16 Agriculture and Development

During the years 2006 through 2008 the world experienced its worst food crisis since the early 1970s. Over that period, the price of corn on world markets nearly tripled, followed closely by the prices of other basic cereals. During the six months from October 2007 to April 2008 the world price of rice tripled, increasing from $335 to over $1,000 per ton. The results were immediate and sometimes violent. Food riots broke out in Bangladesh, Burkina Faso, Cameroon, Egypt, Haiti, Mozambique, and Senegal. A report from Cairo, Egypt, by Al Jazeera on March 13, 2008, recounted, "thousands of people have resorted to violence due to shortages of basic food commodities and rising food prices. At least 10 people have died . . . in riots that erupted at government subsidized bakeries." A few weeks later, on April 18, the *New York Times* reported from Port-au-Prince, Haiti, that, "Hunger bashed in the front gate of Haiti's presidential palace. Hunger poured onto the streets, burning tires and taking on soldiers and the police. Hunger sent the country's prime minister packing. Haiti's hunger, that burns in the belly that so many here feel, has become fiercer than ever in recent days as global food prices spiral out of reach, spiking as much as 45 percent since the end of 2006 and turning Haitian staples like beans, corn, and rice into closely guarded treasures." Grain prices fell in late 2008, but once again rose steeply in 2010–11.

When food prices rise dramatically, what does this imply for developing countries and the welfare of the poor? If many of the poor are farmers, do they benefit from the kinds of food price increases that have occurred in recent years? Some may benefit, if they produce and sell food in sufficient quantities; yet, most poor households are net consumers of food. Similarly, most poor countries are net importers

of food. Increases in world food prices may be quite harmful. According to the Food and Agricultural Organization (FAO) of the United Nations, high food prices in 2008 pushed an additional 40 million people into hunger, raising the total to an estimated 963 million. In addition, the FAO estimates that the food import bill for developing countries increased by nearly 75 percent in 2008 as a consequence of the food price shock.[1] The implications of such events for developing countries are complex and raise central questions about the role of agriculture in both economic growth and poverty alleviation.

Agriculture has substantial implications at both the macroeconomic and microeconomic levels in most developing countries. Among countries categorized by the World Bank as low income, agriculture accounted for 25 percent of the gross domestic product (GDP) in 2008, making it the largest single sector in many countries. In addition, over 70 percent of the population of these low-income countries lived in rural areas. Even though not all rural households earn their primary income through farming, the simple observation that nearly three-quarters of the population of low-income countries was sharing one-quarter of the income suggests that poverty in the poorest countries tends to be disproportionately concentrated in rural areas. The large size of the agriculture sector, both in its share of GDP and employment, along with the likely concentration of poverty in rural areas, points to the unique opportunities that agricultural development provides. This chapter addresses the role of agriculture in economic growth and poverty alleviation; Chapter 17 looks more closely at the specific policies and institutions that governments can use to maximize those contributions.

UNIQUE CHARACTERISTICS OF THE AGRICULTURAL SECTOR

Economists Peter Timmer, Walter Falcon, and Scott Pearson identified five characteristics of the agriculture sector that distinguish it from other sectors of most developing economies: the agricultural sector's share of GDP, the agricultural sector's share of the labor force, special characteristics of the agricultural production function, that much of the agricultural sector's output is directly consumed by its producers, and agriculture's role as a resource reservoir.[2]

Agriculture is a dominant sector in many of the world's poorest countries. Table 16–1a summarizes trends in the agricultural share of GDP for major areas of

[1]FAO, *Crop Prospects and Food Situation*, 2008, www.fao.org/giews/, and A. Mittal, "The 2008 Food Price Crisis: Rethinking Food Security Policies," G-24 Discussion Paper No. 56, United Nations Conference on Trade and Development (UNCTAD), Geneva, June 2009.

[2]Peter Timmer, Walter Falcon, and Scott Pearson, *Food Policy Analysis* (Baltimore, MD: Johns Hopkins University Press, for the World Bank, 1983).

TABLE 16-1 The Share of Agriculture in GDP and Rural Population Share

	1965–75	1976–85	1986–95	1996–2008
(a) Share of agriculture in GDP (%)				
East Asia and Pacific	35.3	29.3	22.8	14.4
Latin America and Caribbean	13.3	10.8	8.9	6.4
South Asia	41.3	34.0	28.9	22.3
Sub-Saharan Africa	20.4	18.8	18.5	17.1
High-income countries	5.7	4.1	2.7	1.8
(b) Rural population share (%)				
East Asia and Pacific	81.1	78.0	70.8	61.2
Latin America and Caribbean	42.5	34.8	29.1	23.8
South Asia	81.1	77.8	75.0	72.2
Sub-Saharan Africa	80.4	76.1	71.6	66.4
High-income countries	33.1	29.4	26.6	23.7

GDP, gross domestic product.

Source: World Bank, "World Development Indicators," http://databank.worldbank.org.

the developing world since 1965. While it is clear that agriculture plays an important role in generating national income, it is also clear that the magnitude of that role has trended downward over time (an observation pursued in greater depth in the following section). Nonetheless, the challenge of accelerating economic growth becomes much more difficult if a large sector such as agriculture is left to lag behind the rest of the economy.

Table 16–1b demonstrates the even greater share of each region's population that lives in rural areas. Not all rural dwellers are farmers, and many farmers earn at least some of their income outside of farming. Yet, most nonfarm rural activities depend substantially on the existence of a vibrant agricultural sector. Agriculture also plays a substantial role in the consumption side of the economy. It is common among poor households in developing countries for food expenditures to make up 50 to 70 percent of total household expenditures.

The agricultural sector is also distinguished from other sectors by both the sheer number of participants and by the degree of decentralization of those participants. A farming sector may consist of hundreds of thousands, or even millions, of individual production units, all operating independently, yet all allocating resources in response to the same broad set of incentives created by government policy.

Key characteristics of the agricultural production function are also distinctive. These features include seasonality, geographic dispersion, the sources of risk, and the sources of technical change. Agricultural production is uniquely sensitive to seasonality. Most countries have distinct growing seasons, usually defined by rainfall patterns. From an economic point of view, we can think of farmers' use of seasonality as cost minimization (for example, it is much cheaper to use natural sunlight

children to school versus putting them to work (either on the family's own farm or as hired off-farm labor). Such decisions may have large impacts on the welfare of poor households.

Finally, agriculture differs from other sectors in having traditionally been seen largely as a reservoir of inexpensive resources (principally labor and capital) available for extraction and use in modern industry and services. In many cases, this perspective justified the neglect of agriculture by policy makers, as agriculture was perceived to be a traditional, low-productivity sector with little to contribute to industrialization. Although later approaches have challenged this view of agriculture's role in economic growth, as economies grow, agriculture tends to account for a declining share of both GDP and employment. This robust empirical regularity is part of the broader concept called **structural transformation**.

STRUCTURAL TRANSFORMATION

Structural transformation refers to the systematic changes in sector proportions as economies grow. Initially, at low levels of income, agriculture dominates both as a share of GDP and as a share of employment. As economies transition toward middle levels of income per capita, agriculture accounts for a smaller share of both GDP and employment (replaced by industry and services). This pattern is a central feature of economic development and both a cause and an effect of economic growth. In advanced economies, the farming population accounts for a negligible share of the total population. As Timmer observes, "there are more lawyers in the United States than farmers, more dry cleaning establishments than farms."[3] The relative decline of agriculture and rise of industry and services that characterize structural transformation imply an additional characteristic—namely, a substantial migration of labor from the rural to the urban economy. Finally, structural transformation is also characterized by a demographic transition (discussed in Chapter 7) in which the high birth and death rates of traditional societies are replaced by low birth and death rates (as health conditions improve with income growth).

From the perspective of the demand side of the economy, this process of structural transformation is driven by **Engel's law**, the observation by nineteenth-century statistician Ernst Engel that the proportion of income spent on food declines as income rises (that is, the income elasticity of food is positive, but less than 1). This implies that income grows faster than the demand for food, resulting in the decline of agriculture as a share of national income.

[3] C. Peter Timmer, "A World without Agriculture: The Structural Transformation in Historical Perspective," Wendt Lecture, American Enterprise Institute, Washington, DC, October 30, 2007, p. 5.

Structural transformation is an empirically robust phenomenon. Figure 16-1 shows the (smoothed) patterns of rural population shares and agricultural shares of GDP by region as a function of income per capita. (The same patterns are apparent in Table 16–1, which includes the average levels of these variables by decade.) It is clear from Figure 16–1 that there is a persistent, though declining, gap between the rural population share and the share of agriculture in GDP. This gap reflects the persistent, though declining, concentration of poverty in the rural economy. However, as the gap falls, labor productivity and wages across sectors tend to converge. The data in Table 16–1 show that significant gaps remain, on average, in the major regions of the developing world. Among those regions, only Latin America has approached low levels (and convergence) of rural population share and agricultural share of GDP that characterize the advanced economies. The particular path followed by any given country will vary from these norms, depending on local circumstances. Yet, the broad pattern is remarkably robust.

We can begin to consider the potential contributions of agriculture to economic growth by looking more closely at the process of structural transformation. History reflects that structural transformations broadly consist of four distinct phases.[4] The first phase begins with an increase in agricultural output per worker (average labor

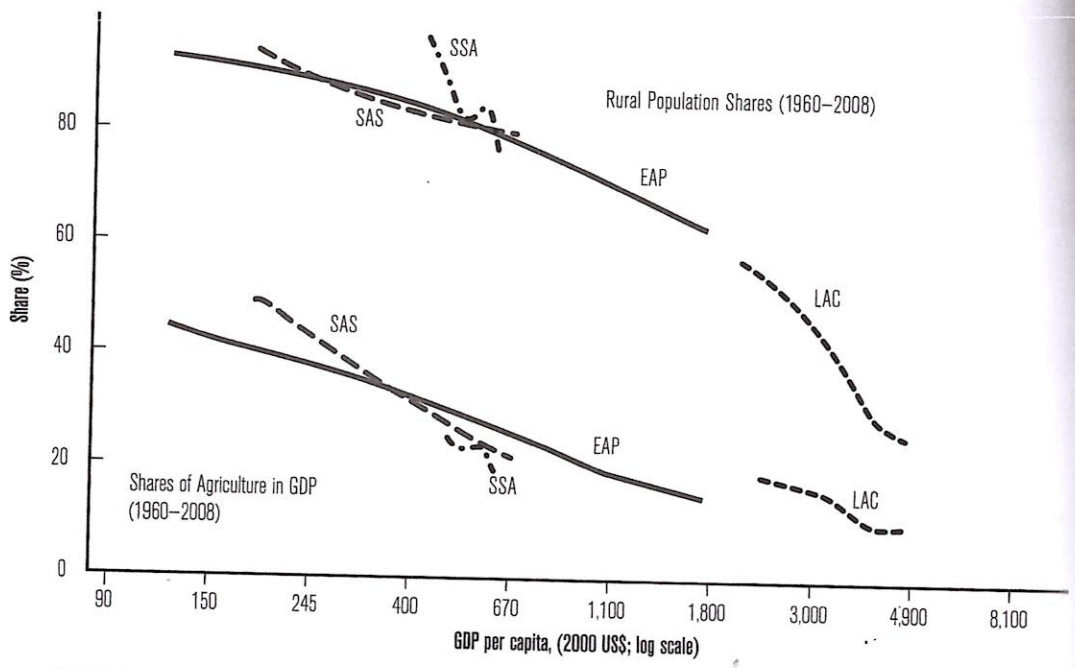

FIGURE 16-1 The Structural Transformation

EAP, East Asian and the Pacific; GDP, gross domestic product; LAC, Latin American and the Caribbean; SAS, South Asia; SSA, sub-Saharan Africa.
Source: World Bank, "World Development Indicators," http://databank.worldbank.org.

[4]C. Peter Timmer, "The Agricultural Transformation," in H. Chenery and T. N. Srinivasan, eds., *Handbook of Development Economics*, vol. 1, (Amsterdam: Elsevier Science, 1988).

productivity). This rising level of output per worker creates a surplus in the rural economy. The second phase of the structural transformation consists of the transfer of that surplus from the agricultural to the nonagricultural sector. This transfer can be implemented either directly (through taxation) or indirectly (through other forms of government intervention). This process of resource transfer is facilitated by the increasing integration of agricultural and nonagricultural factors and product market linkages, with intersectoral trade and labor migration being supported by improved infrastructure. The progressive integration of the agricultural and nonagricultural sectors is the third phase of structural transformation. Finally, the fourth phase occurs when the agricultural sector is fully integrated into the macroeconomy, at which point much of the economic distinctiveness of agriculture will have faded. This is the situation that we currently observe in the advanced economies, where agriculture and nonagriculture operate in essentially the same labor and capital markets.

The concentration of poverty in rural areas that it is implied by the gap between rural employment shares and agriculture's share in GDP also implies that average labor productivity tends to be higher in nonagricultural sectors. Indeed, it may be reasonable to believe that poverty is concentrated in rural areas *because* the level of agricultural productivity is lower than the level of productivity in nonagriculture. Williams College economist Douglas Gollin calculated the ratio of nonagricultural output per worker to agricultural output per worker in 1999–2000 for a number of countries.[5] His results are summarized in Table 16–2. Gollin's calculations confirm that average labor productivity is substantially higher in nonagricultural sectors than in agriculture. In general, the ratio of average labor productivity in nonagriculture relative to agriculture is on the order of 2.5 to 7. Countries in this range include Brazil, Côte d'Ivoire, Ghana, Indonesia, Mexico, and Pakistan. Yet, for more than a few countries, such as Burkina Faso, Burundi, China, and Thailand, this ratio is greater than 10.

If average labor productivity is often substantially higher in nonagriculture than in agriculture, then the process of structural transformation in which labor flows from agriculture to nonagriculture creates a potentially important source of economic growth. We can think of part of the benefit of structural transformation as arising from the transfer of labor from relatively low-productivity to relatively high-productivity employment. Columns 3 to 5 of Table 16–2 present Gollin's calculation of the contributions of sectoral shifts of labor to growth in total output per worker for selected countries.[6] In China, average output per worker in nonagriculture in

[5] Douglas Gollin, "Agricultural Productivity and Economic Growth," in Prabhu Pingali and Robert Evenson, eds., *Handbook of Agricultural Economics*, vol. 4 (Amsterdam: Elsevier, 2010).

[6] Gollin calculates the contribution of sectoral reallocation of labor to growth in aggregate output per worker as a residual. This residual is the growth in output per worker that is not explained by adding the separate contributions to growth in output per worker coming from growth in agricultural and nonagricultural output per worker. Accurate accounting for these distinct sectoral contributions requires that each sector's contribution be weighted by the share of GDP coming from each sector. If the weighted sum is different from the actual growth in aggregate output per worker for a given country, then the difference (that is, the residual) provides an estimate of the contribution of the reallocation of labor between sectors. This type of calculation is thus quite similar in its approach to the growth accounting analysis presented in Chapter 4.

TABLE 16-2 Ratio of Sectoral Labor Productivity, Agriculture, and Nonagriculture (1999–2000) and the Contribution of Sectoral Labor Shifts to Growth (1960–2000)

COUNTRY	NONAGRICULTURAL OUTPUT TO AGRICULTURAL OUTPUT*	GROWTH RATE†	GROWTH FROM		
			AGRICULTURE	NONAGRICULTURE	SECTORAL SHIFTS
Burundi	13.91	0.005	−0.011	0	0.016
Mexico	6.28	0.01	−0.001	−0.002	0.013
Burkina Faso	29.07	0.013	0.002	0.006	0.006
Côte d'Ivoire	3.03	0.014	0.004	0	0.01
Brazil	3.37	0.017	0.002	−0.005	0.021
Ghana	2.43	0.025	0.014	0.007	0.004
Indonesia	5.07	0.028	0.001	−0.001	0.027
Pakistan	2.54	0.03	0.007	0.005	0.018
Thailand	13.07	0.043	0.004	0.007	0.032
China	11.25	0.053	0.014	−0.015	0.054

*Ratio of nonagricultural output per worker to agricultural output per worker.
†Output per worker

Source: Douglas Gollin, "Agricultural Productivity and Economic Growth," in Prabhu Pingali and Robert Evenson, eds., *Handbook of Agricultural Economics*, vol. 4. (Amsterdam: Elsevier, 2010), tables 4 and 5.

1999–2000 was more than 11 times greater than average output per worker in agriculture. Output per worker from 1960 to 2000 grew at 5.3 percent per year, essentially all of which was explained by shifts of workers from agricultural to nonagricultural employment. In Thailand, the labor productivity ratio was over 13. In that case, 3.2 percent of the country's 4.3 percent growth in output per worker during the four decades was explained by sectoral shifts of labor. Intersectoral labor shifts accounted for about three-quarters of the growth of output per worker in Thailand.

Our awareness of the structural transformation comes from historical observation. Yet, the notion of economies consisting of two sectors (agricultural and nonagricultural, traditional and modern, etc.) and the understanding of development as a process centered around the transfer of labor (and capital and other resources) from agriculture to nonagriculture is firmly grounded in the theoretical tradition of two-sector (or dualistic) growth models.

TWO-SECTOR MODELS OF DEVELOPMENT

Although single-sector growth models, presented in Chapter 4, have the great advantage of simplicity, they do not explore production in different sectors such as agriculture, industry, or services (such as banking or tourism); the allocation of capital,

labor, and land across these different activities; or the implications for growth. Like the one-sector models, two-sector models recognize the prime importance of labor and capital in the growth process. Two-sector models can also explore differences in the levels and growth rates of productivity in different activities and the implications for relative wages (and returns on capital investment); the allocation of labor and capital across the two sectors; and the potential for migration of labor from rural (agricultural) to urban (industrial) areas. We present two-sector models here to emphasize their value for understanding the interactions between agriculture and nonagriculture during the course of development, rather than as growth models per se.

THE LABOR SURPLUS MODEL

Two-sector models have a long tradition in economic thinking. The best-known of the early models appeared in David Ricardo's *The Principles of Political Economy and Taxation*, published in 1817. In his model, Ricardo included two basic assumptions that have played an important role in two-sector models ever since.

- He assumed that agricultural production was subject to **diminishing returns** because crops require land and the supply of arable land is limited. To increase production, Ricardo felt, farmers would have to move onto poorer and poorer land, and therefore each new acre of land matched with the same amount of labor would produce less grain.
- Ricardo formulated a concept that today is called **labor surplus**. Britain in the early nineteenth century still had a large agricultural workforce, perhaps more than was necessary to produce sufficient food for all consumers. Ricardo believed that the industrial sector could draw away surplus labor from the farms without reducing total agricultural production or causing a rise in wages in either urban or rural areas.

Labor surplus, to the extent that it exists, is closely related to concepts such as rural unemployment and underemployment or disguised unemployment. Very few people in rural areas of developing countries are unemployed in the strict sense. Yet, agriculture's seasonality implies that rural employment may fluctuate from nearly full employment during planting and harvesting times to substantially lower levels of employment at other times, even though the total number of workers remains more or less constant. Economists call this **underemployment** or **disguised unemployment**.

The two-sector models we examine here focus on employment and are designed to answer several questions. How does surplus labor (or very low productivity labor) in agriculture affect industry? Can workers move to industry without causing a fall in agricultural production and thus expand total economic output? Will accelerated population growth help or make matters worse? And, what is the effect of agricultural productivity growth on intersectoral labor flows and economic growth?

The modern version of the two-sector labor-surplus model was first developed by economics Nobel laureate W. Arthur Lewis in 1954.[7] Lewis, like Ricardo before him, pays particular attention to the implications of surplus labor for income distribution and growth. Our concern here, however, is with the relationship between industry and agriculture, and for that, we use a version of Lewis's model formulated by economists John Fei and Gustav Ranis in 1964.[8]

Our starting point is the agricultural sector and the **agricultural production function**. We assume two inputs, labor and land, produce an output, such as grain. The production function in Figure 16–2 is similar to but differs slightly from the standard neoclassical production function with continuously diminishing returns to labor. Instead of showing output as a function of capital per worker, agricultural output is shown as a function of labor per unit of land. Because any increase in labor must be combined with the existing stock of land (or perhaps new land of decreasing quality), the production function exhibits diminishing returns.

The labor surplus model, however, takes diminishing returns to its extreme: It assumes that at some point, further additions of labor make zero (or even negative) contribution to output. In Figure 16–2, a rise in the labor force from *a* to *b* leads to an increase in output from *d* to *e*; an equal increase in labor from *b* to *c* leads to a smaller

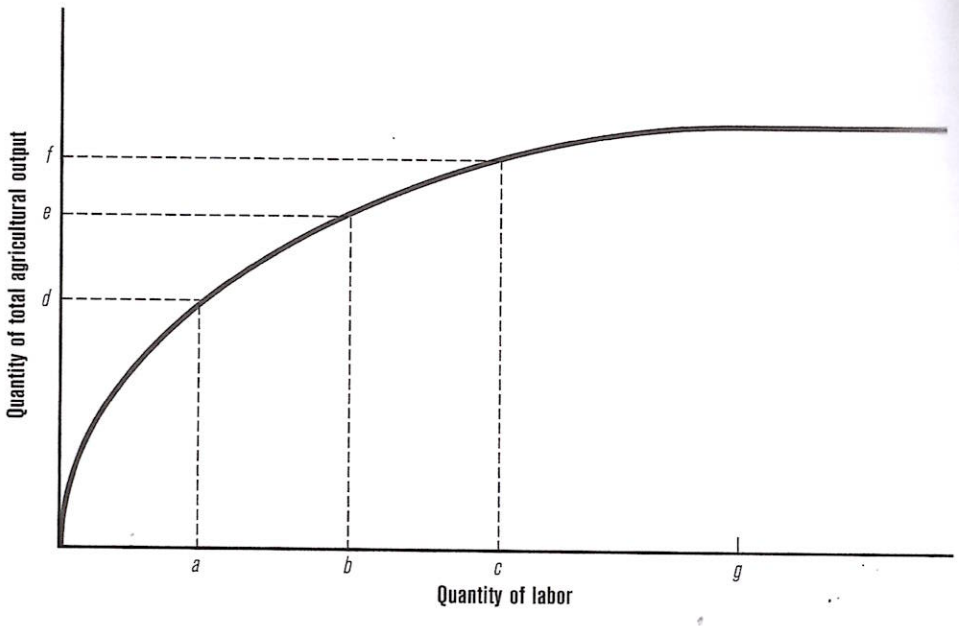

FIGURE 16–2 The Agriculture Production Function

[7]W. A. Lewis, "Economic Growth with Unlimited Supplies of Labor," *The Manchester School of Economic and Social Studies* 22 (1954), 139–91.

[8]John C. H. Fei and Gustav Ranis, *Development of the Labor surplus Economy: Theory and Policy* (Homewood, IL: Richard A. Irwin, Inc., 1964).

rise in output. At point *g*, however, further increases in the amount of labor used lead to no rise in output at all. Beyond point *g*, the **marginal product of labor (MPL)** is zero or negative, so additional labor causes no increase or reduction in output. This could happen if all arable land were fully used and so many workers were available already that adding new ones would not result in more grain being produced.

The next step is to show how rural wages are determined. The standard assumption in all labor surplus models is that rural wages do not fall below a minimum level, regardless of how many workers are available. More specifically, the usual assumption is that rural wages do not fall below the **average product** of farm labor. The logic behind this view is that a member of a farm household will not look for work outside the household unless he or she can earn at least as much as he or she would receive by staying at home. At home, total food production would be divided equally among all members of the household so each person consumes the average product of household production. A slightly different, but comparable concept is that wages are not allowed to fall below a **subsistence level**. In this view, no one would look for work off the farm for wages that were below the amount needed for a minimum level of subsistence. The minimum wage, however determined, sometimes is called an **institutionally fixed wage** to contrast it with wages determined by market forces.

If the MPL falls to zero while wages remain at some minimum level, a wedge emerges between the MPL and the wage rate. This is the key characteristic that distinguishes labor surplus models from standard neoclassical models with perfectly competitive markets (examined in the next section) in which the MPL equals the wage rate. Labor surplus models include not just the possibility that the MPL falls to zero but situations in which the MPL is above zero but less than the rural minimum wage.

These concepts are presented in Figure 16–3, which is derived directly from Figure 16–2, but with several changes. To begin with, the horizontal axis is flipped, so that moving to the right represents a decline in the number of agricultural workers. At the origin, the horizontal axis represents the point where the entire labor force works in agriculture, with no one working in industry. Next, whereas the vertical axis in Figure 16–2 represents the total agricultural product, in Figure 16–3, it is converted to represent the marginal product per unit of labor. Thus when moving to the right, as the number of agricultural workers declines, the MPL begins to increase (corresponding to Figure 16–2 in which increases in the number of workers leads to diminishing returns to labor).

The minimum or subsistence wage is represented by the dotted line *hi*. Agricultural wages remain at this level until the MPL (represented by the solid curve) rises above this minimum, which occurs at point *i*. Thereafter, agricultural wages rise, following the marginal product curve as more labor is drawn away from the sector. This curve plays a dual role: It shows both the agricultural wage and the minimum amount that industry must pay to lure workers off the farm. To hire workers away from the farm, factories have to pay at least as much as the workers are earning on the farm. Therefore, the line *hij* in Figure 16–3 can be thought of as the **supply**

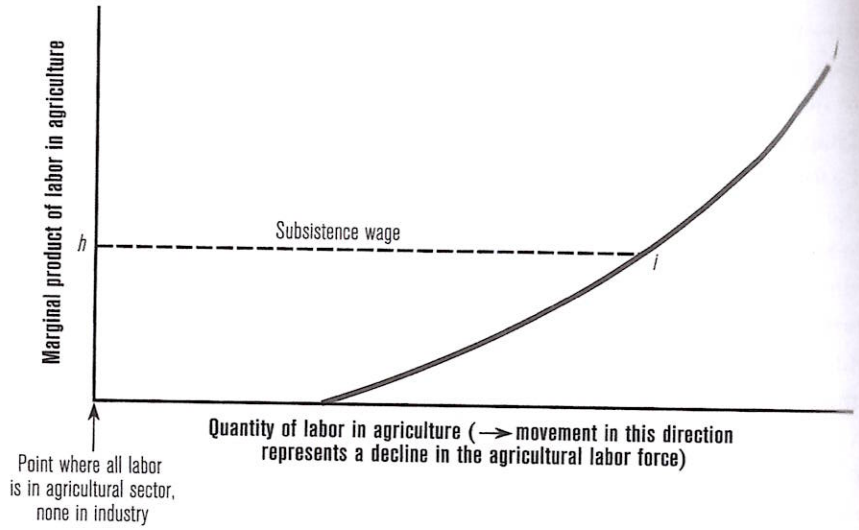

FIGURE 16-3 Modern Product of Labor in Agriculture
As the quantity of agricultural labor decreases, the marginal product increases.

curve of labor facing the industrial sector. Actually the usual assumption is that the supply curve of labor in industry is a bit above the line *hij* because factories must pay farmers a bit more than they receive in agriculture to get them to move.

The key feature of this supply curve of labor is that, unlike more common supply curves, it does not rise continuously as one moves from left to right but instead has a substantial horizontal portion. Formally, this means that the supply curve of labor up to point *i* is **perfectly elastic. Elasticity** is a measure of responsiveness, equal to the percentage change in one variable (in this case, the supply of labor) arising from a percentage change in another variable (in this case, wages).[9] The elasticity becomes very large when small changes in wages induce very large changes in the supply of labor. Perfect elasticity occurs when the ratio of these two percentages equals infinity. From the point of view of the industrial sector, this means that the sector can hire as many workers as it wants without having to raise wages, at least until the amount of labor is increased beyond point *i*. To the right of this point, sometimes called the *turning point*, industrial wages rise as firms draw more workers from the agricultural sector.

Figure 16–4 shows the supply and demand for labor for the industrial market. The supply curve *kk'* is taken directly from Figure 16–3 and shows the wages that industry has to pay to draw workers from agriculture. The amount 0*k* on the vertical

[9]More formally, this elasticity is the ratio of the percentage change in the supply of labor ($\Delta L/L$) to the percentage change in the wage rate ($\Delta W/W$): Elasticity $= (\Delta L/L)/(\Delta W/W)$. In the case of perfect elasticity, this ratio approaches infinity, which implies a flat supply curve along which employers can employ as much labor as they choose at that fixed wage.

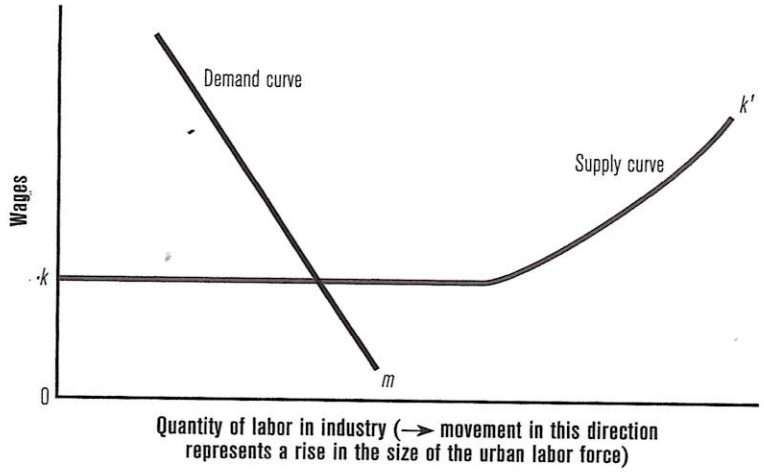

FIGURE 16-4 The Supply and Demand for Industrial Labor

The supply curve, *kk'*, is drawn directly from Figure 16–3. Demand, *m*, is derived from the industrial production function.

axis in Figure 16–4 is assumed to be slightly higher than the subsistence wage in Figure 16–3, as discussed previously. The supply curve turns up when the withdrawal of labor from agriculture no longer can be accomplished without a decline in the agricultural output (when the MPL rises above 0) because, at that point, the relative price of agricultural produce rises and this necessitates a commensurate rise in urban wages. In other words, because after the turning point agricultural production is falling, the price of food rises and industry must pay its workers more to compensate for the higher price of food. The demand curve for labor in industry, *m*, displays the usual downward-sloping quality and shows the wages that the industrial sector is willing to pay for different quantities of labor. This demand curve is determined by the marginal product of labor in industry and can be derived from the industrial production function. To simplify our exposition, we do not show the details of this derivation.

The final step is to combine Figures 16–2, 16–3, and 16–4 into a complete version of the model, which is shown in Figure 16–5. Figure 16–5a is the agricultural production function of Figure 16–2 with the horizontal axis flipped. An increase in the number of agricultural workers is shown as a movement from right to left from the origin (0 workers in agriculture) to point *p*, which is the initial size of the total labor force. Many versions of this model use total population rather than the labor force, and this switch has little effect if the labor force is closely correlated with total population. Figure 16–5b shows the MPL curve from Figure 16–3, and Figure 16–5c shows the supply and demand curves for labor in the industrial sector from Figure 16–4. In all three panels, a movement from left to right represents both a decline in the agricultural labor force and a rise in the industrial labor force—that is, a transfer of labor from agriculture to industry.

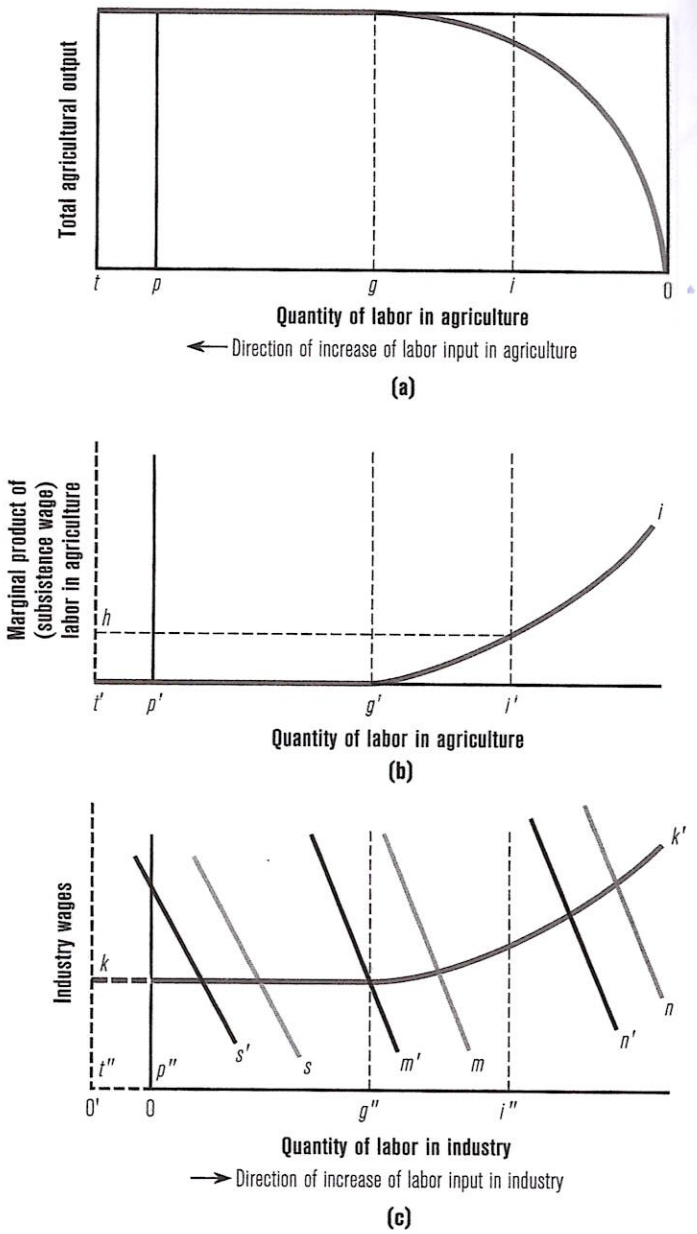

FIGURE 16-5 The Two-Sector Labor Surplus Model

(a) Agricultural production function. (b) Rural (agricultural) labor market. (c) Industrial labor market. The limit imposed by the country's population (0 to p in panel a), coupled with the agricultural production function, allows us to analyze the effects of industry wages on the mix between agricultural and industrial labor.

If a labor surplus economy starts with its entire population in agriculture, it can remove a large part of that population (pg) and move it to industry or other employment with no reduction in farm output. Industry must pay those workers a wage a bit above subsistence (the difference between the vertical distance $p''k$ in Panel c

and $p'h$ in panel b) to get the workers to move. As long as there is some way of moving the food consumed by this labor from the rural to the urban area, industrialization can proceed without reducing agricultural output, implying an increase in total GDP because the marginal product of these workers in industry is greater than zero.

As industry continues to grow, however, it eventually exhausts the supply of surplus labor. Further removal of labor from agriculture leads to a reduction in farm output. A shift in industrial labor demand to m in Figure 16–5c forces industry to pay higher wages to compensate workers for the higher price of food. The rise in the price of agricultural output relative to the price of industrial output (which has not changed) sometimes is described as the terms of trade between industry and agriculture turning against industry and in favor of agriculture. The rising price of food as workers move to industry—that is, the shift in the terms of trade against industry—accounts for the rise in the supply curve of labor between g'' and i'' in panel c.

The Fei-Ranis model can be used to explore the implications of population growth and a rise in agricultural productivity, among other things. To simplify, if one assumes a close relationship between population and the labor force, then an increase in population from p to t increases the length of the horizontal axis in all three panels. Note, however, that additional workers (or a larger population) do not increase agricultural output at all. The elastic portion of both the urban and rural labor supply curves are extended by $p't'$ and $p''t''$, respectively, thus postponing the day when industrialization causes wages to rise.[10]

Most important, if the population rises with no increase in food output, the average amount of food available per capita falls. From the standpoint of everyone but a few employers who want to keep wages low and profits high, population growth is an unqualified disaster. Wages actually may fall in the urban areas, and the welfare of the great mass of farmers certainly falls. It is a model such as this, even if only imperfectly understood, that people often have in mind when they speak of population growth in wholly negative terms.

Britain's economy displayed labor surplus characteristics during Ricardo's time. In the middle of the twentieth century China, India, Indonesia, and some countries in Africa appear to have had surplus labor, but there are few such situations today. The most recent major example of a clear application of the model is China from the 1950s through the 1970s (Box 16–1), but China's surplus labor was fully absorbed by the 1980s. More common is a situation in which a withdrawal of labor leads to a small decline in agricultural production, which brings us to the neoclassical two-sector model.

[10] In the industrial labor supply and demand part of Figure 16–5c, it is also necessary to move the labor demand curves to the left because the 0 point on the horizontal axis has been moved to the left. These new demand curves, s', m', and n', therefore really are the same as s, m, and n. That is, the quantity of labor demanded at any given price is the same for s' as s, and so on.