTAP Model results

Table 6: 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	**2030 slower China & India growth**	**2030 slower China & India growth + slower primary productivity growth**
Australia	27	28	18
New Zealand	26	27	16
Europe	36	37	28
USC	31	33	23
China	150	99	76
Rest East Asia	34	35	25
South Asia	110	81	60
Latin America	43	43	35
MENA	41	39	31
SubSAfrica	70	68	59
HICs	33	33	24
Developing	79	65	51
of which Asia	109	81	61
NR Rich	44	44	36
NR Poor	47	39	26
World	45	39	27

Source: Derived from the authors' GTAP Model results

Table 7: Regional shares of global consumption of grains, fossil fuels and other minerals, 2007 base and 2030 core

(percent)

	2007 base				2030 core			
	Grains	**Grains HH consm[a]**	**Fuel**	**Other minerals**	**Grains**	**Grains HH consm[a]**	**Fuel**	**Other minerals**
Australia	0.9	0.1	1.0	4.1	0.7	0.1	0.7	1.7
New Zealand	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0
Europe	19.2	13.2	29.7	23.2	11.4	8.4	19.0	8.6
USC	8.4	1.3	22.4	8.7	6.1	0.9	15.4	3.3
China	12.3	3.5	10.0	27.4	32.0	4.6	25.1	60.7
Rest East Asia	20.1	20.3	15.4	16.3	13.8	16.5	13.4	8.8
South Asia	14.9	22.5	4.7	4.5	16.0	26.7	9.0	6.3
Latin America	9.3	9.0	6.1	9.0	6.5	7.1	5.0	5.2
MENA	7.6	13.2	9.3	5.6	6.0	12.5	10.8	4.3
SubSAfrica	7.2	16.9	1.2	1.1	7.5	23.2	1.5	1.0
HICs	**34.6**	**19.7**	**58.0**	**41.5**	**20.7**	**11.8**	**37.2**	**15.1**
Developing	**65.4**	**80.3**	**42.0**	**58.5**	**79.3**	**88.2**	**62.8**	**84.9**
of which Asia	40.3	39.7	24.2	41.9	58.8	44.4	44.3	73.8
NR Rich	**37.0**	**50.0**	**29.5**	**27.5**	**29.9**	**52.5**	**28.2**	**16.7**
NR Poor	**63.0**	**50.0**	**70.5**	**72.5**	**70.1**	**47.5**	**71.8**	**83.3**
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

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
Rest SE Asia	0.11	0.99	0.66	0.98	0.86
Argentina	0.94	0.66	0.34	0.11	0.84
Central Asia	0.11	0.87	0.74	-0.54	0.77
Russia	-0.57	0.98	0.69	0.82	0.76
Rest SSAfrica	0.00	0.92	0.78	0.85	0.75
Australia	0.75	0.58	0.80	0.72	0.71
ME&NthAfrica	-0.57	0.93	-0.03	0.02	0.69
Chile	0.38	-1.00	0.93	0.90	0.63
Peru	0.04	-0.60	0.96	0.52	0.62
Pacific Islands	0.06	0.44	0.95	0.91	0.61
New Zealand	0.85	-0.34	0.30	0.98	0.59
Rest LAmerica	0.17	0.75	0.49	0.69	0.56
Brazil	0.84	-0.18	0.70	-0.16	0.54
Indonesia	0.26	0.55	0.60	0.84	0.49
Canada	0.35	0.48	0.40	0.34	0.43
Vietnam	0.20	0.98	-0.61	-0.27	0.38
Mexico	-0.24	0.88	0.03	0.45	0.38
South Africa	0.16	-0.31	0.62	0.69	0.27
Malaysia	0.27	0.51	-0.39	0.69	0.27
Rest NEAsia	-0.63	-0.20	0.64	0.07	0.18
Hong Kong	-0.99	-1.00	0.42	-0.99	-0.24
Western Europe	-0.08	-0.48	-0.14	-0.09	-0.26
Philippines	-0.28	-0.85	0.07	0.52	-0.33
Rest SthAsia	-0.25	-0.99	-0.42	0.73	-0.35
Rest EEurope	0.10	-0.84	-0.11	0.36	-0.36
Thailand	0.42	-0.87	-0.46	0.08	-0.42
USA	0.28	-0.92	-0.16	0.03	-0.50
Pakistan	-0.29	-1.00	-0.33	0.07	-0.52
India	0.22	-0.99	-0.37	-0.68	-0.54
China	-0.44	-0.84	-0.66	-0.65	-0.69
Singapore	-0.60	-0.99	-0.37	-0.48	-0.79
Taiwan	-0.72	-0.94	-0.50	-0.19	-0.81
South Korea	-0.89	-0.99	-0.50	-0.61	-0.85
Bangladesh	-0.86	-0.94	-0.82	0.56	-0.85
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 8.1 database.

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

	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
Europe	1.53	0.04	-1.17	1.34	1.45	2.72	0.55	-2.26	2.07	-0.26
USC	1.96	0.80	0.09	1.56	1.40	2.27	-0.21	0.17	2.07	-0.19
China	7.95	0.42	-0.06	2.75	7.32	-0.40	4.85	5.62	2.07	-0.36
Rest East Asia	2.45	0.70	-0.86	1.51	2.55	1.94	1.61	2.92	2.07	-0.12
South Asia	7.07	1.16	1.40	4.11	5.39	0.23	-0.63	4.87	2.07	-0.05
Latin America	3.32	0.82	0.64	3.16	3.02	4.67	1.62	5.21	2.07	0.23
MENA	4.07	1.37	0.58	3.86	3.78	0.71	3.73	0.96	2.07	0.00
SubSAfrica	5.59	2.13	2.05	4.86	4.18	4.17	2.79	1.89	2.07	0.09
HICS	**1.64**	**0.27**	**-0.53**	**1.41**	**1.34**	**2.53**	**0.74**	**0.17**	**2.07**	**-0.29**
Developing	**5.56**	**1.08**	**0.48**	**3.21**	**4.96**	**2.02**	**2.87**	**4.95**	**2.07**	**-0.13**
of which Asia	6.63	0.84	0.25	2.99	6.00	0.68	1.62	5.16	2.07	-0.20
NR Rich	**3.56**	**1.30**	**0.61**	**2.85**	**3.22**	**2.45**	**2.19**	**2.60**	**2.07**	**0.12**
NR Poor	**2.89**	**0.70**	**-0.39**	**1.64**	**2.76**	**0.95**	**1.29**	**3.55**	**2.07**	**-0.28**
World	**3.04**	**0.93**	**-0.18**	**1.85**	**2.87**	**2.18**	**1.99**	**3.30**	**2.07**	**-0.18**

Source: Authors' assumptions (see text for details)

Appendix Table A.3: Regional shares of world real GDP and GDP per economically active person, 2007 base and the core projection for 2030

(percent)

	World GDP share		World ec. active population share		GDP per ec. active person, relative to world average	
	2007	**2030**	**2007**	**2030**	**2007**	**2030**
Australia	1.5	1.3	0.4	0.4	412	364
New Zealand	0.2	0.2	0.1	0.1	324	279
Europe	36.4	26.0	13.2	9.9	277	261
USC	27.7	21.8	5.9	5.2	470	416
China	6.3	18.3	26.0	20.9	24	88
Rest East Asia	13.2	11.6	12.3	12.1	108	96
South Asia	2.7	6.5	20.4	23.8	13	27
Latin America	6.9	7.4	8.1	8.5	85	87
MENA	3.4	4.2	3.9	4.6	87	93
SubSAfrica	1.6	2.8	9.8	14.5	16	19
HICS	**73.5**	**53.7**	**21.2**	**16.7**	**347**	**322**
Developing	**26.5**	**46.3**	**78.8**	**83.3**	**34**	**56**
of which Asia	14.3	31.5	56.5	55.2	25	57
NR Rich	**20.3**	**22.8**	**32.3**	**37.5**	**63**	**61**
NR Poor	**79.7**	**77.2**	**67.7**	**62.5**	**118**	**124**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100**	**100**

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

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