IFPRI Discussion Paper 01884

November 2019

Economic Growth, Convergence, and Agricultural Economics

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Abstract

After nearly two centuries of lagging behind the industrial countries, growth in many developing countries has surged since the early 1990s. This outperformance has major implications for almost all areas of agricultural economics and, if continued, will likely do so into the future. This paper aims to identify the key ways in which the changes in rich and poor country growth rates matter for agricultural economists, as a basis for formulating better research agendas. A key impact arises through sharp increases in demand for agricultural resources as demand for livestock products increases. This changing structure of food demand has important implications for nutrition studies and policies, with the emergence of a double burden of malnutrition. On the supply side, growth in developing countries tends to increase domestic food supply, which is also boosted by increases in research and development spending. Growth in developing countries both stimulates and benefits from increases in infrastructure investment, evaluation of which requires new analytical tools discussed at this conference. Negative impacts include the contribution of increased demand for livestock products to global greenhouse gas emissions. In terms of trade policy, developing country growth is tending to lead to convergence of agricultural policies with the pattern of assistance seen in today’s developed countries, raising concerns about the future need to deal with collective action problems, particularly those that increase the volatility of world prices.

JEL Codes: O13, O41, O47, Q17, Q18

Keywords: economic growth, convergence, agricultural economics, development, agricultural policy
Economic Growth, Convergence and Agricultural Economics

“The consequences for human welfare involved in questions like these are simply staggering: Once one starts to think about them, it is hard to think about anything else.” —Robert Lucas (1988)

1 Introduction

For almost two centuries, a core group of industrial countries grew much faster than the rest of the world. From around 1990, a large group of developing countries began to grow more rapidly than the developed countries. While this change is not unconditional convergence, in which all poor countries grow more rapidly than richer countries, the growth rate of developing countries has been substantially above that in developed countries for the past 20 years and seems likely—but not certain—to remain so. This remarkable development has major—and much under-researched—implications for almost all fields of agricultural economics.

As pointed out by Abramovitz (1986), there are good reasons to expect that countries that are behind the leading economies of the day will grow more rapidly than the leaders. They can grow not only by adopting new technologies as they become available, but also by moving from inside the existing frontier to the latest new technology. This simple model of convergence, however, was far from the reality during the first two centuries of the Industrial Revolution. While per capita incomes grew, on average, in both the industrial and developing countries, the rate of growth was consistently higher, on average, in the industrial countries. Developing countries fell further and further behind their industrial country counterparts, and absolute poverty and the ills that accompany it remained high.

From the early 1990s, developing countries as a group began—for the first extended period—to grow more rapidly than the industrial countries as a group. This historic change has received considerable attention from economists focused on development and the global economy, but relatively little from agricultural economists. My purpose in this paper is to argue that this change is immensely important for economists interested in agriculture and is likely to have a strong influence—directly or indirectly—on the work that most agricultural economists do in the future.

Income growth in developing countries clearly has direct impacts on the issues of greatest interest to economic development: What is the impact on poor countries in terms of poverty, nutrition, productivity, marketing, price and trade policies, structural transformation, and the environment? Even for those agricultural economists not focused on development, however, there are important implications for outcomes such as global demand, supply and prices of agricultural products, environmental impacts, agricultural marketing, trade patterns, and policy.

1 This work was undertaken as part of, and funded by, the CGIAR Research Program on Policies, Institutions, and Markets (PIM) led by the International Food Policy Research Institute (IFPRI). PIM is in turn supported by the CGIAR fund donors. This paper has not gone through IFPRI’s standard peer-review procedure. The opinions expressed here belong to the author, and do not necessarily reflect those of PIM, IFPRI, or CGIAR.
This topic complements the themes raised in many recent IAAE Presidential Addresses. Joachim von Braun’s address (von Braun 2005) focused on inequality, which has been substantially reduced by the rise in incomes in many low-income countries. Prabhu Pingali’s address pointed to many of the impacts on agriculture and agricultural economics from globalization, which is strongly linked to today’s topic (Pingali 2007). David Colman focused on the terms of trade, which are likely influenced by rapid growth in developing countries (Colman 2010). Kei Otsuka’s address focused on the changes in farm structure necessitated by the rapid decline in agriculture’s share of the economy under rapid growth (Otsuka 2013). And Jo Swinnen’s address focused on the economics of standards, which become much more important as per capita incomes rise (Swinnen 2016).

If growth patterns in developing countries followed the simple model of productivity convergence outlined by Abramovitz (1986), then growth rates would be highest in the lowest-income countries and growth outcomes would be relatively predictable. In reality, growth patterns are much more complex, depending on policy choices in countries themselves, their neighbors, and their trade and investment partners. The next section of this paper therefore focuses on the patterns of growth in developed and developing countries. The third section focuses on the direct impacts of higher growth in developing countries for food demand and nutritional outcomes. The fourth section examines structural transformation and its potential effects on growth. The fifth section examines the impacts for agricultural price, marketing, and trade policies.

2 Economic growth and convergence

Economic theory makes it clear that poor countries might be expected to grow more rapidly than rich countries (Baumol 1986). If this is the case, then the relationship between initial income and the growth rate for country i may be written in logarithms as:

\[ \Delta \ln y_i = \alpha_i + \beta_i (\ln y_i^0 - \ln y^f) \]

where \( y^f \) is per capita income in the country at the production possibility frontier.

Equation (1) is used to define and test for \( \beta \) convergence. Equation (1) tests for unconditional convergence and may be extended to incorporate the effects of different rates of growth in capital and labor inputs (see Dowrick and Nguyen 1989). Another testable consequence of unconditional convergence is that the dispersion of income per capita should decline as the incomes of poorer countries rise. This is frequently examined using the standard deviation of the log of per capita income, \( \sigma \). A necessary, but not sufficient, condition for convergence is that the income of a lower-income group of countries should rise relative to the income of a higher income group. This can be examined even when there is insufficient information to formally test for \( \beta \) or \( \sigma \) convergence, as when we have observations at irregular intervals and/or on a changing set of countries.

The experience from the beginning of the Industrial Revolution was precisely the opposite of economic convergence. Except for a few countries that successfully adopted modern industrial technologies, most countries ended up with economies focused on production of commodities—particularly food, but frequently also industrial inputs such as cotton or wool. For the countries that successfully adopted modern technologies, there was a strong tendency for the initially-low-
income economies to grow rapidly and to converge on the income level of the higher-income economies (Baumol 1986, Dowrick and Nguyen 1989).

By contrast, the experience of most developing countries was characterized by “divergence big-time” (Pritchett 1997). Incomes of the countries characterized by Maddison (1983) as “advanced capitalist” (12 Western European countries 4 offshoots—Australia, Canada, New Zealand and the United States—and Japan) grew faster than the rest of the world, with the gap between their incomes more than doubling between 1870 and 1990. Figure 1, based on Maddison’s data (Maddison 2010), shows the extent of this divergence between the “advanced capitalist” countries and the rest of the world during the period of “divergence big-time”, between 1820 and 1990. While per capita incomes in developing countries grew at an average rate of 0.9 percent per year, per capita incomes in the high-income countries grew at 1.6 percent per year. This small difference in growth rates was enough to take the ratio of incomes between the two groups from 2:1 to 6:1 over this 170-year period (Figure 1).

![Bar Chart: Levels and growth in per capita income, 1820–1990](Image)

Source: Maddison (2010).

Figure 1. Levels and growth in per capita income, 1820–1990
A wide range of formal econometric tests reported in the 1980s, 1990s and early 2000s and using data up to 2000 led to the conclusion that there was no evidence of unconditional convergence in growth rates of per capita income (Acemoglu 2009). There was some evidence for conditional convergence within groups of countries linked by factors such as trade (Ben-David 1993) and regional proximity (Lim and McAleer 2004).

Why was it so difficult for developing countries to catch up? Many of these countries were colonized during much of the period, which may have been part of the problem. Clearly, colonization can have adverse effects on economic (and social) performance, particularly if the institutions created by the colonizers are extractive rather than inclusive (Acemoglu and Robinson 2012). Iyer (2010) points to local rulers having better information than colonists and a perceived lower likelihood of imposing extractive institutions that create uncertainty about property rights. She finds that the parts of British India administered by local rulers—and not directly by British colonists—during the colonial period had superior economic and social outcomes. A potentially important point raised by Lewis (1981) is that the agricultural research agencies in colonial countries tended to focus on raising productivity in cash crops, such as cotton, rubber, or sugar, rather than on raising the productivity of staple food crops.

The trade policies imposed by colonial authorities during the 19th century appear to have been quite different from the mercantilist policies widely used by colonizers in earlier periods to extract benefits from their colonies (see Irwin 1991 for an example). O’Rourke and Williamson (2002) found rapid price convergence in the 19th century between continents as transport costs fell, trade barriers were reduced, and trading monopolies disappeared. This period was also characterized by large investment flows from the core European countries, to neighboring countries and to colonies and former colonies, that appear to have been large enough to raise wages substantially in many recipient countries (O’Rourke 1999). Lewis (1954) argues that most of these investment flows went to countries with initially unused resources, rather than to African or Asian countries, although there was also substantial investment in railways and other infrastructure in India (Donaldson 2018) and parts of Africa.

Much thinking about development after World War II sought to use the agricultural sector to fund development of an import-substituting industrial sector. Growth in most cases was disappointingly slow and heavily dependent on exports of commodities. The faster growth of the core countries resulted in widespread use of a locomotive-and-caboose model in which growth in developing countries was seen to depend heavily on growth in the industrial countries creating demand for exports or stimulating growth through demand linkages (see, for example, Lewis 1981: 18, and World Bank, 1991). Johnston and Mellor (1961) emphasized the role of improving agricultural productivity to enable increases in exports and to finance industrial development. Schultz (1964) also highlighted the importance of agricultural productivity growth, arguing that farmers were “poor but efficient” and that agriculture could not be taxed without reducing its output. Krueger sought to document the extent of agricultural taxation (Krueger, Schiff and Valdés 1988) and emphasized the importance of an open orientation with a view to expanding developing countries’ exports of manufactures (Krueger 1997).

Baldwin (2016) argues that innovations in information technology and communications around 1990 fundamentally changed the opportunities for developing countries by allowing
production processes to be distributed spatially. Prior to the 1990s, many links in the production chain needed to be geographically close together to allow the production process to continue without interruption. With widespread availability of instant electronic communication, it became much less challenging to distribute stages of the production process across countries so that, for instance, labor-intensive stages of production could be undertaken in low-wage countries and skill-intensive stages in skill-abundant countries. This means that, instead of needing to master the full set of stages involved in an industry, countries can focus on the stages that fit their endowments of labor, capital and knowledge. Given the considerable challenges involved in adapting technologies to a new country (Hausmann and Rodrik 2003), this makes it much easier to develop new manufacturing activities, particularly since firms outsourcing production have a strong incentive to provide the know-how needed for successful production.

Gollin, Hansen and Wingender (2018) point to another potentially important contributor to the recent growth takeoff in developing countries—the development and adoption of high-yielding varieties (HYVs) of key agricultural crops. To avoid potential problems of reverse causality—where higher growth contributes to adoption of HYVs—they predict adoption based on agroecological potential. Their results point to a potentially large impact on growth in developing countries in the 1960 to 2000 period. They conclude that this impact is likely to have been much larger in East Asia, South Asia, and Latin America than in Sub-Saharan Africa. In these regions, the development of improved varieties for key staples such as cassava took place much later and greater agroecological diversity makes it much more difficult to develop the range of varieties needed for a productivity takeoff (Otsuka and Larson 2012). It seems likely that there is an interaction between this explanation and the Baldwin hypothesis focused on manufactures—an increase in agricultural productivity potentially frees up labor for use in other sectors.

The shift in the location of global manufactures in recent years has been astoundingly rapid. Over the 1993 to 2016 period, UN national accounts data suggest that the value of manufactured output in Maddison’s advanced countries rose by 1.7 percent per year in current dollars, or roughly the rate of inflation. Given rapid growth in the value of manufactures output in the rest of the world, the share of Maddison’s advanced countries in the value of global manufactures output fell by 30 percentage points, from 75 percent to 45 percent. China’s share of world manufactures output rose by 21 percent, with other developing countries accounting for the remaining 9 percentage points. Given Rodrik’s (2013) finding that productivity growth in manufacturing exhibits unconditional convergence, this increase in the share of manufactures could have an important impact on the rate of convergence in income levels.

Since 1990, the share of the traditional industrial countries in global GDP has fallen sharply, with rapid growth in many developing countries, and particularly high growth rates in China and India. Prior to 2000, this development did not appear to involve unconditional convergence, with lower-income countries generally growing more rapidly than higher-income countries in proportion to the gap between their incomes and that of the highest-income country. Comparing the growth performance of developing countries as a group with that of Maddison’s advanced capitalist countries, however, the change in the 1990s was particularly striking. Figure 2 uses the Lowess regression (Cleveland et al 1992) to smooth the growth rates of per capita incomes in the traditional high-income countries and the rest of the world since 1951. Between 1951 and 1993, the per capita growth rate of the high-income countries was generally higher than
that of the developing countries. Only from 1994 did a substantial gap open in the other direction, with smoothed growth of the developing countries averaging 3.5 percent per year, more than 2 percentage points above the high-income countries.

The pattern of growth underlying Figure 2 is not consistent with unconditional convergence. Growth rates since 1992 have been particularly fast in China and India, and slower in some of the poorest countries, including many in Sub-Saharan Africa. The growth rates of per capita income are shown for each of the World Bank’s regions in Figure 3, with China and India separated from the East Asia and South Asia regions whose growth outcomes they would otherwise dominate. Figure 3 makes clear how strong the performance of China and India has been. Average incomes in China, on a PPP basis, rose from 6.3 percent of those in the World Bank’s high-income category in 1992 to 35 percent in 2017. In India, the increase was from 6 to 15 percent. The performance of the other developing economies of East Asia was also far above the average for the high-income countries, while other South Asian countries and Europe and Central Asia also outperformed the high-income countries. By contrast with the period of divergence, the developing countries of Latin America and Sub-Saharan Africa had growth rates in line with, rather than substantially below, the high-income countries. Diao, McMillan and Rodrik (2019) note the high average growth rates of developing countries, but point to differences in the driving forces, with rapid within-sectoral productivity growth in Latin America and growth-increasing structural change in Africa.

Source: Data on per capita income in PPP from the Maddison database to 2008 and World Development Indicators (accessed 29 October 2019) from 2009 to 2018.
Note: Smoothed using the Lowess Regression model with span 0.33.

Figure 2. Smoothed growth rates of high-income and developing countries, 1951–2017
The much more rapid growth in the largest economies has major implications for the welfare of individuals compared to a simple pattern of convergence. It is one of the reasons that the recent surge in growth in developing economies has had such a powerful impact on poverty and health outcomes (Deaton 2013). The bubble chart presented in Figure 4, in which the area of the bubbles represents the population of each country, clearly shows the tendency for lower-income countries to have higher growth rates.

Source: World Development Indicators, World Bank.

Figure 3. Annual GDP per capita growth rates by region and key country, 1992–2017.

Figure 4. Convergence bubble charts, per capita GDP growth 1993–2017.

Source: World Development Indicators, World Bank.
A key question for applied economists is whether the tendency towards higher growth in developing countries will continue, and if so, to what extent. Projections from the carefully constructed and reviewed *World Economic Outlook* (IMF 2018) suggest that such outperformance can be expected to continue, with a recovery from the narrowing of the gap evident in Figure 2 and continued higher growth in Asia to 2023 (Figure 5). Only in Sub-Saharan Africa do these projections point to lower growth than in the high-income countries.

Some more recent evidence is more supportive of the unconditional convergence hypothesis than earlier evidence. Fukase and Martin (2017) find evidence of relatively weak and slow unconditional convergence in the 2000–2009 period, but not in earlier periods. Analysis for this paper finds a reduction in the standard deviation of income levels in the 2000–2017 period, consistent with σ convergence. Korotayev et al. (2011) find evidence of unconditional convergence among larger economies between 1998 and 2008. One possibility is that the reforms have proceeded sufficiently far in developing countries that something close to unconditional convergence—perhaps at a relatively slow rate—will be a feature of future economic growth. That scenario is called into question, however, by the uncertainty about market access created by the United States’ recent move away from its traditional support for relatively open trade.

Clearly, the outlook for growth remains highly uncertain, particularly over the longer-term horizons relevant for sustained economic development. Will the astounding economic performance of developing countries, and the associated rapid reduction in poverty, continue or will it be brought down by political factors such as attempts to fracture global value chains (Blustein 2019), or pressures resulting from the move of labor-intensive exports from China to the next wave of developing country exporters.

Whatever the actual outcomes, much forecasting work on agriculture is based on growth projections that build in assumptions that are likely to have important implications for their results. Fukase and Martin (2017) found that the widely-used IIASA (International Institute for Applied Systems Analysis) SSP projections for economic growth include a historically strong tendency towards unconditional convergence—a feature that does not seem to have received much discussion either in the general economic literature or among agricultural economists. The remainder of this paper aims to identify some of the key ways in which changes in growth rates between rich and poor countries matter for agricultural economists, as a basis for gathering information and formulating research agendas.
3 Implications for food demand

One of the strongest empirical findings in economics, Engel’s Law, is that the income elasticity of demand for food is less than one and hence, other things being equal, the share of income spent on food will decline as incomes rise. Another important characterization of food demand is Bennett’s Law, which holds that the composition of food demand shifts away from starchy staples as incomes rise, with increasing demand for fruits, vegetables, vegetable oils, and livestock products. The shift in demand towards livestock products has important implications for the resource demands on agriculture because of the much greater per-unit costs of producing livestock products. For ruminant meats in particular, these costs are large not just because of the low efficiency of converting feed into meat, but also because of the large breeding inventory requirements.

The shift of demand into livestock products has frequently been identified as a potential cause of food price rises and of food shortages. Yotopoulos (1985) identified it as a possible cause of the 1973/74 food price rise. Brown (1995) raised the specter of global food shortages as China’s consumers moved to livestock products. And this shift in developing countries more broadly was widely identified as a contributing factor to the high food prices between 2008 and 2011 (e.g., Rayner et al. 2011), although later analysis pointed to the unanticipated increase in demand for food as feedstock for biofuels (Wright 2014).

This shift in demand towards livestock products is widely agreed to be an important influence on the overall demand for agricultural output. But it is difficult to analyze because of the complex nature of Engel curves for individual food products (Gouel and Guimbard 2017) and challenges in projecting intermediate use of feedstuffs under economic growth. One problem in using computable general equilibrium models is that any intermediate use of food products tends to grow relative to food demand because of the default assumption in such models that inputs are used in fixed proportion to gross output.
Recent studies by Tilman et al. (2011) and Fukase and Martin (2016, 2017) have responded to the challenges of structural modeling in this context by directly estimating the total demand for calories (including those consumed directly and those used as inputs into increasingly diverse diets) as a function of household real incomes. These studies highlight the fact that the demand for total calories continues to grow over a much wider range of incomes than the direct demand for calories. While the specific functional forms used differ, both are concave in real income. This means that the impact of income growth on demand is greater if incomes grow in poor countries than in rich countries. The sharp divergence between the demand for total calories (“original” calories in the terminology of Johnson, 1991) and the net calories actually received by consumers from the food they eat is shown in Figure 6. This divergence raises important questions about whether it makes sense to aggregate food demand, as is conventionally done, in terms of food calories consumed.

![Graph showing the relationship between GDP per capita and total calorie consumption.](image)

Source: Fukase and Martin (2016)

Figure 6. Total calories vs. net calories received by consumers as a function of income

Both Tilman et al (2011) and Fukase and Martin (2017) project food demand to 2050 under scenarios where income growth rates tend to decline as per capita incomes increase. Like most projections of food demand, both studies project much larger increases in food demand measured in terms of the total calorie output needed to produce food, compared to the traditional measures that focus on the calorie yield of foods consumed—a difference to be expected given the
fundamental differences in the measures used. Fukase and Martin (2017) find that the mild economic convergence implicit in the widely used IIASA scenario underlying their projections adds about one-third to the growth in per capita food demand relative to a scenario under which all countries’ per capita income grows at the same rate. This effect could be even bigger under scenarios involving more rapid income convergence, although they find that the income elasticity of demand is larger in lower-middle-income countries, where the shift to livestock products is proceeding more rapidly than in the poorest countries. Clearly, this means that projections of food demand need to take careful account of differences in expected rates of economic growth across countries. The importance of these income-induced changes in per capita consumption are likely to be much more important than population growth in the future—primarily because of the sharp slowing of global population growth projected by the United Nations over the next 30 years. How this strong increase in demand affects prices depends largely on the supply response, to which we turn in the next section.

The substantial growth in average per capita incomes in developing countries since the 1990s has contributed to considerable dietary diversification for many households, although too many remain mired in extreme poverty. The introduction of more fruits and vegetables, and of some animal-sourced foods such as dairy products for young children, has had extremely positive nutritional impacts (Headey, Hirvonen and Hoddinott 2018). Dietary changes involving excessive consumption of calories and ingredients such as salt, sugar and fat have resulted in serious problems of obesity and noncommunicable diseases such as diabetes. The co-existence of these problems with the traditional challenges of undernutrition has given rise to a new research agenda focused on the so-called double burden of malnutrition (WHO 2017).

4 Agricultural production

Given the substantial potential impact of income convergence on food demand, a key question is whether food supply will be able to meet that increase in demand. While many traditional partial equilibrium models of food demand and supply took national income as exogenous, this seems a surprisingly narrow approach. Most changes in per capita income—and particularly sustained changes in income—are the result of changes in productivity. To the extent that changes in productivity result from policy changes, it seems likely that these changes would increase productivity in agriculture as well as in other sectors. If, for instance, growth was previously inhibited by an exchange rate or trade policy that restricted access to intermediate inputs, then liberalization of those restrictions seems likely to promote output in agriculture as well as the rest of the economy.

This does not mean that agricultural output would increase in proportion with total output. Given that agriculture has a fixed factor, land, even uniform productivity growth is likely to result in lower growth in agricultural output than in the rest of the economy. This is clear in even a simple model of the economy. In an open economy, an increase in the productivity of labor in all sectors raises the effective labor input relative to land and tends to lower the marginal productivity of labor in agriculture relative to sectors in which there is no fixed factor. This results in pressure to reallocate labor away from agriculture. In a closed economy, the lower income elasticities of demand will have the same effect through a different channel, by lowering the price of agricultural products. High rates of saving in developing economies may result in a different channel of effect,
where an increase in the capital stock shifts resources away from labor-intensive traditional agriculture towards more capital-intensive manufacturing activities (Martin and Warr 1993). Whatever the channel of effect, a decline in the share of agriculture in output as economies grow is one of the most robust empirical findings in economics.

While the demand for agricultural products is, for reasons considered in the previous section, concave in income, there seems no reason to expect the supply function to be similarly concave. Consistent with this, Fukase and Martin (2016) estimated a simple agricultural supply function that was much closer to linear than the demand curve. This combination means that countries like China, whose per capita land endowment is somewhat below the average, are likely to be essentially self-sufficient in agricultural products, go through a phase in which demand exceeds supply, and potentially return closer to self-sufficiency at high per capita income levels where food demand becomes essentially unresponsive to income increases. Countries with far-above-average land endowments, like Argentina and Brazil, are likely to remain food exporters at all levels of development, and extremely land-scarce countries, like Japan and the Republic of Korea, are likely to remain importers at all stages.

If the elasticity of agricultural supply is broadly similar to the average demand elasticity relevant under a particular growth scenario, then that scenario is unlikely to have strong impacts on the global balance between demand and supply. Since both the aggregate income elasticity of demand and of supply consist of value-share weighted elasticities across countries, both the elasticities at national level and the expenditure- and income-share weights are relevant to the outcome. Because of the importance of agriculture in developing country production and spending, the national shares in global agricultural production and expenditure on food are likely to be higher in developing countries than their GDP shares.

Taking both the shares and estimated elasticities in all countries into account, Fukase and Martin (2017) found that more rapid growth in poor countries resulting from convergence had surprisingly modest impacts on global food prices. This provides an answer to a question posed by Yotopoulos (1985) as to whether dietary changes in developing countries could be expected to contribute to food price crises; however, this is an area where more research is needed to obtain better estimates of the impact.

4.1 Agricultural R&D

Another potentially important channel of effect between income growth in developing countries and the supply of food is the investments made by developing countries in agricultural research and development (R&D) to increase agricultural productivity. Pardey et al. (2018) show that spending on public agricultural R&D has increased sharply in key middle-income countries, particularly Brazil, China and India, with China now the largest investor in public agricultural R&D, India the third largest, and Brazil ranked fourth. Unfortunately, this growth in spending has not been mirrored in the world’s low-income countries, home to over a quarter of the world’s poor. While the absolute amounts invested in R&D in the Asia-Pacific region are enormous, they remain quite small as a share of agricultural GDP, at 0.4 percent. Pardey et al. show that only 2.9 percent of global R&D is undertaken by these countries, despite the large potential poverty-reducing impact of improvements in agricultural productivity in these agriculture-intensive countries.
(Ivanic and Martin 2018). Laborde et al (2019) estimate that the public R&D provided by the CGIAR system reduced global poverty by around 70 million since 1971.

Pardey et al. (2018) also report estimates of the returns on investment from agricultural R&D based on almost 500 studies. Key estimates from their survey are presented by region in Table 1, where the first column refers to the number of estimates of the internal rate of return (IRR) considered, the second indicates the number of studies from which they were drawn, the third shows the average estimated IRR, and the fourth shows the median. If we focus on the median to reduce the risk of undue influence from outliers, we see that the estimated IRRs are 30 percent or higher—astoundingly high rates of return. The final column presents results from a trimmed sample excluding those studies with estimated IRRs above 60 percent, findings which the authors felt strained credibility. With this trimming, the mean and median estimates were similar in order of magnitude, at around 30 percent in virtually all cases.

These extremely high rates of return are consistent with developing country R&D investments having a substantial impact on agricultural output, even though the research intensity remains relatively low. It is well within the range of possibility that this research intensity could result in a 40 percent increase in output. This, in turn, would more than outweigh the impact of the increase in demand for food resulting from income growth.

Table 1
Internal rates of return to investments in agricultural R&D

|                | Estimates | Studies | Mean % | Median % | Trimmed Mean % |
|----------------|-----------|---------|--------|----------|----------------|
| **United States** | 986       | 80      | 63.0   | 31.8     | 28.0           |
| **Other developed** | 409       | 81      | 72.9   | 49.3     | 31.5           |
| **Asia Pacific**   | 332       | 61      | 76.6   | 52.0     | 36.7           |
| **Latin America**   | 407       | 120     | 45.2   | 39.3     | 33.1           |
| **Sub-Saharan Africa** | 300       | 83      | 42.0   | 35.0     | 26.0           |
| **Multinational**  | 134       | 40      | 46.0   | 34.0     | 30.9           |
| **Global**         | 59        | 19      | 34.5   | 30.3     | 29.2           |

Source: Pardey et al. (2018), pp. 28–29.

4.2 Rural infrastructure

Economic growth can be expected to allow improvements in infrastructure, and particularly rural infrastructure, that can have important impacts on agricultural production. These effects are challenging to estimate because economic growth facilitates investment both by stimulating demand and potentially by reducing financing constraints and because infrastructure can promote economic growth (Aschauer 1989). Transportation infrastructure is particularly important for agriculture because of agriculture’s geographically dispersed nature. Because government coordination—and sometimes management—are involved, it is important to have ways to identify the benefits and costs of specific transport investments.

Improved transport infrastructure between farms and urban centers potentially raises the returns available to farmers for their output and reduces the prices they pay for both production inputs and consumer goods. It may, in addition, allow them to change the products they produce.
and—by moving from subsistence to market orientation—to increase their real incomes. Another important potential advantage of improved transport infrastructure is associated with the volatility of agricultural output. Allowing food to be imported in poor seasons reduces the risk of food insecurity, while allowing products to be exported in good seasons can help avoid excessively low returns to producers.

New research allows much better estimation of the benefits of transport infrastructure, and particularly its implications for agriculture. These models use advances in estimation of gravity models to take into account the impacts of improved infrastructure on transport costs, and sidestepping the problems of reverse causality that plagued earlier work evaluating the economic impacts of infrastructure investments. Donaldson (2018) used this approach to evaluate the impacts of the railway network in British colonial India and concluded that the gains from increases in agricultural income were around 16 percent, substantially more than estimated using earlier approaches to infrastructure evaluation. Costinot and Donaldson (2016) used a similar approach, with more details on differences in productivity of different crops in finely defined agroecological zones, to assess the impacts of improvements in transportation infrastructure on agricultural incomes in the United States. They conclude that the income gains from lower transport costs were comparable in magnitude to the enormous productivity gains experienced over the 1880 to 1997 period.

While it is important for future work to directly take into account the potential problems of reverse causality in estimating the impacts of infrastructure, the work of Zhang and Fan (2004) suggests that the resulting bias may be relatively small and certainly much smaller than the downward bias created by first differencing, one of the proposed solutions to the problem. The resulting benefit cost ratios for rural roads are in the order of 8 to 20, for education 5 to 15 and for irrigation investment 4 to 8 (e.g. Fan, Gulati and Thorat, 2008). If we accept these results, then the massive investments in infrastructure by developing country governments in recent years would have contributed substantially to the boom in economic growth that is of central interest to this paper.

Burgess and Donaldson (2010) analyze the impact on food security of connecting a location to the Indian railway network. Prior to connection to the rail network, they found that the risk of famine in a district was strongly related to local rainfall. After connection to the network, the risk of famine was no longer significantly related to rainfall. Burgess and Donaldson (2012) conclude that famines essentially disappeared after regions of India were linked to the rail network, and that this resulted in a substantial drop in death rates. This empirical research provides a resoundingly clear answer to an important question on which theory alone provides no guidance—will opening to trade increase food security?

4.3 Yields and productivity

A very simple, crude indicator of the rate at which productivity has increased in developing countries relative to developed countries is given by the value of output at international prices per hectare. This measure accounts for both changes in productivity, such as those resulting from improved varieties that raise yields, and changes that raise output value at world prices, including the effects of moving to intensive livestock operations.
The ratio of output per hectare of agricultural land in developing countries to developed countries is shown in Figure 7. Output per hectare in developing countries was only around half that of the rich countries in 1960, but rose to over 90 percent by 2012 before falling back slightly. This ratio appears to have risen in three stages: gradually from 1962 to 1983 (0.52 percent per year), more rapidly to 2003 (1.4 percent per year), and then very rapidly to 2012 (2.2 percent per year), before declining in the final three years, in response to more rapid growth in the high-income countries. The first two phases of growth may reflect the impact of high-yielding varieties and the third phase a combination of continuing adoption and the growth surge in developing countries.

Source: FAOSTAT.

Note: Measured as the value of output at constant international dollars per hectare of agricultural land.

Figure 7. Ratio of yields in developing countries to rich countries, 1961–2015
4.4 Structural transformation

A key feature of rapid economic growth is movement of labor out of agriculture and into other sectors of the economy. Frequently, this economic transformation is associated with sharp gaps between incomes in agriculture and other sectors—gaps that may be associated with resistance to mobility or to differences in the endowments of workers in agriculture and in the rest of the economy. It is widely believed that these gaps are caused, or at least exacerbated, by resistance to mobility, such as unwillingness to move out of a familiar community environment or the result of errors such as investing in agriculture-specific skills when subsequent labor market developments necessitate a move out of agriculture (Johnson 1991). However, there is considerable debate about whether there are still unexplained gaps between rural and urban incomes that create potential for income gains when labor moves from agriculture to non-agriculture (Gollin, Lagakos and Waugh 2013) or due to differences in skills and human capital (Young 2013).

Rapid structural transformation has occurred in many regions, with both the share of income derived from agriculture and the labor share of agriculture declining rapidly, particularly in Asia (Vos 2019). The decline in agriculture’s employment share is shown in Figure 8 for each of the World Bank developing-country regions and for China, given China’s outsized growth performance in recent years. What is clear from this chart is the rapidity of this change in East Asia, and particularly in China, where the labor share was around 55 percent in 1991 and fell, on average, by more than 1 percent of the labor force each year between 1991 and 2017. The agricultural employment share also fell quite sharply in South Asia, with almost a 20-percentage-point decline over the period. In the other regions, the decline was generally of 10 percentage points or less, a rate of decline that would still have been regarded as very fast in today’s industrial countries, where the decline in agriculture’s share of employment took place more gradually, but was still perceived to create major adjustment pressures (Johnson 1991).
An important question for economic welfare, and for policy, is whether the countries experiencing rapid declines in agricultural employment are also ones in which value added per worker remains low, or is even declining, relative to returns in other sectors. This is a concern given the rapid rate of adjustment out of agriculture, the barriers to mobility out of agriculture in many countries resulting from land-tenure rigidities or limitations on residence rights in urban areas, and the concerns expressed by Otsuka (2013) about continuing farm fragmentation in Asia. If these barriers to exit are sufficiently large, then we might expect to see a substantial decline in value added per worker in agriculture relative to non-agriculture during the period of rapid migration of labor out of agriculture.

Figure 9 reveals considerable complexity in the behavior of labor productivity in agriculture versus non-agriculture. In East Asia and in China in particular, agricultural labor productivity has risen rapidly relative to non-agriculture despite—or perhaps because of—very high rates of out-migration from agriculture. In China, this ratio almost doubled, from 23.4 in 1991 to 40.5 in 2017. In Europe and Central Asia, by contrast, agricultural returns dropped precipitately relative to non-agricultural returns as the support associated with planning systems was withdrawn.
In South Asia, agricultural productivity fell slightly over the period. In the Middle East and North Africa (MENA) and Latin America and the Caribbean (LAC), there was something of a U-shaped pattern, with relative productivity falling in the first half of the period and then rising to a level slightly higher than at the beginning. Relative productivity remained lowest in Sub-Saharan Africa throughout, with a slight, fragile overall increase.

Source: Data on the agricultural share of GDP and of employment, World Development Indicators, accessed 28 June 2018.

Figure 9. Ratio of value added per worker in agriculture to non-agriculture, percent
Whether the lower returns to workers in agriculture are due to slow adjustment out of agriculture or to differences in skills, a pressing challenge is to improve the educational opportunities for children in rural areas. Here, there has been substantial progress in some countries, but next to none in others. If we focus on completion of the lower secondary school, Figure 10 shows that these completion rates are now over 70 percent in China, India and Kenya, close to 70 percent in Indonesia, and around 40 percent in Ghana, Nigeria and Pakistan. Completion rates have increased sharply since the early 1990s in key countries including Bangladesh, India, Indonesia and, from very low levels, in Senegal and Tanzania. Worryingly, completion rates have barely increased at all in Ghana or Nigeria.

Source: UNESCO (2018), accessed 18 July 2018.

Figure 10. Completion rates for lower secondary school, ages 15–24 in rural areas, percent

4.5 Agricultural growth and emissions

Agriculture is an important contributor to greenhouse gas emissions—accounting for up to 30 percent of total emissions (Tubiello et al. 2013)—and extremely vulnerable to global warming. Agricultural growth driven by rising per capita income and dominated by increases in demand for livestock products is likely to have quite different environmental impacts than growth driven by population growth—the type of growth that predominated in the past. Further growth in livestock and fish production cannot be obtained from pasture or from traditional capture fisheries and must rely on livestock fed on crops or on farmed fish. The impacts of this growth on emissions of greenhouse gases will differ depending upon the type of livestock involved and will be greater for intensively-fed cattle than for pigs, poultry, or farmed fish (Fukase and Martin 2016). Godfray (2011) highlights the importance of consumer decisions on the quantity of livestock products they consume and whether, for example, they consume red or white meats.
Tilman et al. (2011) quantify the emissions associated with different paths to meeting demand for food in 2050 under different scenarios for technological advance and land-use intensity. They show that outcomes depend heavily on the rate of technological advance in countries at the frontier of technology and the rate at which other countries converge towards the frontier. Given those technological changes, they show there are important tradeoffs, for instance between greater use of nitrogen fertilizer and land clearing, which has severe implications for greenhouse gas emissions.

Excellent summaries of the emissions associated with agriculture, forestry and land use are provided by Tubiello et al. (2013) and Smith et al. (2014), with detailed estimates by country and mode of emission provided in FAOSTAT (www.fao.org). These studies highlight the importance of livestock production in driving environmental impacts and identify the emissions associated with enteric fermentation\(^2\) and agricultural soils\(^3\)—some of which are directly linked to livestock production—as the most important sources of emissions from agriculture. Figure 11.a shows the contributions of the three main components of agricultural emissions to total emissions. This figure shows both the substantial growth in agricultural emissions since 1990, and the increase in the importance of emissions associated with agricultural soil management relative to other sources of emissions.

![Figure 11](source.png)

Source: FAOSTAT [http://www.fao.org/faostat/en/#data](http://www.fao.org/faostat/en/#data)

Figure 11 Agricultural and land-use emissions, million metric tons of CO\(_2\) equivalent

\(^2\) Particularly associated with emissions arising from ruminant digestive processes.

\(^3\) Including emissions from crop residues, manure applied to soils, manure left on pasture, cultivated organic soils, and synthetic fertilizers (Smith et al p820).
Emissions from net deforestation were greater than those directly from agriculture in 1995 and 2000 but have since fallen to around three-quarters as large in 2005 and 2010. This structure of emissions suggests that the impact of land-use change on emissions is likely to be very important. Figure 11.1b illustrates the levels of emissions associated with agriculture and with net land-use change and highlights the substantial importance of emissions associated with land-use change relative to agriculture. It also shows the increasing importance of agricultural emissions relative to land-use change over the period since 1990. While land-use change emissions have been declining relative to agricultural emissions, they still accounted for 37 percent of total agriculture and land-use change emissions in 2015.

5 Agricultural marketing and trade

This section covers three major issues. The first is the changes in marketing channels for food associated with the rise of supermarkets in developing countries. The second is the change in international trade patterns associated with developing country growth. The third is changes—and needed changes—in international agricultural trade policies.

5.1 The supermarket revolution

Perhaps the most dramatic change to food marketing in developing countries in recent years has been the shift from traditional marketing channels to supermarkets. Reardon, Timmer and Minten (2012) pointed to the dramatic growth of supermarkets since 1990. They identified a first wave of this process in Latin America, Central Europe, and South Africa that took the share of food sold through supermarkets from under 5 percent to over 50 percent by the mid-2000s. A second wave of growth in supermarket sales that started in the mid-1990s in Southeast Asia, Central America, and Mexico took retail shares to 30–50 percent by the mid-2000s. The third wave, in China, Vietnam, India and Russia, began in the late 1990s. Barrett, Riordan, Swinnen and Zilberman (2019) provide a detailed analysis of the changes in marketing chains for food and their economic implications.

This change in marketing channels is associated with changes in marketing technologies, growth in per capita income, and the income-related increase in urbanization. While the shift began in higher-income parts of the developing world, it appears to have moved to high-growth economies such as China at a relatively early stage of economic development. Clearly, the changes in marketing related to growth in per capita income will need more attention from agricultural economists in the future.

5.2 Changes in agricultural trade patterns

The much more rapid growth of developing countries since the early 1990s has also influenced the relative importance of developed and developing countries and the direction of trade. To look at these changes, we begin in 1993 in order to exclude the immediate effects of the breakup of the Soviet Union. Table 2 shows that, in 1993, the WTO Developed countries accounted for 61 percent of global agricultural imports and trade within this group of countries accounted for 32 percent of total agricultural trade. By 2016, the imports of the WTO Developed countries had fallen to 40 percent of global trade and trade among these countries to 14 percent of the total. The intra-
developed-country trade that was the focus for most earlier debates at the WTO on agricultural trade—such as the US-EU debates on agricultural trade and US-Japan debates on market access for beef and citrus—is now a vanishingly small part of global agricultural trade. Only for the 14 percent of trade involving both WTO Developed countries as importers and as exporters do the full set of Uruguay Round disciplines apply. Clearly, any new initiative for global agricultural trade reform will need to find a new focus. Business as usual is not an option.

Table 2
Direction of agricultural trade, percent

|         | Exports | Imports |
|---------|---------|---------|
|         | Developed | Developing | Total |
| 1993    |          |          |       |
| Developed | 32       | 24       | 56    |
| Developing | 29      | 15       | 44    |
| Total    | 61       | 39       | 100   |
| 2016    |          |          |       |
| Developed | 14       | 28       | 42    |
| Developing | 26      | 32       | 58    |
| Total    | 40       | 60       | 100   |

Note: Excludes intra-EU trade. WTO definition of agricultural trade. Source: UN COMTRADE obtained through www.wits.worldbank.org. Accessed 5 July 2018.

5.3 Agricultural trade policies

By the 1950s, there was a sharp distinction between the policies of the industrial and developing countries. Most rich countries protected their agricultural sectors, although this was more difficult for exporters than for importers. They often used administered prices, backed by storage and variable trade barriers, to stabilize their markets while transferring volatility onto world markets. Developing countries typically taxed agriculture to keep food prices down and to raise revenues. Many colonies and newly independent countries focused on food availability and used export bans or state imports to ensure availability. The agricultural policies of the developed countries enjoyed so much support in the 1950s that the disciplines against the use of quantitative restrictions were eliminated in 1955 at the request of the United States (Zietz and Valdés 1988).

As protection in the rich countries rose, the costs of these policies became larger and more apparent, both in terms of the high average level of cost and the volatility they generated. Policy choices in the European Community resulted in seemingly ever-increasing protection, including import restrictions on key inputs such as feed grains, that became very distortionary. Protection on rice in Japan rose to astronomical levels and similar distortions emerged in the newly industrializing economies of Korea and Taiwan, China. D. Gale Johnson’s study of “Agriculture in Disarray” clarified the costs of these distortions and the need for reform (Johnson 1991).
The Uruguay Round (1986–1994) began to deal with the acute collective action problems resulting from industrial country agricultural distortions. Disciplines were reintroduced on quantitative restrictions, all tariffs became subject to tariff bindings, variable levies were banned, and disciplines were introduced on domestic and export subsidies. While the tariff bindings were frequently excessively high (Hathaway and Ingco 1996), they created an incentive for countries to reduce the extent of their market-distorting support. Developing countries were allowed to set their tariff bindings at very high “ceiling” levels without regard to previous levels of support, leaving most developing countries with considerable discretion in setting their agricultural trade policies. The Doha Agenda negotiations sought to further constrain industrial country protection and to introduce some tighter disciplines on developing country policies (Martin and Mattoo 2011). These negotiations failed, but one important element—a ban on export subsidies—was agreed at the Nairobi Ministerial Conference of the WTO in 2015.

Since the 1990s, developing country incomes have risen sharply, as we have seen. Many measures, such as agricultural export taxes, have been abolished or reduced, while many countries have introduced or extended protection to agriculture and the average rate of protection has risen from negative to modestly positive levels (Figure 12). As an economist, it is appealing to think that the move away from agricultural taxation was a consequence of the transparency introduced by the documentation of the extent and impact of these measures (Krueger, Schiff and Valdés 1988). However, political-economy factors, as identified by Anderson (1995), are likely also important.

To summarize these political-economy factors, in poor countries, there are large numbers of farmers, who are widely dispersed and difficult to organize. Because these farmers produce much of their output for subsistence, their real incomes are less affected by price changes than the incomes of commercial farmers. By contrast, consumers in very poor countries spend a large share of income on food and are relatively easy to mobilize politically should prices rise. As incomes rise, all these conditions change in ways that increase the lobbying power of the farm sector: The number of farmers declines, making them easier to organize, while the number of urban consumers rises. Farmers increase the share of their output sold and increase their use of purchased inputs, increasing the impact of price changes on their net returns. Urban consumers diversify their spending away from food, making them less vulnerable to higher food prices.

Figure 12 shows nominal rates of protection to agriculture from border measures in both high-income and developing countries. In the high-income countries, agricultural protection was rising consistently from the 1950s to the late 1980s, but extremely volatile around that trend as policy makers responded to low prices by raising border levies and restricting exports—thereby increasing the volatility of world prices. In developing countries, protection was invariably negative until the early 1990s, but since then has trended upwards. The world price spike of 1973/74 was matched (and was exacerbated) by massive reductions in protection in both developed and developing countries. The 2008 price spike was matched by a decline in protection in developing countries, but not in the (post-reform) industrial countries.
Sources: 1955–2004, Anderson (2009); 2005–2014, Ag Incentives Consortium, [www.ag-incentives.org](http://www.ag-incentives.org).

Figure 12. Nominal rates of protection in high-income and developing country agriculture, percent
5.4 Agricultural trade policy choices for developing countries

A key question is whether continuing income growth in developing countries will take agriculture back into the disarray it experienced in the 1970s, 80s and 90s. Notably, the growth in trade resulting from income growth will generally not be in the core staples, about which developing-country policy makers tend to be extremely sensitive. Per capita consumption of staples falls under rapid growth, as consumers diversify into fruits, vegetables, vegetable oils, and livestock products (see Fukase and Martin 2016), and rapid trade growth is likely to occur in livestock products or feed grains and oilseeds—as in the case of trade between Latin America and Japan.

Even for nonstrategic products, policy makers often adopt policies such as price supports that require variable tariffs like the now-outlawed variable import levies. China tried using price supports for maize between 2007 and 2014 but found this unsustainable, given its tariff binding of 65 percent for maize and lower commitments on substitute products such as 2 percent for grain sorghum. In 2014, China moved to a deficiency payment system to support its corn producers. Protection of this type is frequently justified as needed to raise farm returns relative to nonfarm returns (e.g., Ruan 2017). However, a striking feature of the relative returns to labor in agriculture versus non-agriculture is that, in industrial economies like Japan and the European Union where trade policies have been used to support farm returns over long periods, returns to labor in agriculture are much lower than in countries with lower agricultural protection—a point raised by Johnson (1991) and still just as relevant today.

How agricultural trade policies in today’s developing countries evolve will depend heavily on how policies for nonstaple foods are designed within countries. Some useful general principles for agricultural trade policy designed to serve the interests of individual countries include:

(i) Open trade policy allows countries both to increase real income and to reduce volatility by diversifying sources of supply.
(ii) Quantitative restrictions create unpredictable levels of protection and increase volatility.
(iii) To the extent tariffs are used, the costs are lower if they are low and uniform.
(iv) Externalities and market failures are best dealt with using measures targeted to the problem.

While most economists would accept the income-raising potential of an open trade regime, the claim that it would reduce volatility may seem surprising, given the frequent narrative in which trade is seen as a source of shocks. But the underlying argument is extremely simple. Most of the volatility in commodity markets arises from shocks to production, such as those resulting from weather shocks. The volatility of production in a single country or region is almost always greater than the volatility of production in a broader area, especially when the broader area is the rest of the world. This proposition receives powerful support from Burgess and Donaldson (2010, 2012), who show that lowering transport costs dramatically reduced the incidence of famine in India. Negi and Ramaswami (2018) show that the standard deviation of global rice production is one-eighth of the average of production volatility at the national level, but that only a small share of the potential reduction in consumption volatility is achieved under current policies, despite extensive use of costly storage interventions.
Many countries appear to base food policies on estimates of food availability. As Sen (1981) pointed out, this typically results in outcomes that either do not contribute to food security or which actually increase food insecurity. Chapoto and Jayne (2009) conclude that countries using discretionary policies of this type have more volatile domestic prices than countries using more predictable policies. A reiteration of Sen’s point about the dangers of relying on food availability assessments is provided by a recent World Bank study of Zambia’s response to the 2015/16 El Niño (Al-Mamun et al. 2018). This showed that export bans motivated by the prospect of a short harvest compounded the adverse impacts for poverty—many poor farmers who depend on sales of maize were hit twice, once by the adverse impact of drought on their yields and a second time by depressed prices resulting from the export ban.

5.5 Dealing with collective action problems

Despite the best efforts of trade policy makers, it seems likely that agricultural trade policies will, as countries grow richer, evolve in the direction of the policies that Johnson (1991) decried as contributing to “agriculture in disarray.” A key challenge, then, will be to develop approaches that manage the intense collective action problems associated with such policies.

It may seem unrealistic to consider moving forward on dealing with collective action problems in the middle of a trade war. But it is important to ask whether the trade policy proposals that are being offered by the current US administration are likely to endure as the basis of a new world trading system. These policies involve four main planks: (i) Attack bilateral deficits, which add up to a problematic current account deficit, (ii) Organize negotiations bilaterally and seek larger reductions in partner countries in order to improve the terms of trade, (iii) Increase self-sufficiency in selected products, such as steel, aluminum and motor vehicles, and (iv) Repatriate global production networks.

These policy proposals appear to be based primarily on ideas rather than interest-group pressures, with most of the consequent actions facing opposition from major interest groups, such as US automobile manufacturers. The ideas themselves are old and largely discredited. The first concern, about deficits, fits within the mercantilist tradition of 17th and 18th century writers, a tradition rendered obsolete by David Ricardo in 1817. Even within this tradition, the focus is on the overall current account deficit, which modern economics views as important, but determined by the gap between income and expenditure or, equivalently, the gap between investment and saving. The number and size of bilateral deficits is determined in part by the overall deficit or surplus of each partner, and by patterns of trade, rather than by whether individual partners are more or less protectionist. The use of agreed export quotas to influence bilateral trade flows is particularly problematic as it gives away revenues that would have accrued to the treasury of the importing country. Such voluntary export restraints (VERs) were used extensively between the 1960s and 1980s and discarded when their costs and distortionary implications became evident.

A problem with bilateral negotiations is the large number of such negotiations needed. A world of 200-plus countries would need roughly 20,000 bilateral agreements to cover all trade. And bilateral agreements undertaken sequentially would result in ever-changing conditions of market access as each new negotiating partner sought to obtain better access than that given to the previous partner. It was recognition of these two problems that led from 19th century bilateral
negotiations within Europe to the multilateral trading system and the Most Favored Nation system under which any concessions given to one partner are extended to all other members.

A single large country could improve its terms of trade by raising tariffs relative to its trading partners. However, the response of trading partners is more likely to be retaliation, in which case the terms-of-trade gains are unlikely to be realized; but there are potential gains to all parties from agreed reductions in tariffs. Recognition of this following the enormous increases in protection during the 1930s was the impetus for establishment of the GATT.

The third argument equates self-sufficiency with national security, which clearly makes little sense, especially when modest import shares are provided by close allies. Application of this principle to industries such as steel and aluminum that provide inputs to other industries clearly reduces the competitiveness of the downstream industries.

The fourth idea, the goal of repatriating global production networks, is understandable given the rapidity of this development and the potential losses to some workers acknowledged by Baldwin (2016). However, the reduction in communication costs that contributed to global production sharing are a fundamental change that cannot be reversed by unilateral protection. Measures to discourage globalization of production run into the problem that countries not taking advantage of the lower costs attainable through global production sharing must lose competitiveness relative to countries that do. According to Athukorala (2017), about 70 percent of China’s manufacturing exports to the United States are products produced through global production sharing, with about half being components and the other half final assembly goods, often produced with key inputs such as design and marketing from foreign companies. Barriers to global production sharing would, in the case of components, raise the costs of domestic firms and, in the case of final assembly, reduce the returns to firms such as Apple that manage the production process.

Given the problems with this alternative model, it does not seem likely that it will endure. This assessment must be qualified by recognizing that—if protectionist measures of this type are introduced—they will create interest groups that argue for their retention. Despite their egregious inefficiency, measures such as VERs are of concern because they create two such interest groups—the producers sheltered in importing countries and the recipients of export rents in the supplying countries. The fact that most of the measures involved are plainly WTO-illegal will, if the WTO survives, provide a basis for identifying and removing most of them.

Once the focus of trade policies returns to the design of approaches for dealing with real-world problems in the world trading system, the basic WTO negotiating architecture might provide a suitable structure for managing the collective action problems associated with agricultural trade reform. As argued in Martin and Mattoo (2011), basic approaches such as negotiating formulas to cut tariffs and tighten limits on distortions could achieve a great deal, but exceptions to these approaches would need to be managed differently than under the Doha proposals to avoid completely negating any disciplines and returning to a situation of “agriculture in disarray.” Given the changes in trade and protection patterns evident in Table 3 and Figure 12, it is clear that leadership in dealing with these problems must come from developing countries. But addressing difficult trade challenges needs a clear identification of the problem, and careful analytical work.
to help guide negotiations. There will be an enormous need for analytical work to help provide a focal point for future negotiations, just as D. Gale Johnson’s “Agriculture in Disarray” and Tyers and Anderson (1992) did for the Uruguay Round.

6 Conclusions

The sharp increase in growth rates in many developing countries since 1990 is unprecedented in the 200 years since the Industrial Revolution began. This growth has generally not taken the form of unconditional income convergence, with the lowest-income countries growing faster than higher income countries. The gains have been greatest in Asian countries, which have been able to take advantage both of improvements in agricultural productivity and market opportunities associated with global production sharing.

This shift brings with it profound changes for agricultural economists in all fields and demands more careful and explicit attention than has been the case to date. The impacts come through changes in food demand, changes in production processes, and changes in marketing and trade policies. The change in growth patterns is widely expected to continue, although it will likely evolve in ways that should be monitored and evaluated to fully appreciate the implications for agriculture.

Economic growth in developing countries has much greater impacts on demand for food than income growth in the rich countries, where it has essentially no impact. In terms of the demand for resources from agriculture, the critical change in low-income countries is the increase in demand for livestock products, which require greater production effort. In terms of the nutritional impact, increases in consumption of sugar and fat may have a more profound impact. This dietary shift has profoundly changed malnutrition in developing countries—from purely a problem of undernutrition to a double burden of malnutrition involving both persistent undernutrition and problems associated with obesity and related noncommunicable diseases.

Many have raised concerns that income-driven increases in demand for food have contributed to past food price crises. While it is true that the demand for food grows much more quickly when income grows in poor countries than in rich countries, the productivity changes that cause growth also tend to raise the supply of food. Developing countries have larger shares of GDP in food production than richer countries, and many of the largest developing economies have invested heavily in R&D, with substantial impacts on productivity and output.

Economic growth facilitates and, in turn, is promoted by investments in infrastructure, particularly rural transportation. Historically, these investments have been difficult to evaluate because of problems of reverse causation, but innovations of the type discussed in Dave Donaldson’s Elmhirst Lecture have allowed for much better assessments of the implications of these infrastructure investments for agricultural productivity and the implications of improved transport for food security in the face of output volatility.

Movement of labor out of agriculture is an important feature of economic growth. Raising the productivity of labor in agriculture relative to non-agriculture is vitally important, either by facilitating movement into higher-productivity sectors or by raising productivity within
agriculture. Movement of labor out of agriculture has been extremely rapid in the high-growth economies, and it appears that the income gap between sectors has declined in those countries as well. However, the gap remains extremely large in some regions, particularly in Africa, leaving vast potential for income gains if economists can help provide guidance on ways to reduce it.

A combination of economic growth and developments in marketing technologies has given rise to a “supermarket revolution” that has seen food retailing move much earlier and faster away from traditional markets than in the past. This together with related marketing innovations has created an entirely new field of research in recent years, studying both the implications for consumers and the opportunities for linking poor farmers to these new marketing channels.

Trade policies in the rich countries became extremely distorted by the 1970s and 1980s, with high and rigid domestic prices creating enormously costly distortions between countries and between commodities and low and volatile world prices. Developing countries tended to tax agriculture heavily and to contribute to world price volatility by insulating their markets from changes in world prices. Despite a seemingly flawed agreement, the Uruguay Round turned out to be a watershed for the industrial countries, resulting in a gradual decline in protection and in the price insulation that contributes to world market price volatility. Meanwhile, income growth in many developing countries has contributed to a reduction, on average, of agricultural taxation and a level of average protection that is now in line with the industrial countries. Economic growth and the near-elimination of agricultural taxation in developing countries has contributed to trade expansion that has reduced the share of world agricultural trade among the traditional WTO developed countries to less than 15 percent. When the present firestorm in world trade relations subsides, we must focus on how to avoid a return to “agricultural in disarray” as developing countries move towards agricultural protection and as policies of price insulation increase the volatility of world markets.

The central purpose of this lecture is to remind us how extraordinary a set of developments we have witnessed since the early 1990s. The broad consensus on development prospects has changed utterly since the 1980s and early 1990s, when the world economy was still dominated by the performance of the core set of industrial countries, and the elimination of poverty was but a distant pipe dream. One risk is that this fundamentally changed scenario seems now to be viewed as the new normal, without an appreciation of the dramatic nature of the change relative to the pattern of “big time” economic divergence that had prevailed since the beginning of the industrial revolution. Whether this broad pattern of global growth continues and, if so, how it evolves has enormous implications for research needs and findings in agricultural economics.
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