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Comments welcomed

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1. Introduction

A burgeoning recent literature emphasizes "livelihood" diversification among smallholder populations (Chambers and Conway 1992, Davies 1993, Ellis 1998, Bryceson 1999, Ellis 2000, Little et al. 2001). While definitions vary within this literature, the concept of livelihoods revolves around the opportunity set afforded an individual or household by their asset endowment and their chosen allocation of those assets across various activities to generate a stream of benefits, most commonly measured as income. This holistic perspective has the potential to enhance our understanding of the strategies that farm households pursue to ensure food and income security given the natural and economic environment in which they operate.

Diversification patterns reflect individuals' voluntary exchange of assets and their allocation of assets across various activities so as to achieve an optimal balance between expected returns and risk exposure conditional on the constraints they face (e.g., due to missing or incomplete markets for credit, labor, or land). Because it offers a glimpse as to what people presently consider their most attractive options, given the incentives and constraints they face, the study of diversification behavior offers important insights as to what policy or project interventions might effectively improve either the poor's asset holdings or their access to higher return or lower risk uses of the assets they already possess.

Since diversification is not an end unto itself, it is essential to connect observed livelihood strategies back to resulting income distributions and poverty. Not all diversification into off-farm or non-farm income earning activities offers the same benefits and not all households have equal access to the more lucrative diversification options. Yet the livelihoods literature offers little

documentation or explanation of important differences between observed diversification strategies. This paper addresses that gap by offering a comparative analysis using data from three different countries, Côte d'Ivoire, Kenya and Rwanda. Like Dercon and Krishnan (1996) and Omamo (1999), we emphasize that interhousehold heterogeneity in constraints and incentives must factor prominently in any sensible explanation of observed diversification behaviors. Indeed, section 4 demonstrates that at a very fundamental level – the choice of basic livelihood strategy – households would prefer locally available livelihood strategies other than those they choose, were they not constrained from doing so. A simple appeal to the principle of revealed preference thus suggests that heterogeneous constraints and incentives play a fundamental role in determining livelihood diversification patterns manifest in income diversification data.

The plan for the remainder of this paper is as follows. The next section presents the basic conceptual foundation from which we operate. Section 3 then introduces the data sets and definitions employed in the analysis. Section 4 presents findings relating to the observed variation in income sources across the income distribution, to distinct livelihood strategies pursued by rural African households, to the determinants of strategy choice, and to the effects of alternative livelihood strategies on income dynamics. These findings point especially to significant rural markets failures – especially with respect to finance and land – that force poorer subpopulations to select strategies offering demonstrably lower returns while wealthier subpopulations are able to enjoy higher return strategies to which entry is at least partly impeded by fixed costs and lower marginal costs of participation. Section 5 concludes.

2. Conceptual Foundation

Why do households diversify their livelihoods? One way to conceive of the problem is as follows.[1] Households choose an activity allocation vector v(a) for asset endowment, a, that yields an uncertain income return $\Sigma(v(a)|P)$ from among a feasible set defined by the intersection of a nontradable inputs availability constraint equal to one's endowment level of the input (e.g., land) and a budget constraint equal to one's current cash income plus access to liquid capital through savings or credit. Since income is a function of activity choice, it is an endogenous function of the prevailing (shadow) price distributions (P) for all factors, goods and services. So observed income patterns can be understood as a function of the constraints – including ex ante asset endowments (a) – the realization of ex ante incentives (P) faced by the household, and its preferences. If all households faced identical prices and constraints, then observed differences in diversification patterns would reflect purely measurement error or differences in preferences, such as with respect to risk.

Rural African households do not, however, face identical incentives and constraints. Spatial variation in transactions costs and gross market prices leads to cross-sectional heterogeneity in incentives due to differential market access. Shadow prices for homogeneous factors, goods and services vary predictably across households participating in rural African markets (Barrett et al. 2000). Because transactions and contract monitoring and enforcement costs can be considerable, many households self-select out of particular markets (de Janvry et al. 1991, Goetz 1992). This fuels further inter-household dispersion in shadow prices because households' relative factor endowments then determine on-farm productivity and thus households' allocation of productive assets between on- and off-farm activities. Moreover, quality differences affect factor productivity, leading to further price differentiation between

similar factors, as reflected in wages differences between educated and uneducated workers and in land prices between areas with good soils and sufficient rainfall and those without. Such heterogeneity in returns distributions facing rural African decision-makers surely accounts for some explainable variation in observed income diversification patterns.

So too do the constraints facing households inevitably vary, thereby influencing income diversification patterns. Property rights in productive assets such as land and livestock, labor availability, and access to credit or other sources of liquidity differ across (and within) households. Nontrivial sunk costs impede entry at modest scale to many higher-return activities or subsector niches, such as owning and operating a store, motorized transport, interseasonal commercial storage, skilled professional or trade labor (Barrett 1997, Reardon et al. 1998). Entry into these niches demands sufficient access to necessary financial and human resources, effectively constraining poorer, more illiquid, uneducated and unskilled smallholders' access to many of the more lucrative non-farm activities. As a consequence, differences emerge in the feasible sets from which households choose the portfolio of activities from which they generate their livelihoods. Such differential access to more lucrative niches is a primary reason non-farm income commonly exacerbates rural income inequality in Africa (Reardon and Taylor 1996, Reardon et al. 1998). Heterogeneity in the constraints faced by rural African households likewise must play a role in diversification behaviors.

Constraints not only impede some forms of diversification; they can also compel diversification into low-return activities. Meager endowments of productive, non-labor assets (e.g., land, livestock) commonly force poorer households to sell their labor power, generally for low wages in unskilled labor markets if they have no education or special skills. And sometimes,

adverse yield shocks – a transitorily poor endowment of natural capital – drive households into off-farm or non-farm employment as an ex post response to risk. While some households diversify into relatively lucrative activities because they have a choice, others must diversify into relatively undesirable activities because they have little choice.

3. Data, Contexts, and Definitions

A few papers have surveyed the literature in an attempt to establish patterns of livelihood diversification. For example, Reardon (1997), in reviewing 27 case studies in Africa, found that African rural households' average share of income not sourced either from wage employment on others' farms or from their own crop or livestock production is high, around 45 percent of total income. Of this, wage labor income commonly, if modestly, exceeds self-employment income, and non-farm earnings typically exceed either agricultural wage employment earnings or migration earnings outside of southern Africa. But he also found evidence that non-farm earnings were commonly regressively distributed, with those with the greatest farm income also enjoying a higher absolute level of and share of total income from non-farm sources than do the poor. This is consistent with other findings showing significant entry barriers to high return niches in the rural non-farm economy (Dercon and Krishnan 1996).

A central objective of this paper is to extend comparative analysis of household-level livelihood diversification in rural Africa beyond simple surveying of the published literature and drawing comparisons from results derived using different methods across papers. Instead, we endeavor to apply standardized methods to data sets from different countries and quite distinct agroecologies. The data used in this paper were not collected as part of a single project, nor were

the survey instruments designed with the intent of analyzing livelihood diversification strategies. So there are inherent limitations to the comparability of the data and to the comprehensiveness of the coverage. That said, the household-level data sets employed here provide sufficient detail about the origins of household income as to permit reasonably disaggregated analysis of alternative livelihood strategies using common methods across the data sets. This eliminates natural questions of comparability due to methodological inconsistencies across papers. Any consistent patterns found applying common analytical methods to data from three agroecologies as different as highland Rwanda, agropastoral, semi-arid northern Kenya, and the subhumid and humid rice systems of Côte d'Ivoire likely reflect prevailing conditions in rural Africa more broadly. In particular, this permits assessment of the extent to which household-level variation in constraints, incentives, or both, induces differentiated livelihood strategy choices by distinct subpopulations of rural African households.

3.1 Côte d'Ivoire data and context

The Ivorien data come from the West Africa Rice Development Association (WARDA)'s farm management and household survey (FMHS) of 120 rice farming households selected by stratified random sample in three distinct humid-to-sub-humid agro-ecological zones. These are generally areas of fertile soils, ample water, and reasonably good market access. The Ivorien data thus represent high agricultural potential zones. Rice is the primary cereal in the region, with significant cultivation of tubers, pulses, other cereals and cash crops such as cocoa, coffee and cotton by these households. The WARDA FMHS collected data for three consecutive years, 1993-95, using 22 different questionnaire modules, as described in detail in WARDA (1997). The

panel nature of the data thereby provide us with an opportunity, exploited in section 4, to examine the income dynamics associated with alternative income diversification strategies.

3.2 Kenya data and context

The Kenyan data originate from a 1994-96 stratified random sample of 308 farm households in three locations and 10 sublocations of lower Baringo District. Baringo is an arid-to-semi-arid region populated mainly by agropastoralists more dependent on transhumant livestock production than the area's mean annual rainfall of 600-700 millimeters would suggest because of high evapotranspiration rates that limit water availability. The primary activities for rural Baringo households involve production of small ruminants (primarily goats) and coarse grains: millet, maize and sorghum. So the households in Baringo, Kenya, operate in an agroecology of significantly lower potential than do either the Ivorien or Rwandan populations we study. This helps stimulate diversification out of complete dependence on agricultural production. Human population densities in the District are moderate, with satisfactory access to large metropolitan areas of the Rift Valley (e.g., Nakuru) and the Central Highlands (e.g., Nairobi). This both fuels a more active market for livestock sold to urban terminal markets down country and opens up a wider range of non-farm options to Baringo households than exist for households in more remote arid and semi-arid lands (Little et al. 2000). The District suffers poverty rates above the national average (Kenya poverty stats 1999), and financial intermediation is quite limited, so liquidity constraints tend to bind for many rural households (Little 1994). Between the high poverty rates and difficult climatic conditions, food aid has played a significant role in the area since the early 1980s. The farm household survey data used here was carried out in Food

For Work (FFW) project areas.

3.3 Rwanda data and context

The Rwandan data derive principally from a nationwide stratified-random sample of 1,240 farm households interviewed in 1991 by the Agricultural Statistics Division (DSA) of Rwanda's Ministry of Agriculture. Interviews with heads of households and/or their spouses were conducted over a six-week period beginning in June 1991. The survey instrument treated both household-level variables (such as non-farm income) and parcel-level variables (e.g., land tenure, fragmentation, slope, and other physical characteristics).

Rwanda is a rugged country of sub-humid and humid highlands. 93 percent of Rwanda's population live in rural areas and nearly all rural households farm. The main food staples include beans, sorghum, sweet potatoes and cassava, while coffee, bananas, and white potatoes are important cash crops. Farming is labor intensive; hoes and machetes are the basic farm implements, and animal traction is nonexistent. Livestock husbandry is integral to the farming system, but the progressive conversion of pasture into cropland has caused a reduction in livestock production in recent decades, and a parallel decline in the amount of manure available for improving soil fertility. Rwanda's average population density is among the highest in Africa. Virtually all arable land is now used for agriculture; marginal lands once set aside for pasture or left in long-fallow are now coming under more intensive cultivation. Rural informal and formal credit markets are severely underdeveloped.

3.4 Definitions

The literature on rural income patterns varies in its use of terms such as “non-farm” and “off-farm”, so let us explain our use of these terms clearly. The “farm/non-farm” distinction revolves around sectoral classifications derived from standard national accounting practices while the “on-farm/off-farm” distinction reflects the spatial distribution of activities, with “off-farm” income generated away from one’s own land (Barrett and Reardon 2000).[2] Within the farm income category, we distinguish between four sources of income: (i) retained output represents the value of food production that is not sold by the household but rather is retained for own consumption; (ii) food crop sales represent gross income from sales of cereals, pulses and tubers produced by the household; (iii) cash crops/livestock represents the value of raw agricultural commodities produced by the household for market (e.g., bananas, cocoa, coffee, cotton), including that used in on-farm processing by the household, where such vertical integration occurs, plus the proceeds from sales of livestock and unprocessed animal products (e.g., eggs, milk); and (iv) unskilled agricultural labor on others’ farms. Within the non-farm income category we distinguish between unskilled labor for wages or salary and income from trade, commerce, or skilled labor employment. This latter distinction is often very difficult to make in practice, so there is surely some misclassification in the data. But the broader patterns are likely robust to the inevitable noise associated with discretization of a continuum of employment profiles into distinct categories.

4. Patterns of Income Diversification

Rural African households inevitably depend heavily on the farm sector for much of their income, either through retained output, sale of their own crops or livestock, or wage labor on

others' fields or with others' livestock. Yet, as the subsections that follow each document through different empirical methods, non-farm income sources matter, and most commonly to relatively wealthier rural households.[3] Unfortunately, the data used here do not permit us to explore rigorously the direction of causality between higher income and greater reliance on non-farm income sources; does higher income provide liquidity necessary to enter high-return niches in non-farm subsectors or does participation in non-farm activities increase income? Nonetheless, as we demonstrate, some distinct livelihood strategies become discernible in the data and the clear superiority of some of these over others suggests, based on a simple revealed preference argument, that the poor who fail to choose the more remunerative of these strategies must be somehow impeded from access, whether due to insufficient endowments of productive assets, poor access to information, markets, start-up financing, or social groupings that condition entry into market niches. We therefore interpret the evidence as supporting the hypothesis that higher income is associated with the liquidity, market access and social contacts necessary to enter high-return niches in the rural economy. That raises a crucial follow-on question: is lower income attributable to poor asset endowments, restricted capacity to use one's existing assets or both? The answer to this question clearly matters enormously if policymakers are to try to facilitate universal access to higher return niches in the rural African economy. Such questions set the stage for the empirical evidence we present in the following subsections.

4.1 Income sources: shares, use, and role in explaining broader income patterns

There are numerous measures by which one can represent household livelihood diversification strategies – Herfindahl or Simpson indices, Gini coefficients, portfolio returns

distributions, etc. – but by far the most common and easily understood measure is the vector of income shares associated with different income sources. The leftmost column under each country heading in Table 1 shows mean income (per adult equivalent) shares by source for each of the three data sets. Retained food production for own consumption accounts for roughly half of total household income per adult equivalent on average in Côte d'Ivoire and Rwanda. In Kenya it accounts for one quarter, although agropastoralists' greater dietary dependence on animal products, especially milk, implies that the livestock category – the largest single income source in this population – probably captures a large share of these households' subsistence production. Given that food production for own consumption accounts for a plurality of income, the evidence here is consistent with the view of African rural households as semi-subsistence agricultural producers provided that allowance is also made for their non-farm and off-farm income sources. As we show below, complete reliance on own agricultural production is rare, save for among the wealthiest rural African households. While that may seem to contradict the common observation that non-farm income share is increasing in income level, as we show below, those averages mask an important bifurcation between the wealthy who focus on farming and those who move away from farming.

As one would expect in a survey of rural households in areas not subject to severe land constraints, all households in each data set derived income from food production retained for household consumption. Super-majorities also engage in food crop sales in wetter agroecologies (Côte d'Ivoire and Rwanda), although the meager average contributions to household income underscore the small volumes involved, mostly to satisfy short-term liquidity needs. In drier lands, own food production is less likely to cover the household's own consumption requirements,

so a minority earn income from crop sales. But livestock production and the sale of animal products (especially meat and milk) are especially important to livelihood strategies in the drylands (Little et al. 2001). More than 60 percent of Ivorien and Kenyan households and 44 percent of Rwandan households earn income from off-farm agricultural labor. Once again, the small contribution of this income source to average household incomes underscores the low compensation rates and limited time spent in off-farm employment in farming. This is commonly seasonal, casual labor.

Non-farm income sources are most extensively used by those in agroecologies of lowest potential, likely because agricultural productivity is relatively low. Thus in Baringo, Kenya, almost 30% of average household income comes from non-farm sources and more than 85% of the population there earned some form of non-farm income. The figures are likewise high, albeit less, in Rwanda, while they fall off sharply in the rice growing regions of Côte d'Ivoire, where good climate, soils and market access make food and cash crop production sufficiently remunerative to engage most rural households most of the time. The existence in Côte d'Ivoire of more and better developed intermediate cities into which non-farm activities become relatively concentrated likely also explains some of this difference.

Since household participation is incomplete in each setting for income-earning activities other than retention of own farm output, income from these sources is necessarily less equitably distributed than is total income. As Gini coefficients consistently exceeding 0.6 show, income from each source other than retained output is concentrated among a relatively small portion of the broader population (Table 1). But in only some cases are these concentrated incomes highly correlated with total income. In particular, although off-farm agricultural wage earnings are

highly concentrated, they are weakly correlated with total income – indeed, negatively correlated with total income in Rwanda – signaling the disproportionate dependence of the poorest rural households on this income source. Cash crop and livestock income exhibits consistently high correlation with total income across the different sites, reflecting how the wealthy enjoy privileged access to high-return options based on marketable commodities (Dercon 1998). The strength of the correlation of non-farm income sources with total household incomes seems to increase where the underlying agroecology limits farm productivity (i.e., in arid-to-semi-arid Kenya and erosion-prone, highland Rwanda) and to decrease where soils and climate favor crop production (humid-to-sub-humid Côte d'Ivoire). In the former regions, non-farm activities become a bedrock for income security and the most successful households enjoy dependable non-farm income sources. In the higher potential regions, however, patterns of non-farm income dependence have more to do with local market conditions, household characteristics, etc. and so do not correlate as closely to total household income.

Simple variance decomposition offers an alternative way of identifying which income sources play the greatest role in generating the total income distribution. Recognizing that total income, Y_T, is just the sum of the incomes from each source, Y_i, $Y_T = \sum_i Y_i$, one can represent the variance of total income $V(Y_T)$ as the sum of each source's covariance contribution, $CV(Y_i) \equiv \sum_j COV(Y_i, Y_j)$. The share of total income variance explained by each income source is then reflected by the ratio $CV(Y_i)/V(Y_T)$. This variance decomposition, reflected in the rightmost column under each country in Table 1, reinforces the earlier point that cash crop and livestock production is consistently among the most important factors in explaining income variation across rural African households, and that skilled non-farm income sources – trades and commerce, rather

than wage labor – are extremely important where agroecological conditions are relatively unfavorable. By contrast, labor income from either the farm or non-farm sectors contributes negligibly to variance in household incomes in any of the sites. Minimal amounts of wage labor income accrue to many households, but the amounts involved are sufficiently small and the participation patterns are driven largely by household size, which is weakly related to income (more on this in section 4.3).

4.2 Diversification behaviors and broader income distribution patterns

The discussion and data in section 4.1 suggest the existence of distinct, wealth-differentiated diversification behaviors in rural Africa, with the poor more reliant on farm wage labor and the wealthy drawing more heavily on income from cash crop and livestock production and on non-farm earnings. This subsection explores these questions further by disaggregating the preceding analysis across the income distribution.

Table 2 presents the same income source information depicted in Table 1, now broken into total income quartiles, with quartile 1 being the poorest quarter of the households, in terms of income per adult equivalent, and quartile 4 is the richest cohort. Several points stand out across the data sets. First, the poorest are consistently most dependent on retained output of their own agricultural production. The lowest income quartile derives from half to two-and-one-half times again as much of total income from retained food production as does the upper quartile. Since mean total incomes per adult equivalent are seven to ten times greater in the fourth quartile relative to the first in these data, the wealthy nonetheless enjoy substantially higher gross income per adult equivalent from crop production retained for home consumption. The income shares and

levels here thus signal arc elasticities consistent with the empirical regularity of income elasticities of demand in the neighborhood of 0.25-0.40 for staple foodstuffs (Strauss and Thomas 1995, Deaton 1997).

Second, income from food crop sales and cash crop and livestock production increase sharply with income since they represent an increasing share as one moves up the income distribution. This is further evidence against the once-prevailing belief that increasing food prices provides a progressive policy instrument to reduce poverty. Not only are most of the smallest, poorest food producers net food buyers (Weber et al. 1988, Barrett and Dorosh 1996), but here we find that the lowest income quartile averages one-fifth or less of income from market-oriented agricultural production , as compared to the top income quartile's one-third to one-half.

Third, the poorest depend far more than do the richest on unskilled farm wage income in agroecologies with significant crop production and moderate-to-high population densities (Côte d'Ivoire and Rwanda). In arid-to-semi-arid areas with lower population density, however, limited agricultural labor productivity and plentiful land reduce both supply of and demand for farm wage labor, so the inverse relationship between dependence on farm wage labor income and total income breaks down and no income quartile in Baringo, Kenya, derives more than seven percent of total income from off-farm agricultural labor. But even in the higher potential areas, farm wage labor amounts to no more than ten percent of total household income even in the poorest quartiles. And farm wage labor is commonly increasing in household income. These results are consistent with other published work that emphasizes the limited place of off-farm agricultural wage labor in rural African livelihoods and the limitations of labor markets-based targeting of transfers intended to alleviate rural poverty (Reardon 1997, Barrett and Clay 2000). These

characteristics mirror the relatively low dependence of rural African households on market-oriented agricultural output since those not selling produce but faced with liquidity constraints tend not to hire much wage labor. Incomplete product markets thus lead to muted response in interrelated factor markets (De Janvry et al. 1991).

Fourth, non-farm income varies enormously in importance across the income distribution. There is no universal pattern to who earns non-farm income (Reardon et al. 1998, 1999). To a significant degree this reflects nontrivial barriers to mobility within many non-farm subsectors. Entry into low-return niches (e.g., petty commerce at weekly rural markets) is low-cost and widespread, but movement within the sub-sector into higher-return niches requiring partially-irreversible investment in fixed capital is sharply limited by liquidity constraints, social networks necessary to establish, monitor, and enforce contracts, etc. (Barrett 1997, Fafchamps and Minten forthcoming a,b). One thus finds that income shares associated with a low-entry, low-return processing activity like banana beer brewing in Rwanda – shown in the next-to-last row of Table 2 – are low and reasonably even across income quartiles. Similarly, in wealthier areas with denser financial systems and reasonably good market access, commerce becomes extremely competitive and the wealthy often invest in primary agriculture instead of in tertiary sector activities associated with trades or commerce, as in Côte d'Ivoire.

However, in poor areas with significant liquidity constraints (represented by Baringo, Kenya, and Rwanda here) and significant transport demands to reach major markets, relatively high income individuals are far more heavily engaged in trades and commerce than are lower or middle-income households. In Rwanda, the total nonagricultural income of the lowest three quartiles combined just barely exceeds that of the top quartile. The rich clearly dominate the

sector in that setting. If we perform the same exercise just for skilled non-farm labor earnings, we find even greater concentration among the rich: the fourth quartile earns almost 60 percent of such income. first three quartiles earn 1.7 million vs 2.3 million for just the richest quartile.[4]

Income shares are but one metric of the extent to which households diversify income across various sources. An alternative measure is a Herfindahl-Simpson concentration index, equal to the sum of the shares across each possible income source. A value of one indicates complete dependence on a single income source while a value of 1/k represents perfectly equal earnings across income sources, where there are k different income source categories analyzed. As Barrett and Reardon (2000) explain, this measure has appealing axiomatic features for diversification analysis, yet is rarely used.

The bottom row of Table 2 reports income quartile-specific mean Herfindahl-Simpson concentration indices (HSCI) for each data set. Two points jump out immediately. First, while the differences across strata in household income diversification are negligible in the Kenyan and Rwandan data – with differences of 0.05 or less – in Côte d'Ivoire the poorest are considerably less diversified, as reflected by higher HSCI, than are the other income quartiles. This is certainly inconsistent with the stylized fact of decreasing absolute risk aversion, which would imply a greater demand for diversification among the poor than among the rich. Rather, it seems to reflect barriers to entry to particular, higher-returns diversification opportunities. Perhaps the poor do not diversify as much because their options are more limited.

Second, households are considerably more diversified in the higher risk, drier environment of agropastoral Baringo District, Kenya, than they are in the more humid, higher agricultural potential setting of Ivorien rice systems, with the Rwandan households lying between these two

extremes. While households HSCI in Kenya are far closer to their lower bound of 0.13 than to the upper bound of 1.00, in Côte d'Ivoire household HSCI are closer to the 1.00 upper bound in the bottom half of the income distribution.[5] The underlying agroecology plainly influences the extent to which households diversify income sources. The dispersion of mean HSCI across income quartiles is also minimal in the higher-risk, drier environment while it is far more pronounced in the higher potential region. This hints at an irony of a favorable agroecology: by fostering better agricultural performance and a more robust agricultural wage labor market, it may induce more differentiation in livelihood strategies between wealth cohorts and more specialization in pure agriculture by the poor, leaving them more vulnerable to shocks to the farming system.

4.3 Household Livelihood Diversification Strategies

It is apparent that distinct rural livelihoods strategies exist, with some households able to access more remunerative strategies than can others. This sub-section identifies these distinct strategies and explores households' wealth-differentiated patterns of use of distinct income diversification strategies.

We define four distinct rural income diversification strategies in these data. Some rural African households depend entirely on the farm sector. One of the two cohorts that depends entirely on farming are effectively pure farmers, earning all their income from agricultural production on lands they cultivate and from livestock they own. Some earnings may come from food crops, some from cash crops or livestock, and output may be sold to market, retained for home consumption, or both. But the livelihoods of these "full time farmer" (FTF) households

come entirely from the land they cultivate and the animals they raise. There may be diversification of crops or integration of crops, livestock and forestry. But the full time farmer's livelihood depends entirely on his or her own agricultural production.

Such a strategy plainly requires reasonable access to land for cultivation and grazing. Markets for both rental and sale of land are thin in each of the surveyed areas. As a consequence, while households may be able to rent in or buy some land, land allocations are typically subject to binding constraints[6] based on their exogenous land endowments. If a household has sufficient land to absorb its whole working age labor force, the full time farmer strategy may hold appeal if the household is in a high potential agroecology with satisfactory market access. The intuitive relationship between a household's *ex ante* land/labor endowments and the likelihood that it chooses the FTF income diversification strategy appears clearly in Figure 1, which depicts the nonparametric Rosenblatt-Parzen density of the land/labor distribution in the Ivorien data set and the nonparametric conditional expectation (Nadaraya-Watson estimator) of the binary (0-1) variable of choosing the full time farmer income diversification strategy. This relationship increases sharply and monotonically throughout most of the underlying land/labor density, dipping only at the upper tail, where the most wealthy households are able to recycle the proceeds of well-above-average agricultural sales revenues into non-farm investments yielding a more diversified income portfolio (and a more attractive returns distribution, as we demonstrate below). For all but the wealthy, the probability of relying entirely on one's own on-farm agricultural production is closely related to one's relative land/labor endowment.

As Table 3 indicates, other than in arid-to-semi-arid agroecologies with low cropping potential, the proportion of households choosing the full time farmer strategy is increasing in

income as well as in land/labor ratios. In both Côte d'Ivoire and Rwanda, this strategy occupies a plurality of top quartile households, roughly twice the proportion of lowest quartile households who derive all their income from their own agricultural production. This pattern partly reflects the positive correlation between income and land endowments in these regions. But it also captures differential market access. Farmers with superior access to urban markets and those involved in contract farming schemes with processing plants or exporters are better able to overcome factor market constraints (e.g., for inorganic fertilizer and improved seeds) to production for market and thereby to enter relatively lucrative cash cropping and livestock (or perishable livestock product) markets (Little and Watts 1994, Staal et al. 1997, Fafchamps and Shilpi 2000, Holloway et al. 2000). As a consequence, both income and dependence on market-oriented agriculture increase as one moves nearer to the outskirts of cities.

The second cohort that depends entirely on the farm sector draws income both from their own on-farm production and from off-farm agricultural wage earnings. This cohort is significantly poorer than the first. Once again, the underlying agroecology matters a great deal. There is little demand for agricultural wage laborers in low potential regions such as Baringo District, Kenya, so even the poor are unable to depend just on the farming sector. But where human population densities are higher and soils and water availability more favorable to cultivation, the "farmer and farm worker" strategy predominates among the poorest quartile of the income distribution (Table 3). The richest quartile is least likely to pursue this strategy, reflecting the low returns to agricultural wage labor in rural Africa. Those who have the option to choose other, more remunerative strategies do so. A bitter irony emerges. By virtue of their far greater dependence on the farming sector for the entirety of their incomes, the poorest rural

subpopulations are thus more vulnerable to agricultural yield and price shocks. Exogenous price shocks resulting from sectoral reforms have ambiguous welfare effects since poor net buyers of agricultural commodities tend to see labor earnings vary directly with food prices that determine the marginal value product of their labor to prospective employers. But adverse yield shocks due to pests, disease, drought or floods are especially threatening to the poorest in rural Africa since output from their own farm and agricultural wage earnings move together, inversely with food prices. Although the poor most need diversification to defend against entitlements failure and severe food insecurity, they are often least able to do so because of the incomplete markets problems that restrict their entry into more remunerative non-farm activities (Dercon and Krishnan 1996, Reardon et al 1998).

The last two rural income diversification strategies we find combine farm and non-farm earnings. Within this population, we draw a distinction between those who undertake unskilled labor – whether in the farm or non-farm sectors – and those who do not. The third row of Table 3 shows that higher income households are by far most likely to combine on-farm and non-farm strategies without recourse to unskilled wage labor. We refer to this strategy as "farm and skilled non-farm" (FSNF). Either full time farmer or farrm and skilled non-farm strategies are the most common within the top income quartile in each data set, reflecting the superior returns to self-employment and skilled employment. Although both levels and shares of non-farm income are increasing in income in most of Africa (Reardon 1997), there is no monolithic movement of the rural wealthy toward non-farm activities. Some are wealthy because they are extremely good farmers and thus focus profitably on farming exclusively. Others use their liquidity to branch out into downstream activities or sub-sectors entirely unrelated to agriculture. The large share of the

highest income households fully specialized in farming underscores the concentration of rural non-farm income among an elite cohort. For example, in Rwanda, 40% of the richest concentrate exclusively on farming, so the large share of non-farm income earned by that upper quartile accrues to only 60% of its households, and almost all of it to the 29% that eschews unskilled labor. So there are a few households earning a great deal from non-farm pursuits while most of the rest do without.

The final diversification strategy combines all three basic elements discussed so far: on-farm agricultural production, unskilled farm wage employment, and non-farm earnings. Poorer households are more likely to select this strategy than are wealthier households, as reflected in the declining rates of adoption of this strategy as income increases in each data set. This strategy gets followed by those undertaking non-farm self-employment in low-return niches such as charcoal production, home beer brewing, petty commerce, and ox-cart-based transport. Such activities are common among the young, before they ascend to more skilled positions or inherit enough land to become full-time farmers. We therefore find a reasonable share of even wealthy households pursuing this diversification strategy since those with larger households and teenage or young adult members are likely to undertake both low-return unskilled labor and higher-return non-farm activities in addition to their own agricultural production for home consumption or market. Even if the income elasticity of demand for leisure is significantly positive, in the presence of multiple rural market failures, high household income does not preclude rural households putting working age members to work for low wages.

These four, basic household livelihood diversification strategies do not offer similar returns. Figures 2 and 3 present cumulative frequency distributions of total household income, in

Côte d'Ivoire and Rwanda, respectively,[7] for each of the four diversification strategies – full time farmer (FTF), farmer and farm worker (FAFW), farm and skilled non-farm (FSNF) and mixed farm, non-farm and unskilled off-farm labor (Mixed). The FAFW distribution offers consistently lower returns than the others. At lower income levels, the FTF and FAFW distributions are virtually indistinguishable, but complete dependence on one's own farm production offers upside opportunities absent for those whose land/labor endowments preclude exclusive reliance on own-farm production. In Figures 2 and 3, this appears in the sharp divergence of the full time farmer cumulative frequency distribution from the farmer and farm worker distribution after about the 80th percentile. A household doing well following the full time farming strategy can do very well indeed, while one doing well following the farmer and farm worker strategy still lags behind.

If one were to model smallholders as choosing among the four strategies, FAFW is unambiguously less desirable, in the first degree stochastic dominance sense, than either the farm and skilled non-farm or mixed strategies in Rwanda, and in the second degree stochastic dominance sense relative to all three other strategies in Côte d'Ivoire.[8] The full-time farmer strategy is itself first degree stochastically dominated by the farm and skilled non-farm strategy in Rwanda and second degree dominated by both the mixed and farm and skilled non-farm strategies in Côte d'Ivoire. No dominance ordering is possible between the mixed and farm and skilled non-farm strategies in either country, although the Figures show plainly that the farm and skilled non-farm strategy offers considerably greater upside potential with negligible differences in the lower range of the distribution.

Since the stochastic income distribution associated with each of the strategies differ significantly, indeed in ways that lend themselves to clear welfare ordering, rural African

households are apparently not choosing the farmer and farm worker strategy of farm production and agricultural wage labor over the other strategies in order to either maximize income or minimize risk. Nor are they choosing not to incorporate skilled non-farm work in their portfolio because its returns are insufficiently appealing. Rather, as Dercon and Krishnan (1996) argue, the more plausible explanation is that differences in asset endowments – of land, labor, education, and livestock – and access to markets and financing differentially constrain household livelihood choice in rural Africa. These endowment and markets access constraints prevent some households from accessing more remunerative non-farm activities and, in more extreme cases, even from specializing entirely in farming. We pursue this point further in the next subsection.

4.4 Determinants of Income Diversification

Households endowed with insufficient productive agrarian capital – land and livestock – to absorb their household's full labor endowment are compelled to seek out off-farm or non-farm income sources in the absence of complete and well-functioning markets in land and livestock. Given a fixed stock of household labor time and diminishing returns to on-farm labor, the share of household income derived from off-farm or non-farm sources should be declining steadily in the amount of land a household cultivates because the share of household labor absorbed by on-farm activities is increasing in land holdings, as has been found previously in African agriculture (e.g., Matlon 1979). That is precisely the relationship apparent in Figures 4 and 5, in which the darker, solid lines depict off-farm agricultural labor earnings' expected share of total household income conditional on land/labor and land endowments, respectively, in the Côte d'Ivoire data set, based on a Nadaraya-Watson kernel estimator. Ivorien rice farming households indeed appear to

allocate labor to off-farm agricultural employment only once the returns to on-farm agricultural work fall below prevailing farm wage rates.

What is most interesting about these nonparametric regressions, however, is that this same pattern does not hold for non-farm income. In particular, the share of total household income accounted for by non-farm sources falls consistently, tracking that of off-farm agricultural labor earnings almost exactly, up to about six hectares' land endowment, at which point it levels off then begins climbing again. Households with very little or quite a lot of land appear significantly more likely to derive income from non-farm sources than do households with sufficient land to fully engage all household labor yet perhaps not enough land to generate sufficient liquidity to enter high-return non-farm activities to which the most generously endowed households have access. The land-poor households on the lefthand side of Figure 5 are largely undertaking unskilled non-farm labor (Table 2), while the more land-rich are more commonly involved in trades and skilled employment. Similarly, the pattern in Figure 4 for the non-farm income share regression shows some diminution of non-farm earnings' share up to an endowment of about six or seven hectares per thousand hours of adult labor, at which point it stabilizes at a much higher level than off-farm agricultural earnings do.

While these simple bivariate relationships are instructive, surely multiple variables are at play in determining livelihood patterns. So we also ran multivariate regressions using the Rwandan data, in which the differences in the four livelihood strategies' returns distributions are most pronounced (Figure 3).[9] Table 4 presents estimates from censored regressions of the share of each income source on a range of incentives and constraint variables that jointly determine labor supply behavior.[10] The results are entirely consistent with the above story. First, the share

of income derived from unskilled labor is increasing in household labor supply, decreasing in land and livestock holdings, and, in the case of farm labor, increasing in the local average value product of labor. Second, dependence on unskilled labor is higher in female-headed, illiterate and younger households, which have less human and social capital on which to draw. Third, dependence on own agricultural production – whether through retained output, food crop sales or cash crops and livestock – is decreasing in household labor endowment and increasing in area cultivated. Fourth, greater distance from market and a paved road increases the share of income drawn from retained farm output and sharply decreases the share of income drawn from skilled, non-farm labor.

Interhousehold differences in asset endowments – of labor (including human capital such as education, experience and gender), land and livestock, in particular – and in market access plainly play an important role in driving household choice of livelihood strategies. So the greater rate of reliance by the poorest households on activities offering demonstrably inferior returns distributions can be explained in significant measure by poor endowments of productive assets and weak market access. Self-selection into unskilled labor and, especially, the least desirable, farmer and farm worker strategy reflects a more restricted choice set in an environment of incomplete rural markets. The rural African playing field is not level; the poor have decidedly inferior access to more desirable livelihood options, hence the observed patterns of income diversification across these different rural African sites.

4.4 Income Dynamics and Mobility

To this point we have considered only cross-sectional variation in diversification strategies

and their effects on income. Yet transitorily low income is certainly of less concern than is chronically low income, so it is helpful if we can establish whether the patterns apparent in the comparative analysis in cross-section hold in time series as well. The panel data from Côte d'Ivoire allow for exploration of the relationship between livelihood diversification strategies and income mobility.

The preceding sections' analysis found the poor much more likely to depend heavily on the farm sector than are richer households. The lower desirability of the farmer and farm worker strategy becomes even more apparent when one looks at income distribution dynamics. Table 5 presents the composite transition matrix, in which households' successive income observations are classified by income quartiles to capture mobility over time within the income distribution.[11] While 46% of others enjoyed income above the median in both periods and only 30% suffered below-median income both periods, the corresponding figures among farmer and farm worker households were 32% and 47%, respectively. More dramatically, while 24% of the FAFW households were trapped in the lowest quartile in successive periods, only 9% of other households were. This contrasts starkly with the other end of the income distribution, where only 8% of farmer and farm worker households were in the income distribution's top quartile in successive periods, far less than the 22% of other households consistently at the top of the income heap. A cruel symmetry appears: while roughly 80 percent of those trapped in the lowest quartile of the income distribution year-on-year follow the farmer and farm worker strategy, a similar 80 percent of those consistently occupying the top quartile do not adopt the farmer and farm worker strategy. Furthermore, while a majority of each cohort stays within its income quartile year-on-year (reflected by the shaded cells on the diagonal in Table 5), FAFW households evince more

downward than upward mobility, with 26% falling one or more quartiles versus only 18% rising. Others households, by contrast, were more upwardly than downwardly mobile (27% versus 20%).

These income mobility findings are consistent with the evidence that some households are pushed into off-farm activities because limited endowments of productive assets such as land and livestock mean that diminishing returns force household on-farm labor productivity so low as to induce the household to hire out its labor to other farms but the household's liquidity is insufficient to afford it access to higher return non-farm activities. If rural factors markets were complete, such households could rent additional land or borrow in order to finance either the purchase of additional land or other nonlabor inputs in order to increase their labor productivity on farm or entry into higher return non-farm activities. Those selecting the farmer and farm worker livelihood diversification strategy are more likely to land in the lowest income quartile and to stay there. So rural factor market failures appear to create poverty traps that are easily missed if one looks just at farm/off-farm income shares, treating all forms of diversification as desirable. Some diversification is born of desperation, not opportunity.

5. Conclusions

This paper has emphasized the central role interhousehold heterogeneity in constraints and incentives plays in any sensible explanation of observed income diversification patterns in rural Africa. Using data from three very different agroecologies around the continent – arid-to-semi-arid north central Kenya, highland Rwanda, and humid-to-subhumid Côte d'Ivoire – the paper presents detailed, comparative evidence on differences and similarities in observed diversification behaviors across sites and segments of the income distribution. We find that livelihood strategies

that include non-farm income sources – especially those derived from other than unskilled labor – are associated with higher income realizations and greater income mobility, especially upward earnings mobility. In contrast, those households that have neither access to non-farm activities nor sufficient productive nonlabor assets (i.e., land and livestock) to devote themselves entirely to on-farm agricultural production, typically must rely on a low-return strategy of complete dependence on the agricultural sector and often find themselves caught in a dynamic poverty trap.

As the main source of employment and wage goods, improved agricultural productivity indisputably plays a central role in resolving rural poverty problems in Africa. And facilitating broader access to land likewise can help improve the lot of the poorest. But the evidence presented in this paper – and evident in the broader literature on rural livelihoods – clearly points to the necessity of a vibrant rural non-farm economy, and to the importance of securing access for all to attractive niches within the non-farm sector through improved liquidity and market access. If progress is to be made in combating rural African poverty, donors and policymakers must recognize that rural African households draw heavily on off-farm and non-farm income, and that the most successful commonly draw heavily on such sources.

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Table 1: Income Source Characteristics

	Côte d'Ivoire					Kenya					Rwanda				
	AIS	**Use %**	**Gini**	**Corr**	**Var %**	**AIS**	**Use %**	**Gini**	**Corr**	**Var %**	**AIS**	**Use %**	**Gini**	**Corr**	**Var %**
Farm income															
retained output	55	100	0.44	0.75	0.42	24	100	0.40	0.44	0.04	46	100	0.41	0.74	0.28
food crop sales	13	79	0.70	0.69	0.13	3	15	0.97	0.25	0.14	11	94	0.64	0.58	0.11
cash crops/ livestock	21	49	0.81	0.64	0.36	39	93	0.68	0.81	0.35	20	99	0.54	0.68	0.19
farm labor	5	62	0.86	0.23	0.04	4	62	0.71	0.17	0.00	3	44	0.80	-0.08	0.00
Non-farm income															
Labor	2	19	0.85	0.08	0.01	14	86	0.66	0.26	0.05	2	22	0.88	0.06	0.00
Trades/ commerce	5	9	0.93	0.18	0.04	11	60	0.81	0.60	0.25	15	34	0.88	0.71	0.41
Other*	–	–	–	–	–	4	44	0.81	0.57	0.17	3	68	0.68	0.33	0.01
Total Income	100	100	0.46	1.00	1.00	100	100	0.48	1.00	1.00	100	100	0.35	1.00	1.00

AIS = Average income share in percentage terms
Use % = the proportion of respondents earning income from that source
Gini = Gini coefficient for that income source
Corr = correlation of income source with total income
Var % = share of total income variance explained

* The "other" category includes food-for-work, transfers, pension receipts, rent, interest and other sources of unearned income in the Kenyan data. In the Rwandan data it reflects value-added from banana beer brewing. The Ivorien and Rwandan data only capture earned income.

Table 2: Income Shares by Source and Income Quartile Per Adult Equivalent

	Côte d'Ivoire				Kenya				Rwanda			
	Q1 (90)	**Q2 (90)**	**Q3 (90)**	**Q4 (90)**	**Q1 (77)**	**Q2 (77)**	**Q3 (77)**	**Q4 (77)**	**Q1 (288)**	**Q2 (289)**	**Q3 (289)**	**Q4 (288)**
Farm income												
retained output	73	72	61	48	46	37	29	17	60	55	52	40
food crop sales	5	5	17	14	0	0	0	5	8	9	12	12
cash crops/ livestock	6	10	17	26	21	28	39	44	14	18	21	21
farm labor	10	5	4	4	4	7	5	3	10	6	1	1
Non-farm income												
Labor	4	5	1	6	18	16	15	13	3	3	3	2
Trades/ commerce	3	3	1	2	4	8	9	14	4	6	6	22
Other*	–	–	–	–	6	4	3	5	2	3	4	3
Herfindahl-Simpson concentration index	0.67	0.64	0.54	0.53	0.42	0.41	0.39	0.43	0.49	0.54	0.52	0.52

Q1 is the first quartile, i.e., the one with lowest income.

Numbers of observations appear in parentheses at the top of each column.

* The "other" category includes food-for-work, transfers, pension receipts, rent, interest and other sources of unearned income in the Kenyan data. In the Rwandan data it reflects value-added from banana beer brewing. The Ivorien and Rwandan data only capture earned income.

Table 3: Livelihood Diversification Strategies By Income Quartile Per Adult Equivalent

(percent pursuing each strategy)

	Côte d'Ivoire				Kenya				Rwanda			
	Q1 (90)	**Q2 (90)**	**Q3 (90)**	**Q4 (90)**	**Q1 (77)**	**Q2 (77)**	**Q3 (77)**	**Q4 (77)**	**Q1 (288)**	**Q2 (289)**	**Q3 (289)**	**Q4 (288)**
Farm only												
full time farmer	27	38	45	55	6	6	0	1	24	29	30	40
farmer/farm worker	47	27	18	13	6	3	0	1	46	37	37	19
Mixed farm/ non-farm												
farm/skilled non-farm	2	8	14	18	42	55	65	71	10	12	19	29
farm/skilled and unskilled non-farm	25	26	23	14	45	36	35	26	20	22	15	12

Q1 is the first quartile, i.e., the one with lowest income.
Numbers of observations appear in parentheses at the top of each column.

Counts only earned income (i.e., omitting food aid, remittances, interest, rent, etc.)

Table 4. Censored Regressions Across Shares of Income, by source (Rwanda)

Household and Regional Characteristics	Retained Output†	Food Crop Sales ‡	Cash Crops/ Livestock ‡	Farm Labor ‡	Unskilled Non-farm Labor ‡	Skilled Non-farm Labor ‡
Relative prices and risk						
Average value product of labor in prefecture (100 FRW)	-0.001	0.000	0.002	0.060**	-0.015	-0.019
Average non-agricultural daily wage in prefecture (100 FRW)	0.024**	0.005	0.003	-0.017	-0.030	-0.001
Yearly crop price variability§	-0.619**	0.060	0.138*	-0.097	0.359	0.384
Meso-level factors						
Infrastructure assets						
Distance to nearest market (km)	0.019**	0.001	0.001	-0.001	-0.008	-0.009
Distance to nearest paved road (hours)	0.078**	0.008	-0.039	-0.007	-0.012	-0.112**
Agroclimate assets						
Annual rainfall (100 mm)	0.002	0.003*	0.003	0.001	0.008	-0.012
Elevation (1000 meters)	-0.040	-0.031**	0.016	0.097**	-0.068	0.098*
Micro-level factors						
Land assets (quantity, quality)						
Area cultivated (hectares)	0.039	0.017	0.031*	-0.073	-0.042	-0.048
Area owned (hectares)	-0.040	0.009	-0.022	-0.000	-0.022	0.030
Average field slope (degrees)	0.003**	-0.001**	-0.001**	0.002*	0.002	0.001
Location of fields on slope (1-5 index)	-0.021**	0.005	0.003	0.006	0.006	0.024
Average distance of fields from residence (hours)	-0.069**	0.026	0.008	-0.002	0.001	0.004**
Simpson farm fragmentation index	-0.006	0.0033**	-0.008	-0.020	-0.034	-0.001
Livestock assets						
Value of livestock (million FRW)	0.331	-0.226	0.307	-4.320**	-1.090	0.085
Labor and human capital assets						
Household labor (economically active)	-0.012**	-0.008**	-0.005	0.018**	0.031**	0.052**
Dependency ratio (nonactive/active*100)	-0.000	0.000	-0.000	-0.000	-0.000	0.0003*
Literacy of household head (0=no, 1=yes)	-0.029**	0.009	-0.004	-0.067**	-0.010	0.147**
Age of household head (years)	0.002**	-0.000	0.001**	-0.002**	-0.002**	-0.003**
Gender of household head (0=male, 1=female)	-0.047**	-0.005	0.001	0.057**	0.037	0.077*
No. observations censored at zero	1	70	10	614	838	712
No. observations censored at one	1	0	0	0	0	0
No. uncensored observations	1077	1009	1069	465	241	367

† Dependent variable is doubly censored from below at zero and from above at one.

‡ Dependent variable is singly censored from below at zero.

§ Average coefficient of variation for six crops, 1986-92, weights based on prefecture-level output value shares.

* Significant at .05 level **Significant at .01 level

Table 5: Livelihood Strategies and Income Distribution Dynamics

		Year t+1							
		1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Year t	1st Quartile	.24 *.10*	.09 *.06*	.07 *.03*	.05 *.03*	.01 *.00*	.02 *.01*	.00 *.00*	.02 *.01*
	2nd Quartile	.06 *.02*	.04 *.02*	.10 *.04*	.12 *.07*	.05 *.02*	.07 *.04*	.01 *.00*	.03 *.02*
	3rd Quartile	.02 *.01*	.01 *.00*	.06 *.02*	.07 *.04*	.13 *.05*	.09 *.06*	.05 *.02*	.09 *.06*
	4th Quartile	.01 *.00*	.00 *.00*	.04 *.02*	.02 *.01*	.06 *.02*	.06 *.04*	.08 *.03*	.22 *.13*

1st quartile is the lowest income group, 4th quartile is the highest, each defined for the year-specific income distribution.

Each quartile column-row combination nests within it two columns and two rows. The lefthand column represents respondents pursuing the "farmer and farm worker" strategy involving just own production and off-farm agricultural wage labor. The righthand column captures all other respondents (i.e., those who are full time farmers and those engaged in non-farm activities of any sort). Numbers in the first row of each cell show the proportion of the strategy-specific subsample (86 farmer and farm worker, 130 others). Italicized numbers in the second row of each cell show proportions of total sample of 216 pairs.

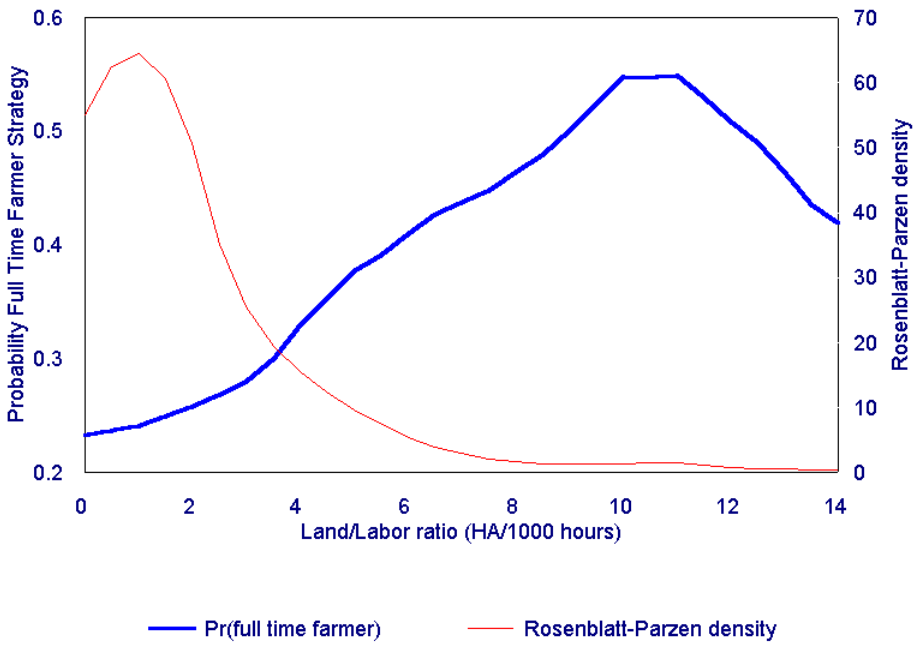

Figure 1: Nonparametric regression estimates of relationship between adoption of full time farmer diversification strategy and household land/labor endowment ratios in Côte d'Ivoire (Epanechnikov kernels with fixed bandwidth of 3.0)

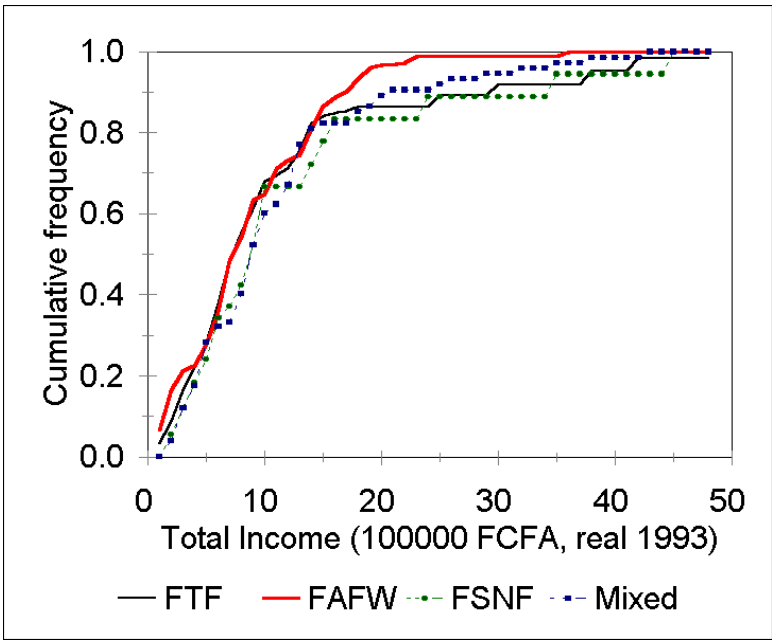

Figure 2. Cumulative frequency distributions of total household real income, by livelihood strategy, Côte d'Ivoire.

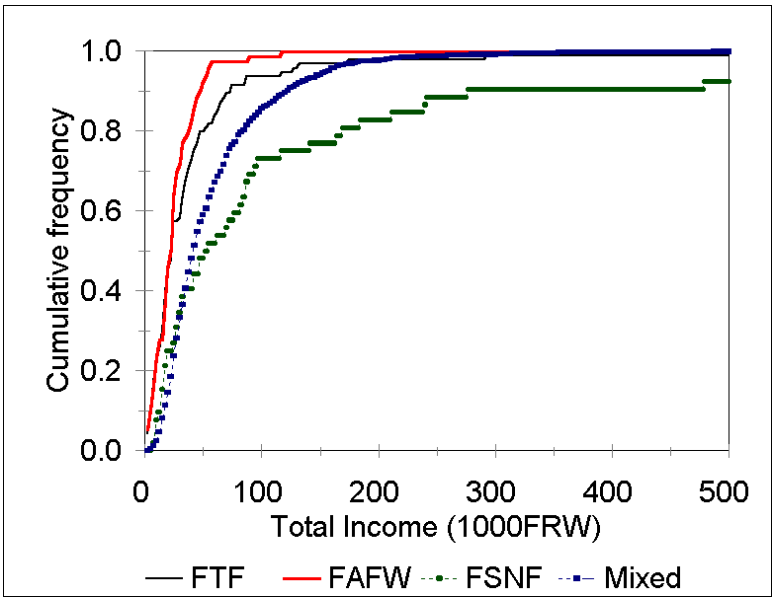

Figure 3. Cumulative frequency distributions of total household income, by livelihood strategy, Rwanda.

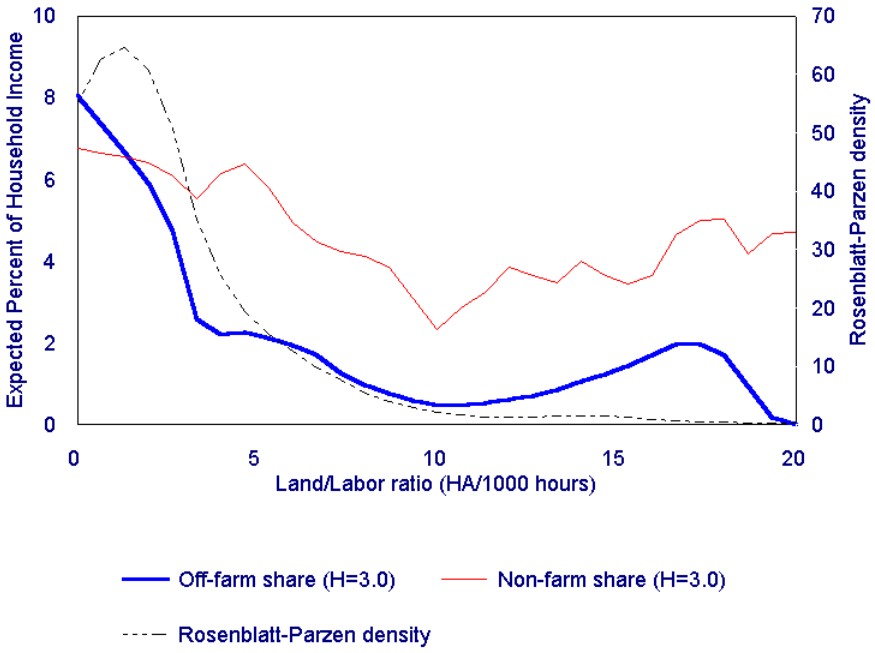

Figure 4: Nonparametric regression estimates of relationship between non-farm and off-farm income and household land/labor endowment ratios in Côte d'Ivoire (Epanechnikov kernels with fixed bandwidth of 3.0)

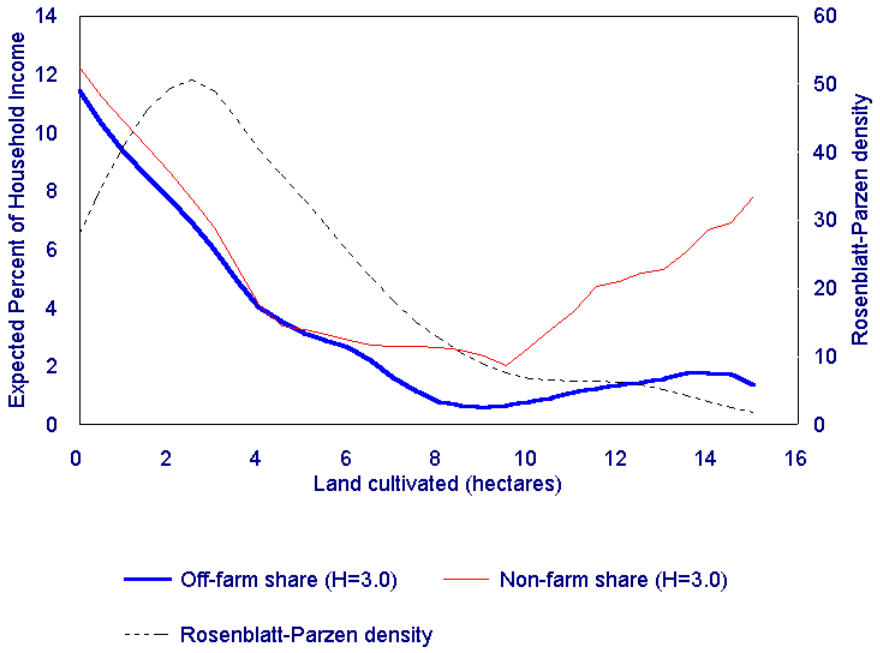

Figure 5: Nonparametric regression estimates of relationship between non-farm and off-farm income and household land endowment in Côte d'Ivoire

(Epanechnikov kernels with fixed bandwidth of 3.0)

Notes

1. Ellis (1998 and 2000) and Barrett and Reardon (2000) offer more detailed explorations of this question.

2. More precisely, "farm" activities are associated with those primary sector production processes that produce raw agrifood products from natural resources (land, rivers/lakes/ocean, air). The process can involve either growing (e.g., cropping, aquiculture, livestock husbandry, woodlot production) or gathering (e.g., hunting, fishing, forestry). "Non-farm" activities are associated with those secondary and tertiary sector production processes that use raw physical intermediate inputs (such as maize, milk, iron, wood) and process them into manufactured goods (such as maize flour, cheese, pails, furniture) or use financial or manufactured capital and labor to produce services (e.g., transport, commerce, banking). Notice that sectoral assignments depend only on the nature of the product and the types of factors used in the production process. Neither location (at or away from home) nor employer (self-employed or hired for a salary or wage) matter.

3. These two points echo existing findings by, for example, Reardon et al. (1992), Reardon (1997) and Ellis (2000).

4. Francis and Hoddinott (1993) find similar patterns in western Kenya.

5. The lower bounds are 0.13 in Kenya, where HSCI were computed off eight income categories, and 0.17 in Côte d'Ivoire, where they were computed off six sources.

6. These are akin to liquidity constraints that don't preclude borrowing, just enforce non-price rationing.

7. The data show roughly similar patterns in the Kenyan data, although there is no first- or second-order stochastic dominance ordering in the Kenyan data.

8. First degree stochastic dominance provides a utility ordering among stochastic variables conditional on the assumption that utility is increasing in income. Second degree stochastic dominance likewise provides an ordering among random variables subject to the additional assumption of income risk aversion (Whitmore and Findlay 1978). In the Rwanda data, OFOO is almost second degree stochastically dominated by the OFO strategy, save for the very lowest observations. There are a small number of very poor pure farmers following the OFO strategy, else OFOO would have been dominated by OFO in Rwanda as well.

9. The Ivorien and Kenyan data are not well suited to this sort of regression analysis as too many relevant variables are missing.

10. In a censored regression (Tobit) model, an unrestricted latent variable, $\tilde{s}$, is assumed to be an unobservable function of a vector of regressor variables, $\mathbf{z}$, as reflected in the linear relationship $\tilde{s}_i = \beta' \mathbf{z}_i + \varepsilon_i$. However, the observable income share, s, is restricted to fall in the [0,1] interval,

according to the following rule:

$s_i = 0$ if $\tilde{s}_i \leq 0$
$s_i = \tilde{s}_i$ if $0 < \tilde{s}_i < 1$
$s_i = 1$ if $\tilde{s}_i \geq 1$

In these data, only the retained output share is doubly censored; the other regressands are each singly censored from below (i.e., at zero). Since Table 4 is already crowded, we provide only categorical indicators to reflect statistical significance. Standard errors and p-values of all estimates are available from the authors by request.

11. This only reflects mobility in the income orderings, not in real income or welfare measures. There was some year-on-year change in the thresholds separating the quartiles. In real income terms and relative to the 1993 thresholds, the dividing lines between the 1st and 2nd, 2nd and 3rd, and 3rd and 4th quartiles fell by 4.4%, increased by 6.5%, and fell by 9.7%, respectively, in 1994, while they increased by 3.2%, increased by 4.3% and fell by 7.5%, respectively, in 1995 (again relative to 1993). So the median household in the Ivorien sample enjoyed an increase in real income in 1994, then a modest fall in 1995.