7 Sectoral Growth Linkages between Agriculture and the Rural Nonfarm Economy

STEVEN HAGGBLADE, PETER B. R. HAZELL, AND PAUL A. DOROSH

The density, composition, and evolution of rural nonfarm activity vary considerably across geographic settings and over time. Chapter 4 has examined broad trends in that evolution, highlighting an array of causal forces driving change in the rural nonfarm economy (RNFE).

In many settings, agriculture plays a predominant role, governing the scale, structure, and evolution of rural nonfarm activity. As the green revolution unfurled across Bangladesh during the 1980s and 1990s, soaring paddy production, the sinking of 750,000 shallow tube wells, and sale of over a million treadle pumps launched an explosion in the RNFE as 50,000 paddy mills, 80,000 small traders, and 160,000 rural mechanics launched operation, generating a highly visible agriculturally driven surge in rural nonfarm activity (Figure 7.1).[1]

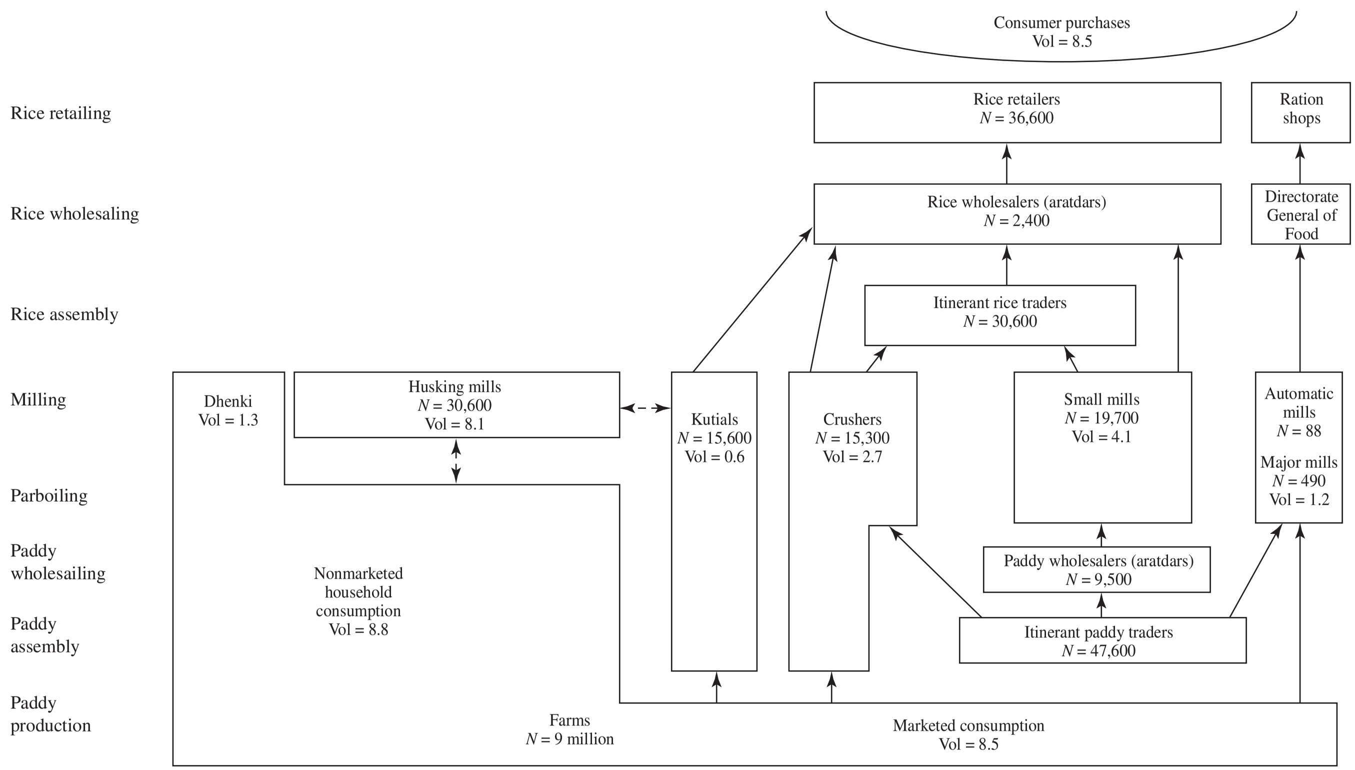
Yet agriculture does not unilaterally govern the size, composition, and evolution of the RNFE. In the early 1990s, rural manufacturing grew substantially in villages surrounding metropolitan Manila, not because of growth in agriculture, which had peaked in the prior decades, but because urban firms faced increasing incentives to move production to suburban locations in search of lower rents and lower wages (Hayami, Kikuchi, and Marciano 1996).

To what extent does agriculture shape the RNFE? In what instances does agriculture predominate as the engine of rural nonfarm growth? And where do other forces emerge as more prominent? The ensuing discussion explores these questions in detail in an effort to summarize the considerable body of evidence accumulated in recent decades on the magnitude of agricultural growth linkages.

The views presented in this chapter represent those of the authors and should not be taken to reflect those of the World Bank or its affiliated institutions.

1. Ahmed (2000), Chowdhury and Haggblade (2000), Shah et al. (2000), Mandal and Asaduzzam (2002), World Bank (2004).

FIGURE 7.1 Rice marketing in Bangladesh, 1990



SOURCE: Chowdhury and Haggblade (2000).
NOTES: *N*, number of enterprises; Vol, volume in million metric tons (MMT) or rice equivalents; ◄- -► indicates contract milling.

A Typology of Linkages

Agriculture to Rural Nonfarm Activity

Analytically, and in roughly chronological order, students of the rural economy have classified agricultural growth linkages into four main categories. *Production linkages* include forward linkages from agriculture to nonfarm processors of agricultural raw materials as well as backward linkages to input suppliers of farm equipment, pumps, fuel, fertilizer, and repair services. These input-output relationships generate distinctive patterns of rural nonfarm activity across different agricultural regions. In western Colombia, the rapid growth of smallholder coffee farming in the early 1900s stimulated a collateral rise in rural transport services, coffee processing, and local production of jute bags and pulping machinery (Berry 1995). The spurt in Vietnam's rice production during the 1990s generated growth in rural nonfarm activity concentrated mainly in favorable agricultural zones and dominated by farm input supply, milling, and commerce (Trung 2000).

Consumption linkages include spending by farm families on locally produced consumer goods and services. A classic early study in green revolution India determined that higher-income small farmers spent about half of their incremental farm income on nonfarm goods and services and another third on perishable agricultural commodities such as milk, fruit, and vegetables, thus generating strong demand linkages for locally supplied consumer goods and services (Mellor and Lele 1973).

Factor market linkages between agriculture and the RNFE have received growing attention in the linkages literature in recent years. In rural labor markets, the strong seasonality of demand in agriculture generates corresponding surges in rural nonfarm activity typically tied to troughs in agricultural labor demand.[2] And, as Chapter 3 emphasizes, links between labor demand and rising rural wage rates may offer important connective tissue by which poor households in one sector can benefit from growth in the other (Figure 7.2). Similarly, cash surpluses from agricultural sales frequently finance nonfarm investments, while reciprocal reverse flows from rural nonfarm activities finance the purchase of agricultural inputs.[3]

Productivity linkages between agriculture and the nonfarm economy have emerged most recently in the growth linkage discussions.[4] More nebulous and difficult to measure, these interactions include an array of beneficial macro

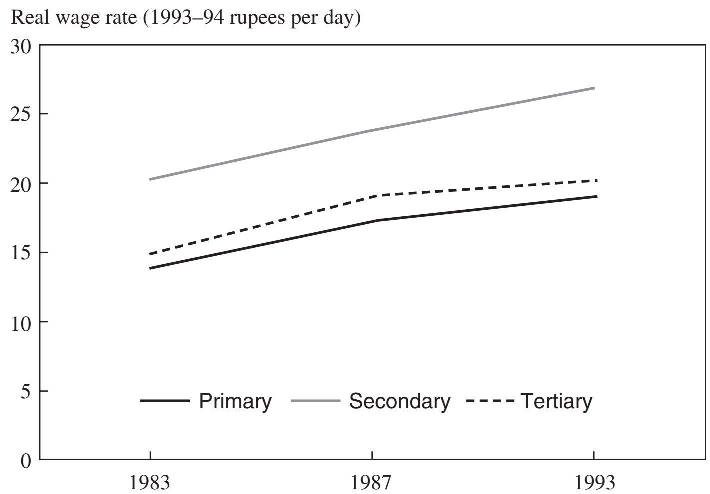
---

2. In addition to Figure 1.1, see Norman (1973), Romjin (1987), and Itoh and Tanimoto (1998) for evidence from Nigeria, Thailand, and Japan, respectively.

3. See Lucas and Stark (1985), Collier and Lal (1986), Evans and Ngau (1991), Reardon, Crawford, and Kelly (1994), Carter and Wiebe (1990), Marenya et al. (2003), and Ellis and Freeman (2004).

4. See Block and Timmer (1994) and Tomich, Kilby, and Johnston (1995).

FIGURE 7.2 Trends in real rural wage rates for casual labor in India, 1983–93



SOURCE: Dev (2002).

linkages transmitted from agriculture to the nonfarm economy. In particular, lower food prices may increase the productivity of poor manual laborers, a linkage of considerable potential importance given growing awareness of the beneficial impact of food prices on nutrition and workforce productivity (Behrman and Deolalikar 1988; Strauss and Thomas 2000). Some proponents have suggested that agricultural productivity also improves food security and political stability, leading to higher productivity of capital and learning by doing by both government and firms (Block and Timmer 1994). Others emphasize knowledge flows that accelerate productivity growth in both agriculture and nonfarm production (Tomich, Kilby, and Johnston 1995). These effects correspond analytically to the productivity-enhancing technical change induced by international trade (Grossman and Helpman 1992).

Reverse Linkages

Early linkage discussions focused primarily on agriculture as the engine of rural economic growth. More recently, with growing recognition of the surprisingly large scale of rural nonfarm activity in many rural areas, the prospect for a reversal of this causality, from nonfarm to farm, has received growing recognition.[5] Certainly production linkages cut both ways. The establishment of rural

5. Ranis, Stewart, and Angeles-Reyes (1990), Reardon, Crawford, and Kelly (1994), Marenya et al. (2003), Ellis and Freeman (2004).

canneries can stimulate on-farm production of tomatoes, fruits, and other perishables (Reardon, Crawford, and Kelly 1994). Likewise, in the consumption arena, nonfarm income—perhaps from mining or rural administrative centers—generates demand for local agricultural products. Hence the commonly observed truck farming that grows up around rural and urban towns.

Factor markets inherently involve ebbs and flows between agriculture and nonfarm activities. Productivity linkages similarly run in both directions, because nonfarm firms introduce benefits to farmers in the form of timely repair services, improved input supply, output marketing, and enhanced farmer incentives.[6] In many instances, liquidity provided by nonfarm earnings provides funds for the purchase of the modern hybrid seeds and fertilizer necessary for increasing farm productivity.

Empirical Evidence

Cross-Section Evidence of Agricultural Growth Linkages

A broad array of empirical work has explored the relationship between changes in agriculture and changes in the RNFE. A cross-country comparison from 43 different countries charts the increasing importance of rural nonfarm activity as agricultural income per capita increases (Haggblade and Hazell 1989). It documents the close connection between nonfarm activity and the development of rural towns. From 0.37 in rural areas alone, the simple correlation coefficient between agricultural income per capita and nonfarm share in rural employment doubles, to 0.77, in rural areas plus rural towns. The jump in rural towns confirms what Chapter 8 and many observers have emphasized—that measurement of the nonfarm spin-offs from agricultural growth requires inclusion of the many agriculturally related nonfarm activities that take root in rural towns.[7]

Based on cross-section comparisons across regions in a given country, many authors have identified clear links between the level of agricultural development and that of the RNFE. In an array of Asian and African countries, empirical studies have found high levels of agricultural income and productivity correlated with high levels of rural nonfarm income.[8] A two-edged sword, agriculture when enfeebled will likewise prove a drag on the RNFE. Reardon's (1997)

6. See, for example, Ranis, Stewart, and Angeles-Reyes (1990), Evans and Ngau (1991), Thomich, Kilby, and Johnston, and Kilby (1995).

7. Gibb (1974), Anderson and Leiserson (1978), Rondinelli (1987b,c), Haggblade, Hazell, and Brown (1989), Evans (1990), Satterthwaite (2000), Tacoli and Satterthwaite (2003).

8. See Reardon (1997) for evidence from 27 case studies in West Africa, Haggblade, Hazell, and Brown (1987) for evidence from Togo and Sierra Leone; Vaidyanathan (1986), Papola (1987), Radhakrishna, Sudhakar, and Mitra (1988), and Chadha (1993) for state and district-level comparisons across India; Evans and Ngau (1991) for data from Kenya; McPherson and Henry (1994) for evidence from Malawi; and Trung (2000) for a recent study from Vietnam.

review of several dozen African case studies explicitly notes that a productive agriculture increases nonfarm activity in rural areas, while sluggish agriculture instead induces emigration.

A cross-section econometric study across 85 different districts in India estimates agriculture to rural nonfarm income multipliers averaging 1.37 (Hazell and Haggblade 1991). That is, a 1 rupee increase in agricultural income produces roughly an additional 37 rupees in rural nonfarm earnings. About half of the increase in rural income occurs in rural areas and half in rural towns. But the strength of the agricultural growth linkages varies considerably across zones. Because of higher agricultural incomes and better infrastructure, agricultural growth linkages in the green revolution states of Punjab and Haryana achieve agriculture to rural nonfarm income multipliers roughly triple those in less favorable agricultural zones.

Agriculture influences not only the quantity but also the composition of rural nonfarm activity. Comparisons between low- and high-productivity agricultural regions suggest that labor market linkages play a key role in the shifting composition of rural nonfarm activity. Where agriculture increases the demand for labor, as it does initially in most green revolution settings, agricultural growth raises rural wage rates and the opportunity cost of labor, thereby rendering low-return nonfarm activities uneconomic.[9] As a result, agriculturally advanced Bangladeshi villages, where farmers plant a majority of their land in high-yielding rice varieties, experience higher agricultural incomes, agricultural wages, and nonfarm income per capita than do villages still dependent on traditional varieties (Hossain 1988b). The higher nonfarm income in prosperous villages reflects a greater concentration of high-return transport and service activities and less low-wage cottage industry, construction, and earth hauling (Table 7.1). Similarly, cross-regional studies from rural India, Togo, and Sierra Leone show a positive correlation between earnings per worker in agriculture and in rural nonfarm activities.[10]

Yet some cross-section studies of agriculture's impact on the RNFE produce ambiguous results, as Vyas and Mathai (1978), Sankaranagu (1980), Unni (1990), and Leones and Feldman (1998) have noted. An understanding of labor market linkages provides a likely explanation for this reported noncorrelation, because in most cases the ambiguity appears to stem from use of rural nonfarm employment rather than income as the measure of nonfarm activity.[11] Even if

[AQ1]Not in the refs.

9. Rising farm wages also lead, over time, to growing incentives for farm mechanization and other labor-saving on-farm technologies. See, for example, Duff (1987) and Estudillo and Otsuka (1999).

10. See Chadha (1986), Haggblade, Hazell, and Brown (1987), Papola (1987), Radhakrishna, Sudhakar, and Mitra (1988), and Jayaraman and Lanjouw (1999).

[Check year.]

11. To complicate matters further, these correlation studies apply an array of proxies for agricultural advance, including agricultural employment, incomes, wage rates, productivity, and level of commercialization.

TABLE 7.1 Labor market influences on the size and composition of rural nonfarm activities in Bangladesh, 1982

	Income per hour in agriculturally underdeveloped regions (Tk/hour)	Percent by which agriculturally developed regions exceed underdeveloped areas[a]		
		Income per hour[b]	Employment (hours/week)	Income per household
Agriculture	5.1	29	8	40
Nonagriculture				
Services	11.4	4	30	35
Cottage industry	4.4	90	–81	–63
Wage labor[c]	2.8	6	–41	–38
Trade	2.3	195	–28	113
Total nonagriculture	4.4	59	–29	12

SOURCE: Hossain (1988a, 95, 120).

[a]Hossain distinguishes agriculturally "developed" and "underdeveloped" regions by a number of criteria: access to irrigation, use of modern rice varieties, and fertilizer consumption, among others. In the agriculturally developed regions, modern varieties cover 60 percent of cropped area compared with only 5 percent in the underdeveloped areas.

[b]Calculated from Hossain (1988a), Tables 48 and 64.

[c]Nonfarm wage labor includes earth hauling, construction, transport, and "other" employment.

perfectly measured, employment offers an imprecise measure of nonfarm activity because high nonfarm employment may emerge in two very different environments. Table 7.2 illustrates this problem by contrasting two very different settings that generate identical gains in rural nonfarm employment. The first represents a typical green revolution Asian setting where growing farm incomes and labor demand induce rising wage rates, growth in high-wage rural nonfarm activity, and growing per capita income (as in Tables 7.1 and 4.3). In the second setting, high population growth in the presence of a sluggish agriculture dampens consumer purchasing power and rural wage rates, by default giving rise to employment growth in low-productivity, tedious nonfarm activities. Though rural nonfarm employment rises, wage rates and per capita income fall. Thus equivalent gains in rural nonfarm employment may signal good news or bad. Even where the impact of agricultural income growth on nonfarm income is clearly positive because of favorable consumption and input demand linkages, its impact on total nonfarm employment remains ambiguous (see Tables 7.1 and 7.2).

Although cross-section comparisons of agricultural and rural nonfarm *income* typically yield positive correlations, one cannot necessarily infer causality from these associations. Favorably endowed zones may simultaneously attract high-productivity agriculture, infrastructure investments, improved agricultural

TABLE 7.2 Contrasting sources of rural nonfarm employment growth in an Asian rice-growing economy (percent)

	The green revolution (pull)	The sponge (push)
Initial shock	Improved agricultural technology,[a] labor-using	Population growth[b]
Resulting changes		
Rural nonfarm employment	1.9	1.9
Total rural employment	6.6	2.1
Rural wage rate	6.6	–3.9
Nonfarm income	1.1	–4.7
Total real per capita incomes	7.4	–4.4

SOURCE: Haggblade and Liedholm (1991).

NOTES: Using a price-endogenous model, with stylized data drawn from the Muda River region of Malaysia, these results simulate the following impacts:

[a]Labor-using technical change in agriculture that increases foodgrain output by 80 percent and is adopted by 50 percent of farmers.

[b]A population growth rate of 6 percent over three years, which is just sufficient to generate an equivalent increase in rural nonfarm employment.

extension and technology adoption, public investment in schools, roads and government offices, as well as external nonfarm investment.[12] So further evidence is required to establish the nature of the common association between high agricultural and high rural nonfarm incomes.

Time-Series Evidence of Agricultural Growth Linkages

EAST ASIA. Time-series evidence from countries with fast-growing agriculture suggests that agriculture may generate powerful growth linkages with the RNFE.[13] East Asia, in particular, has sparked keen interest; many observers have asked why rural nonfarm activity flourished in Japan and Taiwan in the post–World War II period, while in South Korea it did not. In 1980, farm households in Japan and Taiwan earned 80 percent and 65 percent of their income, respectively, from off-farm sources, three-fourths of it in high-paying wage employment in rural towns and nearby urban areas. Yet Korean farmers earned only 33 percent of their total household income from nonfarm sources (only 15

12. Hazell and Haggblade (1991) explicitly correct for endogeneity of agriculture, infrastructure, and nonfarm activity through the use of agroclimatic instrumental variables in fitting agricultural incomes. After doing so, statistically significant links remain between a growing agriculture and agriculturally induced growth in the RNFE. Foster and Rosenzweig (2004) use 28 years of panel data from India to correct for these fixed effects.

13. See Mellor (1995) for an interesting set of case studies exploring the relationship between agricultural and nonagricultural growth.

percent if remittances are excluded), less than half of it in wage employment.[14] Moreover, the structure of employment in Korea's rural economy had not changed significantly in the prior decade (Park 1986). Japan and Taiwan, on the other hand, witnessed rapid increases in rural nonfarm employment and income shares (Ho 1982; Shih 1983).

In explaining this disparity, most analysts point first to differences in agricultural performance.[15] They identify lower initial agricultural productivity in Korea, a relative neglect of agriculture, and its consequently lower growth rate. Weaker agricultural growth diminished rural consumption linkages in Korea and at a later stage restricted the prospects for labor release from agriculture to high-paying, full-time, off-farm employment.

In addition to having more rapidly growing agricultural incomes, Japan and Taiwan invested more heavily in rural roads, railroads, and electricity and adopted a policy environment supportive of dispersed manufacturing, commercial, and service activity. By the early 1960s, Japan and Taiwan boasted a paved road and rural electrical network with densities over five times those in Korea (Saith 1987). Rather than following suit, South Korea concentrated its industrial infrastructure in its two major cities, Seoul and Pusan.

Comparison of the historical records in Taiwan and the Philippines leads to similar conclusions. In the Philippines, although agricultural growth linkages emerged, they proved weaker than in Taiwan because of policy biases in favor of urban and large-scale nonfarm firms, less attention to rural infrastructure, and a less conducive agricultural policy environment (Ranis and Stewart 1993). Unfavorable macro policies—including tight controls of foreign exchange and credit, highly subsidized credit to large firms, and heavy protection of large-scale, urban-based import substituting industries—likewise stifled rural nonfarm growth even in the presence of significant agricultural growth (Bautista 1995).

East Asian evidence suggests two distinct phases in rural nonfarm growth, at least in rural manufacturing: an initial agriculturally induced phase of rural industrialization followed by an urban-led dispersion of subcontract manufacturing to rural areas (Chapter 10). Amsden (1991) suggests that in Taiwan a classic case of agriculture-led rural nonfarm growth launched the first phase of that country's rapid growth of rural manufacturing. Demand linkages from agriculture—for locally specific mechanical equipment produced by rural blacksmiths, for repair services and farm inputs plus the consumer demand generated by a multitude of small family farms—indeed combined to stimulate demand for rurally produced goods and services. Likewise, forward linkages from agriculture to early export industries such as those producing canned fresh fruits and vegetables were instrumental in the rapid rise of rural nonfarm activity in

14. Ho (1986b), Oshima (1986a), Park (1986).

15. See Ho (1979, 1982, 1986b), Kada (1986), Oshima (1986a,b), Park (1986), and Saith (1987).

the 1950s and 1960s (Ho 1979; Ranis and Stewart 1993). After about 1966, however, Amsden contends that Taiwan entered a second phase of urban- rather than agriculture-led rural industrial growth. Focusing on nonagricultural raw materials, this second phase of export-led industrial growth was stimulated by progressive deconcentration of manufacturing activities from urban centers to suburban and surrounding rural areas in order to avoid urban congestion, higher wages, and rental rates.

A much smaller study of rural manufacturing on a major highway loop near metropolitan Manila likewise identifies a second phase of urban-led rural industrialization beginning during the 1990s. Monitoring in these villages over several decades recorded a spurt in rural metalworking when seven new establishments began manufacturing simple tin Christmas ornaments for export under subcontract to firms in Manila, presumably in order to benefit from lower wage and factory rental costs in rural areas.[16] Similar suburban-led rural industrialization has also emerged via rural subcontracting from China's export-oriented town and village enterprises (Liu and Otsuka 1998).[17]

Rather than generalizing to the entire RNFE, it is important to note that all three of these studies focus exclusively on rural manufacturing. Given the greater locational insulation of commerce and services from urban competition, it seems probable that the shifting engines of rural nonfarm growth may apply more to manufacturing than to tertiary sectors.

FAST-GROWING AGRICULTURAL ZONES ELSEWHERE. In other regions of the world, many observers fear that prospects for East Asia–style growth in high-return nonfarm activity will prove less favorable.[18] Given greater landlessness in South Asia, Southeast Asia, and Latin America, they fear that employment in agriculture may not keep pace with population growth. Consequently, the RNFE will become an employer of last resort, a sponge by default absorbing labor force increments unemployed in agriculture into progressively lower- and lower-return nonfarm activities (see Table 7.2).

In spite of these reservations, the limited evidence emerging from Latin America and South and Southeast Asia suggests that, even where landlessness and tenancy exist, agricultural growth can stimulate not only increasing rural nonfarm employment, but also growing nonfarm incomes as a result of diversification into higher-return nonfarm activity. Time-series studies from prosperous agricultural regions in Bangladesh, Colombia, the Indian Punjab, Indonesia, Malaysia, Malawi, the Philippines, Thailand, and West Bengal describe changes in the rural economy that suggest that rising agricultural income, wage rates,

16. Hayami, Kikuchu, and Marciano (1996), Kikuchi et al. (1997), Kikuchi (1998).

17. Da Silva and Del Grossi (2001) notes a similar change in Brazil from agriculture-led rural nonfarm growth to urban-powered rural settlement and economic activity powered by demand for housing, tourism, and leisure services.

18. Islam (1984, 1987c), Deshpande and Deshpande (1985), Mukhopadhyay (1985), Ho (1986a), and Shand (1986b).

and consumption demand from farm households have stimulated increases in rural nonfarm employment and incomes as well as a shift to more lucrative nonfarm activity.[19] In fast-growing agricultural zones of Malawi, where the spread of burley tobacco production by smallholders triggered rapid growth in farm incomes during the 1980s, McPherson and Henry (1994) discovered significantly faster growth of rural nonfarm enterprises and wage rates than in nonburley zones. They likewise found the most rapid growth in higher-return nonfarm activities such as food and beverage retailing. In Haryana, India's fastest-growing agricultural state during the 1960s, the miracle decade of agriculture-led growth produced a dramatic fall in low-return rural cottage industries together with a big jump in factory employment, commerce, and services (Bhalla 1981). Elsewhere in India, an array of village studies has documented how a growing agriculture leads to the tightening of rural labor markets and increased wage rates in rural nonfarm activities (see Chapter 3). Similarly, significant income gains registered in Ugandan export agriculture during the early 1990s stimulated a perceptible demand-led surge in rural nonfarm activity (Reinikka and Collier 2001). As one review concludes, "Historical and current experience suggest that employment generation and industrial and commercial development in rural areas are highly correlated with the rate of growth of agricultural output. This evidence . . . comes mainly from areas that have experienced high agricultural growth rates over long periods, such as the Indian and Pakistan Punjabs, Kaira District in the Gujarat State of India, Malaysia, Taiwan (China), Japan, and some European countries, including Italy and France" (Bhatt 1998, 289).

AREAS OF SLUGGISH AGRICULTURAL GROWTH. Slow-growing agricultural regions have enjoyed less careful scrutiny in the past, though rising concern about rural poverty has elevated policymakers' interest in these areas in recent years. Where available, study results suggest that a sluggish agriculture gives rise to anemic nonfarm incomes and wage rates. Though rural nonfarm employment may actually increase in lackluster agricultural zones (Table 7.2), it normally emerges in low-wage, last-resort activities such as basket weaving, embroidery, and gathering activities. Bhalla's (1994) study of agricultural involution in low-growth agricultural districts in Bihar and Madhya Pradesh, India, and Balisacan's (1993) discussion of slow-growing agricultural zones in the Philippines both document the resulting prevalence of low-productivity rural nonfarm activity.

Even from one year to the next, downward fluctuations in agriculture can generate perceptible downturns in rural nonfarm activity. Between 1978 and 1983, abnormal weather precipitated a 42 percent fall in agricultural income in

19. See Gibb (1974), Anderson and Khambata (1982), Bose (1983), Sander (1983), World Bank (1983), Wangwacharakal (1984), Chadha (1986), Kasryno (1986a), Shand and Chew (1986), Reinhart (1987), McPherson and Henry (1994), Poapongsakorn (1994), Hossain (2004), World Bank (2004), and Table 4.3.

[Not in the refs.]
[Check year.]
[Not in the refs.]

the Bicol region of the Philippines and an associated 49 percent fall in rural nonfarm business incomes (Ranis, Stewart, and Angeles-Reyes 1990). Similarly, a devastating drought during the 1983–84 crop season in the North Arcot region of India triggered a 34 percent fall in agricultural income, dragging in its wake a 24 percent fall in nonfarm earnings (Hazell and Ramasamy 1991). A series of West African case studies indicates that rainfall-induced reductions in year-to-year agricultural output lead to a simultaneous falloff in rural nonfarm income during the affected year (Reardon 1997).

PANEL DATA. These year-to-year fluctuations complicate time-series comparisons and point to an important weakness in the time-series evidence. Because temporal comparisons measure outcomes at two points in time, they normally trace the impact of many changes at once. Even in the presence of major structural changes in agriculture (before and after the introduction of green revolution varieties or before and after a major land reform), factors other than agriculture will certainly have changed. At a minimum, population and labor supply will have changed, often substantially, as the result of agriculturally induced migration into the zones with increased labor demand. Weather, the state of infrastructure, and government policies all may vary over time, commingling their contribution with the impact of the growth (or reduction) in agriculture.[20]

To avoid this problem, Foster and Rosenzweig (2004) have applied a panel data set spanning nearly three decades (1971 to 1999) from 240 villages across India to explore the relationship between agricultural productivity growth, agricultural income, and rural nonfarm employment. This work highlights the importance of labor market linkages between agricultural and rural nonfarm activity, particularly in the presence of mobile nonfarm capital and good rural infrastructure, which permit footloose rural manufacturing to relocate in pursuit of low rural wages. Their cross-section econometric results document a significant correlation between higher agricultural yields, higher farm income, higher wage rates in both agricultural and rural nonfarm activities, and higher local nonfarm incomes. However, when time-series fixed effects are accounted for, the link between agricultural productivity and rural nonfarm activity becomes statistically negligible. The authors conclude that because agricultural productivity drives up both farm and nonfarm wage rates, footloose rural factories relocate from high-wage to low-wage rural villages. Thus, over time, growth in agricultural income leads to an offsetting decrease in rural manufacturing. These countervailing effects neutralize the initial productivity-led income gains in agriculture, thereby depressing demand-driven spending increments on local rural nonfarm goods and services. These results suggest that over long periods, wage rate movements in agriculture and in rural nonfarm labor

[Not in the refs.]

20. A broad array of analysts has noted the difficulties of conducting time-series comparisons of agricultural growth linkages. See, for example, Bell, Hazell, and Slade (1982), Pandochyt (1986), Ranis, Stewart, and Angeles-Reyes (1990), and Hazell and Ramasamy (1991).

markets may significantly alter both the scale and the composition of the RNFE, a finding echoed by a similar panel study in rural Bangladesh (Hossain 2004).

In most settings, however, time-series data on rural nonfarm activity remain in short supply. Therefore, in order to isolate the impact of agricultural growth on rural nonfarm activity, a large component of the linkages literature has drawn on micro field data to construct counterfactual modeling estimates of the impact of agricultural growth on the nonfarm economy.

Modeling Agricultural Growth Linkages

Pros and Cons of Modeling

Apart from a handful of econometric estimates, most attempts at quantifying agricultural growth linkages have focused on counterfactual modeling (Table 7.3). Drawing on a generation of detailed microeconomic evidence from farm budget studies and from nonfarm enterprise surveys, analysts compute input-output relationships that measure the strength of backward and forward production linkages. Similarly, household expenditure surveys, if sufficiently detailed, permit assessment of the locational implications of consumer spending patterns.[21] Following early applications by Bell and Hazell (1980), Adelman (1984), and Thorbecke (1985), an expanding legion of social accounting matrix (SAM) builders has contributed to a growing array of empirical detail on economic interactions across national and regional economies. The subsequent integration of these SAMs into computable general equilibrium models with endogenous prices and factor mobility has enabled incorporation of labor and capital flows between agriculture and nonfarm businesses into the linkages models. The strength of the modeling approach lies in its ability to isolate the probable impact of agricultural growth from other forces affecting the RNFE, forces such as population growth, migration, government policy, major price shocks, and the vagaries of local meteorology.

The counterfactual modeling approach, however, presents several inconveniences that must also be recognized. One difficulty with this approach is that when data or behavioral parameters are unavailable or imperfectly understood, modelers resort to assumptions. In product markets, in particular, supply elasticities of farm and nonfarm goods have been the subject of considerable debate. Most linkages studies—the input-output (IO), the semi-input-output (SIO), and all SAM-based multipliers—assume a perfectly elastic supply of rural nonfarm goods and services. Some analytical models, such as the unconstrained IO and SAM multiplier estimates, assume a perfectly elastic supply of all products, including crop agriculture. Yet this remains a contentious assumption in many

21. See, for example, Mellor and Lele (1973), King and Byerlee (1978), Hazell and Roell (1983), Hazell and Ramasamy (1991), Lewis (1988), Bendavid-Val (1989), and Delgado, Hopkins, and Kelly (1998).

TABLE 7.3 Summary of empirical estimates of agricultural growth multipliers

Estimation method	Agricultural growth multiplier[a] (number of cases)		Differences in indirect income gains		
				Compared to endogenous price multipliers	
	National	Rural region[b]	National – rural	National	Rural
I. Econometric	1.97 (6)	1.39 (3)	0.58	0.22	–0.07
II. Modeling					
A. Fixed price					
1. Input-output	2.78 (5)	1.90 (2)	0.88	1.03	0.44
2. Semi-input-output	2.10 (14)	1.69 (14)	0.41	0.35	0.23
B. Endogenous price	1.75 (11)	1.46 (2)	0.29	0.00	0.00

SOURCE: Table 7.A.

NOTES:

[a]Change in total gross domestic product divided by initial shock in agricultural income. The numbers in parentheses represent the number of studies summarized.

[b]Includes rural regions or villages.

settings, particularly given the wealth of supply response studies documenting generally inelastic aggregate output supply response in agriculture (Binswanger et al. 1987; Binswanger 1989).

Projection of consumption linkages likewise hinges on values of marginal budget shares, though many times SAM builders have only average budget shares (ABSs) at their disposal. Because these normally understate incremental expenditures on nonfarm goods and services, use of the ABSs will normally underestimate marginal spending on nonfoods.

Factor market linkages likewise pose thorny analytical and empirical questions for the modelers. Rural labor markets, though highly variable and only imperfectly understood (Reardon 1997), exhibit a wide range of institutional particularities and rigidities—including long-term contracts, constraints imposed by caste systems, and the frequent immobility of women's labor—with which modelers must come to grips (Bhallah 1994; Jayaraman and Lanjouw 1999). Capital flows and savings allocation become even more difficult. Given the fungibility of funds, the invisibility of many of these flows, and respondents' reluctance to discuss indebtedness, modeling of these capital flows is more frequently based on intuition and assumption than on detailed understanding of the admittedly difficult-to-track flows. The sectoral allocation of investment becomes important in evaluating the dynamic effects of agricultural growth. Yet frequently the magnitude and even the direction of these flows remain subject to large margins of imprecision. Possibly for this reason, the bulk of linkage modeling assessments have ignored dynamic investment-led growth paths over time. Instead they have focused on comparative-static changes in output and income resulting from exogenous growth in key sectors of the economy. In doing so, modeling assessments have focused on consumption and production linkages, for which detailed empirical evidence has been painstakingly accumulated over the past several decades (see Chapter 2).

Methods

UNCONSTRAINED LINEAR FIXED-PRICE MODELS. Studies of growth linkages most commonly apply some variant of the linear IO model. In its most basic form, the IO model uses fixed IO coefficients and assumes fixed prices and perfectly elastic supply in all sectors. With perfectly elastic supply, any increase in demand leads only to higher output, with no change in price. Total supply in each sector (Z) is modeled as the sum interindustry input demand (AZ) and final demand (F), where final demand includes consumption by households (βY) and exogenous sources of demand such as exports (E). Income (Y) is related to production through a fixed value- added share (v) in gross commodity output (Z).

$$\begin{aligned} Z &= AZ + F \\ &AZ + \beta Y + E \\ &AZ + \beta v Z + E. \end{aligned} \tag{1}$$

[AQ2] Please define I (from the equation) somewhere in this paragraph.

Because supply is assumed to be perfectly elastic in all sectors,[22] total output and incomes are determined by the level of exogenous demand (E) and a matrix of multipliers (C):

$$Z = (I - C)^{-1}E. \tag{2}$$

Perfectly elastic supply in all sectors is, of course, an unrealistic assumption in many developing countries, particularly for some sectors. Given high rates of seasonal labor underemployment, typically low capital requirements, and substantial rates of reported excess capacity in many rural nonfarm businesses, a highly elastic supply of rural nonfarm goods and services is frequently an appropriate assumption.[23] In contrast, shortages of skilled labor, foreign exchange,

22. As Haggblade, Hammer, and Hazell (1991) and Bigsten and Collier (1995) note, the existence of a real multiplier hinges on the existence of slack resources that can be pulled into productive activity.

23. Liedholm and Chuta (1976), Steel (1977), and Bagachawa and Stewart (1992) report rates of excess capacity of between 33 percent and 60 percent for the countries of Sierra Leone, Ghana, and Tanzania, respectively.

and fixed capital frequently constrain output in the formal industrial sector. Likewise, in agriculture, seasonal labor bottlenecks, land availability, soil fertility, input supply, marketing infrastructure, and moisture constraints frequently limit supply responses.

Even so, some analysts suggest that agricultural supply elasticities may be high, at least over a certain range (Thorbecke 1994; Delgado et al. 1998). Anecdotal reports of piles of rotting fruit unable to find their way to market and excess bags of grain unevacuated from specific remote regions bolster these claims in some limited circumstances. Yet, apart from these episodic special cases, the overwhelming bulk of empirical evidence points to a low aggregate supply response in agriculture (Binswanger 1989). If farmers in the developing world could, in fact, increase crop output in unlimited amounts, agriculture would indeed represent a powerful engine of economic growth, for both malnutrition and poverty would vanish overnight as hungry farmers availed themselves of this perfectly elastic cornucopia.

By ignoring supply constraints altogether, unconstrained IO and SAM multiplier models exaggerate the magnitude of intersectoral linkages. Given that over half of the reported indirect effects in these unconstrained models come from demand-induced growth in foodgrains and other allegedly elastically supplied agricultural commodities, this questionable assumption biases anticipated indirect income gains substantially upward. Side-by-side comparisons with alternative formulations suggest that the unconstrained IO models overstate agricultural growth multipliers by a factor of 2 to 10 (Haggblade, Hammer, and Hazell 1991).

CONSTRAINED LINEAR FIXED-PRICE MODELS. To better simulate real-world supply rigidities, SIO models classify sectors into two groups, those that are supply constrained (Z_1) and others that are perfectly elastic in supply (Z_2).[24] As described in equations 3 and 4, the SIO model permits output responses only in the supply-responsive sectors (Z_2). Perfectly elastic supply ensures fixed prices for these (Z_2) goods. In the other group, that of supply-constrained products (Z_1), perfect substitutability between domestic goods and imports guarantees that world prices will ensure fixed prices for these goods as well. For these models to produce a reasonable approximation of reality, the supply-constrained sectors must correspond to tradable goods whose domestic supply remains fixed at the prevailing output price. In these supply-constrained sectors (Z_1), increases in domestic demand merely reduce net exports (E_1), which then become endogenous to the system and are determined by the matrix of SIO multipliers (C^*):

$$Z_1 = A_1 Z + \beta_1 v_1 Z + E_1. \quad (3a)$$
$$Z_2 = A_2 Z + \beta_2 v_2 Z + E_2. \quad (3b)$$

24. See Bell and Hazell (1980), Kuyvenhoven (1978), and Tinbergen (1966) for further discussion of the SIO method. In cases in which equations are specified for all accounts of a complete social accounting matrix, SIO models are also termed “constrained SAM multiplier models.”

$$E_1 = (I - C^*)^{-1} Z_1. \quad (4a)$$
$$Z_2 = (I - C^*)^{-1} E_2. \quad (4b)$$

As social accounting matrices have grown in popularity, SAM-based multiplier estimates have emerged to complement and extend the early linkages work. In spite of sometimes different labels, the SAM-based multipliers are formally identical to the IO and SIO models. All require an IO table to calculate the production linkages. All adopt fixed prices, fixed IO coefficients, and fixed marginal budget shares. All come in unconstrained and constrained versions. The SAMs themselves become convenient tools for summarizing the raw data and results. They also provide a basis for incorporating capital, trade, and government accounts. Frequently, given their origin in poverty and income distribution analyses, the SAMs offer great detail on factor allocation and distribution of income across household groups. What many in the literature call "unconstrained SAM-based multipliers" are formally identical to the unconstrained IO models. Similarly, the "constrained SAM-based multipliers" are formally identical to the SIO models (Haggblade, Hammer, and Hazell 1991; Lewis and Thorbecke 1992).

One interesting methodological innovation emerging from the SAM-based stream of linkages work is the "mixed multiplier" model proposed by Parikh and Thorbecke (1996). This variant considers some sectors perfectly inelastic in supply, some perfectly elastic, and some elastic but only over a specified, finite range. This formulation clearly requires detailed knowledge of a local economy and of the extent of excess capacity in all sectors. Where available, this information allows a more refined assessment of the indirect spin-offs of agricultural growth.

ENDOGENOUS PRICE MODELS. A further step toward realism in modeling linkages involves endogenizing prices and relaxing the assumptions of a fixed output of tradable goods and a perfectly elastic supply of nontradable goods. Haggblade, Hammer, and Hazell (1991) relax the assumption of a perfectly elastic supply of nontradable goods by introducing an upward-sloping supply of nontradables. However, their very simple model ignores the possibility of price responsiveness in the supply of tradable goods, and it assumes perfect substitutability between domestically produced and imported tradable goods.

To capture these effects as well as macroeconomic effects of changes in the real exchange rate requires a model with full price endogeneity, such as a computable general equilibrium model. Modeling endogenous prices greatly increases the data requirements, including behavioral parameters, many of which are difficult to obtain. Moreover, rural labor and capital markets—with their wide range of institutional particularities and rigidities—are especially difficult to model. Nonetheless, the importance of food and other agricultural price changes, particularly for low-income households, suggests that even a rudimentary inclusion of these effects on product, factor, and capital markets is desirable. For example, de Janvry and Sadoulet (2002) illustrate the potentially powerful poverty-reducing effects of agricultural growth resulting from indirect effects on food prices and wage rates.

Results

PRODUCTION AND CONSUMPTION LINKAGES. Given that linkage studies have been undertaken in a large variety of settings, at different points in time, using a range of analytical methods and varying units of analysis, it is perhaps not surprising that they have produced a wide range of results (Tables 7.3 and Appendix Table 7A.1). Consider the results from the Muda River region of Malaysia, a bellwether benchmark that has served as a rallying point for both linkage loyalists and doubters. Using a regional SAM disaggregated with 35 production accounts and 6 household groups together with a SIO model, the widely reported Muda study estimates a regional agricultural growth multiplier of 1.83. That is, every dollar in direct agricultural income generated by the Muda River project's investment in irrigation infrastructure and agricultural support triggered an additional 83 cents in second-round income gains elsewhere in the regional economy, 79 cents in nonfarm activity, and 4 cents in other agriculture. Of this incremental income gain, about 80 percent stems from consumption linkages and the remaining 20 percent from production links with agriculture.

Depending on the economy, the magnitude of the agricultural growth linkages varies considerably. Different agricultural technologies, income distributions, business and technical skills, spatial patterns of population, networks of infrastructure, and political, ethnic, and institutional environments all contribute to widely variable nonfarm responses to agricultural growth. Available estimates of agricultural growth linkages generally prove highest in Asia, where high-input agriculture generates strong backward linkages,[25] and where consumption diversification into nonfoods stimulates consumer demand for nonfarm goods and services. They become lower in Africa because of lower-input agriculture, which generates fewer backward linkages, and because lower incomes generate less consumption diversification into nonfoods. In Latin America, rural linkages appear to be low because of the extreme inequality in land and income distribution, absentee ownership of large landholdings, and the consequently feeble rural consumption and input linkages emanating from the often urban-based and urban-supplied hacienda owners.[26] However, given the high input intensity in agriculture and established supply networks from large cities, urban and aggregate national growth linkages prove substantial (de Janvry and Sadoulet 2002).

The unit of analysis also affects the results in a systematic way. While spending linkages to urban-produced goods constitute a leakage to the region,

---

25. See Bagachwa and Stewart (1992), Table 5.15, for quantification of the considerably lower input intensity of African agriculture.

26. Haggblade and Hazell (1989), de Janvry and Sadoulet (1993), Berry (1995).

they represent a gain to the national economy. By including urban as well as rural sources of demand-induced income growth, national multipliers necessarily exceed those limited to a rural region. On average, the 50-plus multiplier estimates summarized in Table 7.3 suggest that indirect income gains at the national level exceed those for rural regions by 50 to 150 percent, increasing indirect income gains by 30 to 90 cents for each initial dollar of agricultural income growth.[27] Inclusion or exclusion of government accounts likewise affects the results. In the Muda case, 6 of the 83 cents in incremental earnings accrued to government. In a comparable North Arcott study, government agencies earned 14 of the 87 cents in indirect income gains emanating from the green revolution varieties in the region (Hazell and Ramasamy 1991). Given that indirect taxes account for the majority of tax revenues in many developing countries, inclusion of indirect taxes in value added can significantly enhance projected results.

The choice of analytical method also affects projected linkages considerably. For this reason, the analyst must be careful to select the method embodying assumptions most appropriate to the economy under investigation. The unconstrained, fixed-price multiplier methods (the IO and unconstrained SAM-based multipliers) necessarily project indirect income gains higher than those obtained from the other methods. In the studies summarized by Table 7.3, the unconstrained IO multipliers generate indirect income gains that exceed those of the price endogenous models by 50 to 100 percent, increasing projected indirect income gains by 44 to 109 cents. Though in isolated instances and over very short ranges agricultural output of individual crops may prove elastic, the weight of available empirical evidence suggests that the bulk of agricultural production remains supply constrained in most of the developing world (Binswanger 1989). Consequently the unconstrained IO estimates, based as they are on the presumption of a perfectly elastic supply in all sectors of the economy, project generally overly optimistic growth multipliers.

Models that incorporate price endogeneity tend to reduce measured agricultural growth multipliers. Most analytical studies have nonetheless adopted fixed-price methods because of their simplicity and their tractability. For a village or a small rural region, this may well be reasonable. But as analysis moves closer to the national level, the fixed-price assumption becomes more difficult

27. The detailed African studies reported by Delgado, Hopkins, and Kelly (1998) suggest even greater increases, with indirect income gains increasing by 125 percent to as much as 600 percent when moving from a rural region to the national level (Appendix Table 7A.1). These large increases arise not only because the catchment area expands to include demand linkages from urban areas, but also because the classification of coarse cereals as nontradable within an SIO framework implies a perfectly elastic supply of sorghum, millet, and maize. Given technology, water, and peak season labor constraints, however, the output supply of these crops is normally considered inelastic. Under these conditions, as de Janvry (1994) points out, supply-constrained nontradables are best modeled using a price-endogenous model, which will reduce the projected multipliers.

to defend, particularly if the anticipated shock is large relative to the overall economy. Moreover, in the case of a large shock to a major agricultural subsector, macroeconomic effects on foreign savings or the real exchange can become important, as well.[28] Efforts to compare the effect of upward-sloping supply curves—as opposed to perfectly elastic ones—suggest that, in the presence of upward-sloping supply curves, fixed-price SIO income multipliers in developing countries may overstate indirect income gains by 20 to 25 percent (9 to 17 cents), depending on the region (Table 7A.1). Full computable general equilibrium (CGE) estimates produce variable results, in part because of the opposing effects of modeling a positively sloped supply curve both for tradables (which tends to increase the multipliers) and for nontradables (which tends to decrease the multipliers). In a recent comparison of SIO and CGE results for four African countries (Dorosh and Haggblade 2003), CGE multipliers were lower than SIO multipliers by 35 to 65 percent (42 to 104 cents) in two countries, but higher than SIO multipliers by about 45 percent (19 to 25 cents) in the other two countries (Table 7A.1).

MODELING FACTOR MARKETS LINKAGES. In rural labor markets, available modeling estimates generally confirm strong links between agricultural growth and labor demand in growing segments of the RNFE.[29] Early estimates of the employment gains generated by agricultural growth suggest strong employment increases in related nonfarm activities, particularly those supplying consumption goods and services to farm households.[30] In some instances, the nonfarm employment gains exceed the direct gains in agriculture.[31] Subsequently, full general equilibrium models in the tradition of Adelman (1984), de Janvry and Sadoulet (2002), and others offer the important benefit of tracking changes in both labor demand and wages in response to agricultural growth. One such study from Bolivia uses a CGE model to compare alternative agricultural growth strategies, projecting the highest growth in wage rates (5.5 percent) and gross domestic product (5.6 percent) from potato-led growth (De Franco and Godoy 1993).

Investment dynamics emanating from agricultural growth have remained confined to national-level simulations and econometric work.[32] Given difficulties in determining the spatial flows of savings and investments, few studies

---

28. Note that most fixed-price multiplier analyses do not formally specify a macroeconomic closure for the foreign trade account. It is important to realize, though, that in a standard SIO model the level of foreign savings (equal to the current account deficit) is endogenous. That is, capital is implicitly allowed to flow into the region or country so as to finance any increase in the current account deficit. See Dorosh and Haggblade (2003).

29. Mellor and Lele (1971), Mellor and Mudahar (1974), Krishna (1975), Ahmed and Herdt (1984), Haggblade and Liedholm (1991).

30. Mellor and Mudahar (1974), Krishna (1975), Ahmed and Herdt (1984).

31. See, for example, Ahmed and Herdt (1984) and de Janvry and Sadoulet (2002).

32. Adelman (1984), Block and Timmer (1994), De Franco and Godoy (1993), Block (1999).

have ventured to extrapolate the consequences of investment-led growth between rural and urban areas.

PRODUCTIVITY LINKAGES. Empirical investigations of productivity linkages from agriculture to the rest of the economy rely on a single analysis by Block and Timmer (1994), an evocative analysis that, by the researchers' own admission, blurs together consumption, production, and productivity effects. Hence their work, while important in highlighting this potentially important set of linkages, should be considered illustrative and evocative rather than definitive. The growing body of microeconomic evidence documenting the important impact of adequate nutrition on learning and on worker productivity (Strauss and Thomas 2000) does, however, offer indirect support for their thesis.

REVERSE LINKAGES. In general, demand linkages (production and consumption) from nonfarm to farm activities are much smaller than those from agriculture to rural nonfarm activities, both because of more inelastic supply in much of crop agriculture and because of the smaller nonfarm base. Indeed, when computed these reverse demand linkages from nonfarm activities to agriculture emerge as smaller or statistically insignificant.[33] Studies such as that by Parikh and Thorbecke (1996), which aim to measure these nonfarm-to-farm linkages at a village level, generate large results by virtue of their assumption of a perfectly elastic supply of agricultural goods over an initial range.

Factor market flows clearly move in both directions. They represent probably the most important of the reverse linkages (Table 7.4). Though these flows remain an integral part of neoclassical CGE models, structural rigidities prevailing in some locations imply that ground-truthing of the kind commonly available from the household case studies described in Chapter 6 will enhance understanding of the actual fluidity of labor flows across sectors and space.

Linkage Debates

Asian Doubters

The linkages literature originated in Asia with the advent of the green revolution. So it is perhaps natural that the richest literature and the loudest debates have emanated from that region. Prominent skeptics of the basic tenets of agricultural growth linkages have included Vyas and Mathai (1978), Harriss and Harriss (1984), Harriss (1987a,b), Hart (1987, 1989), and Leones and Feldman (1998). Their critiques and qualifiers have proven useful in highlighting the nature of agricultural growth linkages and the circumstances under which agriculture will or will not generate rapid growth in the RNFE.

33. Block and Timmer (1994), Delgado, Hopkins, and Kelly (1998), Block (1999), and Bravo-Ortega and Lederman (2005) find smaller reverse linkages, while Hazell and Haggblade (1991) find them statistically insignificant.

TABLE 7.4 Sources of start-up capital in rural nonfarm enterprises (percent of enterprises obtaining capital from each source)

	Own savings		Other sources of capital				
Country	Total	Share from agriculture	Friends and relatives	Moneylenders	Banks	Other	Total
Bangladesh							
Rural areas, 1980	72	33	2	6	0	22	100
Rural areas, 2000	77	—	6	4	11	2	100
El Salvador, 1996	70	—	11	12	7	0	100
Ghana							
Rural towns, 1984	0	—	87	3	7	3	100
Rural areas, 1992	—	71	—	—	—	29	100
India, agricultural trading firms							
Coimbatore district, 1980	92	13	8	0	0	0	100
Tanzania							
Arusha region, 1981	80	—	15	4	1	0	100

SOURCES: Liedholm and Chuta (1976), Ahmed (1984), Harriss (1987b), Thomi and Yankson (1985), Abdulai (1994), Bagachwa and Stewart (1992), Lanjouw (2001); Hossain (2004).

NOTE: A dash indicates that data are not available.

Doubts about the power of agricultural growth linkages revolve around three principal observations. First, the skeptics note that forces other than agriculture may strongly influence the growth of the RNFE. In a rural town in North Arcot, India, the local silk industry expanded rapidly following the green revolution, apparently unrelated to developments in local agriculture, because silk production there was based on imported rather than local inputs and on export rather than local markets (Harriss and Harriss 1984; Harriss 1987a,b). Other observers point to cases in which rural nonfarm employment has grown at rates higher or lower than agriculture, or even ones in which negative agricultural growth has occurred in the presence of nonfarm employment growth. Yet most of these studies track rural nonfarm activity via total nonfarm employment, an imprecise and undiscriminating indicator at best.[34] Even so, the doubters raise an important basic point: that agriculture is not the only force governing the growth of the RNFE. Nor is it always a sufficient condition for rural nonfarm growth, as the discussion of conditioners later in this chapter suggests.

Second, the doubters note that agricultural income growth may stimulate demand for urban rather than rural products. They observe that following the green revolution in North Arcot, farmers increased their use of sophisticated manufactured inputs such as tractors and petrochemical fertilizers, while consumers increased their purchases of imported goods such as cosmetics, ready-made clothes, plastics, and bottled cold drinks. These goods were normally produced in Madras or other large urban areas, not in the rural region (Harriss and Harriss 1984). Similarly, in the Muda River region of Malaysia, growing farm income resulted in increased consumption of television sets and other consumer electronics imported from urban areas and even from Thailand (Hart 1987, 1989). As these examples suggest, agricultural growth may well stimulate demand for urban or imported goods. Yet in these and other well-known instances, rural firms have been able to compete in supplying rural pump sets, farm tools, basic agricultural machinery, tailored clothing, and local beverages.[35] Moreover, rural businesses earn commercial margins selling imported goods, suggesting that rural services and marketing can coexist with imported manufactures. The relative shares of imported and local nonfarm goods and services will, of course, vary across settings. In the case of both Muda and North Arcott, rural nonfarm multipliers remained large—over 75 cents in rural nonfarm earnings for each dollar increase in agricultural income—even after accounting for rural purchases of these imported goods (Bell, Hazell, and Slade 1982; Hazell and Slade 1987; Hazell and Ramasamy 1991). Elsewhere this may not be the case given that basic conditions affecting both the composition of demand and the rural nonfarm supply response differ among regions in important ways.

34. See Vyas and Mathai (1978), Leones and Feldman (1998), and Chapter 1.

35. See Child and Kaneda (1975), Chuta and Liedholm (1979), Tomich, Kilby, and Johnston (1995), Hayami (1998c), and Shah et al. (2000).

Likewise, in evaluating the prospects for urban as opposed to rural demand linkages, it is important to distinguish between rural manufacturing on the one hand and rural commerce and services on the other. Because of the easy transport of urban manufactures as infrastructure improves, rural manufacturing remains the most vulnerable segment of the RNFE.[36] At the same time, rural commerce and services remain more insulated from urban-based competition.

In rural commerce and services, even the most prominent doubters acknowledge that agricultural growth will stimulate rural nonfarm activity. Comparing time-series data between 1973 and 1983 in a market town of North Arcot, India, the Harrisses noted a large increase in rice milling and trading following the introduction of green revolution rice varieties in the region (Harriss and Harriss 1984; Harriss 1987a,b). Moreover, the number of welding and general engineering firms more than doubled over the same period, focusing principally on agricultural input supply and repairs for products such as pump sets, electric and diesel motors, irrigation pipes, agricultural trailers, and bullock carts. The Harrisses also recorded a substantial increase in local consumption linkages, primarily involving service providers such as pawnbrokers, lawyers, doctors, transporters, cycle hire and repair shops, barber shops, and laundries. Similarly, Sander's early study of green revolution Philippines in the region around Cabantuan city found that farmers' spending stimulated nonfarm employment, primarily in commerce (grocery stores, restaurants, cafes, and transport) and in services (most notably in private secondary education) following the introduction of new varieties of "miracle" rice (Sander 1983). In the Muda River region of Malaysia, Hart noted moderate diversification of the nonfarm economy, primarily through the expansion of commerce and services, in this case primarily government services (Hart 1989). In all of these Asian cases, the agriculturally induced linkages consisted most prominently of services and commerce.

Third, the doubters suggest that investment linkages emanating from agricultural growth may result in a transfer of savings and investment out of the rural region. In Malaysia, Hart (1989) notes that historic partitioning of economic roles induces the ethnic Chinese who run many rural nonfarm businesses to channel their profits to urban areas, where opportunities for Chinese are greater. Even among ethnic Malays living in rural areas, large-scale government inducements to improve investment opportunities may have encouraged an outflow of savings to unit trusts and other investment schemes established in urban areas. Indeed, in their efforts to quantify regional economic flows, Bell, Hazell, and Slade (1982) note a large outflow of savings from the Muda region. Similarly, in North Arcot, India, attempts to track the flows of savings and investment emanating from agricultural growth suggest that nonfarm business

36. See, for example, recent evidence from Bangladesh in Table 16.2.

owners evacuated a substantial share of profits from rural areas into urban investment (Harriss 1987a,b), a finding corroborated during the construction of a social accounting matrix for that region (Hazell and Ramasamy 1991). While first-round rural growth multipliers remained large, even after accounting for these outflows, the transfer of capital outside the rural region foreshadows a lower investment-led growth trajectory in future years.

These observations raise the important distinction between first-round income gains from an initial agricultural spurt and the subsequent rounds of investment-led growth. Modelers distinguish between these "level effects," jumps to a new income level, and "rate effects," changes in the rate of income growth over time. Indeed, empirical measurement of growth linkages has focused almost exclusively on the comparative-static estimates of income gains, that is, the level effects resulting from agricultural growth. In large part because of the empirical difficulties associated with measuring and tracing the geographic deployment of savings and investment, few quantitative studies have ventured into dynamic modeling of the impact of investment linkages and the rate effects in and outside the rural regions.[37] Here the doubters point to an important but difficult empirical issue that indeed deserves more careful scrutiny in future empirical work.

African Believers

In general, the growth linkages discussions emerging in Asia in the early 1970s were exported to Africa in the 1980s and have taken root in Latin America only since the mid-1990s. In that transition, Africanist scholars appear generally optimistic that agricultural growth linkages exist in rural Africa, albeit at levels lower than those found in Asia. Both agricultural specialists and students of the RNFE routinely express confidence in the importance of agricultural stimulus to rural nonfarm activity.[38] A study from Burkina Faso states categorically that "80% of the rural nonfarm activity is agriculturally related" (Wilcock 1981; Reardon et al. 1993). Perhaps because of the prevalence of local beer brewing from millet, sorghum, and maize,[39] many observers readily acknowledge that the bulk of rural nonfarm activity is, in fact, agriculturally based. For Africanists, growth linkages clearly exist. The hard question is how to trigger agricultural growth in the first place (de Janvry 1994).[40]

[AQ3]Which is the source of the quote, and on what page in that source is it found?

37. Adelman (1984), De Franco and Godoy (1993), Block and Timmer (1994), and Block (1999) do incorporate dynamic investment linkages from agriculture, though at a national level.

38. See, for example, Chuta and Liedholm (1979), Freeman and Norcliffe (1985), Haggblade, Hazell, and Brown (1989), Bagachwa and Stewart (1992), Reardon et al. (1993), Delgado et al. (1994), and Reardon (1997).

39. See Freeman and Norcliffe (1985), Milimo and Fisseha (1986), Chuta and Liedholm (1989), and Haggblade (1992).

40. Indeed, some scholars have raised doubts about the prospects for broad-based agriculture-led growth in Africa (Maxwell 2003; Ellis 2005). A related body of research has focused on African

Latin American Skeptics

In contrast, Latin American specialists have only tepidly participated in the agricultural growth linkages debates. From the nonfarm perspective, Latin Americanists have explored reasons for the paucity of both rural towns and rural nonfarm activity, an absence they ascribe to the highly urbanized concentration of population and to the highly stratified society and economic control that pervades much of the continent (Berry 1976, 1995). These factors result in minimal farm-nonfarm linkages in Latin American's rural towns, particularly compared with the those in Asia and Africa (Table 7.5), although commercial links with large cities prove more substantial. Given the highly skewed distribution of land and because of the urban-focused consumption patterns of an often absentee landlord class, rural nonfarm consumption linkages remain less significant as well (Haggblade and Hazell 1989; de Janvry and Sadoulet 1993). Although evidence of agricultural growth linkages does exist, particularly at the urban and national levels, many Latin American scholars believe that stimulus to rural nonfarm activity will depend disproportionately on nonagricultural motors such as tourism and urban-to-rural subcontracting for export markets.[41]

Overall, the Latin American discussions underline two important conditioners of agriculture-led growth in the RNFE. Income and asset distribution clearly influence the distribution of income emanating from agricultural growth, and hence the nature of consumption linkages. Likewise, the existing structure of urban settlements, markets, and economic power also powerfully shape prospects for an effective rural nonfarm supply response.[42]

Is Generalization Possible?

Given the extreme heterogeneity of rural nonfarm activity, agricultural growth, like other stimuli, will affect various components of the RNFE differently. Like-

"deagrarianization." This work notes that agricultural income has fallen in many places following liberalization and the consequent withdrawal of agricultural support programs, forcing many rural households to supplement their livelihoods through rural-to-urban migration or diversification, often into unskilled rural nonfarm activities (Bryceson and Jamal 1997; Bryceson 2002). Explanations advanced for this increasing reliance on urban and rural nonfarm income include languishing opportunities in agriculture, growing population pressure, land shortages, environmental degradation, declining formal urban employment, and rising Western consumerism, which renders agriculture a low-prestige occupation. Most of these explanations are consistent with the growth linkages literature, which likewise notes that stagnating agriculture will propel rural labor into migration or low-productivity rural nonfarm activities.

41. Reinhart (1987), De Franco and Godoy (1993), de Janvry and Sadoulet (1993, 2002), Reardon, Berdegué, and Escobar (2001).

42. Differences in definitions of what is considered rural may also explain the apparently lower rural nonfarm growth linkages in Latin America. If Latin American countries generally define settlements over 2,000 as urban while Asian countries use a population size cutoff of 10,000 or larger, at least some of the reported differences in rural nonfarm activity may stem from simple definitional differences of what is considered rural (Tacoli 1998; De Ferranti et al. 2005). We are grateful to Steve Wiggins for pointing this out.

TABLE 7.5 Locational distribution of agriculturally induced nonfarm income growth

	Change in agricultural income	Resulting nonfarm income gains	Nonfarm income increments per $ of farm income gain		
			Rural	Towns	Total
North Arcot, India, 1982 (millions of rupees)					
Rural	408	111	0.27		
Urban villages	13	18			
Regional towns	8	200			
Total	428	329	0.26	0.51	0.77
Kutus region, Kenya, 1987 (millions of shillings)					
Rural	61	17	0.28		
Regional town	3	8			
Total	64	25	0.26	0.13	0.40
Michoacan region, Mexico, 1984 (thousands of pesos)					
Rural	129	43	0.33		
Regional town	90	5			
Total	219	48	0.19	0.02	0.22

SOURCES: Figures computed based on Hazell and Ramasamy (1991), Lewis and Thorbecke (1992), Yúnez-Naude, Taylor, and Dyer (1998), and Rosegrant and Hazell (2000).

NOTE: A blank cell indicates that data are not applicable **[or "available"?].**

wise, because of varying economic structures across continents and regions, the impact of agriculture will differ across locations. Yet even within this overall diversity, several general conclusions do emerge.

GENERALIZATION 1: GROWTH LINKAGES FREQUENTLY PROVE SUBSTANTIAL. On balance, available evidence suggests strong linkages between agriculture and the RNFE—strongest in Asia; weaker in Africa, though with the potential to increase with changes in the input structure of agriculture and with rising incomes; and least strong in Latin America for structural reasons. Differences in available estimates of growth linkages emerge because of differing types of agriculture, economic and social settings, units of analysis, and modeling assumptions. In the end, a plausible range for national agricultural growth multipliers stands between the SIO and price-endogenous estimates. Best-guess generalizations probably lie in the range of 1.6 to 1.8 in Asia and 1.3 to 1.5 in Africa and Latin America.

GENERALIZATION 2: CONSUMPTION LINKAGES DOMINATE. A predominance of empirical studies in the developing world suggests that consumer

long

spending accounts for about 80 percent of agricultural demand linkages, while production linkages account for the remainder.[43] Consumption linkages appear weakest in Latin America and in estate-led agricultural growth in general (Haggblade and Hazell 1989; de Janvry and Sadoulet 1993). Comparisons across a broad group of developed and developing countries indicate that consumption linkages fall from 80 percent of demand linkages in poor countries to about 60 percent in the developed world because of the rising input intensity of agriculture and the growing importance of backward linkages (Vogel 1994). In the developing world, however, particularly in Asia and Africa, consumption linkages from agriculture to the nonfarm economy remain of principal importance, as Mellor and Lele (1973) first suggested.

GENERALIZATION 3: RURAL SERVICES AND COMMERCE ACCOUNT FOR THE MAJORITY OF RURAL NONFARM LINKAGES. Within the RNFE, manufacturing appears most vulnerable to competition from urban goods. Because growing agriculture often brings with it improvements in marketing infrastructure, it facilitates the penetration of urban manufactures in rural areas. So rural manufacturing typically undergoes a substantial transformation in buoyant agricultural regions as low-quality, low-productivity manufacturing in cottage and home-based industries is displaced by the twin pressures of rising rural wages and growing competition from imports. Meanwhile, rural services such as housing, education, transport, health, and personal services grow briskly, largely insulated from outside competition.

GENERALIZATION 4: LABOR MARKET LINKAGES STRONGLY INFLUENCE THE GROWTH AND COMPOSITION OF THE RNFE. Via labor demand and rural wage rates, agricultural growth influences the composition of rural nonfarm activity (Table 7.1). Because agricultural growth induces a decline in low-wage nonfarm activities such as basket weaving and potterymaking while at the same time encouraging growth in higher-return services and factory manufacturing, the net impact on total nonfarm employment remains ambiguous.

GENERALIZATION 5: CAPITAL FLOWS ARE IMPORTANT, THOUGH IMPERFECTLY UNDERSTOOD. Capital flows between agriculture and the RNFE appear very important in both directions, though most evidence remains more anecdotal than empirical. Where available, data on sources of investment and working capital in both agriculture and nonfarm businesses suggest regular flow of funds in both directions. While tracing these flows within a given firm or household remains relatively straightforward, flows across households become difficult to quantify given an absence of institutional intermediation and the reticence of traders and households to reveal their indebtedness to probing outsiders.

43. See Bell, Hazell, and Slade (1982), Ahmed and Herdt (1984), Chadha (1986), Haggblade and Hazell (1989), Ranis, Stewart, Angeles-Reyes (1990), Bagachwa and Stewart (1992), and Delgado, Hopkins, and Kelly (1998).

[Check year.]

Consequently, our understanding of these capital flows remains only partial and imperfect.

GENERALIZATION 6: PRODUCTIVITY LINKAGES ARE PROBABLE BUT LARGELY UNMEASURED. Productivity linkages from agriculture to the nonfarm economy emerge as likely, though direct evidence remains tentative. The large body of microeconomic literature linking food prices, nutrition, human learning, and productivity provides the strongest available evidence of these productivity linkages. Given growing concern about poverty, this feature of agricultural growth linkages will require further work.

Conditioners of Agricultural Growth Multipliers

WHO RECEIVES THE INITIAL INCOME SHOCK? Available empirical evidence suggests that the power of agricultural growth linkages depends on a variety of conditioning factors. Most important are the consumption preferences of the farmers receiving the initial income shock. Because consumption linkages account for about 80 percent of indirect income gains, the propensity of farm households to consume local products as opposed to imports becomes crucial to the spatial distribution of the indirect income gains. For this reason, much of the linkages literature has attempted to identify the farmer groups that offer the most powerful local consumption linkages (Table 7.6).

Many prominent proponents have advocated a "unimodal" agricultural growth strategy, which is shorthand for a small-farm focus in agriculture-led growth (Mellor and Johnston 1984). Yet some confusion surrounds this conventional orthodoxy because the unimodal blanket shrouds a remarkably supple tent into which advocates have swept "small farms," "peasant farmers," "larger, more commercialized farms," "larger farms that are really medium-sized farms by most standards," "middle-sized farms," and "dominant cultivating classes."[44] Confusion arises because of widely differing farm sizes in Asia compared to Africa and Latin America and because of consumption data that are frequently collected by expenditure class rather than by farm size, coupled with the well-known lack of correspondence between the two. In the end, the important generalization emerging from this debate is that resident farmers who consume and send their children to school in rural areas generate the largest rural nonfarm consumption linkages. If their hearts and their spending remain focused in rural areas, they will generate growth in rural nonfarm activity, particularly in commerce and services such as transport, prepared foods, education, and medicine.

FACILITATING THE RESPONSE OF RURAL NONFARM PRODUCERS. In response to an initial demand stimulus from agriculture, the supply responsiveness

44. See Mellor and Lele (1973), Hazell and Roell (1983), Mellor and Johnston (1984), Harriss (1987a,b), Ranis and Stewart (1987), and Tomich, Kilby, and Johnston (1995).

TABLE 7.6 Characteristics of farmers who generate maximum rural nonfarm growth linkages

Setting	Reference	Evidence	Characteristics of farmers
India	Mellor and Lele (1972)	Marginal budget shares by rural expenditure decile	Higher-income rural people (6th to 8th rural expenditure deciles), members of the dominant cultivator class
Malaysia and Nigeria	Hazell and Roell (1983)	Marginal budget shares by farm size	Larger farmers (but "large farms in our sample are really medium-sized farms by most standards"), medium-sized farms
Taiwan	Ranis and Stewart (1985)	Marginal budget shares by labor intensity of farm production	Small farmers, tenants, wage earners
Global	Tomich, Kilby, and Johnston (1995)	Review of literature on consumption and production linkages	Small farmers, suggesting a broad-based, "unimodal" strategy "involving the majority of farms (which are inevitably small)"

of rural nonfarm producers will depend on a variety of structural features of the rural economy:

- The distribution of necessary entrepreneurial and technical skills varies across locations and will strongly influence supply response. Ethnicity, caste, historical specialization, and features of the local educational system all influence the availability of human skills necessary to enable local nonfarm producers to respond. The distribution of political power and social capital and the degree of trust across ethnic groups likewise play key roles in determining the location of nonfarm activity emanating from agricultural growth.
- The quality of rural infrastructure and the degree of integration and openness of the rural economy also matter a great deal. Virtually all case studies of agricultural growth linkages and the RNFE emphasize the importance of rural infrastructure in facilitating communication, transport, and credit flows and improving the responsiveness of the nonfarm economy to increases in demand from agriculture.[45]
- Population density and distribution govern the cost, profitability, and minimum efficient scale of rural production. In general, increasing population density favors local production by reducing the catchment area necessary to achieve minimum efficient scales of production and reduce transport costs, thereby improving the prospects for rural firm response.
- The general policy environment likewise plays an important role in facilitating (or depressing) rural nonfarm enterprise growth. Tax rates on imports and on local production, interest rates, and labor market regulation can all influence the size and spatial distribution of nonfarm activity.[46]
- The average per capita income affects the marginal propensity to purchase nonfoods. Richer regions typically have higher demand for nonfoods and for high-value and processed foods.[47]

Because these conditioners vary across settings, reported agricultural growth multipliers vary substantially. A study incorporating three of these effects (income levels, infrastructure quality, and population density) estimates that agricultural growth multipliers range from 1.9 in the high-income, high-density, high-infrastructure Indian states of Punjab and Haryana to as low as 1.3 in low-income states such as Bihar (Haggblade and Hazell 1990). The indirect effects triple in favorable settings, suggesting that these conditioners will be

45. Barnes and Binswanger (1986), Evans (1990), Hazell and Haggblade (1991), Ahmed and Donovan (1992), Fan, Hazell, and Thorat (1999).

46. Anderson and Leiserson (1978), Chuta and Liedholm (1979), Haggblade, Liedholm, and Mead (1986), Ranis, Stewart, and Angeles-Reyes (1990), Bautista (1995).

47. Hazell and Roell (1983).

crucial in determining the settings in which growth linkages achieve their full potential.

Looking Forward

Changing Motors of Rural Nonfarm Growth

Agriculture, because of its economic importance in rural areas, plays a predominant role in influencing the size and structure of the RNFE early on. At later stages of economic growth, as population density increases, per capita incomes (and hence consumption patterns) change, and as transport improves, rural settlement may be encouraged by forces other than agricultural potential. In crowded settings such as the urban centers of East and South Asia, urban decongestion becomes an important stimulus motivating voluntary movement of people and factories from urban to rural areas.

Today China and the East Asian tigers have moved into a phase in which urban-led rural manufacturing growth probably predominates. In South Asia, extremely high population densities and rising incomes have made possible the beginnings of a shift to urban-led rural industrial growth in small zones clustered around major metropolitan centers and transport arteries. Yet agriculture remains the dominant player in rural areas there and will probably remain so for another generation. Likewise, in Africa, rural population densities remain low and agriculture remains the dominant economic force in rural areas. So there, too, agriculture will remain a primary governor of overall rural nonfarm activity. Meanwhile, in Latin America—where high concentrations of economic power, dendritic markets, and social and ethnic cleavages have shackled economic development in rural areas for generations—modern nonfarm activity, like population, infrastructure, and wealth, has remained concentrated in towns. For the forseeable future, despite ongoing patterns of globalization, agriculture will remain the key driver of rural nonfarm activity in South Asia and rural Africa. Elsewhere, agriculture will remain a force to be reckoned with, though no longer necessarily the dominant factor influencing rural nonfarm activity.

Policy Prescriptions

Wherever agricultural growth occurs, it holds the potential to stimulate second rounds of growth in the RNFE. To maximize the domestic and rural nonfarm spin-offs from agricultural growth, several key prescriptions appear to have maintained their currency over time and across geographic settings.

First, put very simply, agricultural growth should target farmers who shop in rural areas. Because consumption linkages dominate as a stimulus of rural nonfarm activity, the single most important determinant of linkages is the consumption preferences of farmers who enjoy the initial gains in agricultural income. Evidence suggests that targeting different categories of farmers remains an important policy variable largely under the control of government agricultural research and extension services. Comparisons of maize breeding in Africa contrast Zimbabwe and South Africa, where government researchers focused on hybrids appropriate for large commercial farmers, while recent breakthroughs in West Africa have focused instead on open-pollinating varieties more easily adopted and maintained by small farmers (Byerlee and Eicher 1997). Agricultural research and extension programs can target different categories of farmers, and the choices they make will have fundamentally important implications for the size and nature of nonfarm spin-offs emanating from agricultural growth.

Second, rural infrastructure, such as roads, electricity, telecommunications, and the basic public services necessary to sustain rural towns, seems generally to enhance agricultural growth linkages. Other key conditioners of agricultural growth linkages, such as population density, ethnicity, caste, and the availability of local entrepreneurship, are less amenable to policy manipulation. Chapters 11–13 explore in greater depth how both infrastructure and programs of direct support to rural nonfarm firms might improve their responsiveness and hence accentuate the potential spin-offs emanating from agricultural growth.

Ultimately, ministers of finance must join with ministers of agriculture in recognizing that agricultural growth generates not only direct consequences for income distribution and poverty alleviation but also important indirect consequences via agriculture's growth linkages to the RNFE. Yet agricultural growth does not simply appear, like manna from heaven. It requires discipline, focus, and sustained investment by government, farmers, researchers, extension personnel, processors, and farm input suppliers. Most agricultural research is a public good, with strong externalities and a compelling need for substantial, sustained public investment (Anderson, Pardey, and Roseboom 1994). In general, it has proven highly profitable (Evenson and Gollin 2003). Sustained public investment in agricultural research requires political will and, in many cases, elevated priority for agricultural spending. Growth linkages can occur on the heels of agricultural growth. But, as de Janvry (1994) and others have emphasized, the operative constraint in many cases is how to trigger that agricultural growth in the first place. Chapter 17 returns to this theme, suggesting alternative development strategies for various regional settings.

Appendix 7A: Supplementary Table, Agricultural Growth Multipliers

See table on pages 174–182.

TABLE 7A.1 Empirical estimates of agricultural growth multipliers

Study				Initial increase in agricultural income[a]
(Source) and method	Country	Year	Unit of analysis	
I. Econometric estimates				
(1)	Ghana	1966–91	Nation	1
(4)	Philippines	1961–84	Nation	1
(7)	Ethiopia	1975–82	Nation	1
(7)				
(8)	Kenya	1972–92	Nation	1
(8)				
(8)	Zimbabwe		Nation	1
(9)	Less developed countries	1960–2000	International	1%
Latin America			Cross-section	1%
(18)	India	1971, 1981	85 districts	
(18)	India average	1971, 1981	Region	1
(18)	Punjab	1971, 1981	Region	1
(18)	Bihar	1971, 1981	Region	1
(27)	Thailand	1971–88	Nation	1

Additional income generated[a]							
By sector			By location		Total income multiplier[b]		Comments
Nonfarm	Other agricultural		Rural	Urban			
1.15	—	—	—	—	2.15	c	Two-stage least squares results; with ordinary least squares, multiplier falls to 1.73
1.32	—	—	—	—	2.32	c	
0.45	0.09	d	—	—	1.54	—	Investment linkages positive but not statistically significant Reverse linkages, nonfarm to agriculture, are smaller (0.42 service, 0.04 manufacture)
0.93	0.34	d	—	—	2.27	—	Investment linkages positive and statistically significant Reverse linkages from nonfarm to agriculture are smaller, one-third the size
0.63	0.30	d	—	—	1.93	—	
0.15%	—	—	—	—	—	—	Pooled time-series, cross-section data
0.12%	—	—	—	—	—	—	Pooled time-series, cross-section data
0.37	—	—	0.21	0.16	1.37	—	"Urban" includes rural towns only
0.58	—	—	0.34	0.24	1.58	—	Higher multiplier due to higher infrastructure, population density, and agricultural income
0.22	—	—	0.12	0.11	1.22	—	Reverse linkages from nonfarm to agriculture not statistically significant
0.61	—	—	—	—	1.61	c	

(*continued*)

TABLE 7A.1 *Continued*

Study				Initial increase in agricultural income[a]
(Source) and method	Country	Year	Unit of analysis	
II. Modeling estimates				
A. Fixed-price models				
1. IO and SAM multipliers (unconstrained supply response assumed in all sectors)				
(3)	Mexico	1986	Nation	1 GO
(21)	Zaire	1987	Nation	1
(23)	Kenya	1987	1 village	1
(32)	27 countries	Various years		
(32)	Low-income countries		Nation	1 GO
(32)	Low-income countries		Nation	1
(32)	Mid-income countries		Nation	1 GO
(32)	Mid-income countries		Nation	1
(30)	Mexico	1994	Rural region	1
(31)	Indonesia	1980	Nation	1
(31)	Gambia	1990	Nation	1
2. SIO and mixed SAM models (constrained supply response in some sectors)				
(5)	Muda	1967–74	Rural region	1
(12)	Burkina	1985	Rural region	1
(12)			Nation	1
			Sahel region	1
(12)	Niger	1990	Rural region	1
(12)			Nation	1
			Sahel region	1
(12)	Senegal	1990	Groundnut basin	1
(12)			Nation	1
			Sahel region	1
(13)	Madagascar	1984	Nation	1

Additional income generated[a]							
By sector			By location				
Nonfarm	Other agricultural		Rural	Urban	Total income multiplier[b]		Comments
—	—	—	1.30	1.74	—	[c]	GO multipliers
—	—	—			3.13	[c]	Traditional agriculture
—	—	—	—	—	1.86	—	Foodcrops 1.86; coffee multiplier 1.83
2.75 GO	—	—	—	—	—	—	GO mulipliers
1.72	—	—	—	—	2.72	[c]	Computed from GO assuming *va/x* = 0.8 in agriculture and 0.5 in nonagriculture
3.5 GO	—	—	—	—	—	—	GO mulipliers
1.50	—	—	—		2.50	[c]	Computed from GO assuming *va/x* = 0.7 in agriculture and 0.3 in nonagriculture
—	—	—	0.94	0.03	1.94	[c]	
—	—	—	1.33	0.98	3.31	[c]	Foodcrops
—	—	—	0.79	0.45	2.24	[c]	Rice
0.79	0.04	—	—	—	1.83	—	Agricultural tradables
—	—	—	—	—	1.31	—	Agricultural tradables
0.61	1.27	—	—	—	2.88	—	Agricultural tradables
—	—	—	—	—	4.33	—	Agricultural tradables
0.56	0.21	—	—	—	1.77	—	Agricultural tradables
0.67	0.29	—	—	—	1.96	—	Agricultural tradables
1.44	0.90	—	—	—	3.34	—	Agricultural tradables
0.26	0.77	—	—	—	2.03	—	Agricultural tradables
0.43	1.05	—	—	—	2.48	—	Agricultural tradables
0.65	1.46	—	—	—	2.73	—	Agricultural tradables
1.12	1.54	—	1.80	0.86	3.66	—	Irrigated rice (organic fertilizer modeled as nontradable input)

(*continued*)

TABLE 7A.1 *Continued*

Study				Initial increase in agricultural income[a]
(Source) and method	Country	Year	Unit of analysis	
(13)	Madagascar	1984	Nation	1
(13)	Madagascar	1984	Nation	1
(14)	Cameroon	1985	Nation	1
(14)	Gambia	1990	Nation	1
(14)	Lesotho	1987	Nation	1
(14)	Madagascar	1984	Nation	1
(14)	Niger	1987	Nation	1
(14)	Nigeria	1987	Nation	1
(14)	Tanzania	1976	Nation	1
(14)	Zaire	1987	Nation	1
(15)	Pakistan	2001	Nation	1
(15)	Pakistan	2001	Nation	1
(15)	Pakistan	2001	Nation	1
(16)	Sierra Leone	1975	Rural region	1
(17)	Asia	1989	Rural region	1
(17)	Africa	1989	Rural region	1
(17)	Latin America	1989	Rural region	1
(19)	Zambia		Rural region	1
(20)	North Arcott, India		Rural region	1
(21)	Zaire	1987	Nation	1
(22)	India	1974	Nation	1
(23)	Kenya	1987	1 village	1

Additional income generated[a]							
By sector			By location		Total income multiplier[b]		Comments
Nonfarm	Other agricultural		Rural	Urban			
—	—	—	—	—	2.41	—	Irrigated rice (organic fertilizer modeled as tradable input)
1.66	0.46	—	0.66	1.46	3.12	—	Coffee; large export taxes account for one-third of multiplier
—	—	—	—	—	3.02	—	Export crop growth; large taxation increases government income
—	—	—	—	—	1.43	—	Rice
—	—	—	—	—	1.14	—	Foodgrains
—	—	—	—	—	2.61	—	Irrigated rice (organic fertilizer modeled as nontradable input)
—	—	—	—	—	1.55	—	Foodgrains
—	—	—	—	—	2.15	—	Foodgrains
—	—	—	—	—	1.53	—	Foodgrains
—	—	—	—	—	2.30	—	Modern plantation agriculture
—	—	—	—	—	2.51	—	Irrigated wheat
—	—	—	—	—	2.30	—	Irrigated paddy
—	—	—	—	—	2.71	—	Growth in livestock
—	—	—	—	—	1.35	—	Unconstrained IO multiplier is 4.01
0.58	0.06	—	—	—	1.64	—	
0.18	0.10	—	—	—	1.28	—	Ox cultivation technology raises multiplier to 1.47
0.21	0.05	—	—	—	1.26	—	
0.11	0.30	—	—	—	1.41	—	
0.87	—	—	—	—	1.87	—	
—	—	—	—	—	1.74	[c]	Constraining agricultural activities reduce indirect effects by 65%
1.15	0.00	—	—	—	2.15	—	
—	—	—	—	—	1.43	[c]	Foodcrops and coffee give same result
							Constraining agricultural activities reduce indirect effects by 50%

(*continued*)

TABLE 7A.1 *Continued*

Study				Initial increase in agricultural income[a]
(Source) and method	Country	Year	Unit of analysis	
(24)	India	1990	2 villages	1
(26)	Mauritania	1985	Region	1
(28)	Malawi	1990	Nation	1
(29)	India	1985	1 village	1
B. Endogenous (variable) prices				
(2) CGE	South Korea	1963–78	Nation	1
(6) CGE	Kenya		Nation	1
(10) Simulation	Nigeria		Nation	1
(11)	Africa	Circa 1990	Nation	10% agricultural tfp
(11)	Asia	Circa 1990	Nation	10% land productivity
(11)	Latin America	Circa 1990	Nation	10% land productivity
(14) CGE	Gambia	1990	Nation	1
(14)	Madagascar	1984	Nation	1
(14)	Niger	1987	Nation	1
(14)	Nigeria	1987	Nation	1
(16) Simulation	Sierra Leone	1975	Rural region	1
	Muda River, Malaysia	1972	Rural region	1
(25) Simulation	India	1960s	Nation	1

[AQt-3] Please spell out tfp.

Additional income generated[a]							
By sector			By location				
Nonfarm	Other agricultural		Rural	Urban	Total income multiplier[b]		Comments
—	—	—	—	—	3.87	[c]	Irrigated crop agriculture; mixed multiplier assuming 10% supply response in agriculture
0.41	0.00	—	—	—	1.41	[c]	
—	—	—	—	—	1.66	—	
—	—	—	—	—	1.18	[c]	Negative shock in agriculture triggers fall in rural nonfarm income
—	—	—	—	—	1.64	[c]	Agricultural demand-led industrialization fastest and most equitable
—	—	—	—	—	1.20	—	
—	—	—	—	—	2.23	[c]	Balanced food and export promotion strategy
—	—	—	—	—	1.43	—	Converted to value-added multiplier using SAM shares
—	—	—	—	—	1.92	—	Converted to value-added multiplier using SAM shares
—	—	—	—	—	2.35	—	Converted to value-added multiplier using SAM shares
—	—	—	—	—	1.62	—	CGE increases indirect effects by 44% compared with SIO
—	—	—	—	—	1.57	—	CGE decreases indirect effects by 65% compared with SIO
—	—	—	—	—	1.80	—	CGE increases indirect effects by 45% compared with SIO
—	—	—	—	—	1.73	—	CGE decreases indirect effects by 36% compared with SIO
—	—	—	—	—	1.26	—	Upward-sloping supply of nontradables reduces multiplier 25% below SIO
—	—	—	—	—	1.66	—	Upward-sloping supply of nontradables reduces multiplier by 10% compared with SIO
—	—	—	—	—	1.70	—	

(*continued*)

TABLE 7A.1 *Continued*

SOURCES:

1 Abdulai (1994)
2 Adelman (1984)
3 Adelman and Taylor (1990)
4 Bautista (1990)
5 Bell, Hazell, and Slade (1982)
6 Bigsten and Collier (1995)
7 Block (1999)
8 Block and Timmer (1997)
9 Bravo-Ortega and Lederman (2005)
10 Byerlee (1973)
11 De Janvry and Sadoulet (2002)
12 Delgado et al. (1994)
13 Dorosh and Haggblade (1993)
14 Dorosh and Haggblade (2003)
15 Dorosh, Niazi, and Nazli (2003)
16 Haggblade, Hammer, and Hazell (1991)
17 Haggblade and Hazell (1989)
18 Hazell and Haggblade (1991)
19 Hazell and Hojati (1994)
20 Hazell, Ramasamy, and Rajagopalan (1991)
21 Koné and Thorbecke (1992)
22 Krishna (1975)
23 Lewis and Thorbecke (1992)
24 Parikh and Thorbecke (1996)[e]
25 Rangarajan (1982)
26 Rogers (1986)
27 Siamwalla (1995)
28 Simler (1994a)
29 Subramanian and Sadoulet (1990)
30 Yúnez-Naude, Taylor, and Dyer (1998)
31 Thorbecke (1994)
32 Vogel (1994)

NOTES: A dash indicates that data are not available. CGE, computable general equilibrium model; GO, gross output; IO, input-output model; SAM, social accounting matrix; SIO, semi-input-output model; *va,* value added.

[a]The standard measure is 1 unit of local currency. In some instances, however, authors list results as % changes rather than in absolute values.

[b]Initial shock in agricultural income plus indirect gains in nonfarm and additional agricultural income.

[c]Converted from gross output or percentages to value-added multipliers.

[d]Includes dynamic feedbacks from savings in one period to investment and output in the next.

[e]Allows for user-specified capacity constraints in the elastically supplied sectors.