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Women's off-farm employment and dietary quality in rural Africa

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Abstract

Most households in rural Africa are involved in smallholder farming, but off-farm employment is an important additional income source for many. Previous research has analyzed links between off-farm employment and wellbeing, but mostly at the household level, not considering that household members may be affected differently. In particular, gender gaps in employment, nutrition, and other wellbeing dimensions are widely observed. Here, we use survey data collected in Tanzania and Zambia to examine how women's off-farm employment influences their individual-level dietary quality. Regression estimates with instrumental variables show that women's off-farm employment improves their dietary diversity, including more frequent consumption of nutritious foods such as meat, fish, fruits, and vegetables. We also explore potential mechanisms, including changes in household income, women's agency, and time allocation. The main results hold across various robustness checks, suggesting that improving women's access to off-farm employment can help increase household income and reduce widespread gender gaps in rural Africa.

Keywords: Off-farm employment; Dietary quality; Gender; Time allocation; Nutrition; Africa

JEL Codes: J21, I31, Q18

1. Introduction

For most households in rural Africa, small-scale farming is the main source of livelihoods. However, given rapid population growth, shrinking farm sizes, climate change, and structural transformation, off-farm income and employment have gained in importance, and these trends will further continue (Hazell et al., 2024; Musungu et al., 2024; Mutsami et al., 2024). Off-farm employment has been recognized as a key avenue for poverty reduction in rural Africa (Davis et al., 2017; Kijima et al., 2006; Van den Broeck et al., 2017). There is also growing evidence that off-farm employment can help improve diets and nutrition in smallholder farm households, the group most affected by undernutrition worldwide (Dzanku, 2019; Rahman & Mishra, 2020; Sangwan & Kumar, 2021; Van den Broeck et al., 2021). Yet, most existing studies analyze effects at the household level, not considering who in the household is involved in off-farm employment and how the nutrition of individual household members is influenced. This is an important limitation, as gender gaps in employment, nutrition, and other dimensions of individual wellbeing are widely observed (Koppmair et al., 2017; Quisumbing and Doss, 2021; FAO, 2023; UNICEF, 2023). Here, we address this limitation and investigate the effects of women's off-farm employment on their individual-level dietary quality.

A few studies on the role of maternal employment for child diets and nutrition in different countries of Africa and Asia exist, with varying results depending on the context (Debela et al., 2021; Hosen et al., 2023; Melaku et al., 2024; Rashad & Sharaf, 2019). However, very little is known about how women's off-farm employment affects their own diets and nutrition. A focus on women's diets is important, not only because women are disproportionately affected by undernutrition and micronutrient deficiencies, but also because women's nutritional status during pregnancy and lactation is a key determinant of child physical and cognitive development (Cusick & Georgieff, 2016; UNICEF, 2023). Women typically also bear the primary responsibility for managing household diets and nutrition (Tibesigwa & Visser, 2016).

Women's participation in off-farm employment can influence their dietary quality through three main mechanisms, namely changes in household income, women's agency, and time allocation. Income earned from off-farm work may relax household budget constraints, enabling women to purchase and consume more diverse and nutritious foods (Maity, 2020). Increased financial autonomy achieved through own off-farm employment income may enhance women's decision-making power within the household. Studies suggest that income controlled by women often has larger positive diet and nutrition effects than income controlled by men (Kassie et al., 2020; Ogutu et al., 2020). Finally, involvement in off-farm employment may influence women's time available for farm and household activities, which may also influence diets and nutrition. For instance, a higher time burden through off-farm work could reduce women's time spent on food production and meal preparation, with possible negative implications for dietary quality.

We analyze such effects with primary survey data collected in rural regions of Tanzania and Zambia. Existing data, such as from the World Bank's Living Standards Measurement Study (LSMS), could not be used here because these do not contain individual-level dietary information.

We estimate the impact of women's off-farm employment – measured in terms of a binary variable and also the time allocated to off-farm activities – on women's dietary diversity scores (WDDS), using regression models with instrumental variables. We consider various types of off-farm activities, including self-employment in own non-agricultural businesses and wage-employment. Furthermore, we analyze effects of women's off-farm employment on the consumption of different food groups to better understand the nutritional implications. Finally, we examine associations between women's off-farm employment, household income, women's agency, and women's time allocation. In doing so, we aim to connect the research on welfare effects of off-farm employment with the research on drivers of women's dietary quality (Kassie et al., 2020; Komatsu et al., 2018; Quisumbing et al., 2021; Vemireddy & Pingali, 2021).

The remainder of this article is organized as follows. In section 2, we discuss the conceptual framework for our analysis. In section 3, we describe the survey in Tanzania and Zambia, the measurement of key variables, and the econometric estimation strategy. The empirical results are presented and discussed in section 4, while section 5 concludes.

2. Conceptual framework

Women's participation in off-farm employment can shape the quality of their diets through multiple interconnected mechanisms. The key mechanisms include changes in household income, shifts in women's agency, and changes in women's time allocation. The impact of each single mechanism on dietary quality, which can be positive or negative, depends on the specific context and nature of the off-farm work. The three mechanisms are discussed in more detail below.

Changes in household income. Being involved in off-farm employment usually adds to household income in comparison to a situation where all household members are only involved in farming (Baysan et al., 2024). This additional income from off-farm activities can relax household budget constraints, enabling greater consumption of purchased foods (Maity, 2020). Empirical evidence shows that much of the dietary diversity in African rural households is purchased in local markets (Nguyen & Qaim, 2025), so we expect positive effects on women's dietary quality. In addition, some of the off-farm income may be reinvested into agriculture, for instance, in the form of yield-enhancing technologies (Hazell et al., 2024). Higher agricultural yields may further improve women's dietary quality through home consumption or market sales (Ogutu et al., 2020).

Changes in women's agency. Women's involvement in off-farm employment means that women contribute directly to cash income earnings, which can enhance their financial autonomy, likely also increasing their role in household decision-making, for instance, on how the income is spent. Women's priorities in terms of how the limited family income is spent are often different from those of men. Research consistently shows that income controlled by women is more frequently allocated to nutritious foods and family health than income controlled by men (Kassie et al., 2020; Ogutu et al., 2020). This suggests that enhanced women's agency through off-farm employment can lead to higher dietary quality.

Changes in women's time allocation. Women's involvement in off-farm employment means that they have less time for other activities. Women in rural Africa are often time-constrained, having to shoulder most of the household chores and care work and typically also being heavily involved in the household's own farming activities (FAO, 2023). Additional off-farm employment can heighten women's time constraints, possibly reducing the time allocated to meal preparation. In such situations, women may rely on more convenient but less diversified and nutritious food options, potentially compromising dietary quality and nutritional wellbeing (IFPRI, 2024; Komatsu et al., 2018; Quisumbing et al., 2021; Sangwan & Kumar, 2021).

The impact of time constraints on dietary quality may strongly vary by type of off-farm activity and the degree to which different tasks are taken up by other household members. Recent research shows that maternal off-farm involvement in wage-employment can have negative effects of child nutritional outcomes, largely due to reduced breastfeeding and less time spent

on childcare and meal preparation, which is not fully offset by more time spent on these tasks by other household members (Debela et al., 2021; Melaku et al., 2024). In comparison, maternal self-employment in own businesses has no negative impact on child nutrition because this mostly happens at home, is therefore not associated with additional commuting time, and offers greater flexibility in terms of women's time management than wage-employment (Debela et al., 2021). To our knowledge, effects of women's off-farm wage- and self-employment on their own dietary quality have not been examined previously.

Taken together, these mechanisms suggest that the relationship between women's participation in off-farm employment and their dietary quality is complex. The net effect depends on which of the three mechanisms is the most dominant in a particular context. While increases in household income and women's agency will generally contribute to enhanced dietary quality, women's time constraints may counteract these benefits. Given the central role of financial constraints for improving dietary quality in rural Africa, we hypothesize that the positive partial effects will dominate the negative ones, meaning that women's off-farm employment is expected to improve women's dietary quality in the aggregate. This hypothesis will be tested below.

3. Materials and methods

3.1 Survey of households and individuals

We collected data for this study through a survey of rural households in Tanzania and Zambia in May and June 2023. In Tanzania, the survey was conducted in Morogoro and Iringa, two neighboring regions in the mid-eastern part of the country. In Zambia, we focused on the Western Province, bordering Angola to the west and Namibia to the south. In all survey regions, agriculture is the main source of livelihoods for rural households, but self-employment in small businesses – such as food processing, retailing, transport, and other services – and wage-employment in agriculture, construction, manufacturing, and the services sector also exist (Mutsami et al., 2024). Most of the off-farm employment in the study regions is informal. Poverty and undernutrition is widespread, and dietary diversity is low (Tanzania National Bureau of Statistics, 2022; Zambia Statistics Agency, 2022). The regions are not fully representative of rural areas in Tanzania and Zambia, but together provide a range of characteristics typical for many parts of sub-Saharan Africa.

Households to be included in the survey were selected through a two-stage random sampling procedure. First, we randomly selected 60 villages in Tanzania (Morogoro and Iringa) and 30 villages in Zambia, using a probability proportional to size approach. Second, in each village we randomly sampled around 15 households based on full household lists compiled together with the village leaders. Thus, a total of 1307 households were selected for personal interviews, which were conducted in local languages using a structured questionnaire and tablet computers.

The questionnaire had various sections, some focusing on the household in general, and others focusing on individual household members. The general household sections were answered by the household head, who, in most cases, was a male adult. Individual-level sections were administered separately to the main male adult, usually the household head, and the main female adult, usually the head's wife. In some households, only one adult could be interviewed, because a second adult was not available. Here, we only include the 1151 households in which an adult woman could be interviewed. The sample for our analysis includes 773 individual-level women observations in Tanzania and 378 in Zambia.

The household-level questions referred to household size, demographic composition, assets owned, farm production, other economic activities, and a variety of related socioeconomic characteristics. The individual-level questions referred to education, employment, time use, food consumption, and decision-making, among other aspects. Key variables used in the empirical analysis are described in more detail in the following subsections.

3.2 Women's dietary quality

Our main outcome variable of interest is women's dietary quality, which we evaluate using the women's dietary diversity score (WDDS). WDDS is a widely-used indicator in the nutrition literature that is positively associated with various desirable nutrition outcomes, including micronutrient adequacy (Arimond et al., 2010; Haddad et al., 1994; Kassie et al., 2020; Quisumbing et al., 2021).

We calculate WDDS using nine food groups (Kennedy et al., 2011), namely (i) starchy staples; (ii) pulses (beans, peas, and lentils), nuts, and seeds; (iii) milk and milk products; (iv) meat, poultry, and fish; (v) eggs; (vi) dark green leafy vegetables; (vii) other vitamin A-rich fruits and vegetables; (viii) other fruits and vegetables; and (ix) organ meat. Thus, WDDS represents the number of food groups consumed by the adult women during the past 24 hours prior to the interview and, in principle, can take any whole number between 0 and 9. WDDS can also be calculated for longer recall periods, if data are available, but the 24-hour recall is typically preferred due to its higher recall accuracy.

3.3 Women's employment

Our primary explanatory variables relate to women's off-farm employment, which we define as any income-generating activity outside the family farm. We use two different variables to evaluate women's off-farm employment. First, we measure participation at the extensive margin with a dummy variable, which equals one if the woman had engaged in any off-farm employment activity during the 12 months prior to the interview, and zero otherwise. Second, to capture the intensive margin, we use the number of hours spent in off-farm activities during the seven days prior to the interview. Both variables have pros and cons. The 12-month window for the extensive margin is suitable to also capture short-term seasonal employment, which is common in rural Africa. Respondents can easily remember whether or not they were employed in past months, but they may not necessarily remember the exact number of hours or days of employment for the entire year. For the past seven days, however, remembering such details is easier, reflecting recent work intensity. Therefore, using both variables we capture various aspects of women's off-farm employment.

In the main analysis, we combine off-farm self-employment and wage-employment in the same dummy and continuous variables. However, as the effects may possibly differ, we also run additional regressions where we separate these two categories of women's off-farm employment.

3.4 Income, agency, and time allocation

To better understand the mechanisms linking women's off-farm employment to dietary diversity, we also need to measure household income, women's agency, and time allocation. Household income is calculated as the sum of the net income from all economic activities, including farming and off-farm employment, as well as any transfers. Income is measured per capita, by dividing the total income by the number of household members. We convert national currencies to international dollars using purchasing power parity exchange rates from the World Bank's 2017 International Comparison Program.

Women's agency is evaluated by examining their involvement in decisions on how the household income from different sources is spent. We consider four income sources, namely income from crops, from livestock, from off-farm employment, and from remittances. For each income source, we define a dummy variable that takes a value of one if the woman is involved in decision-making – either solely or jointly with her partner – and zero otherwise, according to her own responses to the respective survey questions.

Women's time allocation is evaluated based on an individual 24-hour time-use module in the questionnaire. Respondents were asked to report their activities on a typical working day, recorded in 30-minute intervals, from 3 a.m. to 2.59 a.m. We categorize these activities into nine groups, namely (i) household chores; (ii) self-care and maintenance; (iii) leisure; (iv) resting and sleeping; (v) cooking; (vi) care work; (vii) farming; (viii) wage-employment; and (ix) self-employment, all measured in hours per day. We apply the same approach to measure time allocation for the household's main male adult.

3.5 Basic regression model

We estimate the effect of women's off-farm employment on women's dietary quality using regression models of the following type:

$$WDDS_{ij} = \beta_0 + \beta_1 E_{ij} + \beta_2' \boldsymbol{M}_{ij} + \beta_3' \boldsymbol{X_{ij}} + \tau_j + \varepsilon_{ij} \quad (1)$$

where $WDDS_{ij}$ is the women's dietary diversity score of individual *i* in country *j*. The variable E_{ij} represents off-farm employment of *i*, which in separate regressions is either a binary variable for the extensive margin or a continuous variable for the intensive margin. $\boldsymbol{M}_{ij}$ is a vector of women's characteristics such as age, marital status, household head status, education, and a dummy variable showing their involvement in own farming activities. $\boldsymbol{X_{ij}}$ is a vector of household characteristics such as household size, farm size, asset ownership, and participation in employment by household members other than women *i.* Finally, τ_j are country fixed effects, and ε_{ij} is the error term.

Our parameter of main interest in equation (1) is β_1, which is the estimated effect of women's off-farm employment on *WDDS*. A positive β_1 would mean that off-farm employment enhances women's dietary quality, as hypothesized.

We estimate the models in equation (1) in linear form. However, as *WDDS* is a count variable, we also use a Poisson specification to check whether the findings change. Furthermore, in addition to combining all types of women's off-farm employment in the variable E_{ij}, we also run regressions where we separate between off-farm self-employment and wage-employment.

In additional model specifications, we use dummy variables for each of the nine food groups instead of *WDDS* as the outcome variable. This is of interest to better understand how exactly women's off-farm employment affects their daily diets. These additional models are estimated with linear probability specifications.

3.6 Instrumental variable approach

The estimated parameter β_1 in equation (1) could potentially be biased due to endogeneity stemming from unobserved heterogeneity and/or reverse causality. Even though we control for a wide range of socioeconomic characteristics, women involved in off-farm employment might still be systematically different from those not involved in terms of unobservable characteristics, such as ability, motivation, and attitudes. Reverse causality could also be an issue, especially if better dietary quality increases women's engagement in various economic activities, for instance, due to better health.

To address potential endogeneity bias, we use an instrumental variable (IV) approach. IV methods require at least one exogenous instrument that is sufficiently correlated with women's employment (instrument relevance), but uncorrelated with women's dietary diversity, except through their employment status (instrument exogeneity) (Abadie & Cattaneo, 2018). We use the share of women participating in off-farm employment within a given village (excluding the woman of interest) as our exogenous instrument. This type of instrument has been used in similar studies in other settings (Melaku et al., 2024; Rashad & Sharaf, 2019) because it reflects the local employment environment, which is exogenously determined by local economic conditions and not influenced by the individual household or woman.[1] In our approach, we combine the external instrument with constructed instruments, as described by Lewbel (2012), which helps increase the efficiency of the IV estimator. In

[1] In principle, it is possible that households move to a specific location because of favorable employment opportunities, which could mean that our village-level instrument is not fully exogenous. However, in Tanzania and Zambia, households rarely move from one rural place to another, due to land-market restrictions. The right to use certain farmland is inherited, whereas the land is formally owned by the state (Genicot & Hernandez-de-Benito, 2022; Mulungu et al., 2025).

addition, constructed instruments can be useful for testing the validity of external instruments (Baum & Lewbel, 2019), as we elaborate further below.

The choice of our external instrument, the share of women participating in off-farm employment in a village, is supported by the literature, suggesting that individuals' participation in various rural employment activities is influenced by local social networks (Gee et al., 2017). These networks facilitate the flow of information about job opportunities, which likely increases employment participation (Merfeld, 2023). We do not expect our instrument to directly influence women's diets, as it is measured at the village level and not the household or individual level. It may be argued that the availability of local employment opportunities is also a proxy of broader economic conditions, which may influence women's diets through various channels, particularly income and wealth. Yet, we control for household wealth (measured by assets) in our regressions, thus mitigating this potential concern.

Table A1 in the Appendix shows the first-stage IV regressions, which confirm that our village-level instrument is significantly correlated with women's off-farm employment. In addition, falsification tests, which are shown in Table A2, confirm that the outcome variable (WDDS) is not significantly correlated with the village-level share of women involved in off-farm employment.

Combining our external instrument with constructed instruments further helps to test instrument validity. Based on Lewbel's (2012) heteroscedasticity-based identification approach, the instruments are generated by multiplying the residuals from the first stage regression with the selected exogenous variables in their mean-centered form. Using both external and constructed instruments improves estimation efficiency and also allows testing the overidentifying restrictions (Lewbel, 2012). These tests are shown in Table A3 in the Appendix. All test results suggest that our instruments are valid.

3.7 Robustness checks

We perform two types of robustness checks. First, we use methods proposed by Altonji et al. (2005), Oster (2019), and Diegert et al. (2022) to assess the sensitivity of the results to unobservables. Specifically, these tests help us to determine how much stronger the influence of unobservable characteristics would need to be relative to observable factors, in order to yield a coefficient estimate of zero.

Second, we use the kinky least squares (KLS) sensitivity test developed by Kripfganz and Kiviet (2021). This test is instrument-free and involves confining the admissible correlation of the main regressor of interest (women's off-farm employment) with the error term within plausible bounds. The main output from the KLS test is graphical, indicating confidence intervals from both IV and KLS (Kripfganz & Kiviet, 2021). We, therefore, compare both IV and KLS regressions to obtain empirical insights into the plausibility of our identification strategy.

If the confidence intervals from the IV regression are wider than those from KLS, the instruments would need to be considered weak.

3.8 Exploring potential mechanisms

To analyze potential mechanisms of the effects of women's off-farm employment on dietary quality, we employ regression models similar to those explained in equation (1), but, instead of *WDDS*, we use household income, women's agency, and time allocation as dependent variables. The three mechanisms are estimated in separate models, using ordinary least squares (OLS) estimators. We also considered using IV approaches, but identifying valid instruments for all models was challenging. Some potential instruments failed the validity tests for certain outcome variables. With OLS models, concerns about potential endogeneity remain, meaning that the results on mechanisms should not be interpreted as causal effects, but only as associations.

4. Results

4.1 Descriptive statistics

Table 1 presents descriptive statistics of sampled women and their households, for the full sample and differentiated by country. In the pooled sample, only 17% of women consume at least five food groups, which is considered the lower threshold for micronutrient adequacy. In Zambia, WDDS is still much lower on average than in Tanzania.

Off-farm employment is observed for 19% of the women in our sample (22% in Tanzania and 12% in Zambia). Self-employed activities are more common than wage-employment. Typical self-employed activities for women in the study regions included food vending, tailoring and weaving, transport services, hairdressing, and beauty services, whereas wage-employment occurs in agriculture (working on other farms), education (teaching), retailing, the hospitality sector, and tourism. There are no women in the sample that are both self-employed and wage-employed simultaneously. Table 1 also shows household characteristics.

In Figure 1, we compare women with and without off-farm employment in terms of WDDS and the consumption of specific food groups. Figure 1a shows that women with off-farm employment have, on average, a higher WDDS than those without. Figure 1b further indicates that women with off-farm employment are significantly more likely to consume meat and fish, dark green leafy vegetables, vitamin A-rich fruits and vegetables, and other fruits and vegetables than those without off-farm employment. However, these differences in Figure 1 do not control for potential confounding factors, which we do below with our regression models.

Table 1: Descriptive statistics of women in the sample

	Full sample (N=1151)		Tanzania (N=773)		Zambia (N=378)	
	mean	s.d.	mean	s.d.	mean	s.d.
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Characteristics of women						
Women's dietary diversity score (WDDS)	3.34	1.26	3.76	1.08	2.48	1.17
Consumed at least 5 food groups (0/1)	0.17		0.24		0.06	
Off-farm employed (1/0)	0.19		0.22		0.12	
Self-employed (1/0)	0.15		0.18		0.10	
Wage-employed (1/0)	0.03		0.03		0.02	
Works on own farm (1/0)	0.87		0.87		0.86	
Hours of off-farm employment per week [a]	8.01	20.84	9.44	22.43	5.08	16.77
Hours of self-employment per week [a]	6.93	20.16	8.28	21.80	4.18	15.95
Hours of wage-employment per week [a]	1.07	6.55	1.16	6.86	0.89	5.88
Hours of own farm work per week [a]	49.15	38.72	49.75	35.33	47.93	44.87
Age of woman (years)	46.35	16.46	46.55	15.59	45.94	18.13
Married (1/0)	0.69		0.72		0.63	
Female-headed household (1/0)	0.30		0.28		0.32	
Woman has at least secondary education (1/0)	0.22		0.09		0.49	
Panel B: Household characteristics						
Household size (number)	5.01	2.35	4.64	2.07	5.75	2.69
Number of children	2.79	1.40	2.67	1.26	3.02	1.64
Household assets (index)	4.46	2.45	4.81	2.29	3.73	2.59
Land size (ha)	1.75	1.66	1.39	1.15	2.50	2.21
Panel C: Other household members' characteristics						
Male household members working off-farm (1/0)	0.20		0.23		0.15	
Other women working off-farm (1/0)	0.03		0.03		0.03	
Mean hours of off-farm employment by men [a]	10.44	24.27	12.02	25.89	7.22	20.23
Mean hours of off-farm employment by other women [a]	1.47	8.96	1.53	9.27	1.34	8.28
Men are wage-employed (1/0)	0.07		0.07		0.07	
Men are self-employed (1/0)	0.14		0.17		0.08	
Mean hours of wage-employment by men [a]	3.47	13.78	3.50	14.11	3.39	13.10
Mean hours of self-employment by men [a]	7.24	21.40	8.86	23.33	3.92	16.31
Other women are wage-employed (1/0)	0.01		0.01		0.01	
Other women are self-employed (1/0)	0.02		0.03		0.02	
Mean hours of wage-employment by other women [a]	0.50	5.38	0.45	5.33	0.61	5.48
Mean hours of self-employment by other women [a]	0.97	7.23	1.09	7.65	0.73	6.28
Observations	1151		773		378	

Notes: s.d., standard deviation. [a] Only including individuals employed in the respective category.

(a) Kernel density for women's dietary diversity score (WDDS)

(b) Food groups consumed by women

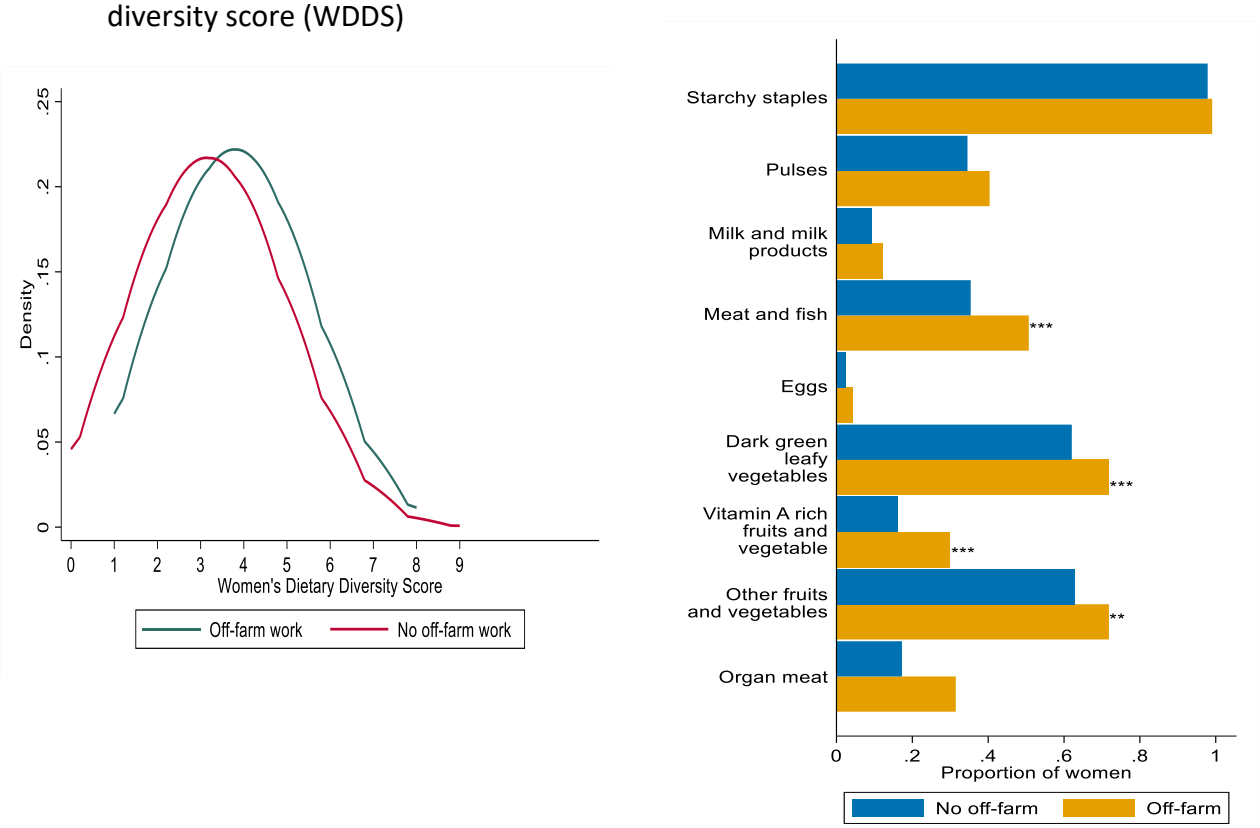

Figure 1: Food consumption by women

Notes: Panel (a) refers to distributions of women's dietary diversity scores (WDDS) for women with and without off-farm employment. Panel (b) refers to the proportion of women consuming different food groups. ** denotes significance at 5%, and *** denotes significance at 1% based on two-tailed tests of the proportion differences.

4.2 Effects of women's off-farm employment on WDDS

The regression results of the models in equation (1) are shown in Table 2. We show results from OLS and IV regressions, which differ somewhat in terms of the magnitude of the estimated coefficients, but both support the same conclusions (Poisson estimates in Table A4 in the Appendix also support the same conclusions). Women's participation in off-farm employment significantly increases WDDS. Specifically, involvement in off-farm employment (extensive margin, shown in column 2 of Table 2) leads to a 0.25 increase in the daily number of food groups consumed. Similarly, the number of hours worked in off-farm employment during the last seven days also increases WDDS significantly (column 4). We express the number of employment hours in terms of logarithms, so the estimates are semi-elasticities, suggesting that the effect on WDDS is non-linear: it is largest for the first hour of off-farm employment and then decreases in absolute terms.

Table 2: Effects of women's off-farm employment on women's dietary diversity

	WDDS (OLS)	WDDS (IV)	WDDS (OLS)	WDDS (IV)
	(1)	(2)	(3)	(4)
Off-farm employed (1 = yes)	0.284***	0.254***		
	(0.097)	(0.093)		
Hours worked in off-farm employment (log)			0.079***	0.067**
			(0.027)	(0.028)
Age of woman (years)	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Female-headed household (1/0)	-0.081	-0.014	-0.071	-0.010
	(0.088)	(0.081)	(0.073)	(0.075)
Woman has at least secondary education	0.214**	0.220**	0.189**	0.221**
(1/0)	(0.093)	(0.097)	(0.094)	(0.10)
Household size (number)	0.039**	0.041**	0.028	0.042**
	(0.018)	(0.016)	(0.017)	(0.017)
Household assets (index)	0.093***	0.092***	0.093***	0.092***
	(0.020)	(0.018)	(0.020)	(0.019)
Land size (ha)	-0.001	-0.005	-0.003	-0.006
	(0.026)	(0.022)	(0.026)	(0.022)
Involved in farming (1/0)	0.133	0.107	0.110	0.107
	(0.116)	(0.111)	(0.120)	(0.105)
Male household members off-farm	0.006	0.005		
employed (1/0)	(0.099)	(0.085)		
Other women working self-employed (1/0)	0.041	0.071		
	(0.181)	(0.211)		
Male hours in off-farm employment (log)			-0.001	0.006
			(0.002)	(0.088)
Other women hours in off-farm			-0.004***	0.073
employment (log)			(0.002)	(0.211)
Country fixed effects	Yes	Yes	Yes	Yes
R^2	0.298	0.298	0.304	0.297

Notes: For the OLS models, robust standard errors, for the IV models, bootstrapped standard errors with 500 replications are shown in parentheses. ** denotes significance at 5%, and *** denotes significance at 1%.

The other estimates in Table 2 show that women's education and household wealth (measured in terms of assets) are also positively associated with WDDS, which is unsurprising. Furthermore, after controlling for wealth, household size is correlated with WDDS. This is also plausible, as in larger households the food needs and preferences of more people need to be considered, which may also contribute to higher dietary diversity for individual household members.

In Tables A5–A9 in the Appendix, we run additional regressions where we separate between women's self-employment and wage-employment. The effects of both types of employment on WDDS are positive and similar in magnitude, but they are statistically significant only for self-employment. This is likely due to the fact that only 2-3% of women in our sample are wage-employed, thus limiting the efficiency of the estimates.

4.3 Robustness of the estimates

As described above, we conduct two types of robustness checks. First, we test the sensitivity of the results to unobservables. Results are shown in Table A10 in the Appendix. For the Oster (2019) method, the 'Delta' value for women's off-farm employment is 2.2, which is far above the recommended minimum level of 1 and indicates that the estimates are quite robust to potential omitted variable bias (Ruml & Parlasca, 2022). This conclusion is further corroborated by the Diegert et al. (2022) method, which does not require the assumption that omitted variables are uncorrelated with the included controls (Table A10 and Figure A1).

Second, we use the KLS method to compare the findings with the original IV estimates. The results in Figure A2 in the Appendix show that the IV estimates have narrow confidence intervals, which suggests that our instruments are not weak, and that the confidence intervals of the KLS and IV approaches overlap, reinforcing the validity of our instruments.

4.4 Effects of women's off-farm employment on specific food groups

Results of the IV models showing effects of women's off-farm employment on women's consumption of the nine food groups are shown in Table 3 (the OLS models lead to similar results and are shown in Table A11 in the Appendix). The coefficients for women's off-farm employment are positive in all nine models and statistically significant for meat and fish and vitamin A-rich fruits and vegetables, both micronutrient-rich food groups. In poor rural households, these food groups are rarely consumed, and if they are consumed, they are often obtained from the market rather than from own production, which was also shown in other parts of Africa (Dzanku et al., 2024; Hülsen et al., 2024). These results further support the conclusion that women's off-farm employment contributes to improved dietary quality in the local contexts.

Models with separate results for women's self-employment and wage-employment are shown in Tables A12 and A13 in the Appendix. For self-employment, the results are similar to those in Table 3. For wage-employment, however, we see a negative effect on dark green leafy vegetable consumption. This negative effect may possibly be due to time constraints, since dark green leafy vegetables are often home-produced by women and also require processing time (washing, chopping, cooking, etc.). Such activities may decline with women's off-farm wage-employment. As the number of wage-employed women in our sample is small, this effect should be interpreted with caution. Associations between women's off-farm employment and time allocation are further examined below.

Table 3: Effects of women's off-farm employment on the consumption of various food groups (IV estimates)

	Starchy staples	Pulses	Dairy	Meat and fish	Eggs	Dark green leafy vegetables	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Organ meat
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Woman is off-farm employed (1/0)	0.008	0.047	0.003	0.075*	0.006	0.012	0.081**	0.021	0.001
	(0.008)	(0.041)	(0.021)	(0.039)	(0.016)	(0.033)	(0.035)	(0.037)	(0.001)
Age of woman (years)	-0.001	0.001	0.001**	-0.001	0.000	0.001	-0.001*	-0.001	0.000
	(0.001)	(0.001)	(0.021)	(0.001)	(0.000)	(0.033)	(0.001)	(0.001)	(0.000)
Female-headed household (1/0)	-0.015	-0.055	-0.006***	-0.047	0.021	0.086***	0.019	-0.011	-0.007
	(0.013)	(0.038)	(0.023)	(0.036)	(0.014)	(0.029)	(0.028)	(0.038)	(0.011)
Woman has at least secondary education (1/0)	0.001	0.012*	0.013***	-0.004	0.007*	0.016***	-0.004	-0.000	-0.000
	(0.002)	(0.007)	(0.005)	(0.006)	(0.004)	(0.006)	(0.005)	(0.006)	(0.002)
Household size (number)	0.000	-0.012*	0.019***	0.034***	0.007**	0.003	0.017***	0.022***	0.002
	(0.001)	(0.006)	(0.005)	(0.007)	(0.003)	(0.005)	(0.006)	(0.006)	(0.002)
Household assets (index)	-0.008*	0.002	-0.003	0.002	-0.003	-0.000	0.005	0.001	0.000
	(0.005)	(0.009)	(0.007)	(0.009)	(0.004)	(0.008)	(0.006)	(0.009)	(0.002)
Land size (ha)	-0.009	0.044	0.019	-0.023	0.001	0.040	-0.017	0.068*	-0.016
	(0.011)	(0.042)	(0.024)	(0.042)	(0.014)	(0.034)	(0.033)	(0.039)	(0.016)
Involved in farming (1/0)	-0.012	-0.007	0.027	-0.016	0.008	0.019	-0.027	0.005	0.008
	(0.011)	(0.037)	(0.024)	(0.039)	(0.015)	(0.031)	(0.032)	(0.036)	(0.010)
Male household members self-employed (1/0)	-0.002	0.001	0.047	0.039	-0.021	-0.027	0.003	-0.002	0.033
	(0.025)	(0.079)	(0.063)	(0.082)	(0.023)	(0.077)	(0.071)	(0.081)	(0.034)
Other women are self-employed (1/0)	-0.001	0.001	0.001**	-0.001	0.000	0.001	-0.001*	-0.001	0.000
	(0.001)	(0.001)	(0.021)	(0.001)	(0.000)	(0.033)	(0.001)	(0.001)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.050	0.039	0.109	0.092	0.052	0.312	0.093	0.093	0.081

Notes: Linear probability models with bootstrapped standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

4.5 Possible impact mechanisms

We now analyze the three mechanisms that may explain the effects of women's off-farm employment on WDDS, namely changes in household income, women' agency, and time allocation.

Household income. Table 4 shows results of a model where we regress per capita household income in logarithmic terms on women's off-farm employment while controlling for confounding factors, as explained above. The results reveal that women's off-farm employment is associated with much higher household incomes (more than 80%). As this OLS model does not fully control for endogeneity, the effect is not necessarily causal. Nevertheless, the estimate suggests that the income mechanism may play an important role for explaining the observed improvements in women's dietary quality.

Table 4: Associations between women's off-farm employment and household income

	Per capita income (log)
Woman is off-farm employed (1/0)	0.838***
	(0.181)
Woman controls	Yes
Household controls	Yes
Country fixed effects	Yes
R-squared	0.393
Observations	1151

Notes: OLS estimates with robust standard errors in parentheses. Full results are presented in Table A14. *** denotes significance at 1%.

Women's agency. Table 5 shows results of models where we regress women's involvement in income spending decisions on women's off-farm employment while controlling for other factors. For all sources of income, the coefficients are positive, but the estimate is only statistically significant for off-farm income. That is, if a woman is herself involved in off-farm employment, she is significantly more likely to be involved in deciding how the off-farm income earned by her and other household members is spent. This result suggests that involvement in off-farm employment may indeed improve women's financial autonomy, at least to some extent.

Table 5: Associations between women's off-farm employment and control of different types of incomes

	Crop income	Livestock income	Off-farm income	Remittances
	(1)	(2)	(3)	(4)
Woman is off-farm employed (1/0)	0.007	0.011	0.051**	0.007
	(0.032)	(0.035)	(0.028)	(0.028)
Woman controls	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
R-squared	0.076	0.074	0.071	0.075
Observations	1049	715	1097	1097

Notes: OLS estimates of linear probability models with robust standard errors in parentheses. Income control is measured with a dummy that takes a value of one if the woman is involved in decisions about how the respective income is spent (alone or jointly with her partner), and zero otherwise. Full results are as shown in Table A15. ** denotes significance at 5%.

Women's time allocation. Table 6 shows regression results from models with women's time allocation to various daily activities as dependent variables. The results show that women's off-farm employment is negatively associated with women's time spent on household chores, self-care and maintenance, care work, leisure, cooking, as well as resting and sleeping. Women's time is measured in terms of hours per day, meaning that off-farm employment is associated with approximately half an hour less time for household chores and 10 minutes less for cooking, which may possibly reduce dietary quality as a partial effect. Note that the association between women's off-farm employment and time allocated to own farm work is negative but not statistically significant.

Additional descriptive comparisons in Table A17 in the Appendix show that households with women in off-farm employment have a somewhat higher farm production diversity than those without, suggesting that food diversity from own production may not be negatively affected through women working off-farm. To better understand possible shifts of tasks within households, it can also be interesting to look at associations between women's off-farm employment and men's time allocation to various activities, which we do in Table A18 in the Appendix. Women's off-farm employment is associated with significantly less leisure time for men, which is interesting. We also see positive coefficients for men's time spent on household chores and cooking, even though these are not statistically significant.

Table 6: Associations between women's off-farm employment and women's time allocation

	Household chores	Self care and maintenance	Leisure	Resting and sleeping	Cooking	Care work	Own farm work	Self-employment	Wage-employment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Woman is off-farm employed (1/0)	-0.466***	-0.279***	-0.749***	-0.530**	-0.191**	-0.399***	-0.294	2.224***	0.498***
	(0.156)	(0.077)	(0.191)	(0.231)	(0.092)	(0.072)	(0.226)	(0.227)	(0.114)
Woman controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.125	0.142	0.050	0.106	0.132	0.095	0.230	0.233	0.108
Observations	1151	1151	1151	1151	1151	1151	1151	1151	1151

Notes: OLS estimates with robust standard errors in parentheses. Full results are shown in Table A16. ** denotes significance at 5%, and *** denotes significance at 1%.

As mentioned, these estimates on possible mechanisms are not causally identified, so they should not be over-interpreted. In any case, our finding that the overall effect of women's off-farm employment on WDDS is positive indicates that the positive partial effects through gains in household income and women's agency are larger than the possible negative partial effects through changes in women's time allocation.

5. Conclusion and policy implications

Off-farm employment generates several benefits for rural farm households in Africa. Effects on income, poverty, and other household-level welfare indicators have been analyzed in the existing literature. However, research on the effects of off-farm employment on individual-level wellbeing is much more limited, which may also depend on who in the household actually pursues off-farm employment. In this article, we have examined how women's off-farm employment affects women's dietary quality, using primary data from rural regions in Tanzania and Zambia. Developing and estimating an instrumental variable approach, we have found robust evidence that women's participation in off-farm employment increases women's dietary diversity scores, and thus improves their dietary quality. In particular, women involved in off-farm employment have a significantly higher likelihood of consuming meat, fish, and vitamin A-rich fruits and vegetables than women not involved in off-farm employment.

We have also explored the main mechanisms through which these positive dietary quality effects may occur. Regression models show that women's off-farm employment is associated with much higher per capita household incomes. Higher incomes enable women to purchase and consume more healthy diets.

We have also found that women's off-farm employment is associated with higher female financial autonomy, measured in terms of women's involvement in decisions about how the household income is spent. Other research showed that the income spending behavior of men and women is often different and that women have a higher tendency to spend on nutritious foods than men (Ogutu et al., 2020). More generally, there is ample research suggesting that improvements in women's agency are associated with better diet and nutrition outcomes for women themselves and also for children and other household members (Quisumbing and Doss, 2021).

Next to gains in household income and women's agency, a third mechanism that may affect dietary quality are changes in women's time allocation. We have found that women's off-farm employment is negatively associated with their time allocated to food preparation, household chores, and self-care and maintenance. This may negatively affect dietary quality. However, this potential negative partial effect seems to be smaller than the positive partial effects through gains in income and women's agency.

We note that the strengths of such effects depends on the particular context. For instance, using data from rural Tanzania, Debela et al. (2021) showed that women's off-farm wage-employment beyond a certain number of hours per week has negative effects on child nutritional outcomes, suggesting that time constraints for childcare and food preparation may play an important role. Similar negative child nutrition effects of women's off-farm wage-employment were also found by Melaku et al. (2024) in Ethiopia. Child nutrition outcomes are different from women's dietary diversity scores, as child nutritional status also depends on feeding practices and other factors. Moreover, the effects of women's wage-employment may be different from those of self-employed activities that often happen at home or nearby. Our

data suggest that women's self-employment has stronger positive dietary quality effects than women's wage-employment, even though the number of wage-employed women in our sample is small.

Our results are robust to several specifications and robustness checks. Nevertheless, a few limitations deserve to be discussed. First, we use cross-section data, which have their limitations in terms of rigorous causal identification. For the main models, we found valid instruments, whereas for the models to explore the underlying mechanisms, we did not. Hence, the results on mechanisms can only be interpreted in terms of associations. Follow-up research with panel data would be useful to substantiate the findings. Second, our food consumption data were collected at one point in time, using a 24-hour recall, meaning that seasonal differences in diets are not captured. Third, the proportion of women in wage-employment in our sample is small, which is why we combined self-employment and wage-employment for the main analysis. It is a general phenomenon in most parts or rural Africa that wage-employment opportunities are limited, which is especially true for women (Christiaensen & Maertens, 2022; Musungu et al, 2024; Mutsami et al., 2024).

In spite of these limitations, a few cautious conclusions and policy implications can be drawn from our results. Women's off-farm employment can contribute to improving women's diets, which is an important finding, given that women are often particularly affected by undernutrition and poor dietary quality. The main mechanism is likely gains in household income, even though we also found a significant positive association between women's off-farm employment, financial autonomy, and decision-making power. Hence, policies that enhance women's access to profitable off-farm activities support various sustainable development goals, including poverty reduction, nutrition improvements, and women's empowerment. Such policies could involve targeted skills training, improved access to credit, investments in rural infrastructure (roads, electricity, water, etc.), and the promotion of rural industries that can create new employment opportunities.

In addition to expanding job opportunities, it is essential to address the often-unfair distribution of household labor. Our findings suggest that – while women's off-farm employment reduces their time for household chores and food preparation – these responsibilities are typically not fully taken over by the husband or other household members. Development programs should promote more gender-equitable labor distribution within households and challenge cultural norms that place the burden of domestic work disproportionately on women. This is a process that will take time but could be supported through awareness campaigns, community engagement, and policies that incentivize men's participation in care work and other household tasks. Finally, improving dietary quality for women (and other household members) requires not only additional income through employment but also better food environments that enhance the accessibility and affordability of nutritious foods.

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Appendix

Table A1: First-stage regressions, showing association between the external instrument and women's off-farm employment

	Off-farm employment (1)	Self-employment (2)	Wage-employment (3)
Share of women in off-farm employment	0.337***		
	(0.121)		
Share of women in self-employment		0.339***	
		(0.130)	
Share of women in wage-employment			0.282***
			(0.136)
Age of woman (years)	-0.002***	-0.001**	-0.001
	(0.001)	(0.001)	(0.000)
Female-headed household (1/0)	0.117***	0.094***	0.025**
	(0.029)	(0.028)	(0.014)
Woman has at least secondary education (1/0)	0.082**	0.065**	0.025
	(0.032)	(0.029)	(0.014)
Household size (number)	0.013**	0.008	0.004
	(0.005)	(0.005)	(0.002)
Household assets (index)	0.018***	0.016***	0.002
	(0.005)	(0.005)	(0.003)
Land size (ha)	-0.013*	-0.005	-0.009***
	(0.007)	(0.006)	(0.003)
Involved in farming (1/0)	-0.071**	-0.037	-0.033**
	(0.033)	(0.031)	(0.015)
Male household members off-farm employed (1/0)	0.153***		
	(0.028)		
Other women off-farm employed (1/0)	0.098		
	(0.062)		
Male household members self-employed (1/0)		0.162***	
		(0.039)	
Other women self-employed (1/0)		0.099	
		(0.086)	
Male household members wage-employed (1/0)			0.175***
			(0.020)
Other women wage-employed (1/0)			0.087*
			(0.051)
R-squared	0.108	0.083	0.094
Country fixed effects	Yes	Yes	Yes
Observations	1151	1151	1151

Notes: OLS estimates; robust standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A2: Falsification test

	(1) WDDS	(2) WDDS	(3) WDDS
Share of women in off-farm employment (0-1)	-0.210		
	(0.351)		
Share of women in self-employment (0-1)		-0.342	
		(0.399)	
Share of women in wage-employment (0-1)			0.720
			(0.873)
Age of woman (years)	-0.001	-0.002	-0.001
	(0.002)	(0.002)	(0.002)
Female-headed household (1/0)	0.015	0.011	0.016
	(0.083)	(0.082)	(0.082)
Woman has at least secondary education (1/0)	0.245***	0.238**	0.232**
	(0.092)	(0.099)	(0.093)
Household size (number)	0.044***	0.046***	0.044***
	(0.015)	(0.017)	(0.015)
Household assets (index)	0.098***	0.101***	0.096***
	(0.015)	(0.018)	(0.014)
Land size (ha)	-0.009	-0.009	-0.006
	(0.021)	(0.021)	(0.021)
Involved in farming (1/0)	0.087	0.075	0.093
	(0.094)	(0.094)	(0.094)
Male household members off-farm employed (1/0)	0.047		
	(0.082)		
Other women working off-farm employed (1/0)	0.102		
	(0.179)		
Male household members self-employed (1/0)		-0.096	
		(0.094)	
Other women working self-employed (1/0)		-0.009	
		(0.211)	
Male household members wage-employed (1/0)			0.198
			(0.127)
Other women working wage-employed (1/0)			0.320
			(0.326)
R-squared	0.292	0.293	0.287
Country fixed effects	Yes	Yes	Yes
Observations	1151	1151	1151

Notes: OLS estimates of association between the external instruments and WDDS. ** denotes significance at 5%, and *** denotes significance at 1%.

Table A3: IV tests

	Kleibergen-Paap rk LM statistic (1)	Cragg-Donald Wald F statistic (2)	Sargan statistic (3)
Panel A: Dummy variable for work by women			
Woman is off-farm employed (1/0)	282.3	6524.4	0.695
	p-value = 0.000		p-value = 0.404
Woman is self-employed (1/0)	228.4	7283	1.212
	p-value = 0.000		p-value = 0.271
Woman is wage-employed (1/0)	38.82	5700.9	0.676
	p-value = 0.000		p-value = 0.411
Panel B: Hours worked by women			
Hours worked in off-farm employment	238.8	6613.0	0.700
(log)	p-value = 0.000		(0.403)
Hours worked in self-employment (log)	190.6	7238.2	1.06
	p-value = 0.000		p-value 0.303
Hours worked in wage-employment (log)	34.58	6427.7	0.695
	P-value = 0.000		p-value = 0.404
Replications	500	500	500

Notes: Following Lewbel (2012), the IV regressions are conducted using the external instrument combined with heteroskedasticity-based instruments. The Kleibergen-Paap Wald rk F-statistic is used to test the relevance of the instruments; in all cases, the statistic is large enough and the p-values show significance at 1%, allowing us to reject the null hypothesis of weak instruments. The Sargan statistic and its corresponding p-value are used as tests for overidentification; in all regressions, we fail to reject the null hypothesis that all instruments are exogenous. The values of the Cragg-Donald Wald F statistic are large, indicating that the constructed instruments are not weak.

Table A4: Poisson estimates of women's off-farm employment and WDDS

	WDDS	WDDS
Woman is off-farm employed (1/0)	0.243***	
	(0.089)	
Hours worked in off-farm employment (log)		0.066*** (0.025)
Age of woman (years)	-0.001	-0.001
	(0.002)	(0.002)
Female-headed household (1/0)	-0.017	-0.015
	(0.070)	(0.071)
Woman has at least secondary education (1/0)	0.258***	0.260*** (0.096)
	(0.096)	
Household size (number)	0.044***	0.046*** (0.017)
	(0.016)	
Household assets (index)	0.088***	0.090*** (0.019)
	(0.019)	
Land size (ha)	-0.005	-0.005
	(0.028)	(0.028)
Involved in farming (1/0)	0.115	0.106
	(0.125)	(0.125)
Male household members working off-farm (1/0)	0.001	
	(0.092)	
Other women working off-farm (1/0)	0.054	
	(0.016)	
Mean of off-farm employed male members (hours)		-0.001***
		(0.001)
Mean of off-farm employed other women (hours)		-0.002
		(0.003)
Country fixed effects	Yes	Yes
Observations	1151	1151

Notes: Poisson marginal effects with robust standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A5: Women's wage and self-employment and WDDS – OLS full results

	WDDS
Woman is self-employed (1/0)	0.291***
	(0.108)
Woman is wage-employed (1/0)	0.246
	(0.228)
Age of woman (years)	-0.001
	(0.002)
Female-headed household (1/0)	-0.020
	(0.069)
Woman has at least secondary education (1/0)	0.215**
	(0.093)
Household size (number)	0.042***
	(0.016)
Household assets (index)	0.093***
	(0.019)
Land size (ha)	-0.004
	(0.025)
Involved in farming (1/0)	0.111
	(0.123)
Male household members self-employed (1/0)	-0.131
	(0.102)
Other women working self-employed (1/0)	-0.061
	(0.249)
Male household members wage-employed (1/0)	0.155
	(0.181)
Other women wage-employed (1/0)	0.304
	(0.264)
R-squared	0.301
Country fixed effects	Yes
Observations	1151

Notes: ** denotes significance at 5%, and *** denotes significance at 1%.

Table A6: Women's wage and self-employment hours and WDDS – OLS full results

	WDDS
Hours worked in self-employment (log)	0.076**
	(0.030)
Hours worked in wage-employment (log)	0.086
	(0.069)
Age of woman (years)	-0.001
	(0.002)
Female-headed household (1/0)	-0.010
	(0.070)
Woman has at least secondary education (1/0)	0.218**
	(0.092)
Household size (number)	0.044**
	(0.017)
Household assets (index)	0.095***
	(0.019)
Land size (ha)	-0.001
	(0.026)
Mean of male members in wage-employment (hours)	0.002
	(0.003)
Mean of male members in self-employment (hours)	-0.003*
	(0.002)
Mean of other women wage-employed (hours)	0.002
	(0.001)
Mean of other women self-employed (hours)	-0.004
	(0.004)
R-squared	0.301
Country fixed effects	Yes
Observations	1151

Notes: * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A7: Women's self-employment and WDDS – IV full results

	WDDS	WDDS
Woman is self-employed (1/0)	0.249**	
	(0.101)	
Hours worked in self-employment (log)		0.067***
		(0.025)
Age of woman (years)	-0.001	-0.001
	(0.002)	(0.002)
Female-headed household (1/0)	-0.016	-0.006
	(0.081)	(0.080)
Woman has at least secondary education (1/0)	0.228**	0.230**
	(0.099)	(0.094)
Household size (number)	0.044***	0.045**
	(0.016)	(0.018)
Household assets (index)	0.096***	0.098***
	(0.017)	(0.018)
Land size (ha)	-0.008	-0.005
	(0.022)	(0.022)
Involved in farming (1/0)	0.088	0.080
	(0.101)	(0.104)
Male household members self-employed (1/0)	-0.140	
	(0.094)	
Other women working self-employed (1/0)	-0.038	
	(0.288)	
Male hours in self-employment (log)		-0.003**
		(0.001)
Other women hours in self-employment (log)		-0.004
		(0.006)
R-squared	0.298	0.298
Country fixed effects	Yes	
Observations	1151	

Notes: Bootstrapped standard errors in parentheses. ** denotes significance at 5%, and *** denotes significance at 1%.

Table A8: Women's wage-employment and WDDS – IV full results

	WDDS	WDDS
Woman is wage-employed (1/0)	0.202	
	(0.219)	
Hours worked in wage-employment (log)		0.077
		(0.069)
Age of woman (years)	-0.001	-0.001
	(0.002)	(0.002)
Female-headed household (1/0)	0.014	0.013
	(0.085)	(0.083)
Woman has at least secondary	0.235**	0.233**
education (1/0)	(0.102)	(0.101)
Household size (number)	0.044***	0.044***
	(0.017)	(0.016)
Household assets (index)	0.095***	0.096***
	(0.018)	(0.018)
Land size (ha)	-0.005	-0.005
	(0.023)	(0.022)
Involved in farming (1/0)	0.101	0.099
	(0.108)	(0.103)
Male household members self-employed	0.164	
(1/0)	(0.162)	
Other women working self-employed	0.305	
(1/0)	(0.343)	
Male hours in wage-employment (log)		0.002
		(0.003)
Other women hours in wage-		0.002
employment (log)		(0.007)
R-squared	0.294	0.294
Country fixed effects	Yes	Yes
Observations	1151	1151

Notes: Bootstrapped standard errors in parentheses. ** denotes significance at 5%, and *** denotes significance at 1%.

Table A9: Poisson estimates of women's wage and self-employment and WDDS

	WDDS	WDDS
Woman is self-employed (1/0)	0.260***	
	(0.096)	
Woman is wage-employed (1/0)	0.213	
	(0.202)	
Hours worked in self-employment		0.070**
(log)		(0.027)
Hours worked in wage-employment		0.069
(log)		(0.060)
Age of woman (years)	-0.001	-0.001
	(0.002)	(0.002)
Female-headed household (1/0)	-0.021	-0.007
	(0.070)	(0.071)
Woman has at least secondary	0.258***	0.249**
education (1/0)	(0.096)	(0.096)
Household size (number)	0.046***	0.048***
	(0.016)	(0.017)
Household assets (index)	0.088***	0.092***
	(0.019)	(0.019)
Land size (ha)	-0.004	0.000
	(0.028)	(0.028)
Involved in farming (1/0)	0.118	0.012
	(0.125)	(0.006)
Male household members self-	-0.132	
employed (1/0)	(0.094)	
Other women are self-employed (1/0)	-0.079	
	(0.229)	
Male household members wage-	0.150	
employed (1/0)	(0.163)	
Other women are wage-employed	0.313	
(1/0)	(0.252)	
Mean of self-employed male		-0.003**
members (hours)		(0.001)
Mean of wage-employed male		0.002
members (hours)		(0.003)
Other women hours in self-		-0.005
employment (log)		(0.005)
Other women hours in wage-		0.002
employment (log)		(0.004)
Country fixed effects	Yes	Yes
Observations	1151	1151

Notes: Poisson marginal effects with robust standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A10: Sensitivity analysis

	Off-farm employment
Panel A: Sensitivity analysis (exogenous controls; Oster, 2019)	
Delta	2.246
R^2_{max}	0.385
Woman controls	Yes
Household controls	Yes
Country fixed effects	Yes
Observations	1151
Panel B: Sensitivity analysis (endogenous controls; Diegert et al., 2022)	
Breakdown point (%)	64.7

Notes: Oster test is performed using the 'psacalc' command in Stata based on Oster (2019). The outcome variable is WDDS.

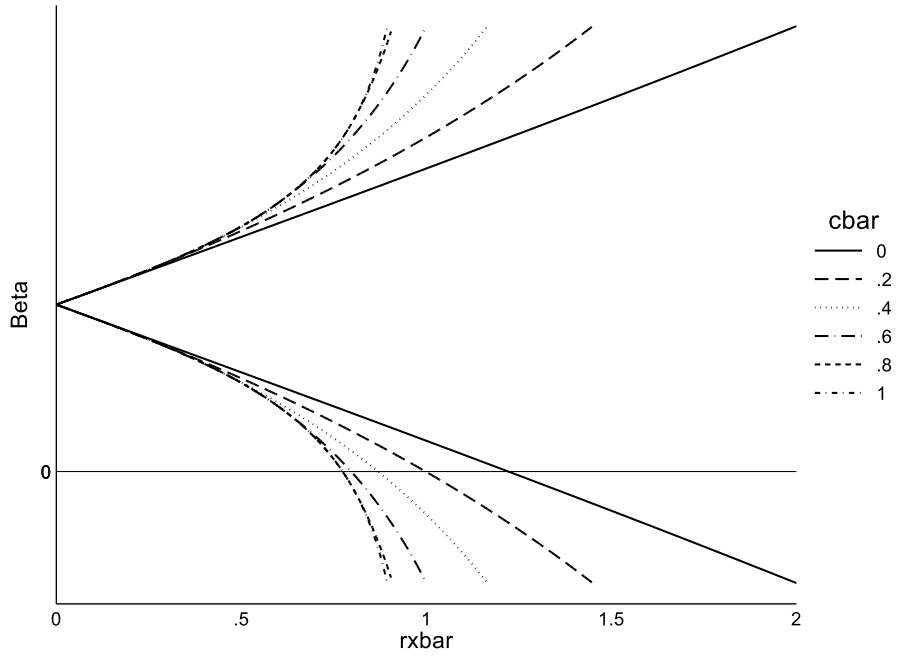

Figure A1: Sensitivity test following Diegert et al. (2022)

Notes: The values of *rxbar* represent the magnitude of how large the selection on unobservables relative to observables would have to be to overturn our results (breakdown point). The different line patterns indicate different levels of assumed endogeneity between included controls and omitted variables (*cbar*). The dotted line is the strictest setting, with full endogeneity assumed.

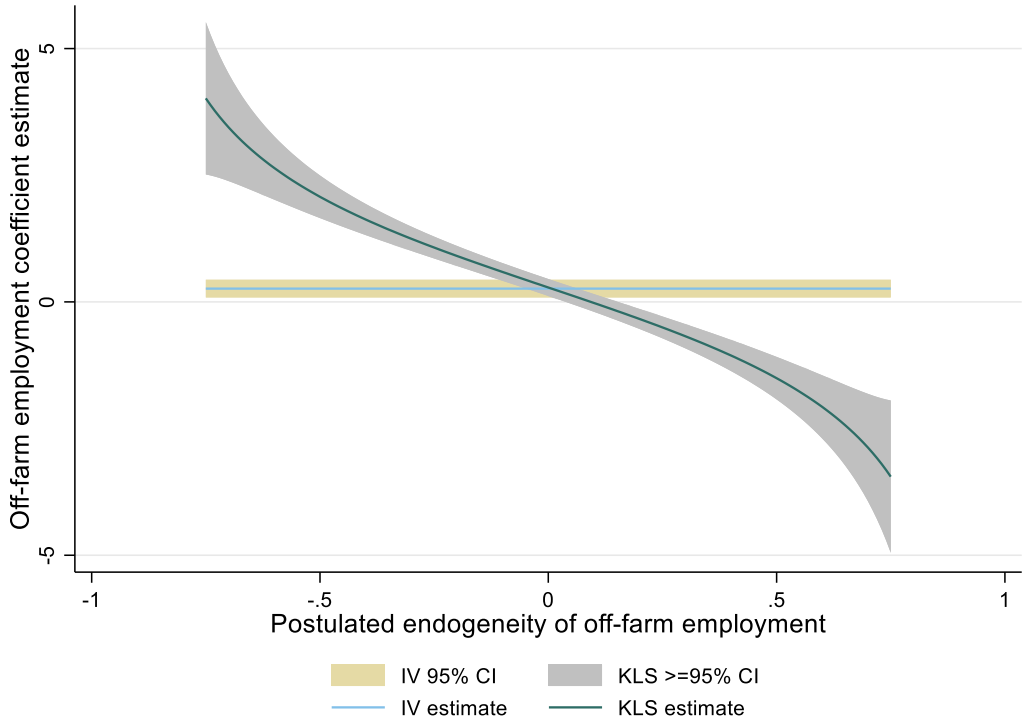

Figure A2: KLS and 2SLS coefficient estimates and confidence intervals

Table A11: Women's off-farm employment and food groups consumed (OLS estimates)

	Starchy staples	Pulses	Dairy	Meat and fish	Eggs	Dark green leafy vegetables	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Organ meat
Woman is off-farm employed (1/0)	0.003	0.046	0.015	0.082**	0.008	0.013	0.092**	0.026	-0.004
	(0.011)	(0.044)	(0.024)	(0.040)	(0.012)	(0.034)	(0.036)	(0.030)	(0.011)
Age of woman (years)	-0.001	0.001	0.002**	-0.001	0.000	0.001	-0.001*	-0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Female-headed household (1/0)	-0.015	-0.055	-0.007	-0.048	0.021	0.087***	-0.018	-0.012	-0.007
	(0.010)	(0.035)	(0.017)	(0.036)	(0.014)	(0.031)	(0.025)	(0.033)	(0.013)
Woman has at least secondary education (1/0)	-0.012	0.033	0.076**	0.043	0.018	0.058	0.007	-0.015	0.011
	(0.017)	(0.041)	(0.030)	(0.036)	(0.015)	(0.040)	(0.027)	(0.040)	(0.015)
Household size (number)	0.001	0.012*	0.013***	-0.004	0.007	0.016**	-0.004	-0.000	-0.000
	(0.002)	(0.007)	(0.004)	(0.008)	(0.004)	(0.007)	(0.006)	(0.006)	(0.002)
Household assets (index)	0.001	-0.012*	0.018***	0.034***	0.007**	0.003	0.017***	0.022***	0.002
	(0.002)	(0.007)	(0.004)	(0.007)	(0.003)	(0.006)	(0.006)	(0.007)	(0.003)
Land size (ha)	-0.008	0.002	-0.003	0.002	-0.003	-0.001	0.005	0.001	0.000
	(0.005)	(0.008)	(0.007)	(0.009)	(0.004)	(0.010)	(0.005)	(0.008)	(0.002)
Involved in farming (1/0)	-0.009	0.044	0.020	-0.022	0.001	0.039	-0.016	0.068	-0.016
	(0.011)	(0.048)	(0.026)	(0.042)	(0.014)	(0.037)	(0.037)	(0.049)	(0.016)
Male household members off-farm employed (1/0)	-0.012	-0.007	0.025	-0.017	0.008	0.021	-0.028	0.005	0.007
	(0.013)	(0.039)	(0.024)	(0.039)	(0.015)	(0.032)	(0.031)	(0.033)	(0.009)
Other women are off-farm employed (1/0)	-0.001	0.000	0.048	0.039	-0.021	-0.026	0.002	-0.002	0.032
	(0.024)	(0.039)	(0.051)	(0.089)	(0.025)	(0.081)	(0.066)	(0.073)	(0.034)
R-squared	0.051	0.029	0.109	0.092	0.033	0.312	0.093	0.093	0.080
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1151	1151	1151	1151	1151	1151	1151	1151	1151

Notes: * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A12: Women's self-employment and food groups consumed (IV estimates)

	Starchy staples	Pulses	Dairy	Meat and fish	Eggs	Dark green leafy vegetables	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Organ meat
Woman is self-employed (1/0)	0.006	0.032	0.009	0.061*	0.006	0.046	0.082**	0.011	-0.005
	(0.008)	(0.040)	(0.025)	(0.041)	(0.016)	(0.039)	(0.038)	(0.040)	(0.009)
Age of woman (years)	-0.000	0.000	0.002**	-0.001	0.000	0.001	-0.001*	-0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Female-headed household (1/0)	-0.014	-0.055	-0.006	-0.045	0.020	0.083***	0.020	-0.011	-0.007
	(0.013)	(0.037)	(0.021)	(0.033)	(0.015)	(0.029)	(0.029)	(0.037)	(0.010)
Woman has at least secondary education (1/0)	-0.012	0.035	0.077***	0.047	0.018	0.055	0.009	-0.013	0.012
	(0.016)	(0.041)	(0.029)	(0.041)	(0.015)	(0.038)	(0.031)	(0.043)	(0.013)
Household size (number)	0.002	0.012*	0.014***	-0.004	0.007*	0.016***	-0.003	0.001	0.000
	(0.002)	(0.007)	(0.005)	(0.007)	(0.004)	(0.006)	(0.005)	(0.007)	(0.002)
Household assets (index)	0.000	-0.012*	0.020***	0.035***	0.007**	0.003	0.018***	0.023***	0.002
	(0.002)	(0.007)	(0.005)	(0.006)	(0.003)	(0.006)	(0.006)	(0.006)	(0.003)
Land size (ha)	-0.008*	0.001	-0.003	0.001	-0.003	-0.000	0.004	0.001	0.000
	(0.005)	(0.009)	(0.007)	(0.009)	(0.004)	(0.008)	(0.007)	(0.009)	(0.002)
Involved in farming (1/0)	-0.009	0.042	0.016	-0.027	-0.000	0.040	-0.021	0.064*	-0.018
	(0.011)	(0.043)	(0.024)	(0.039)	(0.014)	(0.036)	(0.034)	(0.038)	(0.015)
Male household members self-employed (1/0)	-0.010	-0.014	0.003	-0.027	-0.008	0.007	-0.0057	-0.029	-0.006
	(0.011)	(0.043)	(0.026)	(0.044)	(0.015)	(0.036)	(0.035)	(0.041)	(0.009)
Other women are self-employed (1/0)	-0.014	0.072	-0.034	0.056	-0.012	-0.064	-0.003	-0.058	-0.018
	(0.037)	(0.102)	(0.061)	(0.092)	(0.032)	(0.092)	(0.084)	(0.095)	(0.015)
R-squared	0.05	0.029	0.107	0.092	0.051	0.313	0.094	0.093	0.081
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1151	1151	1151	1151	1151	1151	1151	1151	1151

Notes: Bootstrapped standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A13: Women's wage-employment and food groups consumed (IV estimates)

	Starchy staples	Pulses	Dairy	Meat and fish	Eggs	Dark green leafy vegetables	Vitamin A-rich fruits and vegetables	Other fruits and vegetables	Organ meat
Woman is wage-employed (1/0)	0.014 (0.011)	0.088 (0.088)	-0.030 (0.053)	0.117 (0.076)	0.007 (0.038)	-0.144* (0.075)	0.052 (0.090)	0.076 (0.071)	0.024 (0.037)
Age of woman (years)	-0.000 (0.000)	0.001 (0.001)	0.001** (0.001)	-0.001 (0.001)	0.000 (0.000)	0.000 (0.001)	-0.001* (0.001)	-0.001 (0.001)	0.000 (0.000)
Female-headed household (1/0)	-0.014 (0.013)	-0.050 (0.037)	-0.005 (0.028)	-0.040 (0.035)	0.021 (0.016)	0.088*** (0.030)	0.030 (0.030)	-0.011 (0.035)	-0.006 (0.011)
Woman has at least secondary education (1/0)	-0.012 (0.017)	0.035 (0.039)	0.076*** (0.028)	0.048 (0.038)	0.018 (0.015)	0.061 (0.037)	0.013 (0.030)	-0.015 (0.042)	0.010 (0.013)
Household size (number)	0.001 (0.002)	0.013*	0.013*** (0.005)	-0.003 (0.007)	0.007* (0.004)	0.017*** (0.006)	-0.003 (0.005)	-0.001 (0.007)	0.000 (0.002)
Household assets (index)	0.001 (0.002)	-0.012* (0.006)	0.019*** (0.004)	0.036*** (0.007)	0.006* (0.003)	0.004 (0.006)	0.018*** (0.006)	0.022*** (0.006)	0.002 (0.002)
Land size (ha)	-0.008* (0.005)	0.002 (0.009)	-0.003 (0.007)	0.002 (0.009)	-0.003 (0.004)	-0.002 (0.009)	0.004 (0.007)	0.002 (0.009)	0.001 (0.002)
Involved in farming (1/0)	-0.008 (0.011)	0.041 (0.043)	0.021 (0.022)	-0.025 (0.041)	0.000 (0.014)	0.035 (0.035)	-0.020 (0.035)	0.072* (0.041)	-0.015 (0.014)
Male household members wage-employed (1/0)	-0.014 (0.020)	0.011 (0.056)	0.081* (0.046)	-0.040 (0.062)	0.029 (0.028)	0.039 (0.052)	0.007 (0.051)	0.028 (0.053)	0.025 (0.024)
Other women are wage-employed (1/0)	0.026** (0.012)	-0.175 (0.119)	0.226 (0.156)	0.006 (0.165)	-0.044*** (0.017)	0.071 (0.107)	0.013 (0.123)	0.122 (0.149)	0.060 (0.098)
R-squared	0.051	0.029	0.117	0.090	0.053	0.315	0.086	0.094	0.081
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1151	1151	1151	1151	1151	1151	1151	1151	1151

Notes: Bootstrapped standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%.

Table A14: Association between women's off-farm employment and household income (full model results)

	Per capita income (log)
Woman is off-farm employed (1/0)	0.838***
	(0.181)
Age of woman (years)	0.022***
	(0.005)
Female-headed household (1/0)	0.837***
	(0.188)
Woman has at least secondary education (1/0)	0.107
	(0.209)
Household size (number)	-0.592***
	(0.054)
Household assets (index)	0.052
	(0.032)
Land size (ha)	0.086**
	(0.032)
Involved in farming (1/0)	-0.195
	(0.208)
Male household members off-farm employed (1/0)	-0.077
	(0.123)
Other women are wage-employed (1/0)	-0.636**
	(0.256)
R-squared	0.393
Country fixed effects	Yes
Observations	1151

Notes: OLS regression results with robust standard errors in parentheses. ** denotes significance at 5%, and *** denotes significance at 1%.

Table A15: Associations between women's off-farm employment and control of different types of incomes (full model results)

	Crop income	Livestock income	Off-farm income	Remittances
	(1)	(2)	(3)	(4)
Woman is off-farm employed (1/0)	0.007	0.011	0.051**	0.007
	(0.032)	(0.035)	(0.028)	(0.028)
Age of woman (years)	0.002***	0.003***	0.001*	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Female-headed household (1/0)	0.122***	0.104**	0.133***	0.139***
	(0.017)	(0.025)	(0.018)	(0.021)
Woman has at least secondary education (1/0)	0.042*	0.017	-0.031	0.028
	(0.024)	(0.033)	(0.023)	(0.026)
Household size (number)	-0.011*	-0.012*	-0.008	-0.006
	(0.006)	(0.007)	(0.006)	(0.006)
Household assets (index)	0.008*	0.011*	0.009**	0.007
	(0.004)	(0.006)	(0.005)	(0.005)
Land size (ha)	-0.003	0.013*	0.002	0.009
	(0.008)	(0.006)	(0.006)	(0.006)
Involved in farming (1/0)	0.049	0.011	0.029	-0.005
	(0.042)	(0.006)	(0.030)	(0.026)
Male household members off-farm employed (1/0)	-0.054	-0.082	-0.052	-0.051
	(0.036)	(0.046)	(0.034)	(0.032)
Other female members off-farm employed (1/0)	0.125***	0.044	0.112***	0.081**
	(0.022)	(0.056)	(0.021)	(0.033)
Country fixed effects	Yes	Yes	Yes	Yes
R-squared	0.076	0.074	0.071	0.075
Observations	1049	715	1097	1097

Notes: OLS regression results with robust standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%

Table A16: Associations between women's off-farm employment and women's time allocation

	Household chores	Self-care and maintenance	Leisure	Rest and sleeping	Cooking	Care work	Own farm work	Self-employment	Wage-employment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Woman is off-farm employed (1/0)	-0.466***	-0.279***	-0.749***	-0.530**	-0.191**	-0.399***	-0.294	2.224***	0.498***
	(0.156)	(0.077)	(0.191)	(0.231)	(0.092)	(0.072)	(0.226)	(0.227)	(0.114)
Age of woman (years)	-0.017***	0.004*	0.002	0.039***	-0.152	-0.014***	0.007	-0.006**	-0.001
	(0.004)	(0.002)	(0.004)	(0.004)	(0.099)	(0.002)	(0.005)	(0.003)	(0.002)
Female-headed household (1/0)	-0.353**	-0.080	0.275	0.387**	-0.314	-0.031	-0.171	0.023	0.117
	(0.157)	(0.071)	(0.184)	(0.191)	(0.091)	(0.002)	(0.201)	(0.150)	(0.082)
Woman has at least secondary education (1/0)	-0.300	0.180**	-0.246	-0.170	-0.051	-0.103	0.020	0.350	0.130
	(0.208)	(0.070)	(0.167)	(0.221)	(0.109)	(0.088)	(0.221)	(0.210)	(0.096)
Household size (number)	0.001	-0.003	-0.077**	0.052	-0.018	0.066***	0.038	-0.098***	0.025
	(0.031)	(0.014)	(0.034)	(0.035)	(0.019)	(0.014)	(0.031)	(0.019)	(0.018)
Household assets (index)	-0.016	0.029**	0.132***	-0.306***	0.024	0.020*	0.049	0.025	0.034**
	(0.025)	(0.013)	(0.039)	(0.033)	(0.015)	(0.011)	(0.039)	(0.023)	(0.016)
Land size (ha)	0.025	0.011	-0.020	-0.080*	0.026	-0.072***	0.095	0.075**	-0.043***
	(0.040)	(0.022)	(0.039)	(0.045)	(0.024)	(0.015)	(0.059)	(0.035)	(0.015)
Involved in farming (1/0)	0.116	-0.162	0.038	-0.880***	0.179	-0.113	0.947***	-0.226	-0.168
	(0.181)	(0.099)	(0.158)	(0.244)	(0.096)	(0.127)	(0.175)	(0.197)	(0.116)
Male household members off-farm employed (1/0)	0.288*	-0.068	-0.376**	0.409*	0.003	0.144	-0.362*	0.012	-0.003
	(0.151)	(0.093)	(0.158)	(0.229)	(0.077)	(0.090)	(0.190)	(0.154)	(0.085)
Other women are off-farm employed (1/0)	0.601**	-0.024	-0.404	-0.041	-0.018	0.332	-0.209	-0.251	-0.135
	(0.257)	(0.157)	(0.354)	(0.440)	(0.205)	(0.228)	(0.397)	(0.335)	(0.123)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1151	1151	1151	1151	1151	1151	1151	1151	1151

Notes: OLS regression results with robust standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%

Table A17: Farm-level production diversity by women's off-farm employment

	Full sample (1)	Off-farm (2)	No off-farm (3)	Difference (2)-(3)
Farm production diversity	2.74 (0.13)	2.92 (0.12)	2.69 (0.05)	0.22*
Number of crop species	1.83 (0.03)	1.92 (0.07)	1.81 (0.03)	0.12*
Number of livestock species	1.45 (0.03)	1.45 (0.03)	1.46 (0.06)	-0.01

Notes: * denotes significance at 10%.; Standard deviations in parentheses

Table A18: Associations between women's off-farm employment and men's time allocation

	Household chores	Self-care and maintenance	Leisure	Rest and sleeping	Cooking	Care work	Own farm work	Off-farm work
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Woman is off-farm employed (1/0)	0.151	-0.178	-0.559**	-0.030	0.090	-0.009	-0.426	0.287
	(0.143)	(0.111)	(0.249)	(0.218)	(0.127)	(0.022)	(0.320)	(0.290)
Age of woman (years)	0.000	0.003	-0.001	0.028***	-0.009***	-0.001	-2.41***	-0.019***
	(0.143)	(0.003)	(0.008)	(0.007)	(0.003)	(0.001)	(0.008)	(0.005)
Female-headed household (1/0)	0.449**	-1.16***	-1.14***	-0.838**	-0.056	-0.039**	-1.57***	-0.377
	(0.170)	(0.121)	(0.315)	(0.334)	(0.106)	(0.019)	(0.310)	(0.225)
Woman has at least secondary education (1/0)	-0.106	-0.033	0.304	-0.502*	-0.034	0.056**	-0.209	-0.165
	(0.189)	(0.102)	(0.264)	(0.299)	(0.133)	(0.023)	(0.293)	(0.221)
Household size (number)	0.010	0.022	0.002	0.043	0.006	-0.004	0.089	-0.139***
	(0.189)	(0.021)	(0.046)	(0.052)	(0.025)	(0.004)	(0.058)	(0.042)
Household assets (index)	0.027	0.027	0.081	-0.218***	0.005	0.000	0.091	0.058
	(0.024)	(0.019)	(0.047)	(0.029)	(0.020)	(0.005)	(0.055)	(0.045)
Land size (ha)	0.036	0.036	-0.096	0.048	0.019	-0.012	0.119	0.048
	(0.043)	(0.029)	(0.068)	(0.065)	(0.022)	(0.011)	(0.087)	(0.075)
Involved in farming (1/0)	0.369*	-0.113	0.043	0.368	0.315	-0.058	0.474*	-0.898**
	(0.194)	(0.144)	(0.281)	(0.293)	(0.20)	(0.073)	(0.281)	(0.437)
Male household members off-farm employed (1/0)	0.286**	-0.192	-1.38***	-0.488**	-0.003	-0.033	-1.36***	3.43***
	(0.133)	(0.132)	(0.231)	(0.212)	(0.101)	(0.023)	(0.240)	(0.383)
Other female members off-farm employed (1/0)	0.252	-0.298	-0.031	0.262	0.069	0.023	-0.938*	-0.667
	(0.374)	(0.216)	(0.499)	(0.838)	(0.243)	(0.031)	(0.552)	(0.499)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.144	0.112	0.086	0.119	0.132	0.095	0.100	0.237
Observations	938	938	938	762	938	762	938	938

Notes: OLS regression results with robust standard errors in parentheses. * denotes significance at 10%, ** denotes significance at 5%, and *** denotes significance at 1%