Re-examining Policies for Food Security in Asia

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Abstract

In the wake of recent food price spikes, plus growing demands for food in emerging Asia and for biofuels in Europe and the United States, governments are re-examining their strategies for dealing with both short-term and long-term food security concerns. This paper argues that long-run trends in real agricultural prices have policy implications for food security that are at least as important as those related to short-lived spikes around trend prices. The paper therefore summarizes recent projections of markets to 2030 under various scenarios, and then reviews evidence on how trade policy restrictions typically are altered to insulate domestic markets from short-run fluctuations in international prices around their long-run trends. That provides a firm empirical basis for re-examining the effectiveness and efficiency of various policy options for ensuring food security in Asia and elsewhere. Those options include boosting agricultural productivity growth rates to deal with long-run concerns, and using more-appropriate domestic policy measures rather than trade policies to cope with price volatility.

Keywords: Food price volatility; long-term food price trends; Asian economic growth and structural changes; per capita food consumption

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1. Introduction

Between 2004 and 2008, real food prices in international markets rose by 55 percent. They began to drop back towards trend late in 2008, only to rise steeply again at the end of 2011 along with the prices of energy raw materials, and again in the latter half of 2012. Since Asia is home to the majority of the world's poor, and more than 60 percent of the budget of poor households in Asia is spent on food, this is contributing to inflation in the region and possibly exacerbating poverty in Asia and elsewhere (ADB 2012a; Ivanic, Martin and Zaman 2012; Anderson, Ivanic and Martin 2013).

This combination of high and fluctuating food prices understandably raises food security concerns in developing countries. One consequence has been a call for emergency physical grain reserves (Fan, Torero and Headey 2011), and discussions among ASEAN + 3 countries have focused on coordinating rice reserves (Briones 2011). Governments in high-income countries also have expressed concern. Thus another consequence has been that food price volatility was high on the agenda of the G-8 and G-20 meeting in late 2011 (FAO and Others 2011) and 2012, and remains there for 2013.

However, the set of factors influencing the *trend level* of food prices is not the same as the set affecting the *volatility* of food prices around that long-run trend. Also, the distributional and especially poverty effects of fluctuating prices – and of policy responses to them – differ from those associated with changes in the trend price level. This pair of facts is

important to recognize because unless societies and governments clarify what concerns them most, it is not possible to identify the most-appropriate policy actions to ease those concerns.

From the viewpoint of meeting the number one long-run Millennium Development Goal of permanently eradicating extreme poverty and hunger, the concern over high prices should dominate concerns over fluctuating prices. Certainly some groups are harmed by fluctuating food prices, but others can benefit or at least adapt with agility (Barrett and Bellemare 2011). Even so, governments of low-income countries do worry about sudden spikes in food prices and are prone to respond in an attempt to reduce the extent of the rise in the domestic market, but not always in the most-appropriate ways. This paper begins by focusing on the long-run trend level of food prices, before turning to short-run price volatility.

During the 20th century real food prices in international markets traced a downward path (Grilli and Yang 1988, Pfaffenzeller, Newbolt and Rayner 2007), to the point that by the late 1980s many felt the fear of Malthus was behind us. As a result, growth in funding for rural development in general and agricultural R&D in particular slowed as development assistance resources were directed elsewhere (World Bank 2007). Two decades later it is evident that, as a consequence, productivity growth has slumped – and in both advanced and developing economies, according to Alston, Babcock and Pardey (2010).¹ Meanwhile, rapid industrial growth in emerging economies in Asia and elsewhere is raising the demand for imports of primary products, while biofuel subsidies and mandates in numerous countries are reducing available supplies of food. How will these forces play out in the decades ahead? In particular, will Asia become more dependent on imported food, and what does that imply

¹ Fuglie (2008) provides an alternative set of estimates suggesting it is a slowdown of agricultural investment rather than productivity growth that is the main cause. This difference in results between the two studies has yet to be reconciled.

about its food security as measured by, for example, real per capita food consumption?² To address these questions, we summarize a recent set of projections using a model of the world economy that is projected to 2030 both without and then with some policy changes over that period. The paper then reviews analyses of the ways in which governments have responded in the past to year-to-year fluctuations around the trend level of food prices. It reveals that their trade policy measures seek to insulate domestic food markets from international price fluctuations to a very considerable degree. Moreover, because governments of both food-exporting and food-importing countries do this, their combined actions (a) exacerbate international price fluctuations and thereby (b) offset each other's efforts to stabilize their domestic food prices. In the light of those insights into long-term trends and short-term adjustments to border policy interventions, the final section draws out alternative policy options for improving food security in Asia.

2. Global long-term core projection to 2030

Asia's rapid economic growth is shifting the global economic and industrial centre of gravity away from the north Atlantic, and globalization has led to trade growing faster than output. Together these forces are raising the importance of Asia's emerging economies in world output and trade. They are also shifting the comparative advantages of the more-densely populated economies of the region away from agriculture, and causing intra-Asian trade to grow relative to Asia's trade with the rest of the world.

² Throughout, we have in mind the UN Food and Agriculture Organization's definition of food security, which is the state "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO 2003). More precisely, food security refers to not only availability but also economic access to and effective utilization of that food (Pinstrup-Andersen 2009, Barrett 2010). Since access to food (and health care) for any poor household largely depends on its (and perhaps also its extended family's) income and assets, pro-poor economic growth is a key to expanding effective per capita food consumption and thereby reducing food insecurity (Naylor and Dean 2012).

To examine the extent to which those forces could affect perceived food security (and so could trigger changes to food price and trade policies), a model of the world economy needs to be projected forward. This section of the paper summarizes results from work that builds on the global GTAP modeling of Anderson and Strutt (2012a) which was used to project South-South trade for ADB (2011b) and whose projections have since been revised for a study on growth in ASEAN, China and India (Anderson and Strutt 2012b).³

The GTAP 2004 baseline for the world economy is projected forward to provide a core baseline for 2030 by assuming in the first instance that the 2004 trade-related policies of each country do not change over that 26-year period, but that national real GDP, population, unskilled and skilled labor, capital, agricultural land, and extractable mineral resources (oil, gas, coal and other minerals) grow at the exogenously set rates summarized in Appendix Table A.1. The exogenous growth rates for GDP, investment and population are based on the August 2011 projections over the next two decades by ADB. These are supplemented by World Bank data for real GDP and investment growth for the period to 2010, along with CEPII data for population growth to 2010 and for national projections of GDP, investment and population not readily available in the ADB dataset (Fouré et al. 2010). Estimates from Chappuis and Walmsley (2011) are used for projections of skilled and unskilled labour growth rates. We estimate historical trends in agricultural land from FAOSTAT (summarized in Deininger and Byerlee 2011) and in mineral and energy raw material reserves from BP (2010) and the US Geological Survey (2010).

Given those exogenous growth rates,⁴ the model is able to derive implied rates of total factor productivity and GDP per capita growth. For any one country the rate of total factor productivity growth is assumed to be the same in each of its non-primary sectors, and to be

⁴ There is much uncertainty in macroeconomic projections over this kind of timeframe (and even the current size of the Chinese economy is under serious question—see Feenstra et al. 2011). Garnaut (2011) discusses the uncertain nature of GDP, population and energy projections, and Eichengreen, Park and Shin (2011) examine on prospects for growth in China in particular.

somewhat higher in its primary sectors. Higher productivity growth rates for primary activities were characteristic of the latter half of the 20th century (Martin and Mitra 2001), and are necessary in this projection if real international prices of primary products (relative to the aggregate change for all products) are to rise only modestly.⁵ The international price consequences for the core simulation are depicted in the first column of Appendix Table A.2.⁶

As of 2004, developing countries in Asia were close to self-sufficient in agricultural and food products as a group, at 96 percent, and that ratio is between 94 and 101 percent for China, Indonesia, India, and the Philippines (column 1 of Table 1).

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 and that demands are nonhomothetic, ensure that the structures of production, consumption and trade across sectors within countries, and also between countries, is going to be different in 2030 than in 2004. In particular, the faster-growing developing economies (especially those of Asia) will account for considerably larger shares of the projected global economy over the next two decades. Their aggregate share of world GDP is projected to rise from 20 percent in 2004 to 41 percent in 2030, and for just Developing Asia from 11 to 28 percent. Western Europe's share, meanwhile, is projected to fall from one-third to less than one-quarter. Population shares change much less, with the developing countries' share rising

⁵ 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 the next two decades given the slowdown in agricultural R&D investment since 1990 and its consequent delayed slowing of farm productivity growth (Alston, Babcock and Pardey 2010). It is even less likely for farm products if fossil fuel prices and biofuel mandates in the US, EU and elsewhere are maintained over the next decade. 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.

⁶ The extent to which productivity growth rates are higher in each primary sector than in other sectors is the same for high-income and developing countries, 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, this means we are assuming agricultural TFP growth is higher for developing than high-income countries on average (consistent with the estimate by Ludena et al. (2007, Table 2) that agricultural TFP annual growth during 1981-2000 averaged 1.3 percent globally and only 0.9 percent for high-income countries).

from 80 to 83 percent but Developing Asia's component falling a little, from 55 to 53 percent between 2004 and 2030. Thus per capita incomes converge considerably, with the ratio of the high-income to developing country average more than halving, from 16 to 7 between 2004 and 2030. In particular, the per capita income of Developing Asia is projected to rise from 20 to 53 percent of the global average over the projection period (Appendix Table A.3).

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

The developing country share of global exports of all products is projected to increase by half, rising from one-third in 2004 to 57 percent by 2030. China's share alone trebles to 18 percent, at the expense of high-income countries. The group's import share also rises, although not quite so dramatically: the increase for Developing Asia is from 18 to 34 percent (Tables 4 and 5 of Anderson and Strutt 2012b).

The developing country share of global exports of agricultural and food products is projected to remain virtually unchanged, while their share of global imports of farm products rises considerably. Hence its self-sufficiency in farm products is lower in this core scenario for 2030 than in 2004, dropping from 96 to 87 percent in the case of Developing Asia. The source of that change is mainly China but also some countries in Southeast Asia and also Pakistan (columns 1 and 2 of Table 1).

Continuing Asian industrialization causes primary products to become less important in developing country exports and considerably more important in their imports, and conversely for non-primary products, with the changes being largest in Developing Asia. The

opposite is true for high-income countries, which may seem surprising but recall that what one part of the world imports the remaining part of the world must export to maintain global equilibrium.⁷ Services exports, however, are far more important for India than for China or the large ASEAN countries in 2004, and that difference is projected to increase substantially by 2030 (Anderson and Strutt 2012b, Tables 3 to 5).

For China, Indonesia, Malaysia, Pakistan, Philippines and Vietnam the projected economic growth to 2030 leads to a substantial decline in their projected agricultural self-sufficiency, spread over most farm product groups, while for India and Bangladesh the changes are much smaller. The consequent increase in Developing Asia's share of global imports of agricultural and food is from 14 to 41 percent, while its change in the share of world exports is only from 13.9 to 14.7 percent (Anderson and Strutt 2012b, Table 6).

National self sufficiency is a poor indicator of food security, however (Pinstrup-Andersen 2009, Barrett 2010, Warr 2011). A more meaningful indicator is the change in real per capita household consumption of agricultural and processed food products. The first column of Table 3 shows that, for Developing Asia, the volume consumed per capita in the core 2030 scenario would be 1.4 times that in 2004. The increase is even larger for China, India, Pakistan, Philippines and Vietnam, while somewhat smaller for other Asian countries. That clearly represents a huge improvement in food security. But how sensitive is that number to the model's assumptions about farm productivity growth?

2.2 Sensitivity of 2030 projections to primary sector productivity assumptions

⁷ As can be inferred from the first two columns of Table 1, some of the increased imports of farm products by developing countries would come from Australasia, Western Europe and North America (where food consumption is increasing only very slowly compared with farm output growth). Further disaggregation of the results reveals that some of those imports would come also from such large food-exporting developing countries as Brazil and South Africa, both of whose self sufficiency rises by around one-fifth.

The above core projection is compared in this sub-section with two contrasting alternative growth scenarios:

- Slower total factor productivity (TFP) growth in primary sectors in all countries; and
- Faster total factor productivity (TFP) growth in grain cropping in Association of Southeast Asian Nations (ASEAN) member countries, China and India (hereafter abbreviated to ACI).

The first 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. This is achieved by lowering the additional TFP growth rate for forestry and fishing by 1.5 percentage point and for mining, agriculture and lightly processed food by one percentage point. These amendments lead to real international prices for farm products in 2030 to be 25 percent instead of just 9 percent above those in 2004, and those for other primary products to be 101 percent instead of 25 percent above 2004 levels (see Appendix Table A.2 for details by product). Those increases are consistent with the price projections of several international agencies (FAO/OECD 2010, Nelson et al. 2010, IEA 2010).

The higher prices more than compensate for lower farming and mining productivity such that the share of primary products in GDP is slightly higher in this scenario than in the core projection. This does not lead to developing countries being more food self-sufficient though (Table 1), nor to much change in their share of global trade in farm products

(Anderson and Strutt 2012b, Tables 4 and 5). This is because the slower farm productivity growth is assumed to apply to all countries, so they tend to adjust in unison. However, it does lead to much lower increases in real household food consumption per capita, particularly in developing countries (compare columns 1 and 2 of Table 3).

By contrast with the above alternative, the second alternative scenario presumes there is increased investment in the production of new or adaption of imported crop technologies so as to ensure grain output is higher for ASEAN countries, China and India than in the core scenario.⁸ In this alternative scenario the TFP growth rates for rice, wheat and coarse grains are set an extra one percentage point higher for just those key Asian developing countries. This raises overall agricultural self-sufficiency rates of those countries by between 1 and 3 percentage points, but lowers them slightly for other Asian countries (Table 1). More importantly, it raises -- by several percentage points -- self-sufficiency in the staple grain crops of China, Indonesia, Philippines, Thailand, Vietnam and India (compare parts (b) and (c) of Table 2).

This positive shock to grain productivity – even though it is confined just to ASEAN, China and India – has a noticeable impact on the projected real international prices of grains. Instead of rice, wheat and coarse grain prices rising between 2004 and 2030 by 10, 15 and 22 percent, as in the core simulation, they rise in this alternative scenario by only 4, 12 and 18 percent, respectively (compare columns 1 and 3 of Appendix Table A.2). This means that even though the demand for livestock products expands because of higher incomes in those more-productive countries, the international prices of meat and milk do not rise, because animal feed prices are lower. Hence grain self-sufficiency and real household food

⁸ This might come about through, for example, greater recognition on the part of government leaders in those countries of the extremely high marginal social rate of return from further agricultural R&D in developing countries (Alston, Beddow and Pardey 2009). Indeed Asian countries, especially China, have been investing far more in agricultural R&D per dollar of output than other countries in the past two decades (Pardey, Alston and Kang 2012). Recent revisions of marginal rates of return suggest earlier numbers were exaggerated, but even the latest estimates suggest very high benefit/cost ratios (Alston et al. 2011, Rao, Hurley and Pardey 2012).

consumption per capita in developing Asia – and hence likely perceptions of regional food security – are slightly higher in this than in the core scenario for 2030 (compare columns 1 and 3 of Table 3).

3. Alternative policies by 2030

The above projections all assume trade policies remain unchanged between the base period and 2030. This section examines how the above core scenario for 2030 would be altered if some trade policy reforms were to be undertaken over the projection period. Three trade liberalization scenarios are compared with the 2030 core baseline. They are then contrasted with an agricultural protection scenario, in which it is assumed a strong agreement is not reached under the WTO's Doha Development Agenda and as a consequence developing countries follow the prior example of earlier-industrializing countries in Europe and Northeast Asia and allow tariffs on imports of farm products to increase as their incomes and agricultural comparative disadvantages rise.

3.1 Regional and global trade liberalization options

The first two trade reform possibilities considered assume membership of the ASEAN free trade area is extended to six additional countries (China, Japan, South Korea, India, Australia and New Zealand) to form ASEAN+6. The first of them assumes all merchandise trade is freed on a preferential basis within the expanded ASEAN+6 bloc, while the second of them assumes all merchandise trade is freed by all countries in the expanded ASEAN+6 group not on a preferential basis but rather also with the rest of the world (that is, on a most-favored-nation or MFN basis).

If the ASEAN+6 initiative was purely preferential, the global gains by 2030 would \$60 billion per year but most of those gains would be enjoyed in East Asia and Australia/New Zealand, and non-Asian developing countries as a group would be slightly worse off. In that scenario, ASEAN agricultural output would be one-sixth higher because the more-densely populated countries in South and East Asia would specialize more in non-farm products and import more agricultural goods from ASEAN. Were those trade policy reforms by ASEAN+6 to be on an MFN basis (that is, if tariffs were removed for trade not only within the group but also with non-members), the global gains would nearly treble, to \$166 billion per year by 2030, of which Developing Asia's share would be \$52 billion. In that case non-Asian developing countries would gain around \$30 billion, and they would compete with ASEAN+6 exporters of farm products in supplying even more agricultural goods to Japan, China and India.⁹

The impact of expanding the ASEAN bloc by 6 members and freeing trade among the expanded membership causes ASEAN's agricultural exports to increase considerably. With China and India, their share of world agricultural exports (imports) in 2030 then would be 15 instead of 12 percent (39 instead of 34 percent) – even though agricultural self-sufficiency of China, India and ASEAN would not change by more than 1 or 2 percentage points (Table 1).

Accompanying that liberalization would be an expansion in per capita food consumption. This is not surprising, because agricultural trade reform typically lowers food prices in protective import-dependent countries, raises international food prices and hence the earnings of food producers in other countries, and increases economic welfare in the world as a whole. The extent of the improvement in real per capita household consumption of

⁹ Those welfare benefits are nearly half what they would be if all countries of the world were to remove their barriers to goods trade. Such an extreme reform would generate estimated welfare gains of \$384 billion per year globally by 2030, made up of \$150 billion for high-income countries, \$134 billion for Developing Asia, and \$101 billion for other developing countries (Anderson and Strutt 2012b, Table 16).

agricultural and food products in Developing Asian countries is estimated here to be 1-2 percent (Table 4).¹⁰

3.2 The agricultural protection option

Historically, the trend level of national nominal rates of assistance to agriculture¹¹ have tended to be higher, the higher a country's income per capita and the weaker a country's agricultural comparative advantage (Anderson 2009a, Ch. 1). Thus when mapped over time, the agricultural NRA has been gradually rising for developing countries as a group, and also for high-income countries prior to the 1990s. If past policy trends were to continue for today's developing countries, then in the absence of a strong Doha agreement to lower WTO-bound tariffs on imports of farm products their NRA may keep increasing above zero. That is certainly what Korea and Taiwan did in following Japan, and China, India and ASEAN appear to be on a similar trajectory (Anderson 2009b).¹²

Drawing on political economy theory and past experience, Anderson and Nelgen (2011) examine econometrically whether agricultural protection increases with per capita income and agricultural comparative disadvantage, and tends to be higher for import-competing than exported products. They estimate a relationship for ten key traded farm products as of 2004, and project NRAs for each of those products to 2030 for each developing country in the World Bank distortion database compiled by Anderson and

¹⁰ Those are very much lower-bound estimates, not only because the comparative static GTAP model does not include services policy reform but also because it excludes the dynamic gains from trade liberalization. Recent reviews by Tarr (2012a,b) suggest the consumption gains could be several times larger if a more-comprehensive model were to be available.

¹¹ The nominal rates of assistance to agriculture (NRA) is defined as the percentage by which government policies have raised gross returns to farmers above what they would be without the government's intervention (or lowered them, if $NRA < 0$). See Anderson et al. (2008).

¹² Such a trend is already evident for China: its agricultural NRA rose from -3 to 21 percent between 1999 and 2010 (Anderson and Nelgen 2013). 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 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). 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.

Valenzuela (2008).¹³ They assume all developing countries respect their current commitment to WTO not to exceed their tariff bindings but otherwise feel free to allow domestic political forces to determine the degree of protection provided to import-competing farm industries. They use those criteria to obtain projected values for each of the ten products and for each of the 39 developing countries in the World Bank sample. For developing countries as a whole, the average NRA for these products is projected to rise from 7 percent in 2004 to 35 percent by 2030, while for Developing Asia the average rises from 11 to 42 percent.

To see what those projected NRAs imply about the cost of agricultural and other price- and trade-distorting policies in the world economy in 2030, compared with assuming no changes in trade policies since 2004, the above results from the full global trade liberalization are compared with those generated by assuming such farm protection growth. The results suggest Asian developing countries would become only slightly more agriculturally self-sufficient in 2030 (Table 1, and parts (b) and (d) of Table 2), while their real food consumption would grow slightly less in this agricultural protection growth scenario than in the core scenario (compare columns 1 and 4 in Table 3). Full trade liberalization by 2030 from that counterfactual situation of increased agricultural protection would thus raise real food consumption per capita non-trivially (final column of Table 4).

4. Trade policy responses to short-term food security concerns with volatile prices

Both politicians and vulnerable households worry about short-term fluctuations around long-run trends in markets for staple foods. Fluctuations are to be expected in commodity markets

¹³ Their findings are as expected from political economy theory and past experience, so they use them to project NRAs for 2030. The projected NRAs are then subjected to the following two tests for each developing country. First, if a product was in 2004 and is projected to still be a net export product for a country in 2030, then its 2030 NRA is assumed to be the lesser of its 2004 NRA or zero. That is, it is assumed all export taxes will be phased out by 2030, and that no new export subsidies will be introduced. And second, if the product is projected to be an import-competing product in 2030, then its 2030 NRA is assumed to be the lesser of the equation's projected NRA or the country's WTO-bound tariff rate.

subject to periodic supply or demand shocks, especially if adverse supply shocks occur when stocks are at low levels (Wright 2011; Carter, Raussier and Smith 2011). They are even more likely in the presence also of sporadic and unpredictable changes in government storage activity, which end to crowd out stabilizing investments in grain storage by private firms. Many governments seek to shield their domestic markets somewhat from those fluctuations, and especially from severe spikes in international prices of staple foods. Not surprisingly, then, variations in domestic prices often are less than variations in world prices. The extent to which world prices transmit to national markets depends on trade policies, domestic price subsidies or taxes, market integration, infrastructure affecting trade costs, and domestic market imperfections.

Typically governments insulate their domestic markets by altering the restrictiveness of their trade policies, on both imports and exports.¹⁴ An export tax or its equivalent lowers the domestic price below the border price of a tradable product such as grain (as does an import subsidy), whereas an import tax or its equivalent raises its domestic price above the border price (as does an export subsidy). Hence it is not surprising that governments, in seeking to protect domestic consumers from an upward spike in international food prices, consider a change in trade measures as an appropriate response, since that can lower the consumer tax equivalent of any such measure. However, an import tax (or export subsidy) is the equivalent of a consumer tax and a producer subsidy, hence lowering it also reduces the extent to which the measure assists producers of the product in question.

Likewise, since an export tax (or import subsidy) is the equivalent of a consumer subsidy and a producer tax, raising it not only helps consumers but also harms farmers. If farming is discouraged, the demand for labor on farms falls, and with it the wages of unskilled workers not only in farm jobs but also in non-farm jobs – and more so the poorer

¹⁴ For reviews of recent examples of such interventions, see Jones and Kwiecinski (2010), ADB (2012a), and FAO and Others (2011).

and more agrarian is the economy. Thus while poor households may benefit on the expenditure side from a measure that reduces the extent to which the price of food would otherwise rise, they could be harmed on the earnings side if they are sellers of food or suppliers of unskilled labor. Such trade policy responses therefore could add to rather than reduce poverty.¹⁵ In the case of small intervening countries unable to influence their terms of trade, such trade measures also are likely to reduce their national economic welfare, because they distort domestic production in addition to lowering the consumer price of food.¹⁶ They are also wasteful if it is only the poorest consumers who need to be helped, since a trade measure affects all food consumers in the country and in proportion to their level of consumption.¹⁷

Moreover, trade measures are not only *inequitable*, and *inefficient* at protecting a needy group from being harmed by a temporary shock to international food markets, but they are also *ineffective* if food-exporting and food-importing countries respond by altering their trade barriers in an effort to prevent the transmission of the international price shock. If only food-exporting countries respond to an upward price spike, the international terms of trade would turn even further in their favor because of the additional reduction in available supplies on the international markets (and conversely if only food-importing countries alter their trade restrictions when the world price of food collapses). Such action would thus add both to the

¹⁵ Recent empirical studies report numerous cases where trade restrictions have added to or would add to poverty. See, for example, Warr (2005), Hertel and Winters (2006), and Anderson, Cockburn and Martin (2011). The more poor households are net buyers of staple foods, however, the more a grain price spike is likely to add to poverty (Anderson, Ivanic and Martin 2013).

¹⁶ Variable trade restrictions can also affect long-term investments and hence economic growth rates. Drawing on a broad range of developing country case studies, Bevan, Collier and Gunning (1990) and Collier, Gunning and Associates (1999) suggest that faster economic growth would result from allowing producers access to high prices in those rare occasions when they spike, rather than taxing it away. According to the evidence in their case studies, this is because governments are more prone than farm households to squander the windfall either in poor public investments or in extra consumption. An alternative view is that there are high costs of domestic price variability that reduce economic growth. See, e.g., Williamson (2012) on commodity terms of trade volatility generally and Myers (2006) more specifically on food prices.

¹⁷ Conversely, in the case of opposite changes to trade measures aimed at protecting farmers from a spike downwards in international prices, it is consumers who are inadvertently harmed by such trade policy responses, and all surplus producers are helped – and in proportion to their marketed output – rather than just the poorest, thereby adding to farm income inequality.

extent of the international price spike and to the transfer of welfare from food-deficit to food-surplus countries (or from food-surplus to food-deficit countries when the price spike is downward and only food-deficit countries respond).

However, when both sets of countries seek to insulate their domestic markets from an external shock, their impacts on the international price spike are reinforcing but their impacts on the volume they trade internationally – and hence on their domestic prices – are offsetting. Indeed if food-deficit countries shift to the right their demand curve for imports to exactly the same extent as food-surplus countries shift to the left their export supply curve, the domestic price in both sets of countries would be no different than if neither country altered their trade measures following the exogenous shock. That is, in that case the full extent of the international price change from the initial shock would be transmitted to both sets of countries, despite their efforts to insulate their domestic markets.

Furthermore, the more countries that participate and thus the more the international price spike is accentuated, the more compelled will other countries feel to join the bandwagon, which pushes that international price even higher. This is a classic collective-action problem akin to when a crowd stands up in a stadium to get a better view: on average no one gets a better view by standing, but those that remain seated get a worse view and so are induced to stand as well. Clearly there is a case for multilateral agreement to desist from using trade measures for this purpose.

Governments do not limit their interventions in markets for farm products to periods of extreme prices of course. Around the long-run trends in agricultural NRAs for each country there is much fluctuation from year to year in individual product NRAs.¹⁸ NRAs are

¹⁸ A change in NRA may not require any policy action on the part of the government, but rather be part of the original policy design. For example, the use of specific rather than ad valorem rates of trade taxation or trade subsidization automatically ensures some insulation of the domestic market from international price changes, as does the use of quantitative restrictions on trade such as fixed import or export quotas or bans. Explicit formulae for varying the import or export duty according to international price movements also may be part of the policy regime. And in some cases explicit provisions for restricting or relaxing trade barriers in price spike periods also

negatively correlated with deviations from trend in the international price of the product in question, and especially for rice and wheat (Figure 1). To examine how much that behavior varies across products, Table 5 provides new estimates of the elasticity of transmission of the international product price to the domestic market for key crop products in Asian developing economies. Following Nerlove (1972) and Tyers and Anderson (1992, pp. 65-75), they are based on a partial-adjustment geometric distributed lag formulation to estimate elasticities for the period 1985 to 2010. The unweighted averages across that sample of those short-run elasticities range from a low of 0.4 for sugar to a bit over 0.5 for rice and wheat and 0.7 for soybean. Anderson and Nelgen (2012) repeat this exercise for 82 countries and the ten most important farm products, and get an unweighted average of 0.56. Together this suggests that within one year, barely half the movement in international prices of key farm products is transmitted domestically. While some of that may be due to the nature of trade costs, much of it is the result of governments varying their country's trade restrictions.

How successfully have such variations in trade restrictions reduced instability in domestic relative to international markets for farm products? A statistical indicator that can help answer this question is the coefficient of variation (the standard deviation divided by the sample mean) of the domestic producer price relative to that for the corresponding border price.¹⁹ Table 6 provides estimates of that relative indicator for key farm products in various Asian countries, for the period 1985-2010. The averages across countries of those estimates suggest that interventions in Developing Asia were severe enough to provide some insulation

are part of a policy's legislation – even though the use of that provision may lay dormant in all but extreme periods. In what follows such possibilities will be treated no differently than any formal change of policy: both show up as a change in the NRA.

¹⁹ Both prices are deflated by the United States' GDP deflator and deviations are measured around log-linear trends and expressed as a percentage.

for rice and sugar, but to have had little impact in preventing domestic market prices from gyrating less than prices in international markets for the other products shown.²⁰

As mentioned above, such a modest outcome is possible when food-exporting and food-importing countries both alter their trade restrictions in offsetting ways when international prices move away from trend. Indeed the indicator in Table 6 overstates the degree of success of national governments in stabilizing domestic prices, because without such policy actions the international price fluctuations would have been smaller. Martin and Anderson (2012) suggest a method to estimate by how much smaller. While their method relies on a number of simplifying assumptions,²¹ it at least provides an indication of the combined influence of such variations in trade restrictions on each product market. Applying that method to data for the 1972-74 and 2006-08 grain price spikes yields the results shown in Tables 7 and 8.

The first column of Table 7 suggests that in both periods between one-sixth and one-tenth of the maize price rise, between one-fifth and one-quarter of the wheat price rise, and more than one-quarter of the rice spike in those two periods can be attributed to variations in trade restrictions. Furthermore, the right-hand columns show how much of those impacts came from exporting as distinct from importing countries: when averaged across the three grains, the contribution of exporting countries is only slightly greater than that of importing countries.

The proportional contribution of both sets of countries' governments, shown in column 1 of Table 7, can be used to discount the rise in the international prices of those

²⁰ This is consistent with a stochastic dynamic simulation exercise for India's grain markets which showed that unilateral liberalization of trade could lead to greater domestic price stability even though it would make world prices more volatile (Srinivasan and Jha 2001). It is also consistent with the findings of a more-recent study that assessed the contributions that parastatals have made to food security in the six most populous economies of South and Southeast Asia, which found them wanting (Shahidur, Gulati and Cummings 2008).

²¹ It assumes that output cannot respond in the short run, that inventory levels are so low that stock adjustments have limited effect (as is typically the case in a price spike period – see Wright 2011), and that the national elasticities of final demand for the product in question are the same across countries. It also ignores cross-elasticities between products.

grains to suggest how much those prices would have risen if governments had not altered their trade restrictions. That can be seen in column 2 of Table 8. Column 3 gives the unweighted average across all countries in our sample of the domestic price rises for those grains. The numbers for 2006-08 suggest that, on average, domestic prices rose slightly more than the adjusted international price change for wheat, while they rose almost as much for maize and only one-sixth less for rice. The extent of insulation was somewhat greater in developing countries. This recent experience contrasts with the early 1970s, when high-income countries were much more insulated than recently, and also compared with developing countries in the 1970s (see upper half of Table 8). These results provide further evidence that the combined responses by governments of all countries have been sufficiently offsetting as to do very little to insulate domestic markets from this recent international food price spike.

This evidence that even the substantial variations in border trade restrictions practiced in the past have been ineffective in reducing domestic food price fluctuations is of concern for Asia's developing countries not only from a food security viewpoint but also from an inflation viewpoint (ADB 2012a). This is because, leaving aside Japan, Korea and Taiwan, food has a weight of between 30 and 60 percent in the Consumer Price Index of developing Asian countries. It has an even higher weight in the consumption basket of poor households within those countries (Deaton and Dupriez 2011).

5. Policy options and implications

Given the above findings on long-run trends and short-term market fluctuations in global food markets, and past government responses to and influences on both, it is now possible to examine in a more-informed way the options available to national governments – unilaterally,

plurilaterally and multilaterally – for dealing with food security issues in the years ahead.

Asia's two largest developing countries, China and India, have a particularly large stake in this issue, because of their declining food self sufficiency (Table 1) and their rising shares of global grain consumption – which is projected to increase from 25 to 40 percent between 2004 and 2030 (Table 9).

The trade policy scenarios analyzed above suggest that agricultural protection growth is not a long-run solution to boosting food security, in the sense of raising per capita food consumption. On the contrary, it raises the price of food in protecting countries, and it lowers overall national economic welfare in both protecting and food-exporting countries. More specifically, import-restricting food policies reduce the food security of all households that are net buyers of food, including those farm households specializing in producing products other than food staples. In countries where such households account for the majority of the poor, such import restrictions add to poverty (Ivanic and Martin 2010). Thus governments of countries experiencing a long-run decline in food self-sufficiency need to resist the temptation to go down the agricultural protection growth path, and instead consider other options for ensuring their national long-run food security.

As for short-run food security concerns, fluctuations in national trade barriers are not a very effective way of dealing with international price spikes, because when a similar proportion of food-exporting and food-importing countries so act, they tend to neutralize each other's domestic market stabilizing efforts and at the same time accentuate the international price spike and so push more countries into acting similarly. The evidence summarized above suggests there is a strong case for multilateral agreement to desist from using trade measures for this purpose. The case for countries to get together to agree not to alter their border measures in response to price fluctuations is especially strong in situations where only a few countries account for most of the world's production and consumption. Since a dozen Asian

countries account for all but one-tenth of the global rice market, it should be relatively easy for the region's governments to cooperate in this way to reduce short-run rice security concerns. Even if they differ in their desired national long-term trend levels of rice protection, they could at least reduce fluctuations in the international price of rice by agreeing to use fixed ad valorem tariffs rather than variable or volumetric import taxes or quantitative trade restrictions.

Another long-run option for Asian countries is to liberalize their trade, which is shown above to be able to boost per capita food consumption. The extent of those benefits is likely to be greater the more encompassing is any such liberalization.

Turning to domestic measures, possibly the best long-term option for many developing countries is investing more in agricultural R&D. The above results show that this has the potential to boost per capita food consumption in both food-exporting and food-importing countries. If there are high marginal social rates of return from such investments, then they will also boost economic growth. Provided the resulting supply expansion does not depress world food prices too much, it could also boost the incomes of farmers. For both reasons, this option is likely also to be poverty alleviating over the longer term (Ivanic and Martin 2010). So too would be improvements in the formal credit market, since it is the asset- and income-poor who are usually the least able to access credit at reasonable (let alone subsidized) interest rates to tide them over short-term periods of hardship. The development of markets for commodity futures, weather-index insurance and currency hedging offers financial mechanisms for helping traders deal with risk and uncertainty, and ones that are becoming gradually more accessible in many developing country settings (Byerlee, Jayne and Myers 2006; OECD 2009; FAO and Others 2011).

In the past three years there has been a range of other domestic measures adopted by various Asian developing countries to deal with short-term concerns associated with a food

price spike (see Jones and Kwiecinski 2010; Tangermann 2011). Two are mentioned by way of conclusion: altering grain stocks, and conditional/targeted cash transfers.

Government involvement in grain stockholding appeals to many as a sensible food security strategy. However, their involvement in the market for storage services can crowd out private stockholding. This is because usually it adds to market uncertainty, since predicting the sporadic and often politically-driven purchase and selling decisions of a parastatal agency is typically very difficult. This is again a collective action problem: if all governments agreed not to engage in large-scale grain storage, there would be no need for any government to do so because the private sector would then find it profitable to purchase and store when prices were low (thereby putting a floor under farmer prices), and to sell from those stockholdings when prices are high (Wright 2011). If governments are still fearful that a widespread crop failure may deplete those stocks, they may be tempted to get together and contribute to a transparent joint stockholding program with firmly agreed rules for sharing accurate information on stocks held and for buying and selling. Past experience cautions against such action, however, because previous international commodity agreements have led at best to disappointing outcomes (Gilbert 2010). Recent analysis also cautions against regional reserves. Larson et al. (2012), for example, stochastically model the wheat markets of the Middle East and North Africa, and show that a much cheaper option than a regional reserve is targeted consumer subsidies in times of price spikes. It remains to be seen as to whether the ASEAN plan to establish a regional rice reserve will fare better than past efforts with grain reserve schemes.

Potentially, schemes that target only those in most need are far more efficient than administered pricing schemes and trade policies that affect all producers and consumers. In the case of upward spikes in staple food prices, the distribution of coupons for the poor is one example of such a targeted scheme. In the past the transactions cost of making such transfers

to poor households was prohibitively expensive but, thanks to the information technology revolution, it is now possible for developing country governments to provide conditional cash transfers electronically at relatively little cost (see, for example, Adato and Hoddinott 2010).

In summary, governments can play a useful role in enhancing food security in both the short run and long run, but the societal payoffs will be greatest if their activities are focused on improving the efficiency of their domestic markets (e.g. for smallholder credit), overcoming externalities (such as the free-rider problem that leads to under-investment in agricultural R&D), improving rural transport and communication infrastructure (to lower the gap between producer and wholesale prices), and coordinating with other governments to multilaterally dismantle market-distorting price and trade policies (so many of which increase the volatility of international food prices and reduce per capita food consumption).

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Figure 1: Rice and wheat NRAs and their international price, 82 countries,^a 1970 to 2010

(left axis is international price in current US\$, right axis is weighted average NRA in percent)

(a) Rice

(b) Wheat

Source: Based on the update of NRA estimates in Anderson and Valenzuela (2008) by Anderson and Nelgen (2013).

Table 1: Agricultural self-sufficiency ratio,^a 2004 base, 2030 core and 2030
alternative growth scenarios, and trade reform scenarios

(percent)

	Baseline scenarios					Trade reform scenarios		
	2004	2030 core	2030 Slower prim TFP	2030 Faster ACI grain TFP	Incr. agric prot'n	ASEAN +6, pref.	ASEAN +6, MFN	Full lib'n from higher ag prot
WEurope	0.94	1.05	1.01	1.05	1.04	1.04	1.07	1.01
Russia	0.88	0.87	0.82	0.86	0.86	0.86	0.84	0.75
RestEEurope	1.00	1.03	1.06	1.02	1.01	1.03	1.03	1.05
USA	1.04	1.19	1.18	1.18	1.16	1.18	1.22	1.22
Canada	1.09	1.27	1.24	1.27	1.24	1.26	1.30	1.33
Australia	1.39	1.55	1.42	1.53	1.45	1.73	1.57	1.63
NewZealand	1.62	1.90	1.97	1.89	1.88	2.08	1.98	2.03
Japan	0.81	0.83	0.82	0.83	0.83	0.75	0.65	0.65
China	0.97	0.83	0.84	0.83	0.85	0.82	0.80	0.79
Singapore	0.40	0.61	0.72	0.59	0.52	0.78	0.76	0.91
Indonesia	0.95	0.83	0.83	0.84	0.85	0.82	0.82	0.82
Malaysia	0.61	0.47	0.37	0.48	0.48	0.47	0.46	0.45
Philippines	0.94	0.80	0.81	0.82	0.85	0.76	0.72	0.72
Thailand	1.13	1.02	1.03	1.04	0.98	1.08	1.08	1.08
Vietnam	1.15	1.06	1.01	1.06	1.04	1.22	1.21	1.20
RestSEAsia	1.02	0.93	0.92	0.94	0.95	0.95	0.94	0.94
PacificIslan	0.92	0.90	0.88	0.90	0.88	0.91	0.92	2.05
HongKong	0.40	0.37	0.35	0.37	0.36	0.37	0.36	0.36
SouthKorea	0.82	0.84	0.79	0.83	0.84	0.93	0.90	0.88
Taiwan	0.78	0.84	0.83	0.83	0.84	0.86	0.84	0.75
RestNEAsia	0.83	0.73	0.69	0.73	0.77	0.73	0.73	0.71
India	1.01	1.00	1.00	1.01	1.00	1.02	0.99	1.00
Pakistan	0.98	0.84	0.89	0.84	0.83	0.85	0.85	0.84
Bangladesh	0.92	0.87	0.92	0.87	0.88	0.88	0.89	0.87
RestSthAsia	0.96	0.91	0.89	0.90	0.93	0.92	0.91	0.87
CentralAsia	1.04	1.09	1.05	1.09	1.08	1.08	1.08	1.10
Latin America	1.10	1.23	1.29	1.22	1.20	1.23	1.26	1.40
M.E. & Africa	0.93	0.92	0.93	0.92	0.93	0.92	0.92	0.91
High-income	0.97	1.09	1.06	1.09	1.07	1.09	1.11	1.09
Developing	0.98	0.91	0.93	0.92	0.92	0.92	0.91	0.93
of which Asia:	0.96	0.87	0.87	0.87	0.88	0.87	0.85	0.85
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

^aAgricultural self-sufficiency ratio excludes 'other (processed) food products'.
Source: From GTAP Model results summarized in Anderson and Strutt (2012b).

Table 2: Self-sufficiency ratio for various agricultural products, 2004 base, 2030 core, and 2030 under alternative TFP growth and farm trade policy scenarios

(a) 2004 base

	Rice	Wheat	Coarse Grains	Oilseeds	Sugar	Cotton	Beef & Sheep	Pork & Chicken	Dairy
WEurope	0.69	0.96	0.95	0.68	0.88	0.65	0.94	0.99	1.02
Russia	0.58	1.10	0.99	0.99	0.69	0.08	0.93	0.75	0.94
CentralAsia	0.90	1.06	1.03	0.93	0.51	3.15	1.00	0.94	0.97
RestEEurope	0.79	0.96	1.05	0.87	1.02	0.92	1.00	0.88	1.03
USA	1.29	8.72	1.42	1.64	0.95	2.59	0.97	1.03	0.99
Canada	0.27	2.75	1.17	2.21	0.87	0.84	1.12	1.17	0.96
Australia	1.14	n.a.	3.62	8.71	1.31	2.43	1.66	1.12	1.16
NewZealand	0.23	0.73	0.95	0.71	1.01	0.94	1.73	1.54	1.73
Japan	0.96	0.11	0.02	0.08	0.84	0.56	0.83	0.66	0.95
China	1.00	0.84	1.01	0.47	0.95	0.64	0.89	1.01	0.97
Singapore	0.60	0.20	0.61	0.23	0.57	0.58	0.46	0.20	0.59
Indonesia	0.99	0.01	0.96	0.91	0.76	0.05	0.93	1.02	0.78
Malaysia	0.68	0.02	0.05	0.34	0.69	0.40	0.19	1.08	0.35
Philippines	0.93	0.34	0.96	0.75	1.06	0.63	0.83	0.99	0.60
Thailand	1.38	0.01	1.25	0.34	1.55	0.18	0.94	1.07	0.72
Vietnam	1.20	0.01	0.90	1.47	0.97	0.12	0.98	0.99	0.64
RestSEAsia	1.00	0.03	1.31	1.31	0.89	0.79	0.98	0.99	0.25
PacificIslan	0.03	0.35	0.46	6.58	1.35	1.52	0.81	0.56	0.93
HongKong	0.04	0.57	0.26	0.04	0.02	0.01	0.38	0.46	0.67
SouthKorea	0.95	0.02	0.11	0.17	0.70	0.11	0.75	0.86	0.92
Taiwan	0.90	0.01	0.22	0.00	0.58	0.10	0.78	0.93	0.72
RestNEAsia	0.82	0.45	0.61	0.29	0.53	0.85	0.95	0.85	0.75
India	1.04	1.03	1.03	1.01	0.98	1.00	1.03	1.00	1.00
Pakistan	1.32	0.87	0.85	0.58	1.02	0.80	0.99	1.00	1.00
Bangladesh	0.98	0.63	0.36	0.71	0.86	0.68	1.00	0.95	0.74
RestSthAsia	0.96	0.33	0.60	0.99	0.66	1.18	0.97	0.90	0.71
Mexico	0.39	0.45	0.86	0.03	0.98	0.73	0.90	0.91	0.97
Argentina	1.40	3.34	1.97	1.24	1.18	0.82	1.16	1.22	1.16
Brazil	0.94	0.59	1.22	1.66	1.42	1.25	1.12	1.46	1.00
RestLAmerica	0.89	0.59	0.81	1.11	1.11	0.91	1.01	0.99	0.95
ME_NthAfrica	0.68	0.70	0.62	0.60	0.71	1.06	0.85	0.97	0.89
SouthAfrica	0.18	0.62	1.09	0.82	1.02	0.99	1.00	0.99	1.02
RestSSAfrica	0.59	0.32	0.98	1.24	0.93	2.36	1.03	0.94	0.60

Table 2 (continued): Self-sufficiency ratio for various agricultural products, 2004 base, 2030 core, and 2030 under alternative TFP growth and farm trade policy scenarios

(b) 2030 core sim

	Rice	Wheat	Coarse Grains	Oilseeds	Sugar	Cotton	Beef & Sheep	Pork & Chicken	Dairy
WEurope	0.98	1.33	1.00	0.83	0.90	1.90	0.95	1.21	1.03
Russia	0.50	1.13	1.00	0.96	0.57	0.27	0.92	0.74	0.89
CentralAsia	1.28	1.09	1.03	0.90	0.56	4.72	1.00	0.86	0.95
RestEEurope	0.90	1.03	1.09	0.81	1.08	1.20	0.99	0.80	1.06
USA	1.67	12.02	1.46	2.29	0.94	7.30	1.00	1.29	1.00
Canada	0.22	3.67	1.48	2.70	0.80	1.08	1.21	1.38	0.96
Australia	1.32	n.a.	5.15	9.40	1.31	3.68	1.62	1.57	1.09
NewZealand	0.28	0.82	0.97	1.08	1.01	2.03	1.89	3.14	1.69
Japan	0.97	0.19	0.03	0.11	0.85	0.78	0.86	0.65	0.94
China	0.98	0.60	0.96	0.19	0.84	0.48	0.63	0.79	0.93
Singapore	0.99	0.13	0.50	0.20	0.64	0.96	1.27	0.28	1.05
Indonesia	0.96	0.00	0.94	0.75	0.68	0.02	0.76	0.96	0.67
Malaysia	0.68	0.01	0.06	0.29	0.48	0.27	0.19	0.91	0.27
Philippines	0.82	0.11	0.92	0.45	0.95	0.26	0.69	0.91	0.76
Thailand	1.21	0.00	1.01	0.27	1.72	0.10	0.96	0.97	0.72
Vietnam	1.20	0.00	0.89	1.34	0.96	0.06	0.89	0.80	0.61
RestSEAsia	0.98	0.02	1.20	1.06	0.92	0.53	0.78	0.93	0.28
PacificIslan	0.04	0.33	0.45	7.83	1.27	2.87	0.78	0.63	0.83
HongKong	0.06	0.60	0.25	0.04	0.01	0.01	0.27	0.39	0.78
SouthKorea	0.94	0.02	0.10	0.19	0.93	0.13	0.74	0.88	0.91
Taiwan	0.95	0.01	0.17	0.00	0.58	0.16	0.86	1.04	0.75
RestNEAsia	0.79	0.35	0.63	0.20	0.42	0.89	0.64	0.68	0.68
India	1.09	1.13	1.07	1.00	0.95	0.91	0.99	0.97	1.02
Pakistan	1.44	0.60	0.74	0.26	1.05	0.44	0.95	0.92	0.99
Bangladesh	1.00	0.65	0.34	0.72	0.86	0.64	0.99	0.91	0.75
RestSthAsia	0.98	0.31	0.62	0.94	0.61	1.21	0.96	0.85	0.75
Mexico	0.50	0.56	0.87	0.09	1.06	1.32	1.01	0.98	0.97
Argentina	1.21	2.80	1.69	1.23	1.23	0.88	1.08	1.17	1.15
Brazil	0.99	0.57	1.10	1.99	1.50	2.08	1.45	1.99	1.17
RestLAmerica	0.89	0.58	0.80	1.14	1.13	1.40	0.96	0.97	0.92
ME_NthAfrica	0.72	0.70	0.58	0.55	0.77	1.33	0.89	1.10	0.94
SouthAfrica	0.29	0.95	1.43	1.00	1.19	2.13	1.06	1.04	1.11
RestSSAfrica	0.53	0.24	0.96	1.03	0.75	1.67	0.92	0.86	0.53

Table 2 (continued): Self-sufficiency ratio for various agricultural products, 2004 base, 2030 core, and 2030 under alternative TFP growth and farm trade policy scenarios

(c) 2030 Higher grain TFP growth in ASEAN, China and India

	Rice	Wheat	Coarse Grains	Oilseeds	Sugar	Cotton	Beef & Sheep	Pork & Chicken	Dairy
WEurope	0.88	1.27	1.00	0.83	0.89	1.93	0.94	1.21	1.03
Russia	0.47	1.11	1.00	0.96	0.57	0.27	0.92	0.74	0.89
CentralAsia	1.17	1.07	1.03	0.90	0.56	4.70	1.00	0.86	0.95
RestEEurope	0.86	1.00	1.09	0.81	1.08	1.20	0.99	0.80	1.06
USA	1.45	11.53	1.45	2.30	0.94	7.34	1.00	1.28	1.00
Canada	0.20	3.56	1.41	2.77	0.80	1.08	1.21	1.38	0.96
Australia	1.19	n.a.	4.81	9.53	1.31	3.74	1.63	1.56	1.09
NewZealand	0.25	0.80	0.97	1.08	1.01	2.03	1.89	3.09	1.69
Japan	0.97	0.18	0.03	0.10	0.85	0.77	0.86	0.65	0.94
China	0.98	0.65	0.96	0.19	0.85	0.48	0.64	0.79	0.93
Singapore	0.73	0.16	0.57	0.22	0.64	1.02	1.24	0.28	1.04
Indonesia	0.99	0.00	0.95	0.75	0.68	0.02	0.77	0.96	0.68
Malaysia	0.73	0.01	0.06	0.29	0.49	0.27	0.19	0.92	0.27
Philippines	0.89	0.15	0.93	0.45	0.95	0.26	0.69	0.91	0.76
Thailand	1.29	0.00	1.06	0.27	1.70	0.10	0.96	0.98	0.74
Vietnam	1.21	0.00	0.92	1.34	0.96	0.06	0.89	0.81	0.61
RestSEAsia	1.00	0.03	1.33	1.07	0.92	0.54	0.79	0.94	0.28
PacificIslan	0.03	0.32	0.45	7.84	1.27	2.86	0.78	0.63	0.83
HongKong	0.05	0.57	0.24	0.04	0.01	0.01	0.28	0.39	0.77
SouthKorea	0.93	0.02	0.10	0.19	0.93	0.13	0.74	0.88	0.91
Taiwan	0.91	0.01	0.17	0.00	0.58	0.16	0.86	1.04	0.75
RestNEAsia	0.74	0.35	0.63	0.20	0.43	0.89	0.64	0.69	0.68
India	1.11	1.22	1.08	1.00	0.95	0.91	0.99	0.97	1.02
Pakistan	1.36	0.59	0.74	0.26	1.05	0.44	0.95	0.92	0.99
Bangladesh	0.99	0.60	0.32	0.72	0.86	0.64	0.99	0.91	0.75
RestSthAsia	0.96	0.28	0.60	0.93	0.61	1.22	0.96	0.86	0.76
Mexico	0.48	0.54	0.87	0.09	1.06	1.31	1.01	0.98	0.98
Argentina	1.20	2.72	1.65	1.24	1.23	0.88	1.08	1.17	1.15
Brazil	0.98	0.56	1.09	1.99	1.50	2.09	1.45	1.99	1.17
RestLAmerica	0.87	0.56	0.80	1.13	1.13	1.40	0.96	0.97	0.92
ME_NthAfrica	0.67	0.69	0.58	0.55	0.77	1.33	0.89	1.10	0.94
SouthAfrica	0.29	0.88	1.42	1.00	1.19	2.11	1.06	1.04	1.10
RestSSAfrica	0.47	0.23	0.96	1.03	0.75	1.67	0.92	0.86	0.53

Table 2 (continued): Self-sufficiency ratio for various agricultural products, 2004 base, 2030 core, and 2030 under alternative TFP growth and farm trade policy scenarios

(d) 2030 with higher developing country agricultural protection

	Rice	Wheat	Coarse Grains	Oilseeds	Sugar	Cotton	Beef & Sheep	Pork & Chicken	Dairy
WEurope	0.97	1.22	1.04	0.81	0.86	2.01	0.92	1.21	1.02
Russia	0.49	1.05	0.99	0.95	0.57	0.30	0.92	0.71	0.89
CentralAsia	1.25	1.04	1.02	0.96	0.45	4.30	1.00	0.87	0.99
RestEEurope	0.87	0.98	1.01	0.79	1.06	1.17	0.98	0.79	1.06
USA	1.26	10.25	1.33	2.29	0.94	7.56	0.99	1.25	0.99
Canada	0.21	3.40	1.27	2.80	0.80	1.08	1.14	1.38	0.96
Australia	1.20	n.a.	3.54	10.24	1.20	4.21	1.50	1.33	1.08
NewZealand	0.50	0.80	0.97	1.14	1.00	2.23	1.63	4.00	1.66
Japan	0.96	0.16	0.03	0.10	0.85	0.76	0.85	0.66	0.94
China	0.99	0.71	0.97	0.18	0.99	0.50	0.71	0.81	0.94
Singapore	0.87	0.09	0.37	0.16	0.57	1.02	0.85	0.27	0.92
Indonesia	1.00	0.00	0.94	0.81	0.85	0.02	0.80	0.95	0.62
Malaysia	0.91	0.00	0.06	0.28	0.43	0.23	0.17	0.89	0.17
Philippines	0.98	0.09	0.90	0.41	1.00	0.23	0.81	0.93	0.72
Thailand	1.11	0.00	1.00	0.27	1.45	0.10	1.00	0.97	0.81
Vietnam	1.14	0.00	0.88	1.22	1.00	0.06	0.93	0.90	0.79
RestSEAsia	1.00	0.01	1.16	1.03	1.00	0.53	0.87	0.95	0.34
PacificIslan	0.05	0.36	0.45	6.96	1.19	2.38	0.78	0.73	0.87
HongKong	0.05	0.58	0.24	0.04	0.01	0.01	0.27	0.39	0.77
SouthKorea	0.93	0.02	0.10	0.31	0.65	0.13	0.77	0.94	0.98
Taiwan	0.89	0.01	0.18	0.00	0.64	0.15	0.93	1.03	0.85
RestNEAsia	0.93	0.34	0.64	0.21	0.81	0.84	0.70	0.73	0.76
India	1.02	1.08	1.06	1.00	0.98	0.93	1.00	0.98	1.02
Pakistan	1.25	0.72	0.80	0.27	1.02	0.43	0.95	0.92	0.99
Bangladesh	1.00	0.62	0.33	0.70	0.99	0.62	1.00	0.94	0.74
RestSthAsia	1.00	0.35	0.62	0.96	0.89	1.18	0.96	0.84	0.77
Mexico	0.53	0.63	0.98	0.08	1.06	1.20	1.05	1.00	0.98
Argentina	1.07	2.83	1.48	1.20	1.13	0.89	1.07	1.10	1.10
Brazil	0.99	0.64	1.06	1.97	1.25	2.12	1.50	1.86	1.16
RestLAmerica	0.95	0.77	0.84	1.03	1.06	1.30	1.01	1.00	0.95
ME_NthAfrica	0.81	0.75	0.63	0.59	0.96	1.20	0.84	1.03	0.96
SouthAfrica	0.10	0.92	1.29	0.90	1.39	2.24	1.02	0.99	1.01
RestSSAfrica	0.78	0.28	0.97	1.02	0.87	1.40	0.94	0.90	0.68

Source: Derived from GTAP Model results summarized in Anderson and Strutt (2012b).

Table 3: Changes in real household consumption per capita of agricultural and food products from 2004 base in 2030 core and 2030 alternative TFP growth and farm trade policy scenarios

(percent)

	Core Base line	Lower primary TFP growth	Higher ACI grain TFP growth	Increased agric. protection
WEurope	33	25	33	33
Russia	99	105	99	99
RestEEurope	61	39	61	61
USA	41	28	41	41
Canada	48	43	49	49
Australia	64	60	64	64
NewZealand	62	49	62	62
Japan	31	23	31	31
China	226	160	228	226
Singapore	69	40	69	66
Indonesia	113	78	115	112
Malaysia	109	92	110	108
Philippines	143	88	145	142
Thailand	83	38	84	83
Vietnam	251	265	253	251
RestSEAsia	103	86	106	103
PacificIslan	61	69	61	60
HongKong	67	50	68	67
SouthKorea	67	47	67	66
Taiwan	75	56	76	74
RestNEAsia	105	84	105	103
India	177	131	178	177
Pakistan	212	144	212	212
Bangladesh	141	101	141	140
RestSthAsia	130	100	130	130
Central Asia	132	141	132	131
Latin America	79	67	79	79
M.E. & Africa	108	85	108	107
High-income	40	31	40	40
Developing	141	107	142	141
of which Asia:	168	123	169	168
Total	67	48	67	66

Source: Derived from GTAP Model results summarized in Anderson and Strutt (2012b).

Table 4: Changes in real household consumption per capita of agricultural and food products from core 2030 scenario due to trade policy reforms

(percent)

	Trade reform scenarios		
	ASEAN+6 preferential	ASEAN+6 MFN	Full lib'n from higher ag prot'n
WEurope	0.0	0.1	4.4
Russia	0.3	0.3	4.0
RestEEurope	-0.1	-0.2	0.6
USA	0.0	0.0	0.0
Canada	0.1	0.1	4.9
Australia	0.1	-0.1	-0.2
NewZealand	1.9	1.2	2.9
Japan	3.6	5.5	5.5
China	0.2	0.9	2.1
Singapore	2.6	3.0	6.5
Indonesia	0.7	0.8	1.6
Malaysia	3.5	15.4	17.3
Philippines	0.8	1.8	3.4
Thailand	3.8	5.2	5.7
Vietnam	2.7	4.9	5.3
RestSEAsia	1.1	2.5	3.2
PacificIslan	-0.8	0.2	7.0
HongKong	-0.3	2.8	3.0
SouthKorea	7.2	8.7	10.0
Taiwan	-0.9	1.1	8.5
RestNEAsia	-0.1	1.2	5.4
India	0.4	1.3	1.4
Pakistan	-0.4	-0.2	1.6
Bangladesh	-0.1	0.2	0.9
RestSthAsia	-0.5	0.2	2.3
Central Asia	0.2	0.6	2.7
Latin America	0.1	0.0	0.6
M.E. & Africa	0.1	0.6	3.3
High-income	0.5	0.8	3.0
Developing	0.5	1.1	2.6
of which Asia:	0.7	1.6	2.7
Total	0.5	1.0	2.8

Source: Derived from GTAP Model results summarized in Anderson and Strutt (2012b).

Table 5: Short-run (one-year) price transmission elasticities,^a key foodcrop products, Asian developing countries, 1985 to 2010

	Rice	Wheat	Maize	Soybean	Sugar	Unweighted average for these crops
Bangladesh	0.42	0.26			0.04	0.24
China	0.56	0.55	0.47	0.66	0.83	0.61
India	0.44	0.43	0.53	1.00	0.08	0.50
Indonesia	0.58		0.71	0.55	0.46	0.58
Pakistan	0.20	0.29	0.12		0.14	0.19
Philippines	0.32		0.22		0.25	0.26
Sri Lanka	0.29					0.29
Thailand	1.00		0.79	0.14	0.75	0.67
Vietnam	0.57				0.28	0.43
Global average	0.51	0.58	0.63	0.73	0.43	0.58

^a The proportion of a change in the international price that is transmitted to the domestic market of a country within a year, as reflected in the producer price.

Source: Nelgen (2012, Appendix B), drawing on NRA estimates from Anderson and Nelgen (2013).

Table 6: Index of relative domestic food price stability,^a Asian developing countries, selected products, 1985 to 2010

(per cent)

	Rice	Wheat	Maize	Soybean	Sugar	Av. of all covered products ^b
Bangladesh	130	88			60	117
China	94	130	120	101	96	94
India	57	74	118	126	67	99
Indonesia	78		97	97	74	98
Malaysia	107					98
Pakistan	44	64	102		66	72
Philippines	71		67		65	88
Sri Lanka	109					111
Thailand	94		81	50	108	98
Unweighted average	87	89	98	94	77	97

^a Ratio of the coefficient of variation of the domestic producer price to the coefficient of variation of the corresponding border price. Both prices are deflated by the United States' GDP deflator and deviations are measured around log-linear trends and expressed as a percentage.

^b Weighted by the value of production at undistorted prices for the above 5 products plus on average six other key products in each country.

Source: Nelgen (2012, Appendix C), drawing on NRA estimates from Anderson and Nelgen (2013).

Table 7: Contributions^a of importing and exporting countries to the proportion of the international price change that is due to policy-induced trade barrier changes, 1972-74 and 2006-08

	TOTAL PROPORTIONAL CONTRIBUTION	Importing countries' contribution	Exporting countries' contribution
<u>1972-74</u>			
Rice	0.27	0.10	0.17
Wheat	0.23	0.18	0.05
Maize	0.18	0.06	0.12
<u>2006-08</u>			
Rice	0.40	0.18	0.22
Wheat	0.19	0.07	0.12
Maize	0.10	0.03	0.07

^a Expressed such that the two numbers in the right-hand pair of columns add to add to the total proportion shown in column 1 of each row.

Source: Anderson and Nelgen (2012) based on the methodology in Martin and Anderson (2012) and the data in Anderson and Nelgen (2013).

Table 8: Comparison of the domestic price rise with the rise in international grain prices net of the contribution of changed trade restrictions, rice, wheat and maize, 1972-74 and 2006-08

(percent, unweighted averages)

	International price rise		Domestic price rises		
	<u>including</u> contribution of changed trade restrictions	<u>net of</u> <i>contribution of changed trade restrictions</i>	All countries	Developing countries	High-income countries
1972-74					
Rice	300	<i>220</i>	59	72	27
Wheat	157	<i>121</i>	64	77	55
Maize	135	<i>111</i>	49	48	52
2006-08					
Rice	113	<i>68</i>	56	48	74
Wheat	70	<i>56</i>	77	65	81
Maize	83	<i>75</i>	73	62	82

Source: Anderson and Nelgen (2012), drawing on price data in Anderson and Nelgen (2013) and, for column 2, the methodology in Martin and Anderson (2012).

Table 9: Regional shares of global consumption of grains, 2004 and 2030 core projection

(percent)

	2004	2030
Latin America	8.4	6.9
Africa and Middle East	12.9	15.0
Japan	11.7	5.0
Other High-income countries	21.9	14.8
Developing Asia:	45.0	58.4
China	12.0	27.1
ASEAN	9.3	10.5
India	13.2	12.2
Rest of South Asia	5.3	4.8
Other Asia	5.2	3.8
TOTAL	100.0	100.0

Source: Derived from GTAP Model results of Anderson and Strutt (2012b)

Appendix Table A.1: Average annual GDP and endowment growth rates, 2004 to 2030

	GDP growth	Population growth	Unskilled labor	Skilled labor	Produced capital	Agric. land	Oil	Gas	Coal	Other minerals
W. Europe	1.48	0.14	-1.09	1.50	1.60	-0.28	2.81	0.77	-2.51	2.07
E. Europe	3.51	0.02	-0.57	1.49	4.03	-0.23	2.64	0.12	-1.86	2.07
US & Canada	2.09	0.82	0.17	1.59	1.75	-0.20	1.00	-0.14	0.19	2.07
Australia & NZ	2.78	1.07	0.31	1.89	1.59	-0.56	1.49	6.10	3.55	2.07
Japan	0.92	-0.21	-1.45	0.98	0.40	-1.14	0.00	0.00	-9.34	2.07
China	8.05	0.29	0.03	2.88	7.62	-0.36	-0.40	4.85	5.62	2.07
ASEAN	5.25	0.97	0.45	3.67	5.95	0.17	1.31	1.48	11.71	2.07
Pacific Islands	3.66	1.72	2.30	1.88	3.86	0.19	1.54	1.21	0.15	2.07
Rest E. Asia	3.47	0.31	-0.45	2.20	3.11	-0.87	0.00	0.00	-1.59	2.07
India	7.88	1.18	1.37	4.03	7.27	-0.04	0.24	0.00	4.93	2.07
Rest S. Asia	7.23	1.36	1.99	4.93	8.14	-0.10	0.27	-2.18	2.26	2.07
Central Asia	4.09	-0.46	-0.67	1.07	4.38	-0.29	2.81	0.77	-2.51	2.07
Latin America	3.81	0.92	0.78	3.32	4.85	0.22	3.29	-0.34	5.15	2.07
ME & Africa	4.55	1.92	1.04	4.16	5.46	0.05	1.27	3.64	1.89	2.07
High-income	1.73	0.27	-0.55	1.49	1.56	-0.33	2.07	0.40	-0.26	2.07
Developing	5.28	1.03	0.52	3.28	5.81	-0.09	1.48	2.24	5.57	2.07
of which Asia:	6.24	0.78	0.26	2.93	6.26	-0.16	0.72	0.93	5.93	2.07
Total	2.45	0.88	-0.37	1.68	2.65	-0.17	1.67	1.23	2.50	2.07

Source: From Anderson and Strutt (2012b)

Appendix Table A.2: Cumulative changes in international prices, 2004 to 2030
(price relative to global average output price change across all sectors, percent)

	Core 2030 sim	2030 slower prim. TFP	2030 higher ACI grain TFP	ASEAN+ 6, pref. lib'n	ASEAN +6, MFN lib'n	Full global lib'n from higher agric protection
Rice	9.7	22.1	4.0	-0.8	-3.2	-4.5
Wheat	14.6	48.4	11.5	-1.1	5.7	3.0
Coarse Grains	22.0	61.3	17.7	-0.6	1.5	1.3
Fruit & Veg.	40.8	85.8	38.6	-0.9	-4.5	-6.8
Oilseeds	21.4	63.9	20.4	-2.1	-2.4	1.5
Sugar	-2.0	5.3	-2.2	-1.2	-3.5	-4.6
Cotton	30.5	67.6	29.2	-2.0	-2.3	4.1
Other Crops	12.8	48.9	11.9	-1.2	-2.0	-1.8
Beef & Sheep	1.7	13.3	1.4	-0.4	-0.5	-1.0
Pork & Chicken	12.7	24.6	11.5	-0.7	-2.5	-4.8
Dairy	-2.1	8.0	-2.2	-0.8	-0.3	0.2
Other Food	4.3	12.4	4.0	-0.7	-1.8	-2.9
All agric. & food	8.9	24.5	8.0	-0.8	-1.7	-2.6
Other primary	24.7	100.6	24.7	0.3	0.9	0.4
Manufactures	-0.2	0.9	-0.1	0.0	-0.4	-0.4
Services	-1.8	-7.0	-1.8	0.1	0.4	0.5

Source: Derived from a revision and expansion of GTAP Model results in Anderson and Strutt (2012b).

Appendix Table A.3: Regional shares of world real GDP and population, and GDP per capita relative to world average, 2004 and the core projection for 2030^a

	World GDP share		World population share		GDP per capita relative to world average	
	2004	2030	2004	2030	2004	2030
W. Europe	33.0	22.7	7.8	6.4	422.7	357.9
Russia	1.4	1.7	2.2	1.6	61.9	101.2
Rest E. Europe	1.1	1.3	2.4	2.1	47.3	61.5
USA	28.5	22.9	4.6	4.5	617.7	512.0
Canada	2.4	2.0	0.5	0.5	478.9	410.3
Australia	1.6	1.5	0.3	0.3	500.0	460.3
New Zealand	0.2	0.2	0.1	0.1	377.9	358.3
Japan	11.4	6.8	2.0	1.5	569.3	457.8
China	4.1	14.4	20.4	17.3	20.0	83.3
Singapore	0.3	0.3	0.1	0.1	391.0	426.7
Indonesia	0.6	1.2	3.4	3.4	18.1	36.0
Malaysia	0.3	0.5	0.4	0.4	72.2	113.4
Philippines	0.2	0.5	1.3	1.5	16.2	33.1
Thailand	0.4	0.6	1.0	0.9	39.7	68.8
Vietnam	0.1	0.3	1.3	1.3	8.1	24.4
Rest SE Asia	0.1	0.1	1.1	1.1	4.6	7.6
Pacific Islands	0.1	0.1	0.1	0.2	38.2	37.4
Hong Kong	0.4	0.4	0.1	0.1	366.1	393.4
South Korea	1.7	1.8	0.7	0.6	222.0	296.3
Taipei, China	0.7	0.9	0.4	0.3	209.7	315.5
Rest NE Asia	0.1	0.1	0.4	0.3	15.8	26.6
India	1.6	5.3	17.0	18.1	9.2	29.3
Pakistan	0.2	0.7	2.4	2.9	9.6	24.6
Bangladesh	0.1	0.4	2.2	2.3	6.3	18.0
Rest South Asia	0.1	0.2	1.2	1.3	6.9	14.4
Central Asia	0.2	0.3	1.1	0.8	17.8	34.0
Mexico	1.7	1.7	1.7	1.6	101.0	100.8
Argentina	0.4	0.7	0.6	0.6	61.3	117.1
Brazil	1.5	2.3	2.9	2.7	52.4	83.9
Rest L. America	1.7	2.1	3.5	3.7	49.6	56.9
M.E. & N Africa	2.7	3.7	5.3	6.0	51.5	61.7
South Africa	0.5	0.6	0.7	0.7	70.8	92.1
Rest SS Africa	0.8	1.8	10.7	15.0	7.1	12.3
High-income	79.6	59.0	20.0	16.9	398.7	349.9
Developing	20.4	41.0	80.0	83.1	25.5	49.3
of which Asia:	11.1	28.1	54.6	52.8	20.4	53.2
World	100	100	100	100	100	100

^a 2004 prices.

Source: Derived from a revision and expansion of GTAP Model results in Anderson and Strutt (2012b).