LUND UNIVERSITY

Structural transformation and African smallholders: drivers and dynamics of change for eight countries

Andersson Djurfeldt, Agnes; Djurfeldt, Göran

Published in:
Oxford Development Studies

2013

Document Version:
Peer reviewed version (aka post-print)

Link to publication

Citation for published version (APA):
Andersson Djurfeldt, A., & Djurfeldt, G. (2013). Structural transformation and African smallholders: drivers and dynamics of change for eight countries. *Oxford Development Studies*, *41*(3).

Total number of authors:
2

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Structural transformation and African smallholders: drivers of mobility within and between the farm and nonfarm sectors for eight countries

Agnes Andersson Djurfeldt, Department of Human Geography, Lund University
Göran Djurfeldt, Department of Sociology, Lund University[1]

Abstract

Using longitudinal data from 2,354 smallholder households in 103 villages in eight African countries, three processes of agrarian transformation are analysed for the period 2002 to 2008: intensification of grain production, commercial diversification from staple crops and income diversification out of agriculture. Methodologically, three multi-level, binary logistic models are used. The trends observed provide grounds for some optimism: despite an overall picture of stagnation, intensification in grains (yield per hectare) seems to be increasing. Farmers have, however, raised productivity through the more intense use of labour resources rather than through technological change, while political commitments to agriculture have not improved the production environment. Rather, economic growth and commercialisation emerge as strong drivers of intensification, both at country and household levels. Tendencies towards distress-driven income diversification out of agriculture

---

[1] The following article draws on data from the *Afrint II* project which features collaboration between researchers in nine African countries. The team was led by Göran Djurfeldt, Lund University, Sweden, and involved a team of researchers from Lund and Linköping Universities. The country teams were: for Ethiopia, Dr. Wolday Amha, Ethiopian Economic Association, Dr. Teketel Abebe, Addis Ababa University, Dr.Mulat Demeke, Addis Ababa University; for Ghana, Professor Ernest Aryeetey, Institute of Statistical, Social and Economic Research (ISSER), Legon-Accra, Dr. Daniel Bruce Sarpong, Department of Agricultural Economics & Agribusiness, University of Ghana, Mr. Fred Danku, Institute of Statistical, Social and Economic Research (ISSER), Legon-Accra; for Kenya, Professor Willis Oluoch-Kosura, African Economic Research Consortium (AERC), Dr. Stephen K. Wambugu, Department of Geography, Kenyatta University, Dr. Joseph Karugia, the same department; for Malawi, Mr. John Kadzandira, Centre for Social Research, University of Malawi, Zomba, and Dr. Wapulumuka O. Mulwafu, Faculty of Social Science, University of Malawi, Zomba; for Mozambique, Dr. Peter Coughlin, EconPolicy Research Group, Ltd., Maputo; for Nigeria, Professor Olatunji Akande, Nigerian Institute for Social and Economic Research (NISER), Ibadan, and Dr. Olorunfemi Oladapo Ogujndele, the same Institute; for Tanzania, Professor Aida Isinika, Institute of Continuing Education, Sokoine Agricultural University; for Uganda, Dr Bernard Bashaasha, Department of Agricultural Economics & Agribusiness, Makerere University, Kampala; and for Zambia, Mr. Mukata Wamulume, Institute of Economic and Social Research (INESOR) and Ms. Charlotte Wonani, Development Studies Department, University of Zambia. The Swedish team consisted of the following team from Lund University: Professor Göran Djurfeldt, Department of Sociology, Associate Professor. Magnus Jirström, Dr. Agnes Andersson, Ms. Johanna Bergman Lodin, Ms Cheryl Sjöström, Department of Human Geography, Professor Björn Holmquist, Ms. Sultana Nasrin, Department of Statistics. Associate Professor Hans Holmén, Linköping University, was also a member of the team. We had a distinguished group of advisors, including Professor Göran Hydén (now emeritus), University of Florida and Prof. Oliver Saasa, Institute of Economic and Social Research, University of Zambia.

The authors in addition wish to thank Martin Andersson, Christer Gunnarsson, Ellen Hillbom and Tobias Axelsson, whose inputs in various ways have contributed to the following analysis. Thanks are due to two anonymous reviewers from Oxford Development Studies.

The research was funded by the Swedish International Development Authority (Sida), and the Swedish Research Council (Vetenskapsrådet)

appear to have abated somewhat in the face of more dynamism in the grain sector, with households moving between the farm and nonfarm sectors in response to shifts in producer incentives and nonfarm opportunities. Diversification processes within agriculture, meanwhile, point to both push and pull-driven diversification occurring simultaneously. Grain markets, crop diversification and nonfarm opportunities complement one another over time. There is little evidence of even incipient processes of structural transformation among the smallholders surveyed.

The past decade can perhaps be described as the age of contradictions for Africa: rapid economic growth coupled with the emergence of increasingly stable democracies and regional political institutions have combined to assert the growing importance of Africa as a destination for foreign investment and global interest. Simultaneously, however, African agriculture, despite recent policy initiatives focused on smallholder-based agriculture as the basis for poverty reduction and growth, continues to be largely characterized by low productivity and poorly developed markets, gradually coming under pressure from an increasingly volatile climate (United Nations 2011). Global rises in food prices since 2008 have threatened to impoverish the urban poor while the effects of climate change on rural farming are expected to fuel further urbanization (De Zeeuw, van Veenhuizen, and Dubbeling 2011): more than sixty per cent of sub-Saharan Africa’s population are projected to be living in urban areas by 2050 (United Nations 2011).

Such contradictions, coupled with the realisation that African production systems vary within and across countries, have contributed to a reformulation of the African research agenda. Traditionally dominated by stagnation narratives, research has increasingly come to consider possible pathways out of poverty too, drawing lessons from dynamic processes (see for example Haggblade and Hazell 2010,).

The dearth of studies documenting the dynamics of the relatively few successful cases of African agriculture at the household and village levels means there is barren ground for comparison for researchers, as well as for policymakers responsible for formulating policies, that can guide African countries through the development challenges described above. Although much important work has been carried out by economists documenting the prospects and challenges for structural transformation of African countries at the macro level in particular (see Diao, Hazell, and Thurlow 2010), village-level studies of transformation processes are generally lacking (cf. Binswanger-Mkhize, McCalla, and Patel 2010; Lay and Mahmoud 2008). Analysing the transformation dynamics of a multitude of essentially localised production systems requires combining macro-level approaches with studies that draw on detailed knowledge of both the sociology and geography of such systems. This article therefore aims to supplement the economists' perspectives with a broader social science-based understanding and analysis of village-level transformation dynamics. Importantly, the focus is on documenting and analysing broad patterns of change rather than household decision-making processes.

Without such studies, the possibilities for understanding and improving the prospects for African agriculture's ability to provide food and incomes not only for the smallholders that dominate the sector, but also for growing urban populations are slim. The following paper aims to fill part of this research gap. We simplify more elaborate theoretical frameworks, especially as developed by Timmer (2009) and Thorbecke (2009), and take as our starting point three classical processes associated with agrarian transformation: intensification of grain production,[2] commercial diversification[3] from grains into non-staple crops, and finally income diversification out of agriculture into the nonfarm economy.[4] For simplicity's sake we use the terms intensification, diversification and straddling[5] to denote these processes, although we are aware that the latter concept in particular may be subject to discussion.

Longitudinal data covering 103 villages and 2,354 smallholder households in eight African countries – Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Tanzania and Zambia – are used to model the drivers of these processes, primarily at the household and village level. Multi-level, binary logistic models are used to model the three processes. Given that we have only eight countries, variables at the country level cannot be modelled as fixed effects, which would have required a larger sample of countries, but are captured *in toto* as *random effects* (see below).

---

[2] For the purpose of this paper we define intensification as an increase in production due to increasing yields per unit of area for a given crop. This category hence includes households that have increased production on a given area and also households that have increased yields while also expanding the total area devoted to grains. In earlier work on maize (see Djurfeldt et al 2008) we separated the two trajectories, defining the latter as *expansion*, but here the two patterns are discussed collectively as grain intensification. The reason for using agronomic definitions rather than conventional economic definitions based on value of production is that the quality of our agronomic data is higher than that of the economic data.

[3] Here we are referring not to diversification of crop patterns *per se*, but to an extension of the range of crops sold, from staple crops to non-staples and non-food cash crops.

[4] That is, diversification of income sources or allocation of household labour away from agriculture/animal husbandry to the nonfarm sector

[5] We also use the alternative term 'pluriactivity'.

Theoretical points of departure: transformation experiences relevant to the African case

Historically, the composition of an economy changes over time as part of the structural transformation process: at the macro level, the share of agriculture both in total value added and in the labour force falls as the economy grows, resulting in lower labour productivity in agriculture relative to that in services and industry. As part of the process, rising industrial productivity will divert labour from agriculture to manufacturing in particular, while capital transfers from agriculture to industry and services enable the expansion of the latter sectors (Timmer 2009; Chenery and Syrquin 1975). Whether this transformation necessitates a prior productivity increase in agriculture, particularly in grain production (to avoid increasing urban wages and food price hikes detrimental to industrialisation), or whether the process can be jumpstarted by directing public investments directly towards industrial development has been the subject of much debate (see Haggblade 2007 for an exhaustive review). In recent years, this debate – amid a wealth of empirical evidence from India and China – appears to have come down at least temporarily in favour of the view that smallholder-based agriculture is the primary source of poverty reduction and growth linkages in an African context (Diao, Hazell, and Thurlow 2010; Binswanger-Mkhize, McCalla, and Patel 2010).

While the linkage effects of agricultural growth have been demonstrated empirically as well as theoretically (see Johnston and Mellor 1961; Haggblade 2007), these effects and their influence on the process of structural transformation depend greatly on the distribution of assets and the economic resource base involved. The nature of the region with respect to these characteristics is a key element that influences the interplay between agriculture and the nonfarm rural economy. In this respect, Hazell, Haggblade and Reardon (2007) distinguish between the dynamics of pull and push. In a pull scenario, rising farm labour productivity in productive agricultural zones characterised by a relatively equal distribution of assets increases per capita access to food, enabling family workers to engage in nonfarm pursuits. Capital availability rises as farm incomes increase, leading to investments in nonfarm activities. Linkage effects from modernized agriculture and growing demand for rural services tighten trade links to small rural towns, leading to the spatial as well as sectorial growth of the rural nonfarm economy. Increasing lower-level urbanization results in growing urban demand for agricultural products and rural labour. In a pull scenario, agriculture eventually loses its importance as the driver of the regional economy while low-return nonfarm activities are replaced by nonfarm activities characterized by higher returns (pp. 85-87). By contrast, a push scenario involves a deteriorating natural resource base, falling agricultural labour productivity and per capita production. In this situation households are pushed into labour-intensive nonfarm activities with low returns while urban areas become "evacuation points for labour-intensive nonfarm exports" (p. 91).

While the processes outlined above – intensification, diversification and straddling – either in combination or in succession are historically linked to agrarian transformation, the importance of regional dynamics in the context of largely extensive agrarian systems containing only patches of intensified production cannot be overemphasised (see Djurfeldt et al. 2005; Andersson et al. 2010; Jirström, Andersson, and Djurfeldt 2011; Wiggins 2000). For this reason, macro-level trends observable in statistics, for example from the Food and Agriculture Organization, may obscure incipient processes of dynamism which involve increases in land and labour productivity at the village or regional level.

Intensification of grain production is our point of departure. The reason for focusing on grains specifically is related to the well-known problem of quantifying production and yields for roots and tubers as well as the role of grain intensification in historical experiences of intensification. Drivers of the transformation of smallholder grain production that are particularly salient from a theoretical and/or political vantage point are as follows: (i) policy-driven change, i.e. effects of agricultural policy investments, including research and extension at the household and village levels; (ii) drivers endogenous to the individual farm, for instance changes in labour resources and in methods of cultivation and technology use; and in addition (iii) we consider country-level changes, i.e. policy priorities, economic growth and import dependence.

Similar drivers may also be identified in relation to the two other processes we analyse, diversification and straddling. In relation to diversification, commercialization into non-staple crops may occur when households have increased their staple crop production sufficiently to meet household food security and are able to devote capital and labour to the production of other crops. Importantly, diversification may also involve raising cash through the sale of non-staple crops to cope with seasonal variations in production cycles for staples. In terms of straddling, as suggested above, push and pull factors are related to different drivers, but in the classical process of structural transformation, a pull scenario leads to higher per capita food availability which enables farmers to engage in higher-value nonfarm activities.

This paper is written in response to recent calls among Africanists for studies documenting processes of structural transformation at the village level and in this sense is part of a new departure in studies of African agriculture (cf. Binswanger-Mkhize, McCalla, and Patel 2010; Lay and Mahmoud 2008). The article documents and analyses what may be early signs of dynamism within African agriculture, drawing on longitudinal data.

Methodology: sampling and modelling techniques

Household-level panel data from eight African countries collected in 2002 and 2008, respectively, are used to trace signs of dynamism, i.e. the three processes, while their drivers are also modelled. The panel consists of 2,354 households. Village-level data collected in 103 villages in 2007/2008 are used to complement the household data and are included in the multi-level model. The first round of data was collected in 2002 as part of a project on African agricultural intensification reported elsewhere (Djurfeldt et al. 2005). A second round of this project was carried out in late 2007 and early 2008, when the households were resurveyed. In households that had undergone a generational transfer, if there were several descendant households, one of these was sampled.[6] The purpose of the larger survey was to analyse the drivers of smallholder staple crop production in the villages in question (Andersson et al. 2010).

The areas sampled can be characterized as typical of the environments in which a majority of the smallholder population in sub-Saharan Africa lives. Village sampling followed a multi-stage purposive sampling design. Eight countries in the African maize and cassava belt – Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Tanzania and Zambia – were purposively selected. Since the aim of the project was to analyze intensification, regions within countries that were deemed to be above average in terms of ecological endowments and market access were purposively selected, but the most vibrant local rural economies were excluded. With this overarching criterion at the national level, sites within countries were selected to provide variety in terms of agricultural and economic dynamism. In each village, households were sampled randomly. The sample is hence representative at the village level.

Modelling choices and techniques

Our modelling technique draws on a social science-based approach, in which existing theory is used to frame and understand processes rather than to predict individual household behaviour. In this sense we are interested in the dynamics of social and economic change as

[6] The variable "descendant household" is used as a control variable in the models below.

reflected in aggregates of household-level behaviour rather than in modelling household responses to specific policy interventions, as done in the Singh, Squire et al. (1986) model for instance. The object of study is the process itself rather than the household. Another important difference between our approach and econometric models of household decision making is that we evaluate processes *ex post* rather than attempting to predict household behaviour *ex ante*.

The statistical strategy is also limited by a number of aspects related to earlier publications, data structure and quality. Our earlier work modelled drivers of production and yield for maize for the period 2002-2008, using maize production as the dependent variable (see Andersson et al 2010). In the present article we broaden the approach to include other grains too, but here use a binary dependent variable instead. Using a binary (rather than a scale) variable, i.e. intensified grain production (1) or not (0), obviously implies a loss of precision but an increase in reliability. A binary dependent variable is also used for the remaining two models: the commercial diversification model and the model for straddling of the farm and nonfarm sectors. Again we choose binary outcomes rather than scales, since data on household cash income was only collected in the 2008 round of data collection, preventing detailed modelling of changes in degrees of diversification and in shares of farm/nonfarm incomes over time. While this technique offers less detail, using binary variables facilitates comparison between models and enhances their reliability, since the scope for measurement error is much smaller with a simple yes/no format.

On the basis of our broad theoretical framework an *ad hoc* approach to the selection of indicators was used, trying out a number of variables and selecting those providing explanatory value in the models. In some cases this approach led us to abandon variables that although theoretically relevant did not contribute to the explanatory value of the models. In order not to overburden the models and the tables, and with the exception of the panel control variables (age of head of household and descendant households), we have not included all the indicators that were tested but concentrate on those which are crucial from a theoretical point of view or contribute to the explanatory power of the models.

Two latent variables proved to be especially difficult to deal with, i.e. price incentives and infrastructural endowments. Regarding the former, price data contain many missing cases and a great deal of noise. The simple binary indicator, 'started selling grains since 2002' proved to work best as an indicator of household response to price incentives. The infrastructure variables (distances to input and output markets, costs and means of transportation, road standards) both at the household and village level were not significant when tested in the models. Likewise, access to extension services, both at the village and the household level, are relevant as indicators of smallholder-focused government policy as well as technological know-how, but again were not significant in the models. Finally, the agro-ecological potential of individual farms and villages also proved difficult to operationalize directly and for this reason such variability is mainly captured in the residuals of the models, but may also be reflected indirectly in some village-level variables discussed below.

We use a multilevel (or hierarchical) modeling technique (Rasbash et al. 2010). The model uses three levels of data: households, villages and countries, in line with the multistage sampling design for the study as described above (Djurfeldt, Aryeetey, and Isinika 2011). Thus we avoid the tendency of ordinary regressions techniques when applied to multi-level data to underestimate standard errors for, in this case, village and country-level effects. In standard regression techniques, for example Ordinary Least Squares regression, standard errors of regression coefficients are estimated by dividing the standard deviation of a given coefficient with the root of the sample size. In a multi-level dataset, the number of second and third-level units (i.e. villages and countries in our case) is much smaller than the number of first-level units (households) and the quotient for this reason underestimates the standard errors for second and third-level effects, with an associated risk for Type II errors (see for example Snijders and Bosker 1999).

As mentioned earlier, country-level effects cannot be modelled as fixed ones because the number of countries is too small. We therefore use an unconventional technique in which we correlate the country-level random intercepts with country-level indicators.

As noted, we consider three main types of drivers of change: (i) policy-driven change reflected at the household and village level, i.e. agricultural policy investments, including research and extension (using village and household-level indicators); (ii) drivers endogenous to the individual farm, i.e. changes in labour resources and labour intensity and changes in methods of cultivation, for example in fertilization regimes (using household-level data); and in addition (iii) we consider wider macro-level changes in the realm of agricultural policy, general economic growth and import dependence in maize (the main staple in the countries under study) by correlating indicators of these with country-level intercepts, i.e. the random effects as estimated by two of the models. The theoretical and technical reasons for including variables in the particular models are specified in relation to each model.

All three models, details on which follow below, are mixed models and use a logistic link function, with estimates of fixed effects at the household and village levels and random intercepts at the village and country levels. Symbolically, the null models can be described as follows:

$$
\begin{aligned}
& y_{ijk} \sim Binomial(\mathrm{x}_{0ijk}, \pi_{ijk}) \\
& \mathrm{logit}(\pi_{ijk}) = \beta_{0jk}\mathrm{x}_{0jk} \\
& \beta_{0jk} = \beta_0 + v_{0k} + u_{0jk} \\
& [v_{0k}] \sim N(0, \Omega_v) : \Omega_v = [\sigma^2_{v0}] \\
& [u_{0jk}] \sim N(0, \Omega_u) : \Omega = [\sigma^2_{u0}] \\
& \mathrm{var}(y_{ijk} \mid \pi_{ijk}) = \pi_{ijk}(1 - \pi_{ijk})
\end{aligned}
$$

where:

y_{ijk} = the dependent variable, i.e. intensification, diversification and straddling respectively, are binary, household-level variables (as such denoted by the subscript *ijk*). These variables all refer to the time period 1 (p_1), i.e. the period from 2002 to 2008. The dependent variables are assumed to follow a Bernouilli, binomial sampling distribution, with an estimated mean of π_{ijk} . The symbol x_0 denotes a vector of ones, which are necessary for estimating the models. The natural log of the odds of the mean of the independent variable, i.e. the logit of π_{ijk} , is estimated by the coefficient β_{0jk} , which in turn equals the sum of a fixed constant (β_0), the country-level residuals (v_{0k}) and the village-level residuals (u_{0jk}). The latter are assumed to be normally distributed with means equal to zero and variance equal to Ω_v and Ω_u respectively. These variances in turn are estimated by the sample variances σ^2_{v0} and σ^2_{u0} . Finally, the variance of the dependent variables given their means ($\mathrm{var}(y_{ijk} \mid \pi_{ijk})$) is defined as specified in the last row of the model description above. Note that by definition, the variance of a binary variable ($\pi_{ijk}(1-\pi_{ijk})$) depends on the mean of the given variable (π_{ijk}). This implies that dividing the overall variance according to components, i.e. as stemming from variance among households, among villages and among countries, is not straightforward. Variance decomposition is still possible if one is prepared to make some assumptions, however.

The full model can be described as above, but with the second row specified as follows:

$$\text{logit}(\pi_{ijk}) = \beta_{0jk} x_{0jk} + \beta_{ijk} X_{ijk} + \beta_{jk} X_{jk}$$

where X_{ijk}, X_{jk} are matrices of independent variables at the household and village level, with their associated regression coefficients. The above is the fixed component of the model, which empirically is of greatest interest. Aggregate country-level effects are estimated by the country-level variance (v_{0k}). We also use the country-level intercepts (v_{0k}) to analyse the performance of individual countries (see further below).

Since the dependent variables are defined for the period from 2002 to 2008, adequate causal attribution would ideally require that the independent variables be defined for a previous period, in this case from the reference year (defined as the year of household establishment) to 2002, or if this is not possible for a previous point in time (t_1 = 2002 in this case). This has not been possible in all cases, especially not for the village-level variables, most of which refer to 2008. On the assumption that individual responses are conditioned by village-level factors, rather than the other way round, this should not cause problems.

Results and Discussion

As outlined above, the process of structural transformation involves increases in land- and labour productivity through intensification, commercial diversification and straddling. Such changes suggest transfers between the farm and nonfarm sectors of labour and/or capital. In sequential terms, intensified grain production in dynamic growth scenarios has tended to precede commercial diversification within agriculture as well as diversification out of agriculture.

Descriptions of the trends

Our earlier research focussed on grain intensification as a precursor to rising agricultural productivity (see Djurfeldt et al. 2005). For this reason, we have access to more detailed data on grain production between 2002 and 2008 than for other crops, while we also have retrospective data on grain production between the year of farm establishment (on average 1980) and 2002, based on farmer assessments of increases in production and cultivation areas.

Intensification

At first glance, the intensification tendencies between 2002 and 2008 deviate little from the patterns established for maize in earlier work for the period from the reference year (with households having been established on average 22 years prior to 2002) to 2002 (cf. Table 1 and Djurfeldt et al. (2008).

Table 1. Households who intensified grain cultivation between reference year and 2002 and 2002 to 2008, respectively, proportions of total

Period	Proportion that intensified during period	Mean yearly rate of intensifi-cation	Total no. of cases	Missing per cent
Reference year to 2002	0,29	0,013	3198	9,6
2002 - 2008	0,31	0,044	2070	12,8

The data refer to two periods of different length (six years compared to 22 years on the average). Thus more than three times as many households intensified yearly between 2002 and 2008 (4.4 per cent) than in the earlier period, when roughly one per cent (1.3) of the households intensified grain production per year.

These findings contrast with the cross-sectional data on grain area and yields (Jirström, Andersson, and Djurfeldt 2011), where the overall picture is one of stagnation, if not retrogression. Findings are compatible, however, given that the increases in area and production of the intensifying households are greater on average than the decreases of the stagnating ones.

Missing data as well as panel attrition may be causing bias in the results: a comparison of panel data with cross-sectional data in Table A1, rows 18 to 21 (see Appendix), shows small but statistically significant differences in the expected direction, i.e. less stagnation and decline in the panel. Those households it was not possible to re-interview in 2008 are likely to be the less productive ones (the elderly, sufferers of malnutrition and chronic disease and those who have left the villages entirely (see Djurfeldt, Aryeteey, and Isinika 2011, , p. 19 ff.)).

Commercial diversification in farming

As suggested by intensification trajectories historically (both in Asia and in Western Europe and North America) as well as in the more recent African cases, rising land and/or labour productivity in staple crops may be followed by a process of intensifying by value rather than volume, by diversifying commercially into higher-value crops. Such crops may be traditional cash crops such as tobacco, tea, cotton and coffee or, more recently, food crops, cultivated primarily as a source of cash rather than food, such as the much publicized case of horticultural production in the Kenyan highlands (see Minot and Ngigi 2010). Although commercial diversification towards higher-value crops in the context of poorly developed markets for food staples seldom results in smallholders withdrawing entirely from staple crop production, diversification trends can nonetheless be connected to dynamic processes especially in peri-urban areas or other regions that are well connected to urban markets. The extent to which such diversification eventually gives way to specialization in higher-value crops depends not only on the size of urban and/or export demand, but also on the reliability of staple markets as providers of food. Price volatility and staple food shortages, especially in the lean season, may encourage even relatively wealthy households in land-constrained areas to continue self-provisioning (see e.g. Jayne, Mather, and Mghenyi 2006).

However, we must also consider *push-driven diversification*, that is extremely limited commercialisation of non-staple crops through the sale of small amounts of vegetables for instance. The process we are following hence can be mixed, being both push and pull driven.

Table 2. Households engaged in the sale of non-staple crops (other food crops and non-food cash crops), in 2002 and 2008, proportion of total panel households

		Non-staple crops sold 2008, dummy			
		No	Yes	Total	
Non-staple crops sold 2002, dummy	No	0,31	0,14	0,44	
	Yes	0,16	0,39	0,56	
	Total	0,47	0,53	1,00	
Total no. of cases		2331			
Missing, percent		1			

The panel data suggest that commercial diversification into other crops has remained largely stagnant or even declined somewhat since 2002 (see Table 2): 56 per cent of the sample households sold non-staple crops in 2002 compared to 53 per cent in 2008.[7]

Although 39 per cent of the households in the sample were commercially diversified during both years, 31 per cent did not sell non-staple crops in either year. Thus there seems to have been no net tendency towards increasing commercial diversification.

[7] This could be a panel effect, but a comparison of the two cross-sections supports the interpretation of less diversification: in the 2002 cross-section, 55 per cent sold other crops, while in the 2008 round 52 per cent did (cf. Table A1, rows 23 and 24).

Participation in staple markets (grains and tubers) has remained unchanged, even if individual households have exited and entered markets (see Table 3).

Table 3. Households engaged in the sale of staple crops (grains, roots and tubers), in 2002 and 2008, proportion of total panel households.

		Staple crops sold 2008, dummy		
		No	Yes	Total
Staple crops sold 2002, dummy	No	0,20	0,15	0,35
	Yes	0,15	0,49	0,65
	Total	0,36	0,64	1,00
Total no. of cases		2354		
Missing, percent		0		

Pluriactivity and straddling of sectors

As suggested by historical experiences from Asia, structural transformation is associated with macro-level transfers of labour and capital from agriculture to the industry and service sectors (see Timmer 2009). At the regional level, such changes can be measured as changes in income composition among households, away from agriculture towards sources of income found in the rural nonfarm economy. The dynamics of this process differ greatly depending on the type of regional economic engine and the distribution of resources, as shown by Hazell, Haggblade and Reardon (2007). The push scenario indicates a *lack* of transformation rather than rising productivity. This situation is consistent with the empirical signs of de-agrarianization identified by Bryceson and Jamal (1997) in a number of African countries in the late 1990s.

Since we are using dummy variables, rather than exact incomes, and the linkage effects from agriculture to the nonfarm economy are difficult to establish on the basis of the data, it is impossible to distinguish fully negative instances of straddling from positive ones. Generally speaking, however, changes in cash income composition in the panel data suggest that income diversification from activities outside agriculture has decreased: in 2002, as can be seen from Table 4, 54 per cent of the households had cash income from nonfarm sources, whereas the corresponding figure for 2008 was 45 per cent (cross-sectional data point in the same direction, as can be seen from Table A1, rows 15 and 16).

Table 4. Proportion of panel households having income from nonfarm sources in 2002 and 2008

		Income from non-agricultural sources 2008, dummy		
		No	Yes	Total
Income from non-agricultural sources 2002, dummy	No	0,29	0,18	0,46
	Yes	0,26	0,28	0,54
	Total	0,55	0,45	1,00
Total no. of cases		2354		
Missing, percent		0		

As with intensification and diversification, there is a great deal of fluidity when comparing the two years: 57 per cent were stable in their respective positions, either as households with cash income only from agriculture (29 per cent) or as households with cash income from nonfarm sources (28 per cent). Forty-four per cent were mobile, with more households withdrawing from the nonfarm sector (26 per cent) than entering it (18 per cent) between 2002 and 2008.

Although fluidity may stem both from noisy data and seasonal and/or yearly variations, the decline in straddling calls for an explanation. One hypothesis is that, before 2002 poor incentives in the farm sector pushed households into low-return nonfarm activities, through distress-driven de-agrarianization (Bryceson 2002). More recent agricultural dynamism could have redirected households into agriculture, suggesting that the push impulses from agriculture into nonfarm activities have been reduced since 2002.

A more detailed look at the different nonfarm income sources supports this point further: the two cross-sections reveal considerable changes with respect to micro business engagement.[8] Thirty four per cent of the households reported earning income from micro business in 2002, a share that had declined to 23 per cent six years later. In the panel, a similar tendency is obvious (Table A1, rows 13 and 14).

For the panel households there is a marked trend towards less involvement in micro business and considerable fluidity, with 13 per cent having gone into micro business and 23 per cent having moved out of the sector since 2002. Micro business is generally characterized by low barriers to entry and low returns, suggesting that such income sources are sought to compensate for poor earning opportunities in agriculture. Farmers who temporarily moved into low-return nonfarm activities appear to have left these pursuits in favour of agriculture as the producer incentives, in the grain sector especially, have improved.

[8] For reasons of space we do not report these figures in tabular form, only in the text.

Four sources of nonfarm income have been combined into one, covering somewhat higher-return activities with linkages to urban areas: rents, interest, remittances and pensions. While the two cross-sections point to a decrease in these sources of incomes – 19 per cent of the households had such income in 2002, compared to 15 per cent in 2008 (see Table A1, rows 3 and 4), the panel effect is somewhat more pronounced in this case: the share of panel households that had income from these sources fell only marginally from 18 to 17 per cent.

The panel effect may be related to life-cycle aspects with respect to dependence on remittances and pensions. While generational transfer between the two rounds may increase dependence on remittances among de facto female-headed households for instance, reliance on pensions decreases as elderly households leave the panel when they die. Interestingly, however, the movement in and out of this income category is high, with only 4 per cent of the panel households receiving such incomes in both waves.

In 2002 according to cross-sectional data, 19 per cent of the households received income from nonfarm salaried employment. In 2008, this share had decreased to 14 per cent (Table A1, rows 17 and 22). Given that such employment tends to be comparatively stable, a smaller drop would have been expected among the households in the panel. The panel effect is moderate, however, and mobility in and out of nonfarm salaried employment is once again quite high, with only 5 per cent of the households having access to this income source in both 2002 and 2008. In part this may be related to the aging of the panel, with some household heads having moved from salaried employment to receiving pensions. While 13 per cent of the households lost income from nonfarm salaried employment, 9 per cent gained access to it during the period.

Three main tendencies thus emerge in relation to diversification of incomes outside the farm sector in both the cross sections and the panel data: (i) retreat from pluriactivity into farming, primarily through a decrease in petty trading (micro business) and (ii) less reliance on rents, interest payments, remittances and pensions as well as (iii) on nonfarm salaried employment. In all these cases, mobility in and out of the various income sources is high, which may stem either from considerable volatility in the economic environment surrounding the households or from unreliable data. If the latter is the case, it is likely to emerge in the modelling process either as poor fit in models, or as counterintuitive results – a point to which we return later.

Recalling the three processes – intensification, diversification and pluriactivity – the observed tendencies of decreasing pluriactivity should, according to our hypothesis, be seen in the context of recent dynamism in grain production. Over the period 2002 to 2008, grain production contains considerable elements of intensification, while participation in markets for staple crops as a whole is more or less constant.

Aggregate tendencies may be obscuring sub-processes of a contrasting kind. Identifying such patterns is important for understanding local-level dynamics. Similarly, if the dominant pattern is one of constant or declining diversification, are there sub-groups of farmers or villages which move in other directions?

Drivers of transformation

In the following we will model the drivers of the three transformation processes, using three univariate, three-level, logistic regression models (described technically above). The models will be used to capture drivers at the household, village and indirectly also at the country level.

Intensification

The first model concerns intensification of grain production, with having intensified grain production between 2002 and 2008 being the dependent variable. A number of household-level characteristics are included as independent variables: following Chayanov (1966; 1986) the age of the farm manager is expected to increase the odds of having intensified, while descendant household is added as a proxy for partition (land subdivision upon inheritance). Decreases in land size could influence intensification in either direction: promoting intensification to a certain threshold beyond which yields may fall as a result of land fragmentation. Intensification is also expected to be negatively associated with female-headed households as a result of the well-documented gender gap in access to productive resources (see FAO 2011).. Whether intensification privileges wealthier groups of farmers or benefits smallholders more broadly is controlled for using a dummy for the elite segment of the village. The elite is defined as the group of households that belonged to the upper decile of cultivators by area, in the year of household establishment.

Access to productive resources more broadly speaking is considered through variables that capture land availability (whether children will attain land when setting up their households by accessing family land that currently lies fallow), access to manure through stall-fed cattle as well as access to family labour resources in 2008. Changes in fertilizer use are technological drivers of intensification, which can also reflect public policies, for example fertilizer subsidy programmes. Whether patterns of intensification are related to the other two processes (diversification and straddling), or indeed earlier patterns of grain intensification, is also considered, since theory posits a graduation from grain intensification into diversification and straddling.

At the village level, we include credit availability, which is expected to drive market integration, whether through intensification of grain production or through increased diversification into non-staple crops. We similarly check for the influence of land tenure, since a frequently formulated hypothesis is that lack of security of tenure is a hindrance to the processes considered here. The existence of contract farming is added as a proxy for access to markets and extension, even though contract farming generally does not occur in grain crops. In some respects the existence of contract farming may also serve as an indicator for agro-ecological and commercially dynamic villages. The vital role of irrigation in raising yields in what is now almost entirely rain-fed agriculture is often stressed in the literature and a variable capturing irrigation is therefore also included in the model. Finally, a dummy intended to capture the ethnic composition of the village is added. This variable may reflect two characteristics: complementary systems of production and/or livestock rearing that may be related to different cultivation practices among different ethnic groups and patterns of migration to particular villages that may also point to a relative abundance of high-quality land. In the latter sense, ethnically mixed villages may serve as an indicator of favourable agro-ecology.

Recent processes of intensification seem to diverge both from our earlier findings and also in a number of crucial ways from the classical historical cases. While pointing to dynamism that in some respects contradicts the expected, the model confirms and complements our findings in relation to maize production discussed above (see Andersson et al. 2010).

Table 5 suggests a process in which a new category of farmers are pulled into intensified production by improved incentives for commercialization. Age and generation are not significant explanations for this, nor is intensification prior to 2002. Rather, commercialization is the single strongest driver: having entered the market for grains or having increased sale of grains between 2002 and 2008 increased the odds of intensification 3.63 times, compared with households that had not done so, keeping other variables constant. Of course the causality may be difficult to establish: are farmers responding to better producer incentives, or are they able to sell surplus production because they have intensified? Interestingly, while households are intensifying, they also appear to be increasing their area under grains – either at the expense of other crops, or by expanding total farm size. At the household level, this is the second most important factor behind intensified grain production, increasing the odds for intensification by 265 per cent. Both these variables are significant at the 0.1% level.

Table 5. Drivers of intensification: fixed and random parts of multi-level model[9, 10]

Dependent variable: Intensification indicator: increased yields of grain since 2002, dummy					
	Parameter	β	Std.error	Sig.	EXP(β)
Household level variables:					
	Age of farm manager, logged	-0,12	0,09		0,88
	Descendant household, dummy	0,50	0,43		1,65
	Intensified grain production between reference year and 2002, dummy	-0,26	0,17		0,77
	Extensified grain production between 2002 and 2008, dummy	0,98	0,17	***	2,65
	Started using fertilizer on grains since 2002, dummy	-0,16	0,18		0,85
	Started stall-feeding cattle since 2002, dummy	-0,57	0,26	*	0,57
	Family labour resources 2008, logged	0,12	0,14		1,13
	Started selling or increased sales of grain since 2002, dummy	1,29	0,15	***	3,63
	Family fallow land available to children 2002, dummy	-0,37	0,21	.	0,69
	Gender of farm manager, (1=woman)	-0,35	0,17	*	0,70
	Elite membership in reference year, proxy	-0,65	0,32	*	0,52
	Started to save since 2002, dummy	0,40	0,16	*	1,49
	Diversification indicator: started selling non-staple crops since 2002	0,46	0,22	*	1,58
	Straddling indicator: Acquired nonfarm sources of income since 2002	0,00	0,20		1,00
Village level variables					
	Land titling for smallholders present in village, dummy	0,47	0,30		1,59
	Credit available in village, dummy	0,02	0,34		1,02
	Contract farming present in village, dummy	0,85	0,40	*	2,34
	More than 10 per cent of village cultivated area is under irrigation, dummy	-1,04	0,41	*	0,35
	Ethnically mixed village, dummy	1,95	0,59	***	6,99
Constant		-3,15	0,67	***	0,04
Valid cases: 1512 out of 2005, missing: 24,6%.					
The difference in deviance between the null model and the fitted model is 1604,31 – 1431,61=172,7. Chi^2 with 19					
degrees of freedom is significant at 0,1 % level.					
Share of total variance by level:					
	Household	67,51			
	Village	14,36			
	Country	18,12			
Total		100,00			

Although the model points to a connection between intensification and diversification, this positive association needs to be treated with some caution given that it is only significant at the 5% level. In combination with the lack of significance for straddling, the interaction between grain-based intensification and commercial diversification out of staple crops is suggestive of a process of intensification both by volume and by value. This pattern appears to involve a group of commercially oriented smallholders that are able to improve their

[9] One can decompose the total variance of a binary logistic multilevel model according to level if one is willing to assume that one is modelling not the binary variable as such, but an underlying latent variable, the distribution of which is logistic (Goldstein, Browne, and Rasbash 2002; Merlo 2011).

[10] Regression coefficients (β) are logits, while Exp(β) denotes their antilogs or odds. The symbols '***', '**', '*' and '.' are used to refer to significance at 0.1, 1, 5 and 10% respectively

agrarian-based livelihoods as suggested by increases in the ability to save. Although women are disadvantaged in this process – the odds for intensification for women are 70 per cent of those for men (although this is only significant at the 5% level) – this group of farmers does not constitute the village elite. Having belonged to the latter in the reference year actually affects the odds for grain intensification negatively – the odds of intensification for this group were 52 per cent of that of the remainder of the sample.

While pinpointing the socio-economic characteristics of the intensifying households is relatively straightforward, the key components of the process itself are more opaque: the model tells us more about what is *not* driving intensification at the ground level, rather than what is. Increasing land productivity through conventional seed fertilizer technology does not appear to be the cause, nor does access to manure as a result of having started to stall-feed cattle. Neither the availability of labour resources nor increases in such resources contribute positively towards intensification. Recent studies of soil fertility management systems and improved farming techniques suggest that some household-level explanations of intensification that are not captured in the model may lie in enhanced farming techniques, related less to technology than to organization-based innovation (see Haggblade et al. 2010). Due to the generally poor quality of data on improved farming practices we are not able to analyse this influence further, although the results suggest a more intensive use of available labour, rather than increases in labour availability as such.

At the village level, some clues may be found both in relation to such techniques as well as in local-level complementarities in production systems. The strongest village-level influence on household-level intensification in the model as a whole is found in the ethnic composition of the village: living in an ethnically mixed village increased the odds for intensification nearly sevenfold. Of course, this has little to do with ethnicity in itself, but may be connected rather to the complementary and ethnically segregated functions found in the context of mixed farming systems. Here the availability of manure, connected to ethnic groups primarily reliant on livestock, used to intensify grain production may be balanced by a local demand for grains among agro-pastoralists..[11] Mixed farming systems exist primarily in drier areas. This analysis is supported by the finding that intensification in grains is negatively associated with villages where irrigated agriculture is relatively common. The existence of contract farming as an explanatory factor for intensification adds further clarification to this interpretation: contract

[11] The adoption of animal traction could have contributed to intensified grain production, but this variable suggests no significant association and was not included in the final version of the model.

farming offers many secondary advantages in terms of access to credit, infrastructure and markets as well as technology. In the case of three of the Zambian villages, where cotton is grown by the majority of the farmers, the presence of the Dunavant Cotton Company, which has been engaged in promoting conservation farming techniques since the late 1990s (see Hazell, Haggblade, and Reardon 2007; Haggblade et al. 2010), may explain some of these tendencies.[12]

The results conjure up the image of two basic types of production system: one drier mixed farming/livestock system where grain intensification is occurring in conjunction with increases in area, made possible by relatively low population densities and the availability of animal manure. This intensification is carried out in response to improved producer incentives in grain and is made possible by the better use of labour resources, rather than by conventional seed fertilizer technology. Importantly, this necessitates the existence of livestock in the village, not the ownership of, or personal access to, such livestock. For higher-value cash crops, such as tobacco or cotton, urban markets may be relatively distant, but procurement structures or contract farming arrangements replace the need for physical proximity and link farmers to a limited number of centralized buyers, explaining the possibilities for combining intensified grain production with commercial diversification. Grains, as non-perishable, volume-efficient crops cater to a geographically dispersed, (potentially) broad-based market of both rural and urban consumers.

A second system seems to be dominated by non-staple crops, especially non-grains – here productivity is raised by increasing the *value* of crops produced, rather than the volume of lower-value crops. Staples appear to be produced mainly for subsistence in the context of densely populated, irrigated farming systems. It is to these that we turn next.

Diversification

Dynamism may take on a variety of shapes, depending on the production context. Importantly, however, these shapes all involve raising either land or labour productivity and sometimes both. Meanwhile, however, as suggested above, diversification can be prompted both by push and pull factors out of staple crops into non-staple crops, partly as a result of seasonal complementarities in markets and production cycles. On the one hand, commercial

[12] The connection between cotton production and grain intensification has been convincingly demonstrated in the context of Mali by Tefft (2010), who shows how technological improvements in cotton production, primarily in terms of animal traction, spill over into intensified grain production.

diversification outside the staple crop sector may be related to farming systems where urban demand or markets for often perishable goods are to be found relatively close to the areas under cultivation. On the other, however, seasonality may also result in diversification out of grain crops as a result of push factors related to the need to raise even small amounts of cash in months that fall outside the grain production cycle too. In some respects our results point in both these directions.

The model of diversification retains the demographic (age and gender of farm manager, descendant household and family labour resources) and distributional (elite membership, increases in ability to save since 2002) independent variables of the grain intensification model. In addition, land availability is again measured through children's access to family land that is fallow. At the village level, the independent variables are the same as in the earlier model.

Table 6. Drivers of diversification: fixed and random parts of multi-level model

Dependent variable: Diversification indicator: started selling non-staple crops since 2002, dummy					
	Parameter	β	Std.error	Sig.	Exp(β)
Household level variables					
	Age of farm manager, logged	0,10	0,11		1,11
	Descendant household, dummy	1,17	0,44	**	3,22
	Family fallow land available to children 2002, dummy	-0,36	0,26		0,70
	Gender of farm manager, (1=woman)	0,03	0,21		1,03
	Elite membership in reference year, proxy	-3,59	1,18	**	0,03
	Change in total farm size, 2008 over 2002	0,17	0,07	*	1,18
	Households who have started to save since 2002, dummy	0,15	0,21		1,16
	Family labour resources 2008, logged	-0,02	0,16		0,98
	Distance to nearest grain market, logged	-0,21	0,18		0,81
	Intensification indicator: increased yields of grain since 2002, dummy	0,43	0,20	*	1,54
	Straddling indicator: Acquired nonfarm sources of income since 2002, dummy	-0,07	0,19		0,93
Village level variables					
	Land titling for smallholders present in village, dummy	-0,36	0,51		0,70
	No irrigation in village, dummy	-0,94	0,54	.	0,39
	Credit available in village, dummy	0,28	0,58		1,32
	Contract farming present in village, dummy	-0,36	0,54		0,69
	Ethnically mixed village, dummy	0,21	0,71		1,24
Constant		-2,50	1,05	*	0,08
Valid cases: 1477 out of 2331, missing: 36,6%.					
The difference in deviance between the null model and the fitted model is 1086,51 – 949,19=137,32. Chi^2					
with 15 degrees of freedom is significant at 0,1 % level.					
Share of total variance by level:					
	Household	56,17			
	Village	16,77			
	Country	27,06			
Total		100,00			

Unlike for intensification, having experienced a generational transfer since 2002 increases the odds for diversification more than three times, suggesting that a generational shift may encourage this diversification into non-staple markets. Also here, the elite are disadvantaged: diversification, like grain intensification, seems therefore to be connected in part to the emergence of a new group of relatively well-placed smallholders, responding to new commercial opportunities. There is a weak correlation (significant only at the 5% level) between having diversified and having increased total farm size, which indicates that diversification largely occurs on land already cultivated. This may explain parts of the correlation between diversification and intensification.

The positive influence of grain intensification on diversification needs to be treated with caution, since it is only significant at the 5% level. The causality is also difficult to establish in this case: could it mean that grain intensification is driven by diversification, or the other way round? Whatever the causal direction this could be an example of pull-driven development: both intensification and diversification seem to be driven by commercial incentives.

Interestingly, women are not disadvantaged in relation to diversification, which confirms the notion that the production of vegetables – predominantly the domain of women – may be gradually being commercialized. Such patterns, given the negative association between female-headed households and grain intensification processes identified above as well as overwhelming evidence of gender gaps in African agriculture generally, suggest that such tendencies are distress or push-based rather than signs of commercial dynamism.

At the village level, diversification seems positively associated with irrigation (or, as shown by the model, diversification is negatively related to the lack of irrigation in the village), but the regression coefficient is only significant at the 10% level.[13] The low level of significance for irrigation is probably due to the mix of irrigated (horticultural products, fruits) and dry (tobacco, coffee) non-staple crops that are covered by diversification processes. Irrigation in this context is mainly based on small-scale, household-level structures. Note that according to the model, diversification is unrelated to straddling.

Straddling

Whereas intensification and diversification are in some ways related to one another, straddling – despite literature pointing to the interaction between farm and nonfarm income sources (see Ellis 2005; Reardon et al. 2007) – in the context of the villages and smallholders sampled is a process that apparently occurs in isolation from the other two.[14] Yet, straddling is not *negatively* associated with these processes either; it appears to follow a separate logic.

[13] Given that we have 74 villages in the models, they can accommodate up to 7 village-level variables, but the low number of cases makes us willing to accept a 10% level of significance. For household-level variables, we accept a 5% level or lower only.

[14] The dependent variables in the intensification and diversification models have been tested for inclusion in the straddling model. Since they do not contribute to the explanatory power of the model, they were not retained in the final version.

Table 7. Drivers of straddling: fixed and random parts of multi-level model[15]

Dependent variable: Straddling indicator: Acquired nonfarm sources of income since 2002					
	Parameter	β	Std.Error	Sig.	Exp(β)
Household level variables:					
	Age of farm manager, logged	-0,20	0,08	*	0,82
	Descendant household, dummy	-0,13	0,36		0,88
	Family labour resources 2008, logged	0,22	0,11	.	1,25
	Gender of farm manager, (1=woman)	-0,34	0,15	*	0,72
	Elite membership in reference year, proxy	-0,16	0,25		0,85
	Household head highly educated, dummy	0,12	0,15		1,13
	Started to save since 2002, dummy	0,22	0,15		1,25
	Family fallow land available to children 2002, dummy	-0,21	0,24		0,81
	Distance to market for staples, logged	-0,12	0,14		0,89
Village level variables:					
	Land titling for smallholders present in village, dummy	0,69	0,38	.	1,99
	No irrigation in village, dummy	0,00	0,34		1,00
	Credit available in village, dummy	-0,51	0,35		0,60
	Contract farming present in village, dummy	-0,46	0,40		0,63
	Ethnically mixed village, dummy	0,38	0,56		1,46
	Farmers generally forego meals during dry season	0,85	0,37	*	2,35
	Unpredicatability of weather is a food security problem, dummy	0,48	0,35		1,61
	Sale of land, way of coping with threats to food insecurity, dummy	-1,09	0,51	*	0,34
Constant		-3,11	0,98	**	0,04
Valid cases: 1334 out of 2354, missing: 43%					
The difference in deviance between the null model and the fitted model is 1177,457 - 1079,191=98,266, Chi2 with 15					
degrees of freedom is significant at 0,1 % level,					
Share of total variance by level:					
	Household	81,68			
	Village	13,88			
	Country	4,44			
Total		100,00			
Note: Four villages and two extreme households removed from the model.					

As noted above, the data on straddling seem noisy, which increases the risk of getting poor model fit and even counterintuitive results. The former definitely seems to be the case, as indicated by the few variables which are statistically significant and by the variance decomposition for the model: a full 82 per cent of the variance lies at the household level, which is much higher than for the previous two models (cf. Tables 5 and 6 above).

At the household level, the model includes the same variables as the previous two models, with a few additions: a variable on level of education is added to assess whether straddling occurs in relation to income sources with higher barriers to entry (a pull response). At the village level, a number of indicators of food insecurity and coping within agriculture are added to consider the push dimension of straddling.

[15] Since the intensification and diversification indicators were not associated with the straddling indicator in the previous models, we have excluded the former in the straddling model.

Although variance between households is disproportionately high, only two household-level variables can be shown to have a significant impact on straddling (See Table 6). Age of head of household is negatively related to started straddling (significant at the 5% level only), probably because elderly farmers tend to withdraw from the nonfarm sector as the dependency ratio within the households decreases. Gender similarly is negatively associated with started straddling (5% level significance only), perhaps because many women, as a response to growing opportunities in the farm sector, have withdrawn from the nonfarm one. The latter would also be an indication that decreased straddling may be related to less distress in the farm sector.

Looking at village-level drivers, there are indications of both push and pull factors at work. Both food security indicators (whether households in the village generally reduce their meals during the lean season and whether they tend to sell off land as a response to food insecurity) emerge as strong influences on straddling, albeit with different signs. Living in a food-insecure village increased the odds for straddling 2.3 times – a clear indicator of distress-driven diversification. On the other hand, selling off land as a way of coping with food insecurity is negatively associated with straddling: in villages where this way of coping is prevalent, 32 per cent fewer households have become pluriactive since 2002, which we take to indicate that straddling as a way of coping is for some reason a less attractive alternative there. The positive association between the presence of land titling for smallholders in the village and straddling, on the other hand, could signal pull factors at work: when smallholders run no risk of losing their land if they leave the village temporarily to engage in nonfarm activities, they will have better opportunities to respond to pull factors in the nonfarm economy. The odds for straddling are twice as high in villages with land titling, compared to those without.

As a whole, this picture suggests that nonfarm incomes, mainly but not exclusively, play a risk-minimizing (rather than income-maximizing) role in the context of lower farm incomes, and that a significant minority of households have retreated into farm activities as the incentives for agriculture have improved. At the same time, institutional factors such as insecurity of tenure may be dampening the response to nonfarm opportunities in many villages.

Analysing differences between countries

Country-level variables are not included in the models presented above since the number of countries is too low to enable modelling of such variables as *fixed* effects and therefore to test their influence statistically. The multilevel technique allows us to assess the aggregate effect of country-level variables however. This is captured in the *country-level intercepts* or *residuals* (v_{ok} in the model description above). These contain the country-level variance which cannot be attributed to the village and household variables included in the model. Expressed differently, when we control statistically for the effects of the independent variables included in the model, the effects of unmeasured variables are contained in three residuals, at household, village and country levels, respectively. This enables the analysis of correlations of the country-level intercepts with country-level indicators relevant to the three processes. We consider the importance of general economic growth and expect a positive influence on intensification, primarily as a result of growing demand. Likewise we test for the influence of political commitments to smallholder-based growth (operationalized as the proportion of the state budget committed to agriculture and rural development) on intensification and diversification. Finally, import dependence in maize which, given low world market prices in the period up to 2008, may undermine price incentives for domestic producers, is assumed to affect grain intensification negatively. These variables are all lagged, making the causal attribution more straightforward.

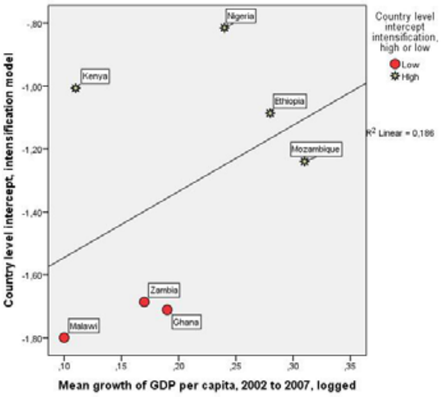
We first correlate the intercepts in the grain intensification model with the country-level indicators mentioned. The intensification model is used as the point of departure since intensification in theoretical terms provides the basis for broader processes of structural transformation. Moreover, the intensification model is the most robust of the three models outlined above.

Four countries are *high achievers* in terms of intensification, i.e. they outperform the predictions of the model. In other words their intercepts are above the mean. They are: Mozambique, Kenya, Nigeria and Ethiopia. Three countries do worse: Malawi, Zambia and Ghana.[16] The correlations between the intercepts and the country level-indicators are presented in Graphs 1a – c.

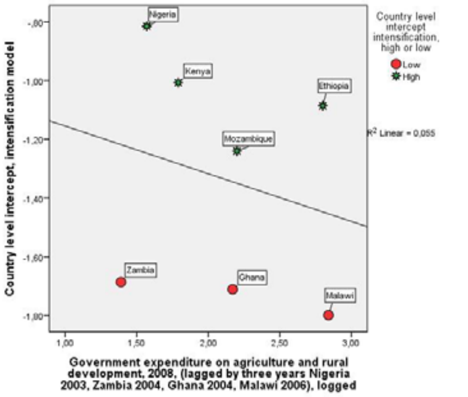
[16] Tanzania is an outlier and is excluded here.

Graph 1a - f: Country-level intercepts in intensification and diversification models correlated with macro indicators, Tanzania excluded.[17]

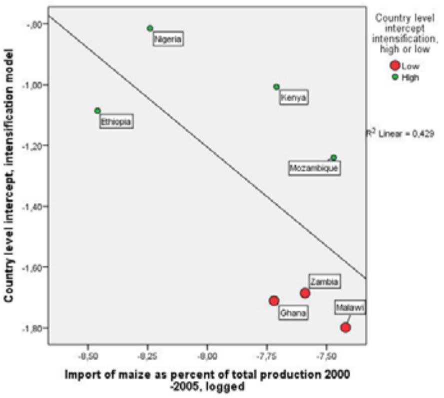
a)



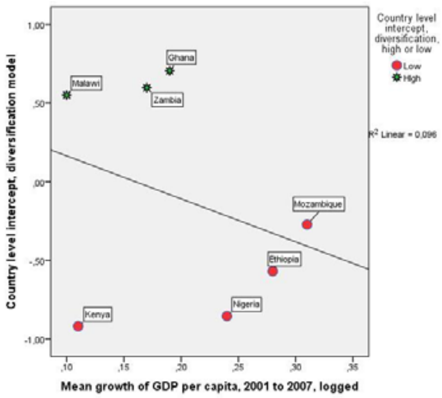
b)



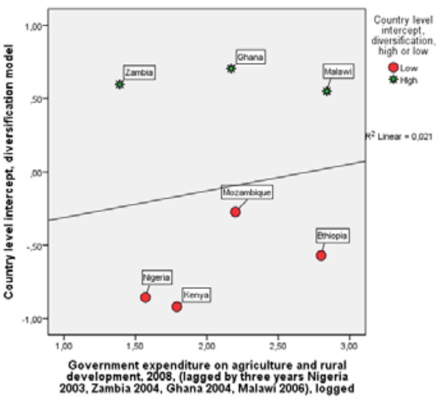
c)



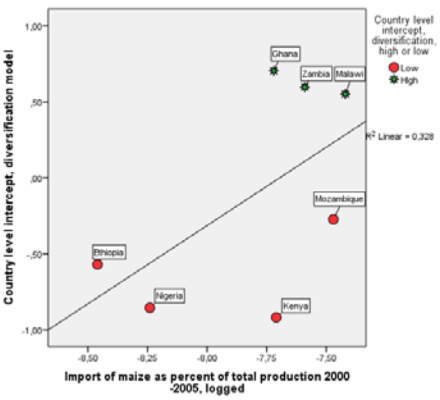
d)



e)



f)



[17] The country level intercepts in graph 1a-f are standardized variables with mean = 0 and standard deviation = 1. In graphs 1a-c, the origin of the graph is not visible because of the exclusion of the outlying case of Tanzania with a high positive intercept in the intensification model while the remaining countries all have a negative value.

With the exception of Kenya, higher-than-expected rates of intensification are positively associated with economic growth, during the period 2001 to 2007 (Graph 1a). Conversely, the countries with low rates of intensification show poor economic growth. Kenya is exceptional, with lower economic growth but higher-than-expected intensification rates. The regression line tilts upwards and the coefficient of determination (R^2) is 0.19, indicating that economic growth explains around 20 per cent of the country-level variance. This would support the hypothesis of *economic growth as a driver* of intensification in grain production.[18]

To assess the role of agricultural policy, we use public expenditure on agriculture and rural development as an indicator of state commitment to agriculture. The lack of a clear connection between public expenditure and intensification rates at the country level, apparent from Graph 1b, supports earlier data at the household and village level which point to little or no influence of government policies on intensification.

Turning finally to import dependence in maize[19] and its influence on intensification, the two groups of countries again show distinct patterns, with Malawi, Zambia and Ghana having relatively higher import dependency in the period preceding 2008. As the indicator for import dependence is lagged (referring to the period 2000 to 2005), the direction of causality is straightforward at least in temporal terms, suggesting that competition from cheap imports may have been undermining price incentives for domestic producers in the countries in question. By contrast, among the high-performing countries there is no apparent association between high intensification rates and import dependency in maize – either negative or positive. This notwithstanding, import dependence contributes a substantial 43 per cent to the overall country-level variance.

We repeat the exercise for the diversification model. Interestingly the analysis reproduces the same country clusters, but this time in reverse order, with Malawi, Zambia and Ghana showing higher-than-expected rates of diversification (Graph 1 d-f). This pattern points to a number of country-level processes: firstly, that economic growth during the period preceding the investigation was associated with grain intensification, but not with diversification out of staple crops. Given the poorer, relatively speaking, economic performance in Malawi, Zambia

[18] Note that the economic growth variable refers to the economy as a whole, including the grain sector, since sectorwise GDP data was not available for all countries.
[19] We have used maize as a proxy for grain imports, since maize is the most commonly grown and imported grain in all the countries in question.

and Ghana during this period, it is tempting to conclude that diversification in these countries was driven by push rather than by pull factors. Secondly, as with intensification, public expenditure on agriculture appears to have had no influence on processes of diversification. Finally the positive association between diversification and import dependence in maize reaffirms the suggestion that domestic market incentives for grains have been poorer in Malawi, Ghana and Zambia during the study period. Graph 1f suggests instead that smallholders in these countries have diversified into non-staple crops, rather than intensified their grain production.

Space does not permit an analysis of village-level intercepts, a topic we hope to return to in a forthcoming work.

Conclusions

Returning to the three processes associated with structural transformation and the theoretical points of departure outlined above, agrarian-based dynamics are easier to locate and explain than those related to the nonfarm sector (whether rural-based or not). In some respects this is due to the nature of the sample, since the most dynamic peri-urban and well-connected areas were excluded from the sampling frame. Nonetheless, as reflective of rural areas where most African smallholders secure their livelihoods, the trends occurring in the villages under study since 2002 provide grounds for some optimism: despite an overall picture of stagnation, intensification at least by volume (in grains) if not by value (through diversification outside the staple sector), seems to be increasing somewhat.

The tendencies towards distress-driven income diversification out of agriculture identified in the literature during the late 1990s appear to have abated somewhat in the face of more dynamism in the grain sector. Since these studies on push-driven straddling are based on one-shot cross-sectional rather than longitudinal data, their conclusions also need to be placed in temporal context. Generally speaking, dynamism in our data appears to be most pronounced in the grain sector, with new groups having entered grain markets since 2002. However, such dynamism may also reflect movements of households between the farm and nonfarm sectors in response to shifts in producer incentives and nonfarm opportunities both seasonally and in the medium term. Diversification processes *within* agriculture meanwhile point to both push and pull-driven diversification occurring simultaneously and related in part to differences in localised production systems, but also to differential access to productive resources on gendered grounds.

The patterns identified in the analysis differ from the classical Asian experience of structural transformation in a number of ways. Raising land and labour productivity among smallholders through state-assisted technological diffusion constituted a key component of the Asian Green Revolution, whereas technology-driven intensification so far appears unimportant in the African case. Instead, farmers have raised labour productivity through more intense use of existing labour resources, while political commitment to agriculture (despite public expenditure reallocations towards rural development) has made no difference in terms of improving the production environment for smallholder farmers. Smallholders, despite public announcements and declarations to the contrary, have therefore largely gone about the business of raising productivity on their own, while general processes of economic growth and commercial drivers emerge as strong influences on intensification both at the country and household levels.

Although some evidence of grain intensification emerges in the data, the results from the diversification and straddling models are inconclusive. The notion that grain markets, crop diversification and nonfarm opportunities complement one another over time, suggests an alternation between the three, rather than an evolutionary process whereby farmers graduate from grain intensification to agrarian-based commercial diversification, finally shifting labour and capital into nonfarm pursuits. In this sense, there is little evidence of even incipient processes of structural transformation among the smallholders surveyed.

Appendix

Table A1. Descriptive statistics for all variables referred to in the text, means and standard errors for relevant cross-section and panel, including tests of the differences between means

		All cases with valid data:			*For cases in relevant model:*					
	Household level variables:	*No. of cases*	*Mean*	*Std.error*	*No. of cas*	*Mean*	*Std.error*	*Diff*	*z- or t-value*	*Sig.*
1	Age of farm manager, logged	3305	2,70	0,02	1521	2,80	0,02	-0,10	-4,74	***
2	Became pluriative between 2002 and 2008, dummy	2374	0,17	0,01	1512	0,17	0,01	0,01	0,64	
3	Cash income from rents, interest, remittances and pensions, 2008, dummy	3810	0,15	0,01	-	-	-	-		
4	Cash income from rents, interest, remittances, pensions 2002, dummy	3537	0,19	0,01	-	-	-	-		
5	Change in total farm size, 2008 over 2002	2248	1,57	0,08	1521	1,29	0,03	0,28	8,79	***
6	Descendant household, dummy	4875	0,02	0,00	1521	0,03	0,00	-0,01	-2,01	*
7	Distance to market, household level, logged	3520	2,03	0,02	1521	1,97	0,03	0,06	2,27	*
8	Elite membership in reference year, proxy	3383	0,07	0,00	1521	0,07	0,01	0,00	0,19	
9	Family fallow land available to children, 2002, dummy	3438	0,20	0,01	1486	0,18	0,01	0,02	2,27	*
10	Family labour resources, 2008, logged, outliers removed	2224	1,27	0,01	1521	1,25	0,01	0,01	0,99	
11	Gender of farm manager, (1=woman)	3523	0,25	0,01	1514	0,23	0,01	0,01	1,36	
12	Households who have started to save since 2002, dummy	2354	0,26	0,01	1521	0,24	0,01	0,02	1,63	
13	Income from micro business 2002, dummy	3524	0,34	0,01	-	-	-	-		
14	Income from micro business 2008, dummy	3804	0,23	0,01	-	-	-	-		
15	Income from non-agricultural sources 2002, dummy	3537	0,55	0,01	1521	0,56	0,01	-0,01	-0,74	
16	Income from non-agricultural sources 2008, dummy	3810	0,44	0,01	1521	0,46	0,01	-0,02	-1,86	.
17	Income from non-farm salaried employment 2008, dummy	3806	0,14	0,01	-	-	-	-		
18	Increased area under grains between 2002 and 2008, dummy	2099	0,26	0,01	1512	0,30	0,01	-0,04	-3,42	***
19	Increased area under grains between reference year and 2002, dummy	1843	0,39	0,01	1690	0,38	0,01	0,01	0,53	
20	Increased yields of grain , 2002 to 2008, dummy	2070	0,31	0,01	1512	0,31	0,01	0,00	-0,03	
21	Increased yields of grain between reference year and 2002	3198	0,29	0,01	1512	0,32	0,01	-0,03	-2,44	*
22	Non-farm salaried employment, 2002, dummy	3522	0,19	0,01	-	-	-	-		
23	Non-staple crops sold 2002, dummy	3528	0,55	0,01	1407	0,55	0,01	0,00	-0,08	
24	Non-staple crops sold 2008, dummy	3784	0,52	0,01	-	-	-	-		
25	Sold other staples in 2002, (incl cassava) dummy	3528	0,40	0,01	-	-	-	-		
26	Sold other staples in 2008 (incl cassava, excl yams/cocoyams), dummy	3794	0,37	0,01	-	-	-	-		
27	Started or increased sale of grains between 2002 and 2008	2078	0,34	0,01	1521	0,32	0,01	0,02	1,69	.
28	Started or increased sale of staples between 2002 and 2008	2469	0,13	0,01	1512	0,11	0,01	0,02	1,99	*
29	Started selling non staple crops between 2002 and 2008, dummy	2354	0,14	0,01	1521	0,14	0,01	-0,01	-0,82	
30	Started stallfeding cattle since 2002 or continued doing so since that year, dummy	2374	0,14	0,01	1521	0,16	0,01	-0,02	-2,10	*
31	Started using fertilizer on grains since 2002, dummy	2271	0,53	0,01	1521	0,55	0,01	-0,02	-1,89	.

References

Andersson, Agnes, Göran Djurfeldt, Björn Holmquist, Magnus Jirström, and Sultana Nasrin. 2010. Drivers of staple food production in sub-Saharan Africa - evidence for maize and for eight countries. In *African smallholders - food crops, markets and policy*, edited by G. Djurfeldt, E. Aryeetey and A. Isinika. London: CABI.

Binswanger-Mkhize, Hans P, Alex F McCalla, and Praful Patel. 2010. Structural transformation and African agriculture. *Global Journal of Emerging Market Economies* 2 (2):113-152.

Bryceson, D F, and V Jamal, eds. 1997. *Farewell to Farms. De-agrarianisation and Employment in Africa*. Aldershot: Ashgate Publishing Ltd.

Bryceson, D. F. 2002. The Scramble in Africa: Reorienting Rural Livelihoods. *World Development* 30 (5):725-739.

Chayanov, A.V. A.V. Chayanov and the Theory of Peasant Economy, Edited by Basile Kerblay Edited by Daniel Thorner, R.E.F. Smith,. Homewood, Ill.: Richard D. Irwin, 1966.

Chayanov, A.V. 1986. On the Theory of Peasant Economy. Edited by Daniel Thorner, Basile Kerblay, R.E.F. Smith, with a foreword by Theodor Shanin ed. Madison, Wis.: The University of Wisconsin Press.

Chenery, H., and M. Syrquin. 1975. *Patterns of development 1950-1970*. New York: Oxford University Press.

De Zeeuw, H. , R. van Veenhuizen, and M. Dubbeling. 2011. The role of urban agriculture in building resilient cities in developing countries,. *Journal of Agricultural Science* 149:153-163.

Diao, Xinshen, Peter Hazell, and James Thurlow. 2010. The role of agriculture in African development. *World Development* 38 (10):1375-1383.

Djurfeldt, G., Ernest Aryeetey, and Aida Isinika. 2011. Introduction. In *African smallholders - food crops, markets and technology*, edited by G. Djurfeldt, E. Aryeetey and A. Isinika. Wallingford, Oxon.: CABI.

Djurfeldt, Göran, Rolf Larsson, Björn Holmquist, Magnus Jirström, and Agnes Andersson 2008. "African Farm Dynamics and the Sub-Continental Food Crisis – the Case of Maize." Food Economics - Acta Agriculturae Scandinavica, Section C 5, no. 2: 75-91.

Djurfeldt, G., H. Holmén, M. Jirström, and R. Larsson, eds. 2005. *The African Food Crisis - Lessons from the Asian Green Revolution*. Wallingford: CABI Publishing.

Ellis, F. 2005. Small Farms, Livelihood Diversification and Rural-Urban Transitions, Strategic Issues in sub-Saharan Africa. In *The future of small farms, research workshop, jointly organized by the International Food Policy Research Institute (IFPRI) and the Overseas Development Institute (ODI) and Imperial College, London*. Wye

FAO (2011). Women in Agriculture - closing the gender gap for development. Rome, Food and Agriculture Organization.

Goldstein, H, W Browne, and J Rasbash. 2002. Partitioning Variation in Multilevel Models. *Understanding Statistics* 1 (4):223-231.

Haggblade, S, and P Hazell. 2010. *Successes in African Agriculture*: IFPRI/Johns Hopkins.

Haggblade, Steven. 2007. Alternative perceptions of the rural non farm economy. In *Transforming the rural nonfarm economy: opportunities and threats in the developing world*, edited by S. Haggblade, P. Hazell and T. Reardon. Baltimore: John Hopkins University Press.

Haggblade, Steven, Gelson Tembo, Daniel Kaboré, Chris Reij, Oluyede C. Ajayi, Steven Franzel, Paramu Mafongoya, and Frank Place. 2010. Sustainable soil fertility management systems. In *Successes in African Agriculture. Lessons for the future*, edited by S. Haggblade and P. Hazell. Baltimore: The Johns Hopkins University Press.

Hazell, P, S Haggblade, and T. Reardon. 2007. Structural transformation of the rural non farm economy. In *Transforming the Rural Nonfarm Economy. Opportunities and threats in the developing world*, edited by S. Haggblade, P. Hazell and T. Reardon. Baltimore: Johns Hopkins University Press.

Jayne, T.S., D. Mather, and E. Mghenyi. 2006. Smallholder Farming under Increasingly Difficult Circumstances: Policy and Public Investment Priorities for Africa. In *MSU International Development Working Paper*: Department of Agricultural Economics, East Lansing: Michigan State University.

Jirström, Magnus, Agnes Andersson, and Göran Djurfeldt. 2011. Smallholders caught in poverty – Flickering signs of agricultural dynamism. In *African smallholders - food crops, markets and policy*, edited by G. Djurfeldt, E. Aryeetey and A. Isinika. Wallingford, Oxon: CABI.

Johnston, Bruce F., and J. Mellor. 1961. The role of agriculture in economic development. *American Economic Review* 51 (4):566-593.

Lay, Jann, and Toman O. Mahmoud. 2008. Few Opportunities, Much Desperation: The Dichotomy of Non-Agricultural Activities and Inequality in Western Kenya. *World Development* 36: 2713-2732

Merlo, J. 2011. On the use of the intra-class correlation coefficient for continuous and binary variables in contextual epidemiology: an example modelling systolic blood pressure and hypertension in the WHO MONICA project. Malmö: Clinical Research Centre.

Minot, Nicholas, and Margaret Ngigi. 2010. Are horticultural exports a replicable success story? Evidence from Kenya and Côte d'Ivoire. In *Successes in African Agriculture. Lesson for the future*, edited by S. Haggblade and P. Hazell. Baltimore: The Johns Hopkins University Press.

MLWiN 2.22. Centre for Multilevel Modelling, University of Bristol, Bristol.

Reardon, Thomas , Julio Berdegué, Christopher B. Barett, and Kostas Stamoulis. 2007. Household Income Diversification into Rural Nonfarm Activities. In *Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World*, edited by S. Haggblade, P. Hazell and T. Reardon. Baltimore/Washington D.C.: International Food policy Research Instituteand The Johns Hopkins University Press.

Singh, I., L. Squire, et al. (1986). The basic model: theory, empirical results and policy conclusions. Agricultural Household Models - extensions, applications and policy. I. Singh, L. Squire and J. Strauss. Baltimore and London, The Johns Hopkins University Press: 17-47.

Snijders, Tom A. B., and R. J. Bosker. 1999. *Multilevel analysis: an introduction to basic and advanced multilevel modeling*. Thousand Oaks, Calif.: SAGE.

Tefft, James. 2010. Mali's white revolution:smallholder cotton, 1960-2006. In *Successes in African Agriculture. Lessons for the future*, edited by S. Haggblade and P. Hazell. Baltimore: The Johns Hopkins University Press

Thorbecke, Eric (2009): The Anatomy of Growth and Development in Sub Saharan Africa, Framework Paper Prepared for the African Economic Research Consortium(AERC) Collaborative Project on Growth and Poverty to be presented at the Conference in Accra, April 20-22, 2009.

Timmer, Peter. 2009. *A World without Agriculture. The structural transformation process in historical perspective*. Washington D.C.: The American Enterprise Institute Press.

United Nations. 2011. World Urbanization Prospects - the 2009 Revision. New York.: United Nations Population Division, Department of Economic and Social Affairs.

Wiggins, Steven. 2000. Interpreting changes from the 1970s to the 1990s in African agriculture through village studies. *World Development* 28 (4):631-662.