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Impact of off-farm income on food security and nutrition in Nigeria

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Abstract: While the poverty implications of off-farm income have been analyzed in different developing countries, much less is known about the impact of off-farm income on household food security and nutrition. Here, this research gap is addressed by using farm survey data from Nigeria. Econometric analyses are employed to examine the mechanisms through which off-farm income affects household calorie and micronutrient supply, dietary quality, and child anthropometry. We find that off-farm income has a positive net effect on food security and nutrition. The prevalence of child stunting, underweight, and wasting is lower in households with off-farm income than in households without. Using a structural model, we also show that off-farm income contributes to higher food production and farm income by easing capital constraints, thus improving household welfare in multiple ways.

Keywords: Farm households; food security; micronutrients; child anthropometry; off-farm income

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Abstract

While the poverty implications of off-farm income have been analyzed in different developing countries, much less is known about the impact of off-farm income on household food security and nutrition. Here, this research gap is addressed by using farm survey data from Nigeria. Econometric analyses are employed to examine the mechanisms through which off-farm income affects household calorie and micronutrient supply, dietary quality, and child anthropometry. We find that off-farm income has a positive net effect on food security and nutrition. The prevalence of child stunting, underweight, and wasting is lower in households with off-farm income than in households without. Using a structural model, we also show that off-farm income contributes to higher food production and farm income by easing capital constraints, thus improving household welfare in multiple ways.

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Introduction

Reducing food insecurity continues to be a major public policy challenge in developing countries. Almost 1 billion people worldwide are undernourished, many more suffer from micronutrient deficiencies, and the absolute numbers tend to increase further, especially in Sub-Saharan Africa (FAO, 2008). Recent food price hikes have contributed to greater public awareness of hunger related problems, also resulting in new international commitments to invest in developing country agriculture (e.g., Fan and Rosegrant, 2008). Obviously, agricultural development is crucial for reducing hunger and poverty in rural areas, but non-agricultural growth can be important as well (Diao et al., 2007). Specifically for African countries, with strong population growth and increasingly limited agricultural resources, the potential role of the rural off-farm sector deserves particular consideration. Smallholder farm households usually maintain a portfolio of income sources, with off-farm income being a major component (Barrett et al., 2001). But often a clear policy strategy to promote the off-farm sector is lacking.

In the available literature, considerable attention has been given to the poverty implications of off-farm income in developing countries (e.g., Block and Webb, 2001; de Janvry and Sadoulet, 2001; Lanjouw et al., 2001). In contrast, much less is known on food security and nutrition effects (Chang and Mishra, 2008). Nutrition impacts might be positive, because off-farm income contributes to higher household income and therefore better access to food. But the impacts might also be negative, at least when controlling for total household income, as working off the farm could potentially reduce household food availability due to the competition for family labor between farm and off-farm work (e.g., Pfeiffer et al., 2009; Huang et al., 2009). A few empirical studies have looked into related linkages, but all of them are confined to issues of household food expenditure or calorie availability. For instance, Reardon et al. (1992) found that diversification into the non-farm sector improves calorie consumption in Burkina Faso. Ruben and van den Berg (2001) obtained similar results for Honduras, and Ersado (2003) showed that non-farm income diversification is associated with a higher level of consumption expenditure in Zimbabwe. We are not aware of studies that have analyzed nutritional impacts from a broader perspective, also taking into account dietary quality, micronutrient consumption, and nutritional outcomes. Here, we address such issues, building on a detailed survey of farm households in Nigeria.

We hypothesize that off-farm income contributes to better nutrition in terms of calorie and micronutrient supply and child anthropometry. In the next section, we present the household survey data. Then, we carry out a descriptive analysis of various nutritional indicators, differentiating between households with and without off-farm income, before using a set of regression models to test the hypothesis more formally. Issues of endogeneity are taken into account by using instrumental variable approaches. In a separate section, we also estimate a system of structural equations, in order to better understand the causal linkages between off-farm income and household nutrition. The last section concludes and discusses policy implications.

Data and sample characteristics

Household survey

Data used in this article are from a comprehensive survey of farm households in Kwara State, north-central region of Nigeria, which was conducted between April and August 2006. We chose Kwara State because of its considerable socioeconomic heterogeneity and location; it is the gateway between the northern and southern regions, and it has a good mixture of the three major ethnic groups in Nigeria. These factors tend to encourage the development of off-farm activities. Moreover, the nationwide living standard measurement survey conducted in 2004 shows that Kwara State is among the six poorest in Nigeria in terms of prevalence of undernourishment and income poverty (NBS, 2006). The state has a total population of about 2.4 million people, 70% of which can be classified as smallholder farmers. The farming system is characterized by low quality land and predominantly cereal-based cropping patterns. Most farm households are net buyers of food, at least seasonally (KWSG, 2006).

Our sample consists of 220 farm households which were selected by a multi-stage random sampling technique. Eight out of the 16 local government areas in Kwara State were randomly selected in the first stage.[1] Then, five villages were randomly chosen from each selected local government area, and finally, five households were sampled in each of the resulting 40 villages, using complete village household lists provided by the local authorities. Personal interviews were carried out with the household head, usually in the presence of other family members. A standardized questionnaire was used that covered information on household expenditure, consumption, farm and off-farm income, socioeconomic characteristics, and various institutional and contextual variables. Farm income covers commodity sales and subsistence production, both valued at local market prices. Respondents were asked to specify in detail all inputs used, outputs obtained, and prices for the different crop and livestock activities over the 12-months period prior to the survey. Off-farm income includes agricultural wages, non-agricultural wages, self employed income, remittances, and other income such as capital earnings and pensions. These were recorded separately for all household members, also covering a 12-months period, in order to avoid a seasonality bias.

Food consumption data were elicited at the household level covering 105 food items. Quantities consumed include food from own production, market purchases, and out-of-home meals and snacks. While also here it would be desirable to have annual data that are free from seasonality effects, it is well known that the accuracy of food consumption data is negatively correlated with the length of the recall period (e.g., Bouis, 1994). Hence, we decided to use a 7-day recall in our survey. The interviews were carried out in the lean season, during which household food consumption is often below the annual average. Therefore, the prevalence of malnutrition derived from the data might be somewhat overestimated. This is not a serious problem in our context, because – rather than establishing the prevalence of malnutrition on a

[1] Local government area is the smallest administrative unit in Nigeria, usually made up of several wards. A ward consists of several villages that are often composed of people of related ethnicity and culture.

representative basis – we are primarily interested in the nutritional impact of off-farm income. However, it is possible that off-farm income helps to better smooth food intake over the year and reduce the consumption decline during the lean season. In that case, our data would overestimate the impact of off-farm income on calorie and nutrient supply for the year as a whole. This should be kept in mind when interpreting the results. Yet the advantage is that we also collected anthropometric data from pre-school children. Height-for-age in particular is an indicator of chronic food insecurity, which fluctuates much less seasonally than food consumption. In the 220 sample households, we obtained weight and height data from 127 children up to 60 months of age.

Sample characteristics

Table 1 shows summary statistics of selected household variables. The average household size of five adult equivalents (AE) is consistent with the national average in Nigeria reported by NBS (2006). About 10% of the households are headed by women. The educational status is slightly higher than the national average, which can probably be explained by the fact that the density of elementary schools is relatively high in rural areas of Kwara State. The mean farm size of 1.9 ha is comparable to the national average of 2 ha. The infrastructure variables indicate that many of the farm households do not have access to electricity, tapped water, or a tarred road. The mean distance to the nearest market place is 11.7 kilometers.

(About here should appear table 1)

Total annual household income is approximately 30 thousand naira (250 US$) per AE over all income sources. This is somewhat lower than the national average in Nigeria. Farming accounts for half of this total; the other half consists of different off-farm sources. This off-farm income share fits reasonably well into the recent literature from Sub-Sahara Africa (e.g., Barrett et al., 2001; Woldenhanna and Oskam, 2001). In our sample, the role of off-farm income increases with overall household income: while for the poorest income quartile, off-farm income accounts for 31% of total income, it accounts for 60% in the richest quartile. The most important component is self-employed income, which makes up almost half (48%) of total off-farm income. Self-employed activities comprise handicrafts, food processing, shop-keeping, and other local services, as well as trade in agricultural and non-agricultural goods. The rest of the off-farm income is made up of agricultural wages (27%), non-agricultural wages (12%), remittances (11%), and other sources.

Descriptive analysis

Calorie and micronutrient supply

Food quantities consumed at the household level were converted to calories using the locally available food composition table (Oguntona and Akinyele, 1995). Only in very few cases, where certain food items were not included in the local table, USDA (2005) data were used. Resulting calorie values were divided by the number of AE in a household, in order to obtain numbers that are comparable across households of different size.[2] We define a food secure household as one whose calorie supply per AE is greater than or equal the minimum daily calorie requirement for adult men of 2500 kcal (FAO/WHO/UNU, 1985). Households with lower calorie intakes are considered to be undernourished. In terms of micronutrients, we concentrate on iron and vitamin A, for which deficiencies are particularly widespread in Sub-Saharan Africa (Mason et al., 2005). As for calories, levels of iron and vitamin A supply per AE were calculated based on local and USDA food composition tables. Yet, unlike for calories, we did not compute the prevalence of

[2] This procedure implicitly assumes that food is distributed equally within each household. More detailed analysis of intra-household distribution is not possible with our data.

micronutrient deficiencies, because this would have required vague assumptions on bioavailability, especially for iron. For our purpose it suffices to examine factors that influence gross micronutrient consumption levels.

Table 2 shows calorie and micronutrient consumption levels per AE in our sample. The average daily calorie supply of 2428 kcal is slightly below the 2500 kcal recommendation, which is in line with another recent study for rural Nigeria (Aromolaran, 2004). Sixty-one percent of all sample households are undernourished, falling below the minimum daily calorie supply by 22% on average. As mentioned above, our survey was carried out in the lean season, so that the average prevalence of undernourishment might be somewhat overestimated. Nonetheless, our results fit fairly well into the range of recent estimates for African countries based on representative household expenditure surveys (Smith et al., 2006). Disaggregating our sample by income quartiles shows that poorer households consume fewer calories than richer households. Furthermore, dietary quality – measured in terms of calorie supply from fruits, vegetables, and animal products – and micronutrient supply are positively correlated with household income. These patterns underscore the importance of income for food and nutrition security. In the following, we analyze the role of off-farm income in this connection more explicitly.

(About here should appear table 2)

Role of off-farm income: preliminary evidence

Table 3 shows important nutritional indicators, differentiating between households with and without access to off-farm income. Households with off-farm income consume significantly more calories than those without, so that the prevalence of undernourishment is notably lower. Likewise, dietary quality is significantly higher among households with off-farm income. Figure 1 shows further details on household dietary composition. The contribution of high-value foods –

such as fruits, vegetables, and animal products – to total calorie supply is larger for households with off-farm income. By contrast, the contribution of starchy staple foods is remarkably smaller. Households with off-farm income seem to have better access to more nutritious foods, which is also reflected in significantly higher levels of micronutrient consumption (table 3).

(About here should appear table 3)

(About here should appear figure 1)

In addition to food consumption data, we also analyzed child anthropometric data as indicators of nutritional status. Using a standard reference population as defined by the United States National Center for Health Statistics (NCHS), *Z*-scores for height-for-age, weight-for-age, and weight-for-height were calculated.[3] Results are also shown in table 3. Children in households with off-farm income have significantly higher *Z*-scores and thus better nutritional status than children in households without off-farm income. Accordingly, the prevalence of child stunting, underweight, and wasting is lower in households with off-farm income.[4]

These results suggest that participation in off-farm activities is associated with better food access and nutrition, and they challenge the skepticism sometimes expressed towards the impact of the off-farm sector on food security. The concern that working off-farm would reduce household food availability is not confirmed here. The pathway by which off-farm income contributes to better food security is further analyzed in the following sections.

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[3] For example, the height-for-age *Z*-score is calculated as $Z = X - \mu/\sigma$, where X is the child's height-for-age, μ is the median height-for-age of the reference population of children of the same age and sex group, and σ is the standard deviation of the reference population.

[4] Stunting is defined as height-for-age *Z*-score less than -2, underweight as weight-for-age *Z*-score less than -2, and wasting as weight-for-height *Z*-score less than -2 (WHO, 1995).

Explaining calorie and micronutrient supply

Off-farm income and calorie supply

Previous sections have already suggested that off-farm income contributes positively to food security. Here we analyze this effect more formally by controlling for other factors. At first, we estimate a model in which household calorie supply per AE is regressed on the amount of annual off-farm income, farm income (both measured in naira per AE), and several other explanatory variables. Since farm and off-farm income are not randomly distributed among households, these variables are likely to be endogenous. First, there might potentially be a reverse causality problem, because calorie supply and food security at the household level might also influence labor productivity and access to different economic activities. Second, farm and off-farm income might be influenced by household unobservables, which can lead to correlation with the error term. In order to avoid an endogeneity bias, we employ an instrumental variable (IV) approach, using household assets, access to electricity, tapped water, tarred road, and distance to market as instruments. This is similar to approaches that have been used by Ruel et al. (1999) and Ruben and van den Berg (2001) in different contexts. In terms of functional form, we tried different specifications, with a linear model showing the best statistical fit.[5] Furthermore, we use a cluster correction procedure for model estimation (Deaton, 1997, p. 76). Given our multi-stage random sampling approach, with household observations clustered by villages, this approach takes care of potential intra-cluster correlation of the error term and produces a consistent variance-covariance matrix.

While results of the first-stage income regressions are shown in appendix table A1, the second-stage results are displayed in table 4. The Durbin-Wu-Hausman test statistics given in the

[5] A double-log specification also resulted in a relatively good model fit, but with fewer observations, because all households with zero off-farm income had to be excluded. This appeared inappropriate in our context.

last row of the table confirm that the farm and off-farm income variables are endogenous, so that the IV approach is appropriate. Column (1) illustrates that off-farm income contributes significantly to higher household calorie supply. This is consistent with findings by Ruben and van den Berg (2001) for Honduras and by Reardon et al. (1992) for Burkina Faso. An increase in annual off-farm income by 1000 naira per AE results in an average consumption improvement by 22 kcal per day. Strikingly, the marginal effect of farm income is identical in magnitude, suggesting that the level of income is more important than the income source for household calorie supply. The results further show that male-headed households consume more calories than female headed ones. While it is known that women usually take greater care of family nutrition, female-headed households are often disadvantaged in terms of social status and economic opportunities. Farm size also contributes positively to calorie supply with a marginal effect of 193 kcal per additional ha. By contrast, age of the household head has a significantly negative effect. This might be explained by the fact that older people are often less aware of nutritional aspects. Moreover, their calorie and nutritional requirements are usually somewhat lower than those of younger adults.

(About here should appear table 4)

A potential problem in estimation might be that there are unaccounted village factors that could be correlated with the income variables. This would lead to an omitted variable bias. To some extent, village factors are captured by the infrastructure variables that we use as instruments in the first-stage regressions. As we have a sufficient number of instruments available, we tried to include some of them in second-stage estimation, yet with insignificant results for these additional coefficients. We also included interaction terms between household assets and infrastructure variables to increase within village variations, but again with insignificant results.[6] To account for village unobservables that are not properly captured by the instruments, we include village fixed effects through 39 dummy variables, representing the 40 villages in our sample. These estimation results are shown in column (2) of table 4. None of the village dummies is significant at the 5% level, and only two are significant at the 10% level. An F-test showed that the dummies were jointly insignificant ($F_{(93, 173)} = 0.74$; $p = 0.89$). Furthermore, the magnitude of the other coefficients, especially those for farm and off-farm income, remains unaffected. We therefore conclude that village fixed effects do not bias the results and proceed without the village dummies, in order to save degrees of freedom.

Column (3) in table 4 shows results of a model with a slightly different specification. Instead of including farm and off-farm income as separate variables, we include total household income in monetary terms and the share of off-farm income in percentage terms. Again, first-stage results of this IV approach are shown in the appendix. Total income has a positive effect on calorie supply, while the off-farm income share coefficient is insignificant. This is not surprising, given the previous result of equal marginal effects of farm and off-farm income on household calorie supply. The other coefficients are not much affected by this modified model specification. In column (4), the dependent variable is changed. Instead of measuring calorie supply as a continuous variable, we use a dummy that takes a value of one when the household is food secure with a daily calorie supply above 2500 kcal, and zero otherwise. This specification is estimated as an IV probit model. As can be seen in table 4, farm and off-farm income both increase the probability of households being food secure. Somewhat surprisingly, education has a

[6] One might expect that there is no within village variation in the infrastructure variables, which however is not true in the setting analyzed here. Except for tarred road, which is indeed a village level variable, the other infrastructure characteristics are household level variables. Farm households are scattered and not located in one central place, so that there are within-village differences in distance to market and access to water and electricity.

significantly negative effect in this model. However, this is only the net effect of education beyond its influence on household income, the latter of which is clearly positive (table A1).

Off-farm income, dietary quality, and micronutrient supply

To examine the impact of off-farm income on dietary quality, we use similar models as described above, but instead of total calorie supply per AE we take the calorie amount stemming from fruits, vegetables, and animal products as dependent variable. Again, we use an IV approach with cluster correction. Estimation results are shown in column (1) of table 5. They indicate that off-farm income has a positive and significant effect on dietary quality. That is, when off-farm income increases, not only more food in general, but also more higher-value food is consumed, and again the marginal effects are identical for farm and off-farm income. This is an interesting result, because a priori one might expect that off-farm work could especially be at the expense of livestock and horticultural on-farm activities, as these are particularly labor intensive (e.g., Pfeiffer et al., 2009; Huang et al., 2009). Hence, off-farm income might potentially result in lower household availability of nutritious non-staple foods. Yet, this is not the case here. Off-farm income contributes to higher total income, and, since more nutritious foods have a higher income elasticity of demand than staple foods, their absolute and relative importance in household diets increases.

The other results in the dietary quality model are in line with the calorie supply model discussed above. In addition, household size has a significantly negative coefficient, meaning that per capita calorie consumption decreases in larger households. This might potentially be due to economies of scale in food preparation and consumption: in larger families there is often less food waste than in smaller ones, so that lower average calorie supply does not inevitably mean lower calorie intake. Such details are difficult to disentangle with food expenditure data (e.g., Bouis, 1994).

(About here should appear table 5)

The other columns in table 5 show that off-farm income also has a positive and significant effect on household micronutrient consumption. Column (2) looks at iron supply per AE, using an IV approach. However, since the Durbin-Wu-Hausman test fails to reject the exogeneity hypothesis for the two income variables, we re-estimated the model using ordinary least squares (OLS), results of which are shown in column (3). Vitamin A supply is analyzed in column (4). For every 1000 naira of additional off-farm income, daily iron supply increases by about 0.15 mg per AE, while vitamin A supply increases by 2 μg. The effects of farm income are again in equal magnitude, although not statistically significant in the vitamin A model. The signs and significance levels of the other coefficients are similar to those in the calorie models, suggesting that improving dietary quantity and quality are complementary objectives. An exception is the education variable, which has a significantly positive effect on iron supply in column (3). The reason is that this is an OLS regression, which does not account for the indirect effect that education has on household income. Estimating the other models by OLS does also produce significantly positive education coefficients in most cases.

Off-farm income and child nutritional status

To analyze the effect of off-farm income on child nutritional status, we regress anthropometric indicators on a set of socioeconomic variables. The sample is confined to children up to 60 months of age. As explanatory variables we use the same household characteristics as before, but additionally include a few individual level variables such as child sex, age, and mother's education, plus a dummy for households with a private toilet, which is a proxy for the sanitary conditions. As above, a cluster correction approach is used to obtain a consistent variance-covariance matrix. The exogeneity hypothesis for the income variables could not be rejected, so that OLS estimators are used.

Columns (1), (2), and (3) in table 6 show the estimation results; the dependent variable is the individual child *Z*-score for height-for-age, weight-for-age, and weight-for-height, respectively. Within the age range covered, older children have lower *Z*-scores for height-for-age and weigh-for-age and thus a worse nutritional status than younger children. This is plausible considering that many of the younger children are breastfed, so that more severe malnutrition sets in only after weaning.[7] Having a toilet in the household has a positive effect on child anthropometry in all three models, which is unsurprising, as better sanitary conditions entail a lower risk of infectious diseases. The same explanation holds for the positive coefficients for the tapped water dummy in columns (1) and (2). These findings are consistent with the literature (e.g., Strauss and Thomas, 1995; Armar-Klemesu et al., 2000). Off-farm income has a positive effect on child height-for-age, which is significant at the 10% level. Also in the weight-for-age model, the effect is positive, albeit insignificant.

(About here should appear table 6)

These estimates are not very robust. Nevertheless, there is some indication that off-farm income contributes not only to higher nutrient intakes but also to better nutritional status among children. This is supported by the observation of lower prevalence rates of stunting, underweight, and wasting in households with off-farm income (table 3). One reason why the results in these regression models on child anthropometry are somewhat weaker than in the calorie and micronutrient supply models might be that further child-specific details – such as birth weight

[7] For breastfed infants, anthropometric measures are usually closely correlated with the mother's nutritional status, for which we have no data in our sample.

and birth order – as well as health related variables, are not available from our data set. Such variables can play an important role (e.g., Strauss and Thomas, 1995), and some of them are likely correlated with income. Moreover, our sample size of 127 pre-school children is relatively small. It is well possible that with comprehensive data more significant effects of off-farm income could be shown.

Explaining structural relations

The previous sections have shown that off-farm income has a positive impact on food security and nutrition in rural Nigeria. Still, the mechanisms through which this impact occurs are not completely clear. An expected direct effect is that off-farm income contributes to overall household income such that food becomes more accessible. But there may also be more indirect effects when off-farm activities have an influence on farm income through interlinkages in factor use. When there are labor constraints, off-farm activities will reduce the labor input in farming (Pfeiffer et al., 2009; Huang et al., 2009). On the other hand, when capital is scarce, off-farm income can contribute to higher agricultural input use by relaxing liquidity constraints. The outcome also depends on development opportunities and household strategies in a specific context. For instance, Kilic et al. (2009) found that rural households in Albania tend to use their off-farm earnings to move out of agriculture, whereas Oseni and Winters (2009) showed that off-farm activities in Nigeria help households to improve their farm production through higher input use, including more employment of hired labor. This is consistent with our sample data where households with off-farm income use more fertilizer, pesticides, and hired labor and obtain an almost 10% higher food output per AE than households without off-farm income.

To analyze the relationships between off-farm income, farm income, and nutrition more formally, we develop a structural model as follows:

$$C = \alpha_1 + \alpha_2 H + \alpha_3 FS + \alpha_4 OFI + \alpha_5 FI + \varepsilon_1 \quad (1)$$

$$OFI = \beta_1 + \beta_2 H + \beta_3 I + \varepsilon_2 \quad (2)$$

$$FI = \gamma_1 + \gamma_2 H + \gamma_3 FS + \gamma_4 I + \gamma_5 OFI + \varepsilon_3 \quad (3)$$

$$FS = \delta_1 + \delta_2 OFI + \delta_3 V + \varepsilon_4 \quad (4)$$

where *C* is calorie supply, *OFI* is off-farm income, and *FI* is farm income, all measured in per AE terms. *H* is a vector of household variables, *FS* is farm size, *I* is the set of asset and infrastructure variables used as instruments in the previous section, and *V* is the vector of village dummies. α, β, γ, and δ are the coefficients to be estimated, and ε_1 to ε_4 are random error terms. Equations (1) to (3) are similar to the IV calorie supply model estimated above, with the only exception that *OFI* is now included also as an explanatory variable in the farm income equation. Given higher input use and food output among households with off-farm income we expect the coefficient γ_5 in equation (3) to be positive.

Equation (4) looks at another interesting phenomenon by considering farm size as an endogenous variable. Note that farm size in our context is not defined as area owned but as area cultivated in the survey year. The reason is that land in Kwara State of Nigeria is community owned. Permission of use is granted by the village head, and farmers may cultivate as much land as their capacity permits. Although very high-quality soils are largely under cultivation, land in general is not the major constraint for increasing agricultural production.[8] Rather, capital for buying farm inputs, machinery, or to pay for hired labor seems to be the scarcest factor. Hence, off-farm income can potentially help to increase the area cultivated, so that the coefficient δ_2 is expected to be positive. As access to further land for cultivation can vary from location to location, we include the village dummies as additional covariates in equation (4). This system of

[8] This cannot be generalised to all parts of Nigeria, especially not the cocoa producing areas in the south-west. However, with some exceptions, land scarcity in countries of Sub-Saharan Africa is less pronounced than in Asia.

equations is estimated using three-stage least squares; results are shown in table 7. Due to a multicollinearity problem, household size had to be excluded in some of the equations.

(About here should appear table 7)

The coefficients in the calorie supply equation (column 1) are similar as they were before with both farm and off-farm income having a significantly positive effect. Yet the farm income coefficient is slightly larger than before, while the off-farm income coefficient is smaller. This suggests that there are important interactions between these two variables. Indeed, the results in column (3) demonstrate that off-farm income has a significantly positive effect on farm income, with a relatively large marginal effect: for every naira earned from off-farm sources, farm income increases by 0.62 naira on average. Moreover, column (4) confirms that off-farm income allows households to cultivate larger areas: 1000 naira of extra off-farm income per AE lead to 0.018 ha of additional cropping area. And, as expected, farm size contributes positively to farm income (column 3). Thus, through various mechanisms farm and off-farm activities are complementary sources of income, and the positive impact of off-farm income on nutrition is partly channeled through improving household food production and farm income.

Conclusions

In this article, we have analyzed the effects of off-farm income on household food security and nutrition in Kwara State of Nigeria. Descriptive analyses and econometric approaches have shown that off-farm income contributes to improved calorie supply at the household level. This is in line with previous research in other countries. In addition, we could show that off-farm income has a positive impact on dietary quality and micronutrient supply, aspects which have not been analyzed previously. Furthermore, child nutritional status is better in households with access to off-farm income than in households without.

There is a widespread notion that farm income has more favorable nutrition effects than off-farm income, especially in semi-subsistent production systems. The argumentation is that off-farm orientation might lead to a decline in own agricultural production, which would cause lower food availability at the household level. This effect might be especially pronounced for labor-intensive but highly nutritious foods like vegetables and livestock products. So, even if off-farm income contributes to better nutrition, the effect might be smaller than for farm income. This notion is clearly challenged by our results. Off-farm income has the same marginal effect as farm income, which holds true not only for household calorie consumption, but also for dietary quality and micronutrient supply. Obviously, this finding is specific to the empirical example and should not be generalized. But it shows that widespread beliefs are not always correct. In the case of Kwara State, where shortage of capital is a major constraint, off-farm income can even contribute to more intensive farming and higher food production and farm income, as results from our structural model demonstrate.

Both farm and off-farm activities can contribute to better food security and nutrition. Yet, while investing into agricultural growth is currently featuring high on the development policy agenda, promoting the rural off-farm sector receives much less attention. This should be rectified, especially in regions where agricultural resources are becoming increasingly scarce. Off-farm income diversification is already an extensive phenomenon among rural households in developing countries. But without a clear policy strategy on how to support this process in a pro-poor way, outcomes might be socially undesirable, because of unequal household access to certain off-farm activities.

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Tables and Figures

Table 1: Summary statistics of selected household variables

Variable	Description	Mean	SD
Male	Dummy for gender of household head (male = 1)	0.90	0.31
Household size	Number of household members in adult equivalents (AE)	5.08	1.31
Age	Age of household head (years)	59.10	6.80
Education	Number of years of schooling of household head (years)	6.89	3.93
Farm size	Area cultivated by household in survey year (ha)	1.90	0.58
Productive assets	Value of household productive assets (thsd. naira)	73.76	53.15
Electricity	Dummy for electricity in household (yes = 1)	0.83	0.38
Tapped water	Dummy for water tap in household (yes = 1)	0.65	0.48
Tarred road	Dummy for tarred road in the village (yes = 1)	0.74	0.44
Distance to market	Distance to the nearest market place (km)	11.71	12.89
Total income	Total household income per year (naira/AE)	30245.74	23416.34
Farm income	Income from on-farm activities per year (naira/AE)	15226.49	12824.71
Off-farm income	Income from off-farm sources per year (naira/AE)	15019.25	17930.51

Notes: Official exchange rate in 2006: 1 US dollar = 120 naira; SD is standard deviation. AE is adult equivalent. The number of observations is N = 220.

Table 2: Calorie and micronutrient supply by income quartiles

	All households	Income quartiles			
		First	Second	Third	Fourth
	Mean (standard deviation)				
Calorie supply (kcal/day/AE)	2427.5	1943.7	2386.5	2480.3	2899.5
	(704.0)	(494.6)	(759.4)	(654.1)	(513.3)
Prevalence of undernourishment (%)	60.9	96.4	67.3	52.7	27.3
Depth of calorie deficiency (%) [a]	22.2	25.7	22.5	21.5	10.3
Dietary quality (kcal/day/AE) [b]	436.9	349.9	429.6	446.4	521.9
	(126.7)	(89.8)	(136.6)	(118.2)	(95.9)
Iron supply (mg/day/AE)	26.6	20.8	25.2	26.6	33.8
	(8.58)	(6.91)	(8.11)	(8.21)	(5.40)
Vitamin A supply (µg RE/day/AE)	289.0	235.0	283.9	293.4	343.6
	(86.7)	(62.6)	(94.3)	(78.1)	(74.1)

Notes: AE is adult equivalent. RE is retinol equivalent.
[a] This only refers to food insecure households.
[b] This is the calorie supply that comes from fruits, vegetables, and animal products.

Table 3: Food security and nutritional status by access to off-farm income

	All households (N = 220)	Households with off-farm income (N = 193)	Households without off-farm income (N = 27)
	Mean (standard deviation)		
Calorie supply (kcal/day/AE)	2427.5	2465.2	2157.9**
	(704.0)	(698.7)	(695.3)
Prevalence of undernourishment (%)	60.9	58.0	81.5
Depth of calorie deficiency (%) [a]	22.2	21.6	25.2
Dietary quality (kcal/day/AE) [b]	436.9	443.7	388.4**
	(126.7)	(125.8)	(125.2)
Iron supply (mg/day/AE)	26.6	27.4	20.6***
	(8.58)	(8.3)	(8.4)
Vitamin A supply (µg RE/day/AE)	289.0	293.1	259.8*
	(86.7)	(86.2)	(85.8)
Child nutritional status [c]			
Height-for-age *Z*-score	0.456	0.734	-0.682***
	(2.64)	(2.66)	(2.27)
Weight-for-age *Z*-score	-0.586	-0.389	-1.391***
	(1.41)	(1.34)	(1.38)
Weight-for-height *Z*-score	-0.991	-0.929	-1.243
	(1.88)	(1.94)	(1.65)
Prevalence of stunting (%)	23.6	20.6	36.0
Prevalence of underweight (%)	22.0	18.6	36.0
Prevalence of wasting (%)	14.2	13.7	16.0

Notes: AE is adult equivalent. RE is retinol equivalent.
*, **, *** differences between households with and without off-farm income are statistically significant at 10%, 5%, and 1% level, respectively.
[a] This only refers to food insecure households.
[b] This is the calorie supply that comes from fruits, vegetables, and animal products.
[c] Child nutritional status refers to pre-school children up to 60 months of age. The total sample includes 127 children: 102 from households with and 25 from households without off-farm income.

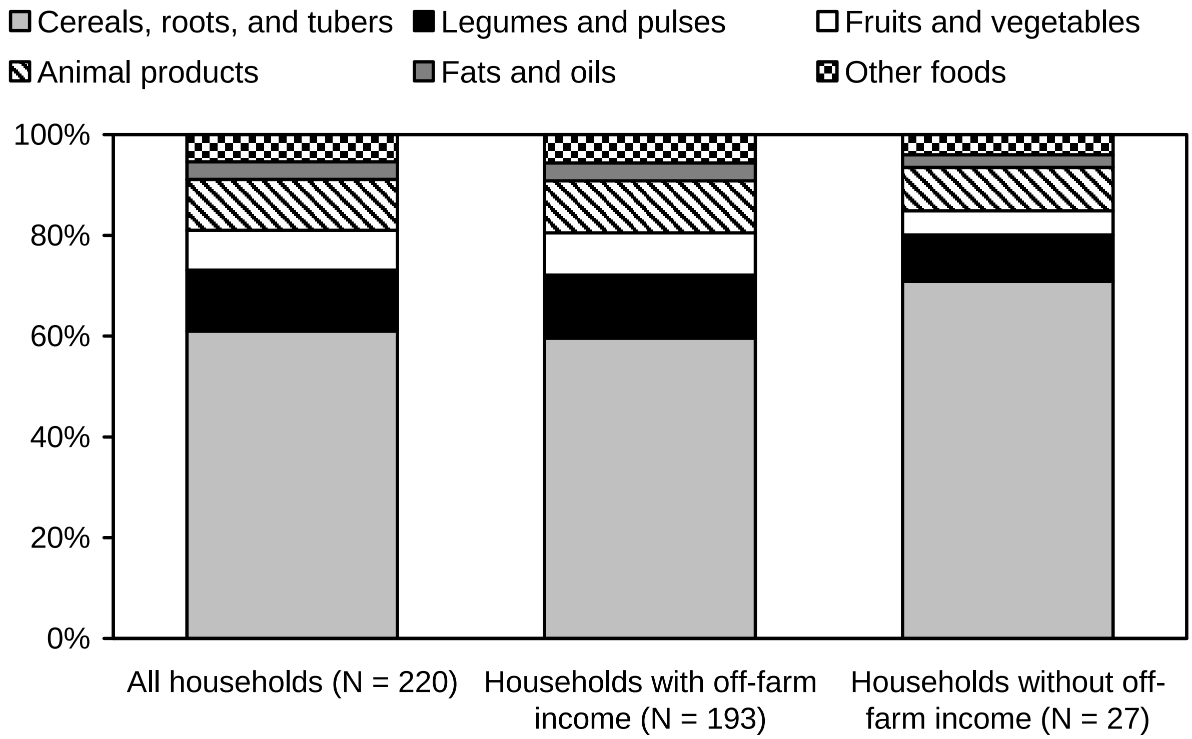

Figure 1: Share of different food groups in household calorie supply

Table 4: Household calorie supply models

	(1) Calorie supply (kcal/AE)	(2) Calorie supply (kcal/AE)	(3) Calorie supply (kcal/AE)	(4) Food security status (dummy) [c]
Constant	2403.789***	2409.975***	2375.639***	0.526
	(4.60)	(3.59)	(5.83)	(0.61)
Male (dummy)	274.148**	314.597**	284.212**	0.089
	(2.00)	(2.13)	(2.07)	(0.31)
Household size (AE)	-73.658	-83.830*	-71.018	-0.083
	(-1.61)	(-1.69)	(-1.67)	(-0.95)
Age (years)	-13.432**	-14.387**	-13.085**	-0.018
	(-2.27)	(-1.99)	(-2.26)	(-1.55)
Education (years)	-15.109	-9.301	-13.468	-0.097***
	(-0.93)	(-0.42)	(-0.77)	(-3.38)
Farm size (ha)	193.300**	146.185	190.798*	-0.021
	(2.01)	(1.46)	(1.97)	(-0.14)
Farm income (naira/AE) [a]	0.022**	0.022		2.3E-05***
	(2.12)	(1.36)		(2.90)
Off-farm income (naira/AE) [a]	0.022***	0.022**		6.7E-05***
	(4.17)	(2.35)		(15.09)
Total income (naira/AE) [a]			0.023***	
			(4.07)	
Off-farm income share (%) [a]			-88.125	
			(-0.28)	
Village fixed effects [b]	No	Yes	No	No
Adjusted R^2	0.382	0.342	0.382	
Durbin-Wu-Hausman chi^2	10.482***	8.583**	14.072***	47.930***

Notes: The number of observations in all models is N = 220. Figures in parentheses are *t*-values.
*, **, *** statistically significant at the 10%, 5%, and 1% level, respectively.
[a] These are instrumental variables. Results of the first-stage regressions are shown in appendix table A1.
[b] Village fixed effects are captured through 39 village dummy variables.
[c] This is an IV probit model.

Table 5: Household dietary quality and micronutrient supply models

	(1) Dietary quality (kcal/AE)	(2) Iron supply (mg/AE)	(3) Iron supply (mg/AE), OLS	(4) Vitamin A supply (μg/AE)
Constant	472.471***	26.838***	26.620***	300.452***
	(5.11)	(4.27)	(6.10)	(4.75)
Male (dummy)	48.138**	4.121***	4.498***	27.912*
	(2.06)	(2.96)	(3.69)	(1.69)
Household size (AE)	-18.682**	-0.455	-0.837**	-11.877*
	(-2.23)	(-0.71)	(-2.16)	(-1.99)
Age (years)	-2.356**	-0.161**	-0.140*	-1.425**
	(-2.25)	(2.00)	(-1.95)	(-2.08)
Education (years)	-3.342	0.011	0.322**	-1.627
	(-1.15)	(0.06)	(2.69)	(-0.89)
Farm size (ha)	35.979**	0.285	0.881	27.766**
	(2.16)	(0.36)	(1.30)	(2.34)
Farm income (naira/AE) [a]	0.004*	2.1E-04	1.6E-04***	0.002
	(1.82)	(1.41)	(4.37)	(1.62)
Off-farm income (naira/AE) [a]	0.004***	2.7E-04***	1.5E-04***	0.002***
	(4.09)	(3.87)	(5.95)	(3.47)
Adjusted R^2	0.392	0.395	0.443	0.343
Durbin-Wu-Hausman chi^2	9.758***	3.553		7.045**

Notes: The number of observations in all models is N = 220. Figures in parentheses are *t*-values.
*, **, *** statistically significant at the 10%, 5%, and 1% level, respectively.
[a] In columns (1), (2), and (4) these are instrumental variables. Results of the first-stage regressions are shown in appendix table A1.

Table 6: Child nutritional status models

	(1) Height-for-age (*Z*-score)	(2) Weight-for-age (*Z*-score)	(3) Weight-for-height (*Z*-score)
Constant	7.497**	-0.334	-6.334**
	(2.33)	(-0.27)	(-2.71)
Male household head (dummy)	0.003	-0.478	-0.033
	(0.00)	(-0.17)	(-0.06)
Male child (dummy)	0.607	0.255	-0.203
	(1.36)	(0.96)	(-0.65)
Household size (AE)	-0.225	0.072	0.251**
	(-1.21)	(0.77)	(2.43)
Age of household head (years)	-0.016	0.000	0.019
	(-0.47)	(0.03)	(0.73)
Age of child (months)	-0.076***	-0.033**	0.012
	(-3.28)	(-2.56)	(0.67)
Education of household head (years)	-0.006	-0.026	-0.033
	(-0.08)	(-0.78)	(-0.58)
Education of child's mother (years)	0.058	0.074**	0.071
	(0.61)	(2.55)	(1.04)
Farm size (ha)	-0.529	-0.464**	-0.142
	(-1.48)	(-2.72)	(-0.54)
Farm income (naira/AE)	-2.0E-05	1.1E-05	2.8E-05**
	(-0.86)	(1.53)	(2.25)
Off-farm income (naira/AE)	1.7E-05*	8.5E-06	-1.8E-06
	(1.80)	(1.40)	(-0.20)
Productive assets (thsd. naira)	0.000	-0.002	-0.002
	(0.01)	(-0.85)	(-0.58)
Electricity (dummy)	-0.639	0.286	0.822
	(-1.04)	(0.77)	(1.64)
Tapped water (dummy)	0.921	0.484*	-0.026
	(1.57)	(1.73)	(-0.06)
Toilet (dummy)	0.927*	1.429***	1.184***
	(1.81)	(6.12)	(3.36)
Tarred road (dummy)	-1.535***	0.158	1.295***
	(-3.77)	(0.65)	(3.27)
Distance to market (km)	-0.001	0.009	0.013
	(-0.06)	(1.21)	(1.05)
Adjusted R^2	0.259	0.458	0.267

Notes: The number of observations in all models is N = 127. Figures in parentheses are *t*-values.
*, **, *** statistically significant at the 10%, 5%, and 1% level, respectively.

Table 7: Structural relations between off-farm income, farm income, and calorie supply

	(1) Calorie supply (kcal/AE)	(2) Off-farm income (naira/AE)	(3) Farm income (naira/AE)	(4) Farm size (ha)
Constant	2078.547***	-18195.400*	31948.790***	1.399***
	(4.63)	(-1.92)	(2.99)	(7.63)
Male (dummy)	303.143**	103.103	-4233.331	
	(2.50)	(0.03)	(-1.40)	
Household size (AE)	-102.073***			
	(-3.07)			
Age (years)	-10.668**	186.034	-366.482***	
	(-1.98)	(1.36)	(-2.76)	
Education (years)	-12.544	1421.181***	-571.916	
	(-0.85)	(4.17)	(-1.51)	
Farm size (ha)	346.943***		8929.194***	
	(3.07)		(3.21)	
Farm income (naira/AE)	0.026***			
	(4.64)			
Off-farm income (naira/AE)	0.016***		0.619***	1.8E-05***
	(3.60)		(4.95)	(5.06)
Productive assets (thsd. naira)		58.376***	-51.105**	
		(3.03)	(-2.42)	
Electricity (dummy)		2995.723	-1120.374	
		(1.19)	(-1.44)	
Tapped water (dummy)		8151.58***	-4329.47	
		(3.17)	(-1.59)	
Tarred road (dummy)		1279.502	-4986.345**	
		(0.57)	(-2.22)	
Distance to market (km)		-58.853	-204.206**	
		(-0.70)	-(-2.45)	
Village fixed effects [a]	No	No	No	Yes
Chi^2 (model significance)	239.46***	149.83***	69.26***	126.25***

Notes: The number of observations in this simultaneous equation model is N = 220. Figures in parentheses are *t*-values.
*, **, *** statistically significant at the 10%, 5%, and 1% level, respectively.
[a] Village fixed effects are captured through 39 village dummy variables.

Appendix

Table A1: First-stage regressions explaining household income

	Farm income (naira/AE)	Off-farm income (naira/AE)	Total income (naira/AE)	Off-farm income share (%)
Constant	40382.100***	-17266.150	23115.940*	-0.550***
	(4.63)	(-1.64)	(1.81)	(3.03)
Male (dummy)	-3207.046	1206.378	-2000.667	0.113**
	(-1.20)	(0.37)	(-0.51)	(2.02)
Household size (AE)	-3286.55***	-2624.646***	-5911.196***	-0.006
	(-5.18)	(-3.42)	(-6.35)	(-0.42)
Age (years)	-143.578	292.218**	148.640	0.007***
	(-1.24)	(2.09)	(0.87)	(3.04)
Education (years)	109.734	1155.445***	1265.180***	0.022***
	(0.37)	(3.20)	(2.89)	(3.54)
Farm size (ha)	2997.751**	3538.225**	6535.976***	-0.005
	(2.10)	(2.05)	(3.11)	(-0.18)
Productive assets (thsd. naira)	2.034	84.405***	86.439***	0.001***
	(0.12)	(4.12)	(3.48)	(3.26)
Electricity (dummy)	2550.785	4667.923*	7218.709**	0.060
	(1.16)	(1.76)	(2.24)	(1.32)
Tapped water (dummy)	-976.436	2535.546	1559.110	0.092*
	(-0.43)	(0.92)	(0.47)	(1.93)
Tarred road (dummy)	-2798.154	2556.181	-241.973	0.127***
	(-1.42)	(1.08)	(-0.08)	(3.09)
Distance to market (km)	-265.681***	-89.051	-354.732***	0.002
	(3.64)	(-1.01)	(-3.31)	(1.52)
Adjusted R^2	0.223	0.418	0.497	0.384

Notes: The number of observations in all models is N = 220. Figures in parentheses are *t*-values.
*, **, *** statistically significant at the 10%, 5%, and 1% level, respectively.