The Economics of Agricultural Development: An Overview[1]

Christopher B. Barrett

I. Agricultural Development: The Gateway to Improved Standards of Living

Virtually all past cases of rapid, widespread economic development have been causally associated with the transformation of agricultural systems, from 18th and 19th century Europe and North America to late 20th century east Asia. Striking increases in agricultural productivity, improvements in food processing and storage, and markedly reduced costs of food distribution improved the quantity, quality, safety and variety of food available at lower prices. Through these advances, agricultural development permitted historically unprecedented growth in incomes, increased life expectancy, decreased the risk of chronic or acute malnutrition and enabled increased investment in education and non-agricultural activities in today's advanced economies.

Failure to achieve such improvements is strongly associated with the development failures of the poorest economies in the world today. Hence the opening sentences of T.W. Schultz's 1979 Nobel Prize lecture: "Most of the people in the world are poor, so if we knew the economics of being poor, we would know much of the economics that really matters. Most of the

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[1] This essay draws heavily on Barrett, Carter and Timmer (2010) and has benefited enormously from conversations on this topic over the years with Michael Carter, Jean-Paul Chavas, Alain de Janvry, Bob Herdt, Per Pinstrup-Andersen, Tom Reardon, Peter Timmer and the late Vern Ruttan. I thank them for the many lessons they have taught me; any errors of fact or interpretation in this essay are entirely mine, however.

world's poor people earn their living from agriculture, so if we knew the economics of agriculture we would know much of the economics of being poor" (Schultz 1980, p.639). Schultz famously observed that until communities and countries made scientific and institutional advances to reliably meet their subsistence food needs through improved production, processing and trade, few could begin the process of modern economic growth.

Understanding the process of agricultural development is therefore central to most contemporary research and advanced study in agricultural economics and development economics, in international development, in related social science subdisciplines such asanthropology, geography and sociology, and even in much of the agricultural sciences more broadly. The broad reach of this topic arises because research on agricultural development has long operated at the intersection of distinct subdisciplines in economics, other social sciences (especially anthropology, geography and sociology), and biophysical agricultural sciences. Today, virtually every college and university in the world teaches undergraduate and/or graduate courses in agricultural development, typically in a department of agricultural economics or economics. Many schools of international relations, public policy, development studies, agriculture, etc. likewise include programs in agricultural development. Interest in the field is especially intense and growing, for obvious reasons, in the emerging economies of Africa, Asia, Latin America, and Central and Eastern Europe that still rely relatively heavily on agricultural development to ignite their own economic growth, international trade and poverty reduction.

Agricultural development is thus a field of many disciplines, but economics has provided the main intellectual framework for analysis of what policies to follow that will speed the process of raising rural productivity and well-being. This four volume collection of seminal readings is therefore rooted in the economics of agricultural development.

Agricultural development is a relatively young field of scholarly inquiry. Serious interest began in the 1950s as independence movements in the Third World gathered steam, leading to a veritable explosion of research in the 1960s that established agricultural development as a powerful and influential field in the social and agricultural sciences. Following some waning interest in the 1980s and 1990s, the field has enjoyed a renaissance over the past decade – especially in the wake of the 2007-8 global food price crisis – as scholars and policymakers have increasingly recognized that there remain few firmly established dogmas and many unanswered questions. The realm of the unknown is so large because the reality of agricultural development on the ground is so complex, encompassing production and agroecological issues, post-harvest processing and distribution questions, and a wide array of economic and political institutional arrangements. Enormous progress has been made since the 1950s in documenting and understanding this complexity, although these issues' breadth and unsettled state lead to considerable ongoing intellectual activity in agricultural development. To be sure, we know a lot more than we did even fifty years ago. But it is sobering to read the classics from the early 1960s and realize how relevant many of their insights remain. Much of what was not known then remains unknown today.

This edited set surveys the literature in this vast field, structuring the presentation around four broad themes. The first volume revolves mainly around macro-scale issues of agricultural development at the national and global scales, addressing intersectoral spillovers, the relation between agriculture and sectoral and macroeconomic policies, the political economy of agriculture, and international trade in agricultural products. The second volume focuses on the microeconomics of markets and institutions, which are crucial to agricultural development as an ever-shrinking number of farmers strive to feed an ever-rising population of non-farm

consumers. We review the wide array of arrangements under which producers secure essential inputs such as labor, land and credit, and by which they supply surpluses into the agricultural marketing channel. The third volume is structured around the theme of farm-level productivity growth, emphasizing the role of technological innovation and diffusion and risk management in successful agricultural development through growth in land, labor and total factor productivity. The fourth volume explores the post-harvest distributional impacts of agricultural development, exploring how agricultural development affects poverty, food insecurity and the intra-household distribution of well-being.

Economists of all stripes have made fundamental contributions to the field of agricultural development. So I have had to be ruthlessly – and sometimes admittedly arbitrarily – selective in narrowing the hundreds of candidate articles and book chapters down to the 66 that follow this introductory essay. Necessarily and regrettably, I had to omit much important work – especially longer pieces that are difficult to fit into a set with a page ceiling – in order to tell the story of the economics of agricultural development compactly and (hopefully) coherently. It is therefore important for readers to appreciate that this collection really only scratches the surface.

My objective in this collection and especially in this introductory essay is not to be comprehensive, nor to go deep into the details of the many fascinating threads that jointly make up the rich fabric of the economics of agricultural development. Even important works are mentioned only in passing. Rather, the aim is to introduce the broad themes of the topic, to familiarize the reader with central issues and seminal findings that have guided the field's evolution over the past half century or so, to flag several dozen seminal readings for those who wish to plumb particular sub-topics in greater detail, and to use the references lists of those readings and this introductory essay as a gateway for students who wish to engage the topic in

greater depth. My aspiration is that this set kindles interest in students and younger scholars so that they will dive more deeply into the luxurious pool of economic research on agricultural development.

II. Agricultural Development and Economic Growth

We start with the big question: the role of agriculture in the broader process of economic growth and development. This macro perspective introduces key linkages between the agricultural sector and the rest of the economy, often via the rural non-farm economy, and pursues the dynamic evolution of structural transformation. The economic and demographic pathways inherent in this transformation present strategic challenges and opportunities to development policymakers, which leads as well to a discussion of the political economy of agricultural policy design and implementation during the structural transformation. And the tremendous heterogeneity of countries' experience of productivity growth and the pace of agricultural development (Mundlak 2000, chapter 3) binds these issues closely to associated questions of global poverty and food insecurity (Dercon 2009, chapter 9).

Agricultural development as an analytical topic, with economics as an organizing framework, dates to the rapid emergence of Western Europe from the late 18th century. Economic historians have documented the critical role of agriculture in the development of virtually all the now-rich countries in the world, an experience drawn upon by W. Arthur Lewis when he wrote: "industrial and agrarian revolutions always go together, and … economies in which agriculture is stagnant do not show industrial development" (Lewis 1954, p. 433).

A. Inter-sectoral Linkages and Agriculture in the Macroeconomy

These insights by Lewis stimulated three lines of thought about the role of agriculture in economic development. First, the direct outgrowth of Lewis' analysis of dual economies was formal two-sector modeling (Ranis and Fei 1961, chapter 4; Jorgenson 1961, chapter 5), with its focus on structural changes. Hayami and Ruttan (1985) explain how the dual economy literature marked an important break, introducing a "dynamic dualism" to replace prior, "static dualism" approaches that had mostly followed a descriptive, sociological and structural approach. Hayami and Ruttan concluded that neither modeling approach significantly advanced the understanding of how agricultural modernization actually takes place, although they acknowledged that the models help explain why it is necessary if overall economic growth is to take place. "The very simplicity of the models, a major source of their insight into the fundamental process of development, however, has led to substantial underestimation of the difficulties that face poor countries in achieving such a transformation" (Hayami and Ruttan 1985, p. 30).

Second, the macro perspective and the importance of two-way linkages between rural and urban economies were stressed by Johnston and Mellor (1961, chapter 6). Johnston later became increasingly concerned about the size distribution of farms and the "uni-modal" lessons from East Asia for Africa and Latin America (Johnston and Kilby 1975; Johnston and Clark 1982). Mellor continued his focus on South Asia and the difficulties for the agricultural sector on its road to industrialization (Mellor 1966, 1976, 1986). Both saw higher productivity on small farms as the key ingredient to rapid poverty reduction and a healthy structural transformation.

Third, T.W. Schultz (1964) stressed the need for an "agrarian revolution," or higher productivity through technical change in agriculture. He emphasized the importance of human capital, especially the education of rural workers, in facilitating productivity growth, and

governments' failure to provide appropriate policy environments (Schultz 1975, chapter 7, 1978).

Masterfully synthesizing the main lessons from nearly five decades of such analysis, Staatz and Eicher (1998, p.31, chapter 2) explain:

> By the end of the 1990s, development thinking had come nearly full circle. In the 1950s and 1960s, many development economists analyzed how the agricultural and nonagricultural sectors interacted during the process of economic growth, using simple two-sector models. This abstract theorizing was sharply criticized by dependency theorists, among others, who argued that such work abstracted from the institutional and structural barriers to broad-based growth in most low-income countries. During the 1970s and 1980s, the focus of research shifted to developing a more detailed theoretical and empirical understanding of the rural economy. But the emphasis on structural adjustment in the 1980s forced reexamination of agriculture's relationship to the macroeconomy. By the late 1990s, economists were again focusing on how the rural economy was linked to the broader world market, but they demonstrated a renewed recognition of how important institutions are in determining a country's pattern of growth and the distribution of the benefits of that growth.

In the ensuing decade, the profession finally got agriculture back on the broader development agenda. A key breakthrough was the publication by the World Bank (2007) of the *World Development Report 2008: Agriculture for Development*. Coordinated and drafted by Derek Byerlee and Alain de Janvry, this *WDR* was the first in a quarter century to focus specifically on agriculture. Its publication late in 2007, just as the world food crisis was heating up, looked prescient. Still, none of the major donor agencies have figured out how to gear up quickly to

support more spending on agricultural development, partly because there remains deep uncertainty over what to do and how to do it.

From a macro perspective, this uncertainty stems from two dimensions of the agricultural development process that remain poorly understood: (1) the dynamic role of the rural non-farm economy and how it mediates the linkages between the farm sector and the macroeconomy during the structural transformation; and (2) the political economy of agricultural policy and how that too evolves. Both topics have received substantial research attention almost from the beginnings of the field, but the research began to show new empirical depth and policy impact by the end of the 2000s (Haggblade, Hammer and Hazell 1991, chapter 10; Haggblade, Hazell, and Reardon 2007; Timmer 2009).

Formal two-sector models typically assumed the smooth functioning of the linkages that placed the fate of urban workers and farmers in each other's hands. The actors who mediate these linkages in a real economy, and how their role and structure change over the course of economic development, only became a topic of serious analysis in the 1970s. Then a veritable cottage industry sprang up to conceptualize and measure the "multipliers" implied by market-mediated linkages between agriculture and industry. Haggblade, Hazell, and Reardon (2007) nicely synthesize this literature, stressing the crucial and changing role of the rural non-farm economy.

The rural non-farm sector provides the bridge between commodity-based agriculture and livelihoods earned in the modern industrial and service sectors in urban centers. Most rural households earn a large share of their incomes from non-farm sources, and often this sector is the "ladder" from underemployment at farm tasks to regular wage employment in the local economy, and from there to jobs in the formal sector (Delgado, Hopkins and Kelly 1998; Mellor

2000; Barrett, Reardon and Webb 2001, chapter 15). The firms and activities in the rural non-farm sector mediate many of the two-way linkages between agriculture and the macroeconomy that are at the core of the development process. These linkages can be summarized in three categories (Timmer 2002, chapter 8).

The "Lewis linkages" between agriculture and economic growth provide the non-agricultural sector with labor and capital freed up by higher productivity in the agricultural sector. These linkages work primarily through factor markets, but there is no suggestion that these markets work perfectly in the dualistic setting analyzed by Lewis (1954). Chenery and Syrquin (1975) argue that a major source of economic growth is the transfer of low-productivity labor from the rural to the urban sector. If labor markets worked perfectly, there would be few productivity gains from this structural transfer, a point emphasized first by Jorgenson (1961, chapter 5) and later by Syrquin (2006).

The indirect "Johnston-Mellor linkages" allow input-output interactions between the two sectors so that agriculture can contribute to economic development. These linkages are based on the agricultural sector supplying raw materials to industry, food for industrial workers, markets for industrial output, and the exports to earn foreign exchange needed to import capital goods (Johnston and Mellor 1961, chapter 6). As with the Lewis linkages, it is difficult to see any significant role for policy or economic growth unless some of the markets that serve these linkages operate imperfectly. Resource allocations must be out of equilibrium and face constraints not immediately reflected in market prices if increases in agricultural output are to stimulate the rest of the economy at a rate that causes the "contribution" from agriculture to exceed the market value of the output, i.e., the agricultural income multiplier is greater than one (Timmer 1995).

Writing in the mid-1960s, Mosher (1966) assumed that "getting agriculture moving" would have a high priority in national plans because of its "obvious" importance in feeding people and providing a spur to industrialization. That assumption has held only in parts of East and Southeast Asia, and has been badly off the mark in much of Africa and Latin America. Indeed, the widespread lack of progress in both agricultural productivity growth and poverty reduction has prompted serious scholars to question whether agricultural growth really is crucial as an engine for growth (Dercon 2009, chapter 9). One key obstacle in Africa and Latin America has been that a historically prolonged and deep urban bias led to a distorted pattern of investment. Too much public and private capital was invested in urban areas and too little in rural areas, especially in more remote, "less favored areas" (Fan and Hazell 2001, chapter 14). Too much capital was held as liquid and non-productive investments that rural households use to manage risk. Too little capital was invested in raising rural productivity.

Such distortions resulted in strikingly different marginal productivities of capital in urban and rural areas (Lipton 1977; Timmer 1993; Fan and Hazell 2001, chapter 14). New growth strategies — such as those pursued in Indonesia after 1966, China after 1978, and Vietnam after 1989 — altered investment priorities in favor of rural growth and benefited from this disequilibrium in rates of return, at least initially. For example, in Indonesia from the mid-1960s to the mid-1990s, real value added per farm worker increased by nearly half, whereas it had apparently declined from 1900 through the mid-1960s. In China, the increase from 1978 to 1994 was nearly 70 percent, whereas this measure had dropped by 20 percent between 1935 and 1978 (Prasada Rao, Maddison and Lee 2002). A switch in investment strategy and improved rates of return on capital increase factor productivity (and farm income) by improving efficiency in resource allocation.

The contribution of agricultural growth to productivity growth in the non-agricultural economy stems from several other sources as well: greater efficiency in decision making as rural enterprises claim a larger share of output; higher productivity of industrial capital as urban bias is reduced; higher productivity of labor as nutritional standards are improved; and a link between agricultural profitability (as distinct from agricultural *productivity*) and household investments in rural human capital, which raises labor productivity as well as facilitates rural-urban migration. These mechanisms capitalize on the efficiency of rural household decision making, the low opportunity cost of their labor, the opportunity for on-farm investment without financial intermediaries, and the potential to earn high rates of return on public investments that correct for urban bias. In combination, these mechanisms translate faster agricultural growth into measurably faster economic growth in aggregate, after controlling for the direct contribution of the agricultural sector to growth in GDP itself (Timmer 2002, chapter 8).

This structural transformation is the defining characteristic of the development process, both cause and effect of economic growth (Syrquin 2006). Four relentless and interrelated processes define the structural transformation: a declining share of agriculture in GDP and employment; rural-to-urban migration that stimulates urbanization; the rise of a modern industrial and service economy; and a demographic transition from high birth and death rates common in backward rural areas to lower ones associated with better health standards in urban areas (Timmer 2002, chapter 8, 2009). The final outcome of the structural transformation is an economy in which capital and labor productivity in agriculture is equalized with other sectors through well-functioning labor and capital markets.

As Chairman Mao crudely but correctly put it, “the only way out for agriculture is industry”. Unless the non-agricultural economy grows, there is little long-run hope for

agriculture. At the same time, the historical record is very clear on the key role that agriculture plays in stimulating the non-agricultural economy (Timmer 2002, chapter 8). This bidirectional feedback has sparked a long-contested literature on the role of agriculture in economic development (Johnston and Mellor 1961, chapter 6; Hayami and Ruttan 1985; Mundlak 2000, chapter 3).

Part of the controversy stems from the structural transformation, a general equilibrium process not easily understood from within the agricultural sector. Over long historical periods, agriculture's role seems to evolve through four basic stages (Timmer 1988): the early "Mosher" stage when "getting agriculture moving" is the main policy objective (Mosher 1966); the "Johnston-Mellor" stage when agriculture contributes to economic growth through a variety of linkages (Johnston and Mellor 1961, chapter 6); the "Schultz" stage when rising agricultural incomes fall behind those in a rapidly growing non-farm economy, inducing political tensions (Schultz 1978); and the "Johnson" stage where labor and financial markets fully integrate the agricultural economy into the rest of the economy (Johnson 1997, chapter 12; Gardner 2002). Efforts to "skip" the early stages and jump directly to a modern industrial economy have generally courted disaster.

In the early stages there is typically a substantial gap between the share of the labor force employed in agriculture and the share of GDP generated by that work force. This gap narrows over time as incomes rise; the convergence reflects better integrated labor and financial markets. But this structural gap often widens during periods of rapid growth, as is evident in the history of OECD economies (Timmer 2009). When overall GDP grows rapidly, the share of agriculture in GDP falls much faster than the share of agricultural labor in the overall labor force. The turning point in the gap generated by these differential processes, after which labor productivity in the

two sectors begins to converge, has also been moving "to the right" over time, requiring progressively higher per capita incomes before the convergence process begins.

B. The Political Economy of Agricultural Development

This lag inevitably presents political problems as farm incomes visibly fall behind incomes earned in the rest of the economy. The long-run answer is faster integration of farm labor into the non-farm economy, including the rural, non-farm economy. But such integration takes a long time. It was not fully achieved in the United States until the 1980s (Gardner 2002), and the productivity gap appears increasingly difficult to bridge through economic growth alone (Timmer 2009). Lagging real agricultural earnings growth fosters deep political tensions over the course of the structural transformation, and those tensions grow with the lag. The standard government response to these tensions has been to protect the agricultural sector from international competition and ultimately to provide direct income subsidies to farmers (Lindert 1991).

Modern political economy has its roots deep in agriculture. Explaining the evolution of agricultural policy has long been difficult for models that use democratic institutions, median voters, or other forms of representative governance. Two aspects of agricultural policy are especially puzzling: the "development paradox," whereby the sector is discriminated against when a large share of the population works in agriculture but is protected when the number of farmers becomes much smaller; and the "trade paradox," whereby both agricultural imports and exports are taxed. Such strategies neglect economic laws of comparative advantage based on factor endowments and typically lead to higher prices and greater inefficiency and environmental damages than does reasonably free international trade in agricultural goods (Anderson 1986,

Stiglitz 1987, chapter 33; Krueger et al. 1988, chapter 13, 1991; Johnson 1997, chapter 12). Neither of these patterns makes sense in a democratic society where rational voters elect officials who defend their interests.

Consequently, policy analysts and political theorists have long tried to understand whose interests officials defend and why. Olson (1965), Bates (1981), Anderson (1986), Lindert (1991) and Kreuger, Schiff and Valdes (1991) documented trends in historical biases and offered explanations based in "positive" political economy that explains public policy formation based on the assumed self-interested rationality of policymakers. Bates (1998, pp. 238-9) explains:

> "I have moved away from a form of analysis which views policy as the result of efforts to maximize the social welfare. I have moved instead to a set of approaches that looks at public policy as a solution to political problems. The general theme … is that politicians are rational actors, but they are solving problems that do not take a purely economic form. What appear as economic costs may offer political benefits: noncompetitive rents or inefficient projects, for example, may be politically attractive in that they offer tools for building loyal organizations. What economists may evaluate as bad policy, then, is not necessarily the result of poor training, obduracy, or other deficiencies on the part of policy makers. Rather, policy makers may simply be solving a different problem than are economists. As policy analysts, it behooves us to represent explicitly the political problem as perceived by the policy maker and to use our analytic techniques to solve it, both in order to offer better explanations of government behavior and to advocate better policy more effectively."

So what drives the decisions of these self-interested policymakers? DeGorter and Swinnen (2002) provide a long list of factors found empirically to influence agricultural policies over time

and across space. They identify four key elements that political economy models of agricultural policy have considered: individual preferences of the citizenry, collective action by lobby groups, preferences of politicians, and political institutions. In the end, deGorter and Swinnen (2002) conclude that the extensive empirical work on agricultural policies needs to be better integrated into political economy theory.

The difficulty with this integration, however, is that the current theory is built almost exclusively on neo-classical foundations that have dubious assumptions about how individuals behave in the face of uncertainty and economic change. Two of the most pervasive policy tendencies have been for governments to stabilize their staple food prices and to provide price protection to a sector with lagging incomes. Both tendencies are hard to explain within the neo-classical paradigm (Barrett 1999), but are obvious political choices from a behavioral perspective if most individuals base welfare judgments on "reference points", and so dislike instability (Timmer 2009). Similarly, if individuals judge incomes based on relative standing, then lagging incomes generate direct political pressures for assistance.

III. Microeconomics of Markets and Institutions

Exploitation of comparative advantage so as to reap gains from market-based exchange is a fundamental engine of agricultural development. Economists dating back at least to Adam Smith and David Ricardo have trumpeted the static and dynamic welfare gains from trade. Further, macroeconomic policies commonly require smooth market transmission of signals sent by governments. And well-functioning markets pool demand and supply shocks across markets, enhancing producer incentives to adopt improved technologies and dampening price risk

exposure. For these reasons, much economic research on agricultural development has explored the nature and performance of market and non-market institutions.

A. Market Performance and Participation

Perhaps the most distinguishing feature of developing economies over the past quarter century has been their sharp, nearly universal movement toward relatively open markets through liberalization and privatization, perhaps especially in agriculture (Lin 1992, chapter 18; Anderson 2009). The statist model of government control of markets that prevailed in various degrees and forms in most low- and middle-income countries prior to about 1980 gave way by the late 1980s and 1990s to a model of market-based development. Dramatic reforms in rural China (Lin 1992, chapter 18), the fall of the Berlin Wall and the crumbling of the former Soviet empire were the most dramatic expressions of this rather abrupt shift, but the pattern has extended throughout the world over the past two decades.

Despite the faith economists and many policymakers place in markets as a means for fostering an efficient, even equitable, allocation of resources, we spend shockingly little time studying markets directly. The Walrasian fiction of frictionless equilibration of demand and supply – or, to be more precise, elimination of all excess demand – is too rarely embellished by explicit examination of the performance and institutional underpinnings of markets and the impact of the resulting equilibria. But if societies pin many hopes for agricultural development on markets, more explicit exploration of modes of exchange, not just the familiar domains of production and consumption, promises high returns.

Scholars of agricultural development have long recognized that general equilibrium theory quietly and unsatisfyingly rests on four crucial assumptions: (a) property rights are clearly defined, universally accepted, and costlessly enforced, (b) a unique set of rules governing

exchange exists and is universally understood, obeyed, and enforced by all transactors, (c) all actors belong to the same market, i.e., no exclusionary mechanisms exist, and (d) exchange is frictionless. In the absence of such assumptions, socially costly behaviors – e.g., lying, stealing, cheating, foregone profit-taking – may be individually rational acts and interventions in one place may not affect the incentives faced by agents in another.

One path via which agricultural development scholars have empirically probed failures of standard general equilibrium theory has been through the study of spatial and intertemporal price transmission in agricultural markets. In low-income rural settings, poor communications and transportation infrastructure, limited rule of law, and restricted access to commercial finance often sharply limit the degree to which markets function as effectively as highly stylized models typically assume. The notion that state-controlled markets are allocatively inefficient undergirded most liberalization efforts in the 1980s and 1990s.

But as economists have gradually come to appreciate the array of institutional failures that limit market performance, it has become increasingly clear that private markets may likewise be characterized by considerable allocative inefficiency. In particular, the agricultural development literature has documented considerable commodity price variability across space and time in developing countries, typically finding significant foregone arbitrage opportunities (Fackler and Goodwin 2001). In exploring such puzzles, agricultural development scholars have innovated extensively in spatial price analysis methods, dating from Jones' (1972) use of correlations in price time series to determine the extent of markets in west Africa, to Ravallion's (1986, chapter 16) pre-Granger introduction of error correction modeling to study price transmission in response to shocks in the Bangladesh famine of 1974, to Baulch's (1997, chapter 17) introduction of the parity bounds model to study food market performance in the Philippines.

Of course, the commercial agricultural system itself has been undergoing a significant transformation over the past several decades. The rapid emergence in developing countries of supermarkets, fast food chains and other retailers with downstream market power, as well as increased penetration by global agro-exporters has shortened supply chains and tightened food quality and safety standards, while at the same time threatening to leave small farmers behind because of the high transactions costs involved (Reardon et al. 2003, chapter 11, Swinnen 2007, Reardon et al. 2009).

Given the apparent massive static and dynamic gains from trade, it seems puzzling that many rural households opt out of market exchange for many goods and services. Market participation choices revolve around the tension between gains from specialization and corresponding increases in transactions costs that result from depending more on the market to procure one's needs. Transactions costs vary with social distance from counterpart transactors and economic distance from trading points, where this distance is defined over space, time or form. Fixed and variable costs are therefore household-specific and endogenous. People know exchange is costly and choose production and exchange strategies recognizing that they implicitly also choose transactions costs. This helps explain why some farmers forego yield-increasing technologies and opt for activity diversification not for reasons of self-insurance but rather because of demand for consumption variety in the face of costly commerce (Omamo 1998, chapter 20). For many, autarkic behavior is a low-level equilibrium (de Janvry et al. 1991, chapter 19, Goetz 1992, Key et al. 2000, chapter 21, Bellemare and Barrett 2006). Increased engagement in the commercial agricultural marketing system is therefore a central feature of agricultural development, both cause and consequence of productivity growth and improved standards of living among rural households.

B. Agricultural Household Models and the Institutions of Exchange

Singh, Squire and Strauss (1986) make clear that 'non-separable behavior,' in which households use resources differently with different productivity levels, is fundamentally a result of missing or imperfect markets, so that prices are not parametrically given to the household, rather than a reflection of the fact that the household is an integrated production and consumption unit. The agricultural household model advanced in Singh, Squire and Strauss (1986) and its implications have been the empirical workhorse of development microeconomics. The Singh-Squire-Strauss volume emerged as agricultural prices were liberalized in many developing countries, with the expectation that agricultural production and market supply would buoyantly follow price increases. However, the non-separable model accurately predicted muted supply response as price increases induce a compensating rise in the shadow price of labor, choking off production growth. Even when markets are complete and separability holds, the elasticity of marketed surplus can be markedly lower than that of output as income effects can lead the household to auto-consume a large share of the price-induced increase in output.

Endogenous market failure and local non-separability relate closely to work on market participation and transactions costs discussed earlier. In a paper aptly subtitled "paradoxes explained," de Janvry et al. (1991, chapter 19) show that because transactions costs drive a wedge between producer and consumer prices, some households may fall into a non-participation regime in which they neither purchase nor sell the goods they produce. Because they do not face parametrically given prices, such households exhibit behaviors associated with the non-separable model, including sluggish response to price incentives. While de Janvry et al. (1991, chapter 19) ignore the endogeneity of market participation, subsequent work by Key et al. (2000, chapter 21) and Bellemare and Barrett (2006) explores the endogeneity of market

participation decisions in the face of fixed and variable transactions costs, and draws out its econometric implications.

In spite of widespread non-separability due to agricultural market imperfections in developing economies, in at least one sense, a case can be made that markets are more important in low-income economies than in high-income ones. Unlike in high-income economies where large, vertically-integrated corporations commonly internalize sequences of transactions, commonly using formal contracts over multiple attributes of the goods and/or services exchanged – not just price – in low-income economies the small scale of most firms necessitates a larger number of inter-firm exchanges in the passage from first-stage producer to final consumer. The overwhelming majority of those exchanges are spot market transactions not underpinned by formal contracts; as Fafchamps and Minten (2001, chapter 22) vividly put it, market arrangements are often akin to a "flea market economy". Large-scale firms are conspicuously absent in most low-income settings. So spot market-based exchange becomes extraordinarily important. In this sense, extraordinary dependence on markets and the great number of vertical transaction linkages are what define developing economies, not their absence.

At the same time, idiosyncratic market failures due to high transactions costs, risk, etc. may induce households to self-select out of markets into semi-autarky. So in a different, but equally important sense, agricultural input and output markets are less widely used in low-income economies because market exchange is more complex and costly than in the more advanced economies. This paradox of markets that are at once more important vertically (in linking producers to consumers) and less important horizontally (because many individuals self-select out of markets) helps motivate a significant recent push in the literature to understand better the functioning of markets (Platteau 2000, Fafchamps 2004, Reardon et al. 2009).

If agricultural markets do not work well, the scope for allocative inefficiency in the economy becomes enormous. Indeed, the idea that state-controlled markets are allocatively inefficient undergirded most liberalization efforts in the 1980s and 1990s. Over the past decade or so, economists have gradually begun acknowledging that private markets may likewise be characterized by considerable allocative inefficiency (Fafchamps and Minten 2001, chapter 22). Understanding the sources and potential correctives for this inefficiency and its implications for growth and equity remain important but under-researched topics.

Central to the objective of an improved understanding of how markets function and whether and why allocative inefficiencies arise is careful consideration of the means by which order is maintained in markets. By what mechanisms are or can ubiquitous problems of asymmetric information and contract monitoring and enforcement be resolved? There is no unique mechanism that suits all economies. Platteau (2000) and Fafchamps (2004) emphasize that there are inherent complementarities between different types of market order mechanisms. The most widespread mechanism is endogenously self-enforcing contracts that do not require any exercise of state authority, backed by repeated interactions among prospective transactors or by reputation mechanisms. Institutions that create informal incentives for cooperative behavior are crucial to resolving the significant externalities that can otherwise tax an economy and impede structural transformation (Seabright 1993, chapter 24). But the scope for such arrangements to resolve asymmetric information and contract enforcement problems is necessarily limited. Private order mechanisms, in which private firms (e.g., credit rating agencies) resolve coordination failures and thereby create and share the gains from coordination, can help fill the breach. So can public order institutions backed by the police power of the state through establishing, promoting and enforcing grades and standards, contract law, etc.

One of the most important public order institutions concerns property rights. As Besley (1995; chapter 25) and a long literature show, the strength of individual rights over productive assets such as land is fundamental to determining investment incentives. Because investment – in accumulating productive assets, adopting improved technologies and engaging in potentially remunerative markets – is a key engine of growth at both micro and macro level, property rights become key. But as Carter and Olinto (2003; chapter 23) demonstrate in a seminal empirical example of the theorem of the second-best, resolving one imperfection – incomplete and insecure property rights in land – does not necessarily lead to efficient and equitable equilibria when another market imperfection – in Carter and Olinto's Paraguayan case, credit constraints – persists. Because of the pervasiveness of market imperfections in developing countries, the importance of non-market institutions to economic incentives and performance is brought into stark relief.

C. Agrarian Contracts

Increased reflection on the endogeneity of market failure, commonly due to institutional failings, spawned considerable reflection on the nature of production relations in agriculture. Binswanger and Rosenzweig (1986, chapter 26) emphasized how imperfect information and uninsured risk exposure combine with heterogeneous agroecological endowments to generate highly varied institutions of agricultural production and exchange. In some places, small-scale owner operators cultivate and sell their surpluses, while in other places large-scale plantations employ large numbers of landless or near-landless workers, and in still other places sharecropping links labor and land markets inextricably.

One of the principal obstacles to improving the welfare of poor rural people in low-income countries is the need to increase agricultural output resulting from the application of

existing inputs. There is relatively little ecological capacity for agricultural extensification, so at a minimum yields (output per unit area cultivated) must increase significantly if food availability is to increase, a necessary condition for appreciable reduction of hunger and food insecurity in the medium term. Moreover, since the poor are endowed chiefly with labor power – and in the case of the rural poor, secondly with land – improving labor and land productivity is central to any effective and sustainable rural poverty alleviation strategy. So identifying how best to achieve these objectives necessarily involves a solid understanding of current production technologies, their performance, and the effects and performance of related factor and product markets. Together, these are the ingredients that determine the productivity of smallholder agriculture.

It has long been noted that partial or total factor productivity measures routinely appear non-constant in low-income agriculture. Typically, an inverse relationship exists between yields (output per unit area cultivated) or labor use per hectare and farm size. Conversely, a positive relationship typically exists between credit use or the probability of modern technology adoption and farm size, and in some circumstances these effects seem to overwhelm the labor effects to generate a positive relationship between farm size and yield (Kevane 1996). Neoclassical theory tells us that factor productivity should be equalized across production units else the high marginal productivity user should purchase or rent the factor from a low productivity user at a mutually attractive price, thereby generating greater aggregate output and welfare. So the existence of a relationship between farm productivity and farm size, and especially the typical inverse relationship between the two variables, has attracted much attention as perhaps indicative of key market failures.

The genesis of the relationship between farm size and productivity has important practical implications. For example, if small farms are inherently more efficient in a given setting, this makes a strong case for redistributive land reform as a source of both equity and efficiency gains. If the source of the productivity gradient is markets failures, this suggests that the fundamental welfare theorems of neoclassical economics do not hold in the setting, so competitive markets do not necessarily yield Pareto optimal distributions, providing a theoretical justification for government interventions into rural markets. Conversely, if the inverse relationship is purely a statistical artifact attributable to the omission of hard-to-observe variables (e.g., levels of nutrients in the soil) and in truth there is no variation in productivity across farm sizes, then the rural economy does seem to function as predicted by Walrasian theory and market interventions will generally prove inefficient. So explaining the oft-observed inverse relationship between farm size and productivity has been an important cottage industry for development economists for many decades.

The seminal theoretical explanation of size-varying productivity is due to Feder (1985, chapter 27). He establishes that in the face of just one market failure (e.g., for land or for labor), productivity is invariant to farm size. The mobile factors (hired labor, land, capital) move to the immobile factor (family labor, in his model). Put differently, in a neoclassical world of almost complete, perfect markets with constant returns to scale, all variable inputs and fixed factors are applied in equal proportions across farms so there can be no yield differences. But when there is a second market failure, then optimal farm size and labor application rates will in general vary with the amount of land owned. If credit constraints dominate, then larger farmers will be more productive, while if labor supervision constraints are most limiting, smaller farmers will enjoy

higher yields, leading to an inverse farm size-productivity relationship.[2] A large literature finds strong evidence of both credit constraints and moral hazard.

Market imperfections likewise affect the organization of the agricultural sector, the particular manner in which land, labor, and other inputs combine for productive purposes. When market imperfections exist, individuals can either (i) participate in the market, adjusting behavior to suit their specific net costs or benefits (shadow prices) of market participation, (ii) opt out of the market and practice autarkic production, or (iii) contract directly with a counterparty rather than undertaking a semi-autonomous open market transaction. The very information failures and risk characteristics that typically bedevil markets also make contracting complex and highly variable. Indeed, it is the variability of the contracts one observes in low-income agriculture that makes the subject of agrarian contracts so fascinating and important to a solid understanding of the microeconomics of development.

An important underlying theme in development microeconomics is that market imperfections of one sort (e.g., in labor or insurance) are often transmitted to other, related markets (e.g., for land). The fundamental interrelationship of various factor markets means the inefficiencies in one often affect another and that means of resolving problems in one factor market often turn on arrangements involving one or more other factor markets. Explicit interlinkages emerge and persist naturally due to the existence of transactions costs, uninsured risk and exogenous barriers to factor movements. But even without explicit interlinkage among contracts – as when credit and forward crop sales contracts are bundled together to reduce the

[2] When individuals make decisions non-cooperatively, multiple market failures can even result in intra-household productivity gradients, providing strong evidence of the allocative inefficiency resulting from market imperfections (Udry 1996; chapter 65).

risks faced by both borrower and lender – markets are typically implicitly interlinked by contractual arrangements prevailing in many low-income economies.

There are multiple reasons for this. One is that when one market is ostensibly missing, residual demand for and supply of the non-marketed good or service can still be satisfied implicitly through adjustments to the terms of exchange in other markets. So, for example, when a government declares land markets illegal and enforces a prohibition on land exchange, there are alternative (e.g., labor market) mechanisms to accommodate repressed demand and supply for land. Distortions are commonly displaced into other markets within an economy.

Another reason is that the anonymous and independent transactions of the standard Walrasian model do not capture the repeated and multi-faceted interactions of individuals living in rural communities. If there are fixed costs to each transaction, it may be more efficient to bundle several exchanges together at once than to negotiate separately over each factor exchanged between the same two parties. The resulting, explicitly interlinked contracts necessarily enmesh market failures in one domain with equilibrium contractual arrangements in another.

The main contractual arrangements studied by development economists have concerned sharecropping and labor. In a world of perfect information, complete and perfectly competitive markets with no uncertainty and constant returns to scale production technologies defined over inputs of land and labor, it would make no difference whether landowners hired laborers or whether laborers rented in land. Wage laborers would be paid their marginal revenue product, with the residual output accruing to land owners on a constant per hectare basis. A fixed rental contract yielding the same rent per hectare (so that the landowner is indifferent between renting out the land or hiring in the laborers) yields the equilibrium wage rate as the residual paid to the

tenant, leaving him or her indifferent as well between renting in land or hiring out their labor. In such a fictional, perfect world, there should be no sharecropping, however, as it explicitly creates an externality by making the landowner a beneficiary of the tenant's additional labor effort, and is therefore socially inefficient.

In a more realistic setting where uncertainty and imperfect markets (and perhaps non-constant returns) prevail, the alternative means of allocating factors of production will not be equivalent, however. Indeed sharecropping becomes commonplace because it strikes a potentially optimal balance among competing market imperfections due to asymmetric information problems and incomplete markets for risk or credit. These missing markets result in Pareto inefficiency that helps account for some of the observed low productivity of agricultural lands and workers in low-income economies.

The heterogeneous pattern – in both cross-section and time series – of observed contract forms has drawn much attention from development economists. Otsuka et al. (1992) emphasize agency theory as the main device needed to nest together parallel theories of labor contracts, land contracts, and the ubiquitous observation that owner-cultivation dominates all other forms of organization in both frequency and productivity terms. The relative efficiency of different contractual forms and the ex ante distribution of land ownership are the critical ingredients determining prevailing agrarian institutional arrangements. Agency theory highlights the trade-offs involved between worker (dis)incentives due to, on the one hand, asymmetric information and effort or quality shirking (the latter being attributable to carelessness in work, regardless of effort level, that causes damage to the produce), and, on the other hand, the limited risk-bearing or borrowing capacities of poor tenants or increasing returns to scale in particular types of agriculture (e.g., mechanized or export-oriented plantation agriculture).

Eswaran and Kotwal (1985, chapter 28) offer perhaps the most compact and elegant model to date explaining the observed heterogeneity of agrarian contracts. In their view, different contracts reflect different techniques of combining non-marketed productive inputs. The equilibrium institutional arrangements for agricultural production arise from the optimizing decisions of both parties to the contract, the land owner and the tenant/worker, given prevailing technologies, market conditions, etc. In this setting, sharecropping can be understood as the outcome when essential intermediate inputs (labor supervision and managerial ability in their model) are non-tradable but each party to the contract holds sufficient comparative advantage in one or the other input as to make their comingling through joint production optimal. If the inputs could be freely traded on the market, sharecropping would never arise. Moreover, as the relative advantages of landlords and tenants shift over time, in particular since access to information and credit tends to equalize in the process of development, there is a natural evolution in contractual form, generally away from sharecropping and toward fixed rent contracts in which the gap in labor supervision ability remains while the gap in managerial ability vanishes.

The theoretical literature on agrarian contracts suggests some disagreement as to whether sharecropping is truly inefficient at the level of individual producers, that is, whether Marshallian labor monitoring problems are significant and whether long-term contracts perhaps resolve any such moral hazard problems through repeated interaction. Following a line of illuminating empirical inquiry on this question (e.g., Bell 1977, Shaban 1987, chapter 29), Laffont and Matoussi (1995, chapter 30) explore these questions directly in their study of sharecropping in Tunisia, wherein they also explore whether risk aversion or financial constraints seem a better explanation of sharecropping's existence. Although they find lower efficiency on sharecropped than on owned land, presumably because the sharecropper's labor effort is reduced in line with

reductions in his share of output, the length of the sharecropping contract also has a positive and statistically significant effect under multiple alternative specifications, signaling that the contract duration may indeed help to resolve some of the inefficiency associated with sharecropping, following the predictions of the Folk Theorem.

While the basic agricultural household model suggests that small, family labor farms will have a productivity advantage in the face of land and labor market imperfections, wealth-biased capital access creates a countervailing market failure that potentially offsets this advantage. Feder's (1985, chapter 27) work on countervailing market failures was closely followed by general equilibrium analysis that asked whether and how productivity is influenced by the distribution of land among rural households when there are imperfections in both labor and capital markets (Eswaran and Kotwal 1986, chapter 31). Eswaran and Kotwal's numerical analysis shows that an economy with high land inequality will indeed produce less than an economy with a more equal land distribution. They also show that a credit market reform that equalizes access to capital across farm households will have an effect similar to land redistribution.

This reopened a long-standing debate about redistributive land reform. Research at the Land Tenure Center (LTC) at the University of Wisconsin played an important role in land reform policy in the 1960s and 1970s, emphasizing that small farms were more productive than large farms and hence redistribution of land and from the large to small holders would improve economic performance and enhance social equity. Two books by Peter Dorner (1970, 1992) nicely capture the spirit of this argument.

Redistributive land reform of course proved politically contentious, with some of the more ambitious redistribution programs implemented as part of political coups or social

revolution. The economics of redistributive reform also came under attack by those who doubted the capacity of small farms to handle the capital and risk requirements of modern agriculture. Ironically, some of the more ambitious redistributive reforms in Latin America (Chile, Cuba, El Salvador, Nicaragua and Peru) converted large scale private farms into large scale cooperative or state farms (rather than redistributing land to small holders) because reform administrators doubted the productive capacity of small holders. As discussed in Thiesenhusen (1989), these cooperativist reforms in most instances eventually decollectivized and shifted to smaller scale, family farms, as also happened to similar farms in China and in much of Eastern Europe and the former Soviet Union.

Empirical works such as Lin (1992, chapter 18) on China and Macours and Swinnen (2002) on Eastern Europe find that substantial productivity gains accompanied the eventual shift to smaller scale farming. At a policy level, recent years have seen a renewed interest in redistributive reforms, although this time with redistribution pursued through market-assisted programs in which beneficiaries receive grants that allow them to purchase land from large-scale farmers (Deininger 2001). Market-assisted reforms remain based on the logic that small farmers' superior productivity impart competitive advantage in land markets. While such programs have been implemented in several places (most prominently in Brazil and South Africa), the evidence on their effectiveness remains thin.

The growing literature on the security of property rights over land held by farmers has been closely intertwined with debates over land reform. Feder et al. (1988) found that policies that enhanced the formal, legal tenure security of Thai farmers offered substantial payoffs in the form of increased investment and enhanced productivity. Such payoffs were hypothesized to arise due to interactions between credit supply effects, if legally titled land offers improved

collateral to agricultural lenders, and investment demand effects, if legal title increases farmers' willingness to make long-lived investments as they are assured of recouping the benefits of up-front investment costs over a longer time horizon. Influenced by these arguments, property rights reform policies quickly became and remain a staple of agricultural development policies.

The empirical evidence on these policies has been mixed, especially in areas of Africa characterized by customary tenure systems (Bruce and Mighot-Adholla 1994). In these circumstances, property rights reform policies represent an individualization (or redistribution) of rights as well as change in the legal status of rights already held. An especially careful study finds no evidence of an investment effect in Burkina Faso and suggests that the customary tenure system was not insecure and that the rural financial system was unresponsive to the putative increases in the collateral value of land (Braselle, Gaspart and Platteau 2002).

In a study in a Latin American economy with better functioning credit markets, Carter and Olinto (2003, chapter 23) separately identified the credit supply from the investment demand effect. They find that the latter applied to everyone, but that the credit supply only expanded for medium and larger scale farmers, with the net result that property rights reform only had substantial impacts for relatively advantaged farmers.

Buttressed by ample descriptive evidence that working capital to purchase inputs was scarce and expensive in low-income agricultural economies, a literature grew up around the concern that capital constraints retard rates of agricultural development and economic growth. Feder (1985, chapter 27) explored the impact of wealth-biased access to capital on the inverse farm size-farm productivity relationship, showing that if capital access improved with (collateralizable) land endowments, then the relationship between farm productivity and size could become positive even in the presence of the classic land and labor market failures. The

seemingly obvious solution to this problem of scarce and expensive agricultural capital was to impose interest rate ceilings, often augmented by the creation of public development banks that offered agricultural loans at concessional interest rates. Unfortunately, this experiment in public sector banking led to high default rates and a pattern of unsustainable lending that required annual infusions of capital. The influential USAID Spring Review of Small Farmer Credit (Donald 1976) documented this situation and became the foundation for the "Ohio State" critique of rural financial market interventions (Adams et al. 1984). Buttressing this critique were the arguments that observed 'usurious' interest rates simply reflected the real costs of lending to small farms and that well-intentioned efforts to assist with interest rate restrictions caused small farm credit to dry up completely through the operation of what Gonzalez-Vega called the iron-law of interest rate restrictions (Gonzalez-Vega 1984).

Even as the influential Ohio State critique moved policy toward *laissez faire* principles, a second generation of analysis influenced by the economics of imperfect information (Stiglitz and Weiss 1981) questioned what a laissez faire credit market equilibrium would look like in low income agriculture. Carter (1988, chapter 32) showed that even a *laissez faire* credit equilibrium may exclude the small farm sector because lenders worried about the adverse consequences of moral hazard and adverse selection engage in non-price rationing (i.e., imposing their own interest rate ceilings) that leads to wealth-biased credit rationing of the sort Gonzalez-Vega attributed to government intervention. Binswanger and Rosenzweig (1986, chapter 26) added the important observation that covariate risk in agriculture further suppresses the development of deep agricultural loan markets in risk-prone, rainfed, low-income agricultural sectors.

If there is at least imperfect evidence that credit constraints limit the productivity and income of small farmers, then the question of what to do about it retains its importance. The

'microfinance revolution' that employed novel incentive and contractual devices to enhance the credit access of collateral-poor households in the urban sector has had more modest impact on agricultural credit. This outcome is not surprising given that microfinance lending principles are undercut in agriculture by the preponderance of covariate risk. One resolution to this problem might be to use the sort of index insurance contracts discussed by Hazell (1992) and Barnett, Barrett and Skees (2008) to remove the covariate risk from the system, with the expectation that this can crowd-in credit supply from microfinance and other lending institutions. While there are now several experiments underway to test this proposition, its effectiveness has yet to be proven.

Given the multiplicity of market failures that pervade rural economies in the developing world, government intervention is commonly important. As Stiglitz (1987, pp.53-4, chapter 33) emphasizes, "the design of agricultural policies should be viewed as an exercise in the theory of second best, an exercise requiring detailed information about a country and careful judgment about the nature and relative importance of market (and nonmarket) failures. Against these standards, most of the simplistic prescriptions fail. The assertion that governments should never intervene in agricultural markets misses the potential importance, in some cases, of market failures." Perhaps the biggest of those market failures concern the development and diffusion of new technologies and the management of risk.

IV. Technological Change, Adoption, Risk and Efficiency

It borders on the tautological to say that low-income countries are saddled with rudimentary technologies that are both cause and consequence of low incomes. Modern growth theory focuses heavily on technological change as an engine of economic growth and on externalities as a source of endogenous growth (Solow 1957, Lucas 1988). Elegant as these models might be,

they typically assume that processes of technology development and adoption and market exchange are exogenous, irreversible and relatively frictionless. In contrast, the micro-level agricultural development literature paints a picture of slow, halting, reversible and ultimately incomplete adoption of improved inputs or production technologies, which, coupled with incomplete market participation and price transmission, impede productivity growth and slow structural transformation in agriculture.

What drives the emergence of more productive technologies for low-income agriculture? The dominant theory has long been the induced innovation model of Hayami and Ruttan (1985) and Binswanger and Ruttan (1978). Under the induced innovation hypothesis, technical innovations are guided by changes in relative incentives. As an input becomes dearer relative to prospective substitute inputs, there emerges a profit incentive to develop a technology that makes relatively greater use of the cheaper input and less of the dearer one. The hypothesis of induced innovation suggests that Hicks-biased technical change is causally driven by changes in relative prices that induce either profit-seeking innovation by private firms or political demands for public research to relieve increasingly binding constraints.

The empirical evidence on the induced innovation hypothesis is somewhat mixed, however, and at present, no general theory of technical change really exists (Ruttan 1997, 2002, chapter 34). Some discoveries are stochastic and path dependency sometimes seems to lock in even relatively inefficient technologies (David 1985, Arthur 1994). At the same time, many agricultural technological breakthroughs – perhaps especially the Green Revolution advances in improved rice and wheat germplasm in the 1960s and 1970s – emerged not from profit-seeking induced innovation but rather from scientific research following the non-profit motives of philanthropists, scientists and governments.

Such investment is justified by the sizable externalities associated with innovation (Ruttan 1980, 1997, 2002, chapter 34). These spillover benefits take two major forms. First, because agricultural research generates nonrival – and often nonexcludable – knowledge, it yields classic public goods benefits that justify public investment. Although much adaptive agricultural research is highly specific to particular agro-climatic regions, the resulting genetic material and especially basic research has had substantial national and international spillover effects (Evenson, Waggoner and Ruttan 1979, chapter 35; Alston and Pardey 1996, Evenson and Gollin 2003, chapter 36). Hence the high estimated annual rates of return on public (and non-profit) agricultural investment, typically in the 30-60 percent range both for individual commodities or factors of production and for total research systems (Evenson, Waggoner and Ruttan 1979, chapter 35; Alston and Pardey. 1996, Raitzer and Kelley 2008, chapter 37).

The second major spillover effect arises from the "technology treadmill" inherent to agriculture (Cochrane 1958; Gardner 2002). In a small open economy in which producers face infinitely elastic demand, the gains from technological change accrue entirely to producers in the form of higher profits. By contrast, if demand is perfectly inelastic, all gains accrue to consumers in the form of lower prices. The distribution of welfare gains from technical change therefore depends crucially on the price elasticity of demand for the product. Since most agricultural products exhibit price inelastic demand, producers in aggregate tend not to benefit much in long-run equilibrium from technological change. Producers adopt new technologies because they reduce unit costs, thereby increasing productivity. But in general equilibrium, when many producers adopt the cost-reducing technology, the aggregate supply curve shifts and prices fall. Producers can wind up worse off if demand is sufficiently inelastic. The empirical evidence on technical change in agricultural development suggests that most welfare gains are

captured as consumer surplus due to lower prices, rather than in producer surplus (Evenson and Gollin 2003, chapter 36; Minten and Barrett 2008, chapter 38). Of course, if the benefits from technical change in agriculture largely accrue to consumers in the form of lower prices, it may be socially optimal to pay for much technology development with tax revenues paid by consumers.

Because technical change seems key to – arguably even the main driver of – agricultural development, understanding remarkably heterogeneous patterns of technology adoption and diffusion has been a major preoccupation of agricultural development researchers. Much of the literature traces back to the seminal work of Griliches (1957, chapter 45), who documented the now-standard S-shaped diffusion curve in studying the adoption of high-yielding corn varieties in the United States. Since that time, a large literature has focused on understanding better who will adopt a given technology, especially who will adopt first because, given the technology treadmill, the benefits of innovation accrue disproportionately to early adopters.

So who adopts first? In general, those with the most to gain, the lowest cost access to the technology, and the lowest evaluation costs and least uncertainty about the technology. Precise hypotheses depend crucially on the specification of the adoption model and local context (Feder, Just and Zilberman 1985, chapter 46). But in general, large farm operators adopt before smallholders. Agricultural technological change can thereby contribute to widening inequality within agriculture, although general equilibrium food price and wage effects eventually offset such effects for landless rural laborers and small, net buyer farmers who sell surplus labor to larger neighboring farms (David and Otsuka 1994).

Several candidate explanations exist as to why large farms seem to adopt new technologies first. One is scale-biased technical change. If technology development occurs not due to induced innovation but due to political research prioritization, smaller, more vocal groups

of large landowners using inherently different production technologies and perhaps growing different crops might steer public research efforts toward technologies most likely to benefit them disproportionately (de Janvry 1981).

Even with scale-neutral technical change, larger farms might acquire technologies earlier due to superior credit and insurance access. If informational asymmetries and repayment enforcement problems induce creditors to require land or other real assets as collateral, then borrowing constraints will be an increasing function of landholdings (Feder 1985, chapter 27, Carter 1988, chapter 32). If the new technology demands increased input purchases, then borrowing constraints may bind, with larger landowners facing a lower shadow price of capital than smallholders, making the effective acquisition cost of the new technology lower. Similar arguments apply to risk bearing capacity if risk aversion is declining in farmer wealth. The effect of financial market imperfections can be magnified by fixed or sunk costs to technology adoption, which privilege scale. Simple models of technology choice in the presence of financial market failures thus underpin many poverty trap models (Azariadis and Stachurski 2005, Carter and Barrett 2006, chapter 53).

Another possibility is that large farms are more likely managed by well-educated operators or visited by extension agents promoting the new technology and that human capital and information flow are the key drivers of technology adoption (Schultz 1975, chapter 7). This view is consistent with renewed recent emphasis on learning models of technology adoption in which farmers update their information on a technology and refine their skills and efficiency applying the technology as they use it (Antle and Crissman 1990, chapter 52). Producers able to afford the costs and risks of experimentation therefore adopt earlier. The literature has focused anew on the dynamics of agricultural technology diffusion (Besley and Case 1993, chapter 48),

particularly on processes of learning by doing and learning from others (Bandiera and Rasul 2006, Conley and Udry 2010, chapter 49, Foster and Rosenzweig 1995, chapter 50, Moser and Barrett 2006, chapter 51). This more recent thread of the literature highlights, in particular, the empirical challenges of disentangling wealth, education and social network structure as causal drivers of technology adoption and diffusion.

Still another possibility is that larger landowners may impede the adoption of improved technologies by poorer tenants as a means of increasing their well-being at the expense of laborers in the face of market failures that enable landowners to link credit and land contracts (Braverman and Stiglitz 1986, chapter 47). The basic logic is that if poorer agricultural tenants adopted improved technologies, their higher incomes would reduce their demand for loans, weakening landlords' ability to impose especially inequitable terms on them. Thus the institutional structure of the economy, not just the distribution of material endowments also matters to the trajectory of diffusion of agricultural innovations.

If W. Arthur Lewis built the intellectual framework supporting the "why" of agriculture's role in economic development, T.W. Schultz built the framework for understanding the "how" of stimulating agriculture to play that role. Schultz came to development issues after a distinguished career analyzing problems with American agriculture, especially instability (Schultz 1945) and poverty (Schultz 1953). His classic volume on agricultural development, *Transforming Traditional Agriculture* (Schultz 1964) grew directly out of these earlier analyses.

Schultz had long been convinced that the problem of poverty in American agriculture stemmed from the intersection of rapid technical change, the industrial organization of the sector, and its dependence on an unstable macroeconomy to determine its output prices. The solution was to be found in greater macro stability (outside the agricultural sector's purview) and greater

capacity of farmers to adjust to change, both on the input side—new technologies—and to the prices of output. In Schultz's view, new technology was the essential driver of higher farm incomes, but only in the context of new investments in human capital on the farm. He famously rejected the notion that small farmers were poor due to cultural characteristics, deeming them instead "poor but efficient" users of long-established technologies and limited available factors of production. Farmers needed new knowledge and skills to adopt new technologies, but also to cope with changing economic environments, especially with the need to exit agriculture as farm productivity increased and the structural transformation proceeded. *Transforming Traditional Agriculture* stresses both elements as the keys to a successful agricultural development strategy.

Schultz's "poor but efficient" hypothesis sparked much debate around the importance of technology development to expand the production possibility frontier for poor farmers versus improving productivity within the existing production frontier. Widespread estimates of considerable technical inefficiency among small farmers have often fuelled arguments that investment in new technologies might not be as valuable as investment in extension services to increase adoption and improve the use of existing technologies (Ali and Byerlee 1991). An opposing thread of the literature notes the many econometric problems inherent to the technical inefficiency research and demonstrates that as one begins to control for exogenous, stochastic environmental factors that influence productivity, apparent inefficiency diminishes appreciably and becomes essentially untargetable based on farm or farmer characteristics, supporting Schultz's hypothesis (Barrett 1997, chapter 43, Sherlund et al. 2002, chapter 44).

The dominant view in the contemporary agricultural development literature is that most cross-sectional heterogeneity in returns is due to variations in endowments, starting with geographical endowments of climate, soils and distance from ports (Gallup and Sachs 2000,

chapter 39) and with national-scale institutional endowments (Acemoglu, Robinson and Johnson 2005). But also, at more disaggregated levels, intra-national variation in factor and product markets and in household endowments and preferences condition the uptake and impact of improved agricultural technologies.

This micro perspective on household decision making reveals how much progress has been made since the days when "traditional" peasants were seen as the recipients of "modern" knowledge about farming techniques. Diversity remains crucial in this decision making process, but imperfect and missing markets for risk and finance, thin input and output markets, and asymmetric information problems and transactions costs that lead to widespread apparent inefficiency and disequilibrium explain much of apparently perverse behavior by poor households that are vulnerable to devastating shocks to their livelihoods.

Imperfect markets mean that household technology and other choices are fundamentally shaped by wealth endowments. At a theoretical level, these core insights have been based on static models, taking household endowments as given. Of course, household endowments of land, labor and financial assets evolve endogenously over time. Perhaps households can use time as an additional degree of freedom to work around imperfect markets, by building up their own savings to offset non-price rationing in credit markets. Analysis of the dynamics of accumulation necessitates paying close attention to the economics of risk.

Risk and its impact on decision making has played an important role in the economics of agricultural development, especially from the pioneering work of Hans Binswanger measuring risk aversion in India and studying its impact on technology choice (Binswanger 1980, chapter 40, 1981). Perhaps one of the more important observations by Binswanger and his collaborators was that risk mattered most not because different individuals varied in their degree of subjective

risk aversion, but because they differed in their access to credit and other financial markets that could be used to mediate risk (Binswanger and Sillers 1983).

Households lacking ready access to credit and other financial markets have to adapt production practices to help manage risk. If they are able to reduce risk *ex ante* through mitigation behavior (e.g., precautionary savings, selection of low risk portfolios), then (i) the need for emergency response may be reduced but (ii) it is also easy to understate the magnitude of the risks perceived by the households since they take action *ex ante* to avert undesired variability (Morduch 1995; chapter 41). Observed variability of incomes, for example, is almost surely dampened by individuals' mitigation efforts. If households instead primarily cope *ex post* with shocks, then shocks are in principle fully identifiable in the data, but rapid response may be especially important. One regular finding of the empirical literature is that better off households prove far more successful at smoothing consumption than do poorer ones (Morduch 1995, chapter 41).

Risk considerations also factor into agricultural households' portfolio choices over assets and activities, at least some of which offer uncertain returns. If risk preferences are related to ex ante wealth, portfolio choices might reinforce pre-existing wealth distributions. Rosenzweig and Binswanger (1993, chapter 42) indeed find that wealthier households in rural India hold higher risk, higher expected return portfolios, which naturally leads to different growth rates and increasing inequality over time and potentially leading to poverty traps among less well-endowed agricultural households.

V. Poverty, Food Insecurity and Gender

There are several types of dynamic models in which risk and capital constraints come together to create a poverty trap, understood as an initial wealth threshold below which the household will optimally settle into a low level dynamic equilibrium (Carter and Barrett 2006, chapter 53). Households who begin with endowments above that threshold will optimally move toward a higher level equilibrium. The implications are potentially profound because a poverty trap suggests that an unequal agrarian asset distribution that leaves large numbers of households below the critical asset threshold will stagnate and yield high levels of persistent poverty. Zimmerman and Carter (2003, chapter 55) demonstrate how, in the face of such processes, poorer households may not only endogenously opt for asset portfolios of lower expected return and risk in the face of asset price risk and incomplete financial markets, but how they may also intentionally destabilize consumption in order to smooth assets over time, overturning the familiar consumption smoothing hypothesis. The emergence of detailed micro-level panel data sets has sparked a recent empirical literature of micro-level studies of growth, many of which find evidence strongly suggestive of poverty traps and the persistent effects of shocks on the poor (Dercon 1998, chapter 56, 2004; Jalan and Ravallion 2002; Lybbert et al. 2004, chapter 54; Adato, Carter and May 2006; Barrett et al. 2006, Carter et al. 2007; Barrett 2008, chapter 57).

Low agricultural productivity is a key causal factor behind the existence and persistence of poverty traps. When the costs of adoption of new technologies or of entry into emerging high-value markets are non-trivial, the poor commonly cannot afford the initial costs of entry. The resulting frictions generate multiple equilibria, one of which is optimal underinvestment in modern inputs and modern marketing arrangements, thereby trapping some agricultural households in poverty. Marenya and Barrett (2009) illustrate this in the case of fertilizer uptake in rural western Kenya, while Dercon (1998, chapter 56) demonstrates this in the crop-livestock

systems of western Tanzania. The upshot is that the introduction of improved seed varieties (Moyo et al. 2007, chapter 58), yield increases (Minten and Barrett 2008, chapter 38), and farm productivity growth more generally (Datt and Ravallion 1998, chapter 59), have all been shown to generate significant poverty reduction, generally faster than that obtainable through the non-agricultural sectors of the economy.

Perhaps the most intuitive mechanism through which agricultural productivity growth facilitates an escape from poverty arises from the impact of expanded supply on food prices, nutrient intake and human health. For most of human history, lives were short and unhealthy due in large measure to insufficient nutrient intake. Malthus' well-known explanation was that human population growth routinely overtaxed the Earth's capacity to provide sufficient food, leading to regular famines. Since the 18th century, however, dozens of countries have escaped widespread hunger and premature death due largely to dramatic advances in food availability and associated income growth broadening access to a satisfactory diet. The apparent reinforcing feedback between nutritional status and productivity has led several scholars to hypothesize that the escape from the nutritional poverty trap helped to catalyze the unprecedentedly rapid and widespread advance of living standards over the past 300 years (Dasgupta 1993; 1997, chapter 61; Fogel 2004).

Much of this progress stems from greater food availability made possible by agricultural technological change associated with plant breeding, improved agronomic practices such as intercropping and crop rotations, irrigation, and the emergence of mechanical implements and chemical fertilizers. Food security has therefore often been equated with food availability, typically measured in terms of satisfaction of dietary energy requirements, such as calories per person per day, such that food insecurity arises due to insufficient and unstable production. An

availability-based view of food security naturally leads policymakers to pursue food self-sufficiency strategies, to ensure domestic production will suffice to feed the population, although these can prove highly inefficient (Anderson 1986; Krueger et al. 1988, chapter 13, 1991; Johnson 1997, chapter 12).

The second generation of thinking on food security stems directly from Sen (1981a, p.1, emphasis in original), whose famous opening sentences underscore that "starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat. While the latter can be a cause of the former, it is but one of many *possible* causes." Ironically, Sen (1981a, 1981b, chapter 60) eschewed the concept of food security, focusing instead on the "entitlements" of individuals and households. Sen shifted the focus from supply side issues associated with aggregate food availability toward individual access to food, and thus to the role of (perhaps idiosyncratic) demand failure due to unemployment, adverse movement in the terms of trade, production failure, termination of transfers, or other forms of "entitlement failure." Sen thus placed increased emphasis not only on traditional economic variables of incomes and prices, but equally on human rights and on the legal institutions of the state, as well as the moral and social norms of cultures. This perspective mirrored the renewed attention paid to institutional issues in technology development and diffusion and in agricultural commercialization.

The emergent third generation view of food security builds on food availability and access measures to introduce more explicit attention to risk, dynamics and the complex health consequences of nutrient deficiencies (Barrett 2002). By expanding the conceptualization of food insecurity beyond production, prices and incomes, the literature of the past decade or so more closely relates food insecurity to poverty, to social, economic, and political disenfranchisement,

and to structural patterns of control over (financial, human, and natural) resources and of access to markets, technologies, and finance (Drèze and Sen 1989), and has largely discredited single-causal explanations (Ravallion 1997, chapter 62). But with dozens of countries still lacking adequate food availability to meet the dietary needs of their residents, even if distribution were perfectly equitable, longstanding concerns about food production per capita maintain their currency in the 21st century (Barrett 2010, chapter 63).

Increased appreciation of the complex causation of food insecurity – that it is not simply a function of aggregate food availability – have paralleled growing appreciation for the heterogeneous experiences of individuals within the same household, with respect to food consumption, nutrient intake, health, and many other dimensions. Just as more nuanced insights on food insecurity have forced reconsideration of longstanding theories of hunger, so have more fine-grained observations of intra-household dynamics induced economists to reexamine long-prevailing theories of intra-household decision-making. The basic household model treats utility as a function of the per capita levels of consumption and leisure. Such representations are only valid to the extent that intra-household inequality in the distribution of goods is trivial or unimportant to individual household members. While inter-household inequality is clearly non-trivial, growing evidence that intra-household inequality can also be non-trivial sparked the growth of a literature, and eventually policies, focused on intra-household distribution.

Drawing on Philippine data, Folbre (1984) provocatively argued that observed patterns of intra-household inequality were hard to rationalize with any model that assumed beneficent maximization of a unified, family utility function. Building on the nascent intra-household bargaining literature (e.g., McElroy and Horney 1981), analysis of the rural household in developing countries began to explore models that replaced the unified household – or

"benevolent paternal dictator" – model with a household bargaining function based on individual utility functions and threat points based on the assets that the individual can carry away from the household should it dissolve as well as the external legal and social environment that shapes individuals' ability to use those assets.

Even assuming that household members can make and costlessly enforce bargains over all resource allocation decisions, this individualized or deconstructed household models yields a number of important insights. Chief among these are that interventions that influence the exit option of one household member may affect the intra-household distribution of goods. For example, interventions that enhance men's legal and economic control over land resources in an effort to enhance 'household welfare' may actually weaken women's bargaining power and decrease their and their children's well-being. As a consequence of the weight of the theoretical and empirical evidence built up around this point (Haddad and Kanbur 1990, chapter 66; Pitt, Rosenzweig and Hassan 1990, chapter 67; Haddad et al. 1997, Quisumbing 2003), a number of rural development policies have been designed with the intra-household bargaining equilibrium in mind. Examples include efforts to assure that both men and women benefit from land titling programs (Deere and León 2001) as well as efforts to target social transfers to women with the expectation that enhancing women's economic endowments improves child outcomes because women's preferences favor children relative to men's preferences.

Linking back to a core thread of the agricultural development literature, intra-household bargaining can also result in inefficient production patterns in the sense of failure to equalize returns to factors of production allocated among different household production activities (Jones 1983, chapter 64, Udry 1996, chapter 65). While these production-side issues have proven difficult to study, the preponderance of evidence that bargaining matters for household

expenditure priorities continues to shape and reshape a broad range of agricultural interventions in low-income countries. The course of agricultural development matters to individual and household-level experiences in sometimes unexpected ways.

VI. Conclusions

The 2007-8 global food price crisis drew global leaders' and media attention back to the imperative of agricultural development. Renewed interest in this area has reinvigorated research on the topic. Much of the best current work employs the formal analytical toolkit the economics discipline has developed over the past several decades. Some of this literature rediscovers longstanding themes: poverty traps, human capital, the criticality of technology adoption and market participation, the obstacles posed by coordination failures, the importance of institutions, inter-linkages across contracts and sectors, and the complex political economy of agricultural policy. These time-tested themes remain central to the ongoing exploration of the causal reasons why in many countries agricultural productivity remains low and rates of poverty and food insecurity high.

Those of us who have dedicated years to the study of agricultural development continue to delight in new empirical, methodological and theoretical discoveries that help us inch along the path of using scholarship to help relieve human suffering and sustain the natural environment on which rural livelihoods – indeed, life on Earth –depend. Because the challenges of agricultural development are so complex and intertwined, many of the richest insights come from building bridges across themes and scales of analysis or developing tools or findings that are broadly applicable to a wide class of problems.

Hence this collection of papers. It has been compiled, and this introductory essay written, principally with young scholars in mind – advanced undergraduates and graduate students in economics, agricultural economics, development studies, public policy, international relations and natural resources programs – as well as adventurous young scholars from cognate agricultural and social sciences. These volumes offer such readers an introduction to the field. But as I have personally discovered in editing these 1600 pages, a collection such as this offers a wonderful opportunity for an interlude of synthesis between the various narrowly-defined projects in which we scholars are always engaged, a chance perhaps to see the forest for the trees.

The chapters that follow reprint a selection – and unfortunately, space constraints permit only a quite sparse selection – of the finest work on the economics of agricultural development, spanning topics, decades and continents, including the work of luminaries as well as some seminal papers by scholars whose work unfortunately gets less attention in the mainstream of the profession. The papers I chose for these volumes I have read multiple times, each time learning something new and useful. I hope readers find similar riches in the pages that follow. Why should one take on the task of reading, such a broad-ranging, immense and admittedly, sometimes dense collection of papers? By familiarizing ourselves with the central themes and seminal work of the field we not only enjoy the collective brilliance of many scholars' noteworthy individual contributions, we also reap the benefits of intellectual arbitrage from parallel sub-literatures within the vast literature on agricultural development and, most importantly, we better equip ourselves to help address the many practical societal challenges that scholars working on these topics are privileged to research and debate. In order to do original

research that can contribute in some small measure to improving the human condition, we must first do our homework.

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