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WELFARE AND OPPORTUNITIES FOR SMALL-SCALE PRODUCERS AND MSMES IN RURAL AFRICA: AN ECONOMETRIC ANALYSIS

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ABSTRACT

This study examines how participation in commercial agriculture and micro, small, and medium enterprises (MSMEs) is associated with inclusive development outcomes for small-scale producers (SSPs) across six African countries representing diverse income levels.

We explore two interrelated hypotheses: first, that engagement in commercialization and MSME ventures enhances well-being through improved off-farm employment, empowerment, poverty reduction, food security, and resilience, and second, that these effects are amplified in territories characterized by high levels of agrifood dynamism and interconnectivity, as captured by a novel Cluster Index.

Using nationally representative panel data (cross-sectional in Ghana) we estimate two-way fixed effects models to assess direct and contextual effects. The results show that participation in comercial agriculture or MSMEs is consistently associated with better inclusión outcomes across all countries, with stronger effects in Nigeria and Tanzania. The relationship is particularly robust for empowerment and non-farm income generation.

Significantly, these benefits extend to smallholders with limited land, especially in Malawi, Uganda, Tanzania, and Nigeria, suggesting the potential for broad-based inclusion. We also find that territorial conditions matter: in Ethiopia, participation effects are significantly amplified in more Dynamic agrifood clusters, whereas in Nigeria and Malawi, clusters Benefit both participants and non-participants through spillover effects.

Moreover, the inclusiveness of clusters appears to evolve with national income levels, which are associated with greater inequality in low-income countries and more equitable outcomes in middle- and high-income settings.

Finally, using the territorial Cluster Index as an instrument for participation in a robustness check, we find sizable causal gains—0.5–1.4 s.d.—in Malawi, Ethiopia, and Nigeria. These findings highlight the need for integrated development strategies that simultaneously promote commercial engagement by small-scale producers and foster clustered agrifood ecosystems. Tailoring such strategies to local contexts and stages of economic development is crucial to ensuring both growth and equity in the agricultural transformation process.

Key words: Small-scale producers, Micro, small and medium enterprises, Agrifood value chains, Inclusive development, Rural Africa, Territorial clusters, Panel data econometrics, Commercial agriculture, Poverty reduction.

RESUMEN EJECUTIVO

Este estudio examina cómo la participación en la agricultura comercial y en las micro, pequeñas y medianas empresas (MIPYMES) se asocia con resultados de desarrollo inclusivo para productores de pequeña escala (PPE) en seis países africanos que representan distintos niveles de ingreso.

Exploramos dos hipótesis interrelacionadas: primero, que la participación en procesos de comercialización y en emprendimientos MIPYMES mejora el bienestar a través de un mayor empleo fuera de la finca, el empoderamiento, la reducción de la pobreza, la seguridad alimentaria y la resiliencia; y segundo, que estos efectos se amplifican en territorios caracterizados por altos niveles de dinamismo e interconectividad de los sistemas agroalimentarios, medidos mediante un novedoso Índice de Clústeres.

Utilizando datos de panel representativos a nivel nacional (y datos de corte transversal en el caso de Ghana), estimamos modelos de efectos fijos de dos vías para evaluar efectos directos y contextuales. Los resultados muestran que la participación en la agricultura comercial o en MIPYMES se asocia de manera consistente con mejores resultados de inclusión en todos los países, con efectos más fuertes en Nigeria y Tanzania. Esta relación es particularmente robusta en términos de empoderamiento y generación de ingresos no agrícolas.

De manera significativa, estos beneficios también alcanzan a pequeños productores con acceso limitado a la tierra, especialmente en Malawi, Uganda, Tanzania y Nigeria, lo que sugiere un potencial de inclusión de base amplia. Asimismo, encontramos que las condiciones territoriales son relevantes: en Etiopía, los efectos de la participación se amplifican significativamente en clústeres agroalimentarios más dinámicos, mientras que en Nigeria y Malawi los clústeres benefician tanto a participantes como a no participantes mediante efectos indirectos.

Además, el carácter inclusivo de los clústeres parece evolucionar junto con los niveles de ingreso nacional, los cuales se asocian con mayor desigualdad en países de bajos ingresos y con resultados más equitativos en contextos de ingresos medios y altos.

Finalmente, al utilizar el Índice Territorial de Clústeres como instrumento para la participación en una prueba de robustez, encontramos ganancias causales significativas —entre 0,5 y 1,4 desviaciones estándar— en Malawi, Etiopía y Nigeria. Estos hallazgos subrayan la necesidad de estrategias de desarrollo integradas que promuevan simultáneamente la inserción comercial de los productores de pequeña escala y el fortalecimiento de ecosistemas agroalimentarios organizados en clústeres. Adaptar estas estrategias a los contextos locales y a las distintas etapas del desarrollo económico es clave para garantizar tanto el crecimiento como la equidad en los procesos de transformación agrícola.

Palabras clave: productores de pequeña escala; micro, pequeñas y medianas empresas (MIPYMES); cadenas de valor agroalimentarias; desarrollo inclusivo; África rural; clústeres territoriales; econometría de datos de panel; agricultura comercial; reducción de la pobreza.

1. INTRODUCTION

Over Agricultural transformation in low- and middle-income countries (LMICs) has traditionally emphasized smallholder production and changing consumer preferences, often overlooking the distinct contributions of commercial small-scale producers (cSSPs) and micro, small, and medium enterprises (MSMEs) within agrifood systems.[1] This paper examines two interconnected hypotheses. First, engagement in commercial agriculture (defined by selling any amount of crop) and/or MSME ventures contributes positively to inclusive development outcomes—specifically off-farm employment, empowerment, poverty reduction, food security, and resilience. Second, these positive effects are amplified in territories marked by high levels of economic activity and interconnection among agricultural businesses, as captured by a tailored Cluster Index. By examining these hypotheses, the paper sheds light on the direct effects of commercialization and MSME participation and the role of territorial dynamics in reinforcing inclusive rural development.

We operationalize this spatial hypothesis through a territorial Cluster Index of agrifood dynamism, supported by additional spatial indicators, including satellite-derived nighttime lights and road density metrics. Existing research has occasionally explored meso-level determinants such as urbanization, infrastructural connectivity, or MSME development. However, a notable gap remains regarding analyses explicitly addressing the joint density and interaction of cSSPs and MSMEs within specific territorial contexts. By integrating detailed geospatial data with panel survey evidence, our study contributes novel insights into how spatially defined conditions shape inclusive agricultural transformation, offering actionable policy recommendations to integrate cSSPs into broader and more inclusive value chains.

Much of the previous work on inclusive agricultural transformation and related outcomes primarily emphasizes micro- level determinants and household decisions. For instance, studies have explored determinants of smallholders' well- being, focusing on crop production and commercialization decisions, group memberships, income diversification, and market access, often neglecting meso-level territorial influences. Research focusing on household decisions related to gender norms and women's empowerment (Baada et al., 2023; Adeyeye et al., 2019), household food security and dietary diversity (Ochieng et al., 2015; Janssen, 2018), and productivity or land use (Lim and Khun, 2022) has consistently prioritized individual and household-level characteristics. Likewise, broader studies examining resilience to food insecurity (d'Errico et al., 2021) remain anchored at the household level, emphasizing coping strategies and asset holdings.

Similarly, literature explicitly addressing food security has predominantly examined household-level outcomes, includ- ing dietary diversity, nutrition, and market participation (Bolarinwa et al., 2020; Kilimani, Buyinza, and Guloba, 2020; Mpehongwa and Cassian, 2024; Saha et al., 2024; Linderhof, Janssen, and Achterbosch, 2019). Collectively, these studies reinforce the critical gap regarding the omission of meso-level territorial factors. Our analysis addresses this limitation by systematically incorporating territorial dynamics to better understand their influence on inclusive agricul- tural transformation outcomes.

While existing studies on this topic typically focus on a single country or specific subnational regions, our research substantially contributes by analyzing panel data across six different countries (except for

Ghana, which is not a panel). This multi-country approach represents a methodological advantage, as it enables a systematic comparative analysis between six nations classified in different income strata to identify common patterns among groups while controlling for time-varying factors, allowing for stronger inferences.

1.1 Research objectives and questions

This paper addresses the following key research questions:

1. Does engagement in commercial agriculture (selling any crop[2]) and/or owning a household-run MSME contribute positively to inclusive development outcomes?

2. How do territorial conditions (captured by the Cluster Index and night–lights) relate to key inclusion outcomes for SSPs, such as resilience, food consumption, empowerment, off-farm income opportunities, and poverty?

1.2 Contribution and structure

This paper contributes to the existing literature by explicitly integrating spatial and territorial factors into analyzing agrifood value chains and inclusive development. By focusing on the spatial dimension, the paper fills a gap in understanding how territorial conditions foster or hinder inclusion opportunities for SSPs.

While some research has examined meso-level variables in agricultural development, few studies have analyzed smallholder farmers and MSMEs' agglomeration and clustering effects in a given area. Agglomeration effects refer to the economic benefits firms and producers gain when located near each other, including knowledge spillovers, labor market pooling, and input sharing (Long and Zhang, 2011). Clustering effects represent increased efficiency and innovation when interconnected actors in a value chain are concentrated geographically, reducing transaction costs and facilitating coordination. Agricultural clusters, specifically, may experience these benefits through easier access to specialized inputs, better diffusion of new technologies, enhanced market linkages, and collaborative problem-solving among value chain participants (Hu et al., 2019).

[1] An inclusive agricultural transformation is a process that integrates smallholder farmers, youth, women, and marginalized groups into modernizing food systems through targeted investments and policies. It prioritizes the growth of small farms and SMEs along value chains, creating equitable economic opportunities. This approach generates broader societal benefits including poverty reduction, improved nutrition, and enhanced climate resilience (IFAD, 2016; AGRA, 2017). It emphasizes not only productivity growth and market participation, but also the equitable distribution of benefits, empowerment, poverty reduction, and sustainability (AGRA, 2017).

[2] We define a "commercial" producer as being engaged in the output market (selling any amount of crop). We excluded input buyers from these analyses, as engagement in the input market does not necessarily translate to output market participation.

One novel approach of our work is the creation of a Cluster Index at the regional or "territorial" level, which groups neighboring districts to mitigate representativeness bias. This index measures MSME and cSSP density, alongside their aggregate revenues, as a proxy for agribusiness dynamism in the area. In essence, the greater the value of the index, the more these actors exist in per capita terms, and higher revenues in the region will be obtained. Our methodology closely follows Hu et al. (2019) and Long and Zhang (2012), who developed similar clustering indices to capture horizontal agglomeration and vertical interconnections among actors in value chains. Like these pioneering studies, our approach allows us to quantify the degree of spatial concentration and interconnectedness within agricultural value chains, providing insights into how these territorial dynamics influence smallholder inclusion and business performance. As a robustness check, we also implement an instrumental variables (IV) strategy, exploiting variation in the territorial Cluster Index as an instrument for participation (selling crops and/or owning an MSME).

The structure of the paper is as follows: Section I introduces the research problem, objectives, and contributions to existing literature. Section II reviews the relevant literature on crop commercialization and household well-being, the benefits of operating MSMEs, the role of midstream MSMEs in inclusive agricultural transformation, and agricultural clustering. Section III describes our data sources, variable construction methodology, and econometric approach. Section IV presents descriptive analyses and empirical findings regarding the association between participation in commercial agriculture/MSME activities and inclusive development outcomes, as well as how these relationships are moderated by territorial conditions or farm scale. Section V discusses the interpretation of our research's main findings, policy implications, and limitations. Section VI concludes with synthesizing key insights and directions for future research. The paper includes appendices with additional methodological details and supplementary results.

II. LITERATURE REVIEW

2.1 Agricultural commercialization and MSME entrepreneurship

Much research across Africa and Asia links smallholder crop commercialization with improved rural welfare. Numerous studies find that transitioning from subsistence to market-oriented farming raises household incomes and helps reduce poverty. For example, panel data from Ethiopia show that greater commercialization is associated with higher household income, increased asset wealth, and significantly lower poverty rates, with the poorest farmers seeing the most significant gains (Girma & Tabe-Ojong, 2024). Similarly, evidence from China and Nigeria indicates that market participation and cash-crop adoption can substantially boost incomes and lift households out of poverty (Wang et al., 2024; Etuk & Ayuk, 2021).

The effects on food security and resilience are more nuanced. Many studies report modest improvements in food security and calorie intake as farm income rises (Carletto et al., 2017), and recent evidence shows crop commercialization strengthens smallholders' resilience to shocks by increasing their capacity to cope with income shortfalls (Hung & Nguyen, 2024). However, some cases reveal trade-offs: in specific contexts, focusing on cash crops for sale has reduced dietary diversity and local food availability (e.g., cacao farmers in Ghana experienced lower diet diversity) (Anderman et al., 2014). Gender dynamics are also complex. While added income from commercialization can benefit the whole household, research from several countries finds that when men take over high-value commercial crops, women's decision-making power and control over resources may diminish (Tavenner et al., 2019). In summary, the literature on agricultural commercialization is extensive and generally positive about its role in reducing rural poverty. However, it also highlights important considerations for nutrition and gender empowerment in designing inclusive market-led development.

A parallel strand of development research emphasizes the vital contribution of rural non-farm enterprises (NFE) – micro, small, and medium businesses – to household livelihoods and community well-being. Households across Sub-Saharan

Africa and Asia increasingly diversify into non-farm entrepreneurship: in fact, roughly 30–50% of rural households engage in some non-farm business activity, providing key off-farm income sources (Nagler & Naudé, 2017; Araujo, 2004).

These enterprises have been shown to enhance food security and resilience by diversifying income. Rural families with off-farm income in Nigeria had significantly better food security and nutrition outcomes (lower child stunting and higher dietary quality) than those relying only on farming (Babatunde & Qaim, 2010). Owning an NFE could act as a buffer against agricultural shocks – many smallholders start side businesses to maintain consumption when crops fail or during the off-season (Barrett et al., 2001). The non-farm sector generates substantial employment and is widely seen as a pathway out of poverty in rural areas. Studies in Rwanda and elsewhere conclude that household enterprises significantly reduce poverty and provide non-farm employment opportunities for those who cannot secure a sufficient livelihood from agriculture (Abbott et al., 2012). This income diversification tends to particularly benefit women: when

rural women operate micro or small enterprises, it can increase their financial autonomy and decision-making power, contributing to women's empowerment (Mgomezulu et al., 2024).

Overall, the evidence base is rich and indicates that promoting small non-farm businesses alongside crop commercial- ization can reinforce each other's benefits, improving food security, bolstering household resilience, creating off-farm jobs, empowering women, and accelerating poverty reduction in rural communities.

2.2 The role of midstream MSMEs and territorial conditions in inclusive agricultural transformation

Recent studies on low- and middle-income countries (LMICs) highlight the importance of intermediate actors—micro, small, and medium-sized enterprises (MSMEs)—in agri-food value chains (Reardon, 2015; AGRA, 2019; Berdegué et al., 2023). These enterprises operate in processing, logistics, and wholesale, bridging the gap between primary agricultural production and consumer markets. Although the concept of "hidden middle" is relatively new, evidence shows that intermediate MSMEs influence agricultural markets, local economies, and livelihoods (Reardon et al., 2021; Barrett et al., 2022). On the one hand, smallholders often benefit from the inputs, technical services, and marketing channels that these firms provide (Liverpool-Tasie and Reardon, 2024; Liverpool-Tasie et al., 2020); on the other, MSMEs benefit from a steady flow of agricultural production (AGRA, 2019; Berdegué et al., 2023).

Despite their relevance, the intermediate MSMEs' role, spatial clustering, and meso-level factors such as road density and night-time lights have been studied less than other chain segments. In particular, their contribution to five key dimensions—employment, empowerment, poverty reduction, food security, and resilience—is central to advancing inclusive agricultural transformation (IFAD, 2021; Hazell et al., 2017).

2.2.1 Employment and empowerment opportunities Employment generation

In agri-food value chains, MSMEs represent a key source of employment generation, especially in LMICs. The "hidden middle" within these chains—processing, wholesale, logistics, and midstream trade—drives employment growth. They are recognized as catalysts of job opportunities in diverse sectors. For example, Castillo et al. (2014) found that innovation policies for MSMEs in Argentina generated, on average, five additional jobs per enterprise and wage improvements. In Nigeria, Matthew et al. (2020) investigated micro-enterprises and observed that employment growth positively correlates with firm size.

Nursini (2020) showed that in Indonesia, a 1% increase in SME output was associated with a 1.483% increase in employment. However, low wages limit the impact on poverty reduction. Ajuwon et al. (2017) observed in Nigeria that small firms tend to create jobs quickly but struggle to sustain them, leading to precarious employment with limited security. This finding underscores the need for policies that strengthen job stability and quality.

The midstream segments of agri-food chains generate employment in rural and urban areas (Reardon et al., 2022; Dolislager et al., 2020). Technological adoption, branding, and product differentiation drive productivity and income, positively affecting employment. Barrett et al. (2022) highlighted cases such as

Ethiopia, where horticulture employs 180,000 workers, 85% of whom are women. The fresh vegetable industry in Kenya generates between 40,000 and 60,000 jobs from only 7,000 smallholders (Webber and Labaste, 2010).

Intermediate MSMEs also contribute to labor inclusion, especially for women and youth. According to IFAD (2021), they offer an entry point into the labor market for landless rural workers. Reardon et al. (2022) highlighted their high labor intensity. However, many operate with informal labor arrangements, low wages, and limited social protection. Meemken et al. (2019) showed that Fair Trade certification in Côte d'Ivoire improved conditions for small suppliers, although with fewer worker benefits.

The role of MSMEs in employment is widely recognized, especially in LMICs, as they effectively absorb labor and reduce unemployment through labor-intensive activities. The diversification of agri-food chains and the demand for processed foods increase their potential. They span manufacturing, transport, and retail trade.

Despite these advantages, challenges persist: low wages, poor working conditions, informality, and limited social protection. These limitations restrict their potential for sustainable growth and labor well-being. Therefore, the midstream sector of agri-food chains is a crucial yet undervalued employment source whose evolution deserves further analysis due to its impact on labor markets and economic inclusion.

Women and youth empowerment

By contributing to empowerment, particularly of women and youth, MSMEs go beyond job creation and foster economic inclusion and social transformation. The UN Department of Economic and Social Affairs (UNDESA, 2020) highlights that MSMEs could advance SDG 5 by increasing economic participation and female leadership. However, women-led businesses face structural barriers such as limited financing, reduced professional networks, and low business training. Addressing these gaps is essential for MSMEs to act as effective empowerment platforms. Recent syntheses based on the Women's Empowerment in Agriculture Index (WEAI) show that early tracking of empowerment outcomes can surface emerging gendered constraints and improve programme design (Quisumbing 2024).

MSMEs offer employment to women, though often under precarious conditions. Improving these conditions can enhance their economic participation. Inclusive financial practices, equal pay, job security, and promotion opportunities are needed, with a gender perspective throughout the value chain (UNDESA, 2020). These patterns echo the wider feminisation of agricultural labour, where women increasingly fill low-paid and insecure positions as men exit the sector (Doss 2024).

Mekonnen and de Brauw (2024) found that women lead 53% of food MSMEs in Ethiopia, but they generate less employment than those led by men. The differences point to lower scalability and the need for targeted support. Sanu et al. (2020) in India reported that only 19% of MSMEs were women-led, hindered by sociocultural and structural factors. Nonetheless, they showed higher employment growth, though lower net returns than male-led enterprises.

Thakar (2023) noted that women represented only 19% of entrepreneurs in India in 2021. MSMEs can help overcome barriers by offering training, job security, and fair compensation. Elias and Arora-Jonsson (2017) analyzed the shea industry in Burkina Faso, where the sector provided new opportunities for women, yet they remained confined to traditional roles. Although a women's union improved their market access and networks, the benefits were unevenly distributed, favoring young urban women.

Hoque et al. (2020) found a positive correlation between entrepreneurship and women's empowerment in Bangladesh. Key elements included favorable regulation, training, networks, and spousal support. Shingla and Singh (2015) developed an empowerment index in India that showed improvements in mobility and decision-making, though persistent inequalities in asset ownership remained. This shift is consistent with the broader move from proxy "bargaining-power" variables toward multidimensional empowerment metrics that capture resources, agency, and achievements (Quisumbing 2024). Noor et al. (2021) compared female entrepreneurs and homemakers in Pakistan, finding greater autonomy, resource control, and political participation among the former.

Despite the potential, informality and lack of social protection limit MSMEs' role in gender equality. Comprehensive strategies are needed: policy reforms, financial support, and gender-focused business practices. Strengthening women- led MSMEs and improving working conditions are key to closing gaps. Moreover, entrepreneurship fosters economic independence, social mobility, and political participation, challenging gender norms and yielding broad community benefits.

Territorial factors play an important role in empowerment. Ndjobo & Abessolo (2023) use access to paved roads in rural sub-Saharan Africa as the key territorial variable, defined by the presence/proximity of paved road infrastructure. Women's empowerment is proxied by economic participation (youth employment rates by gender). Using cross-country DHS data for 31 countries, the authors employ a bivariate probit regression to address potential endogeneity between road access and employment. They find that better road access significantly reduces rural youth unemployment, with a more substantial impact for young women than young men.

Dhamija et al. (2025) focus on India, examining urbanization - measured as night-time light intensity as a proxy for urban development - and its effects on women's empowerment (multifaceted index). They conclude that rapid urbanization yields limited empowerment benefits for women, mainly through its effects on women's mobility, one pillar of their index. Similarly, Gupta et al. (2024) examine Women's Empowerment in Nutrition Index (WENI) on night-time lights data, finding that in regions where NTL (urbanization) doubled, women's dietary diversity – an outcome tied to agency – increased by 7–8%, and overall women's empowerment rose alongside urbanization.

Lecoutere (2017) – Using a farmer cooperative in Uganda as a case study of an agro-cluster (a local agricultural group), this article evaluates how participation in such a cluster impacts women's empowerment. The territorial factor is membership in an agricultural co-operative society, which serves as a cluster of farming activities. Women who joined the co-op experienced greater economic well-being and adoption of improved farming practices, notably, gains in their decision-making power at the household, group, and community levels.

2.2.2 Poverty reduction, food security pathways

Pathways to poverty reduction

MSMEs influence poverty reduction by generating employment and strengthening household incomes in agri-food value chains. Their impact goes beyond direct job creation by expanding market access, absorbing labor, and stimulating new economic activities. Various studies show direct and indirect effects on income distribution and economic well-being.

In northern Ghana, Ma et al. (2023) found that producers involved in value chains earned higher incomes due to access to technology, credit, and market information. Education, household size, irrigation access, and group membership enhanced these benefits. Nursini (2020) observed that MSME productivity growth was associated with employment in Indonesia, though low wages limited its impact on poverty. Medium-sized firms were more effective in reducing poverty than microenterprises, which often operate at subsistence levels.

Regionally, Manzoor et al. (2019) provided South Asian evidence of the link between MSME growth and poverty reduction, reinforced by trade liberalization and social investment. In ASEAN countries, Lamaile and Trihadmini (2023) found that the positive impact of MSMEs is evident but shaped by structural factors such as trade growth.

In Zambia, Nuhu et al. (2021) showed that soybean producers improved incomes by selling to large buyers, reducing their likelihood of remaining in poverty. Tambunan (2023) highlighted MSMEs' multiplier effect by fostering complementary businesses and increasing household consumption in Indonesia.

Dey and Singh (2023) found that direct market participation improved monthly income and per capita consumption for small vegetable producers in India. Price information, storage, and training were key to market integration. In Rwanda, Diao et al. (2022), using IFPRI's RIAPA model, demonstrated that value chain growth reduces poverty rates and depth, improves caloric intake, and enhances diet quality.

The same study shows that although value chain growth may reduce agricultural employment, it generates new jobs in midstream and downstream segments, highlighting MSMEs' role in agri-food labor transitions.

Informality, low wages, and poor infrastructure limit MSMEs' impacts on poverty. Microenterprises face more significant challenges in generating sustainable profitability. Strategies must include credit access, better education, infrastructure, and market expansion. Strengthening links between agri-food MSMEs and rural producers can amplify the benefits.

Evidence from Asia and Africa underscores MSMEs' role in job creation, subcontracting support, and smallholder income improvement. However, success depends on trade policies, social development, and support for vulnerable communities.

Integrated approaches that combine value chain development with labor transition support, improved market infrastruc- ture, and financial inclusion are needed. Investment in training and livelihood alternatives is key to ensuring MSME-led growth translates into sustainable and equitable poverty reduction.

Solomon et al. (2022) analyzed panel data from 29 SSA countries regarding territorial-level analyses. They found that a 1-percentage-point increase in urban population share reduced poverty headcount rates by 0.05 percentage points in the short run, with larger effects in the long run. However, urban growth benefits are not uniformly distributed across population segments or geographic areas.

Calderon and Serven (2014) provided cross-country evidence that better infrastructure correlates with higher per capita income and reduced inequality.

Djemaï, Clark, and D'Ambrosio (2023) examined the impact of proximity to paved roads on well-being across 24 African countries. Using an instrumental variable approach, they found that distance to roads significantly increases material deprivation by about 0.7 points for each log-unit increase in distance ($p < 0.01$). However, it has no significant effect on subjective well-being. Public good provision emerged as an essential mediator in this relationship.

In Ethiopia, Tabe-Ojong & Godana (2023) found that being in an "agro-cluster" (areas where farmers grow similar crops in proximity) is associated with significantly higher household income and lower poverty incidence. Using instrumental- variable estimators to address selection bias, they found that agro-clusters reduce poverty rates and poverty gaps, though benefits were larger for higher-income households.

Evidence from outside Africa supports the poverty-reducing power of clusters. In Indonesia's West Java province, Wardhana et al. (2017) found that areas with greater concentrations of agricultural employment tend to have significantly lower poverty rates, with spillover effects to neighboring districts. In Ghana, Ackah et al. (2023) linked proximity to industrial clusters with improved household welfare, as households within 20-30 km of special economic zones experienced higher consumption and lower poverty incidence.

Trinh et al. (2024) demonstrated that enterprise growth creates employment benefits that extend beyond immediate boundaries. Their study in Vietnam showed that a 10% increase in total enterprise capital in a major city increased local incomes by 0.53% and positively impacted first- and second-ring neighboring provinces by 0.22% and 0.17%, respectively, highlighting how economic clusters contribute to broader regional development and inclusion.

Food security enhancement

MSMEs contribute to food security by participating in agri-food value chains, influencing access to nutritious foods, healthier diets, and food safety standards. Engaging in production, processing, distribution, and sales can improve food availability, affordability, and quality, especially in LMICs. However, challenges persist, such as unequal access, food waste, and regulatory limitations.

Mossie et al. (2021) found that apple and mango producers in Ethiopia increased their daily caloric intake by 7.67% by participating in value chains. Legesse et al. (2024) showed a 4.8% increase in food security among avocado producers accessing high-value markets. Price information, education, farming experience, and market access were key factors influencing these outcomes.

MSMEs strengthen food systems by supporting smallholders, improving supply chains, and promoting better food practices. Reardon et al. (2022) note that intermediate enterprises reduce post-harvest losses through modern storage and preservation. However, the spread of ultra-processed foods poses health risks, particularly in poorly regulated markets.

In Nepal, Kafle et al. (2021) found that linking remote farmers with traders increased incomes and dietary diversity. Capacity-building activities such as financial literacy and post-harvest management enhanced resilience and food security.

Food safety is a major concern. Liverpool-Tasie and Reardon (2024) argue that MSME compliance with standards can be inconsistent without strong governance frameworks. Nguyen et al. (2024) emphasize that incentives, modern infrastruc- ture, and collaboration are essential to improving safety. Certification, labeling, and local regulations help align these firms with required standards.
MSMEs influence household nutrition by improving market access and infrastructure and reducing food handling risks. Evidence shows that connections with formalized markets increase caloric intake and dietary diversity in urban and rural settings. Nonetheless, the risks linked to unhealthy diets must also be addressed as ultra-processed food consumption expands.

Regarding territorial factors such as road density and connectivity, Nakamura et al. (2019) evaluated Ethiopia's rural road expansion program. They found that new all-weather roads increased household consumption by 16.1% over four years, with the most pronounced benefits in isolated communities.

Stifel and Minten (2015) conducted a quasi-experimental study in rural Ethiopia, which found that households with better market access had higher dietary diversity and lower food insecurity than those in remote areas. Their results underscore the critical role of spatial planning in enhancing the welfare of smallholder farmers and rural residents.

Gidelew, Alemu, and Kassie (2025) assess the impact of cluster farming on multidimensional food security among smallholders in Northwestern Ethiopia. Here, "cluster farming" refers to an arrangement where neighboring farmers coordinate planting the same crop and share resources (echoing the national cluster program). They find that participation in cluster farming has a significant positive effect on all major dimensions of food security. In particular, households engaged in clusters achieved greater food availability (higher crop yields or purchasing power for food), improved dietary acceptability, and more stable food consumption throughout the year.

MSMEs can enhance food security with adequate infrastructure, stable market linkages, and nutrition education. Nepal's case illustrates that connecting producers with markets, providing technical training, and ensuring stable trade relation- ships can drive sustainable improvements. Coordinated efforts are needed to harness their contributions and minimize risks, allowing them to become key agents in more equitable and secure food systems.

2.2.3 Resilience and agricultural clustering

Building resilience through MSMEs and favorable territories

In some contexts, MSMEs contribute to the resilience of rural communities and agri-food value chains. Liu et al. (2023), studying vegetable value chains near Wuhan, China, highlight the role of knowledge sharing, social capital, and information flows as determinants of community resilience. Community collaboration helps address market volatility and sustain agricultural livelihoods. In one case, farmers shared practices and strategies to mitigate risks from fluctuating demand. In another, institutional linkages with research organizations and governments facilitated access to critical information, though disparities in access and consumer expectations persisted.

Regarding agricultural clustering, Ranran and Jingsuo (2024) use panel data from 2007–2022 to employ a spatial Durbin regression (to capture regional spillovers) and a threshold model based on technology levels. The results show that greater agricultural clustering significantly improves economic resilience in a province's farm sector and confers positive resilience spillovers to adjacent provinces. In other words, regions with denser agricultural clusters tend to absorb shocks better, and this benefit extends spatially.

Strengthening resilience requires closing information gaps among agri-food system participants. Proactive community organization enhances economic sustainability and social cohesion, benefiting actors at all levels. However, fragmented community agencies, weak policy integration, and lack of coordination remain persistent barriers.

Fostering solidarity, trust, and cross-sector collaboration among agribusinesses, government agencies, and local groups can facilitate adaptation to future challenges. These collective efforts help respond to immediate sustainability issues and foster innovative responses to systemic risks. Communities that leverage their human, social, cultural, and political capital—supported by good governance and strong networks—are better prepared to face evolving agri-food markets. Also, embedding a Climate-Resilient Development for Agriculture (CRDA) lens—explicitly integrating gender equity across mitigation, adaptation, and loss-and-damage responses—can help ensure climate-smart and gender-inclusive cluster-based strategies (Akter 2024).

Agricultural clustering

Hu et al. (2019) define clustering as the geographical concentration of interconnected actors in a value chain within a specific area. They create a Cluster Index that measures both horizontal agglomeration (presence of similar firms) and vertical interconnections among actors in the value chain (farmers, input dealers, and traders). Their index builds on the theoretical works of Marshall (2013) and Porter (1998, 2000), who emphasized the importance of "external economies" and interconnectedness in clusters. However, they do not analyze their impact on our inclusion pathways.

Besides this study, little more has been found regarding territorial agricultural clustering, which is measured as the concentration of cSSPs and MSMEs in a given area and their effect on well-being outcomes, let alone inclusion pathways, through our aforementioned variables. While Gidelew, Alemu, and Kassie (2025) and Tabe-Ojong & Godana (2023) discuss agro-clusters, their methodology does not

align with our hypothesis of cSSP-MSME symbiosis and clustering, given that their analyses of clusters consider only farmers growing the same crops in a given area (measured as a household-level binary, without meso-level considerations), without considering MSMEs.

III. DATA AND METHODOLOGY

3.1 Data sources and sample characteristics

The empirical analysis draws on data sets primarily sourced from the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) initiative, supplemented in some instances by national household surveys of a comparable design. These data sets provide rich information on agricultural production, household demographics, and community-level features, enabling a nuanced examination of socioeconomic and agronomic outcomes. In the case of Ghana, the data come from a series of nationally representative household surveys spanning multiple years. However, these surveys are not strictly longitudinal and thus do not form a true panel like the LSMS-ISA sources.

To retain the panel structure across countries, the regression analysis uses specific survey waves for each country. In Ethiopia, we rely on the Ethiopia Socioeconomic Survey (ERSS) for the 2011, 2013 and 2015 waves, which form a balanced panel. For Malawi, we use the Integrated Household Panel Survey (IHPS) from 2010, 2013, 2016 and 2019, which provides a multi-wave panel of households. In Uganda, the analysis draws on the Uganda National Panel Survey (UNPS) for the 2010, 2012, 2014, 2016 and 2020 waves, again exploiting the panel structure. For Tanzania, we use the 2014 and 2020 waves of the Tanzania National Panel Survey (TZNPS), which together constitute a two-wave panel. For Nigeria, we rely on the General Household Survey (GHS) panel for the 2010, 2012, 2015 and 2018 waves. In Ghana, by contrast, we use the Ghana Living Standards Survey (GLSS) rounds from 1998, 2006, 2013 and 2017; these are repeated cross-sections rather than a true panel, and the Ghana data are therefore treated accordingly in the analysis.

An unbalanced panel design is employed to maximize the amount of information available across different countries and waves. Households remaining in the sample for multiple survey rounds are tracked over time, while households that appear only once contribute to the cross-sectional variation when feasible. Adopting an unbalanced approach enables the inclusion of a larger number of household-year observations than would be possible under a strictly balanced panel. This decision is critical given attrition or the introduction of new households in certain waves. However, when performing fixed-effects estimations, households that appear in only one wave are dropped to avoid singletons, as including them would not contribute to within-household variation and would interfere with standard estimation procedures (Correia 2015).

For all regressions, the set of control variables is broadly consistent across specifications. Household-level controls include the age and gender of the household head, average years of education among working-age members, demo- graphic variables such as household size and the ratio of dependents to total household members, and the share of off-farm income. Agricultural or “farm” controls include the

cultivated area in hectares and its square value. We decided against including additional input and crop choice controls as they are correlated with the decision to commercialize.

We categorized the six countries into three income strata (Table 1) based on a series of macroeconomic variables to allow us to identify clear patterns and correlations between income levels and our outcome variables.

Table 1. Selected country characteristics and classification.

Country	GDP per capita (constant US$): recent 5-yr avg.	GDP per capita (constant US$): survey period avg.	Agric GDP share (%) recent 5-yr avg.	Agric GDP growth (%) recent 5-yr avg.	Stratum name
Ghana	2,011	1,301	19	6	Upper
Nigeria	2,449	2,529	23	2	Upper
Tanzania	1,050	912	25	3	Middle
Uganda	930	858	24	5	Middle
Ethiopia	836	649	36	5	Lower
Malawi	560	542	23	3	Lower

Box 1. Economic development and inclusion patterns across agrifood clusters.

In this box, we explore patterns of economic development and inclusion across countries and levels of agrifood clustering. We define high and low clustering areas using a threshold of one standard deviation above or below the mean of our Cluster Index for each year. Using this classification, we examine variations in income inequality, off-farm income, poverty, and overall inclusion outcomes, while distinguishing trends across country income levels.

Income inequality in clusters varies by country income level

Our analysis reveals a distinct pattern in the relationship between agrifood clustering and income inequality. As shown in Figure 6, we plot average income inequality for high- and low-cluster areas in each country based on the most recent survey wave available. Income inequality is measured using the Gini index, which we constructed using total household annual income, computing weighted cumulative distributions, and measuring the area between the Lorenz curve and line of perfect equality.

In lower-income countries (Ethiopia and Malawi), territories with high clustering exhibit greater income inequality as measured by the Gini index (Figure 6). However, this pattern reverses in middle- and high-income countries, where clustered areas show more equal income distribution. As economies develop, the benefits of agrifood clustering become more widely shared.

Clusters generate off-farm income opportunities

The data also reveal that areas with high levels of agrifood clustering generate significantly greater earnings from off-farm activities than low-cluster areas. In Figure 7, we plot the ratio of off-farm income earned in highly clustered territories versus low-clustering areas for each country by dividing the weighted average of household non-farm cash income in high-cluster areas by the same measure in low-cluster areas. The results show that this ratio exceeds 1.2 across all countries, reaching as high as 2.5 in Ethiopia and 1.6 in high-income countries. These findings suggest territorial clustering is strongly associated with expanded economic opportunities beyond farming, especially in lower-income contexts.

Clustering associated with lower poverty and greater inclusión

Using Nigeria as an illustrative case, we explore state-level patterns in poverty, women's inclusion, and farm size according to meso-levels of agrifood clustering. Figure 8 explores trends in consumption poverty rates (red line) and women's MSME ownership share (blue line) across Cluster Index levels. In contrast, in Figure 9, we look at the relationship between the average cultivated area and the Cluster Index.

Figure 8 reveals that areas with higher cluster indices consistently show lower consumption poverty rates. This pattern holds across all countries except those in the lowest income category, where the reverse is observed. Additionally, territories with higher clustering consistently show more women-owned MSMEs. Meanwhile, Figure 9 shows that States with higher cluster indices (x-axis) tend to have smaller average farm sizes (y-axis), as the downward-sloping red trend line demonstrates that clustering is associated with smaller farming operations. These findings indicate that higher clustering correlates with improved inclusion of both smallholder farmers and women entrepreneurs.

These results highlight how the socioeconomic characteristics of agrifood clusters evolve with broader economic development, transitioning from potentially exacerbating inequalities in early stages to fostering more equitable and inclusive growth in more advanced economies.

3.2 Variable construction and measurement

3.2.1 Wellbeing dimensions

This study adopts a multidimensional approach to measuring inclusive development, focusing on five key dimensions: women's empowerment, poverty reduction, food security, resilience, and off-farm employment. In the following section, we describe how each indicator is constructed. We conclude by introducing a composite measure—the Inclusion Index— that summarizes these five dimensions into a single, standardized metric.

Resilience indicator (RIMA-II framework)

Household resilience was measured using a framework closely aligned with RIMA-II (FAO, 2016). This approach conceptualizes resilience as a multifaceted construct, typically encompassing household access to basic services (e.g., improved water, sanitation, and energy), the extent and diversity of asset ownership, the availability and effectiveness of social safety nets, and a household's adaptive capacity (Annex, Table A1). Within these core dimensions, selected variables were aggregated into four dimensions through factor analysis and then into a single index through structural equation modeling (SEM) using food consumption score and dietary diversity index as resilience outcomes.

Women's empowerment (Adapted A-WEAI)

Women's empowerment was evaluated using an approach based on the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI) (IFPRI, 2012). Survey modules captured whether women in the household participated in or exclusively controlled major agricultural and economic decisions (e.g., the selection of crops, the purchase and use of inputs, and the allocation of income). Additional domains included access to and decisions regarding credit, workload distribution, and ownership or control of key assets (see Annex, Table A2 for more details about each indicator). We modified the index to emphasize land ownership or livestock holdings in contexts where comprehensive asset modules were unavailable. This flexible structure allowed for broad comparability across countries while reflecting localized variations in data availability.

Consumption poverty

Using consumption expenditure variables from the LSMS-ISA datasets, we classified households as poor if their daily per capita consumption fell below the World Bank's international poverty threshold of 2.15 USD (2017 PPP) as a measure of extreme poverty. For Malawi, where consumption expenditure data were unavailable, we relied on an asset-based wealth index instead.

Off-farm employment

Another essential inclusion aspect we analyzed is off-farm income-generating opportunities, measured in the natural logarithm of total per capita household non-farm cash income (remittances, wage employment, income from owned enterprises).

Food security

Our food security measure is based on the Food Consumption Score, which the World Food Programme (2012) outlined. It measures dietary diversity, food frequency, and the relative nutritional importance of different food groups consumed over the past seven days. Based on the FCS, households are classified into poor, borderline, or acceptable food consumption categories. For these analyses, we use the raw food consumption score.

Quality of diets

To complement the food consumption score, we also create an Adapted Per Capita Global Diet Quality Score based on (Intake, 2022), which contains less food groups than the ones needed to build the complete indicator, for Tanzania, Ethiopia and Nigeria. As an adaptation, results should be taken cautiously.

Inclusion index

To find a single construct that summarizes our inclusion variables into one, we create an "inclusion" index by running principal component analysis on the following variables at the household level: empowerment score (A-WEAI), resilience index, food consumption score, off-farm cash income, and consumption expenditures. All variables were min-max normalized.

Min-max normalization was applied as a preprocessing step by Seidel and Lakner (2019), Wang and Chen (2022), and Tadjiev et al. (2023) to ensure that all variables are dimensionless and on a comparable scale before Principal Component Analysis (PCA). The Kaiser-Meyer-Olkin (KMO) test indicated that our set of five variables is suitable for dimensionality reduction via principal component analysis (PCA), with KMO values exceeding 0.65 for all countries except Ethiopia, which had a slightly lower KMO value of 0.57.

3.2.2 Cluster index

To investigate the dynamism of agrifood value chains, a composite Cluster Index was developed by integrating a range of indicators, including (i) the share of land dedicated to commercial production by smallholders, (ii) the volume and monthly revenue of agro-related downstream enterprises (for instance, retailers and processors), (iii) the density of agriculture-oriented MSMEs per square kilometer, and (iv) output trader quantity. These were calculated in per capita terms except for MSME area density. Principal Component Analysis (PCA) was conducted on the latest wave of survey data to identify the underlying factor structure that best reflects these agrifood dynamics. The resulting factor loadings were then used to standardize and score equivalent indicators in preceding survey years, holding constant both the mean and standard deviation from the latest wave's distribution. After standardization, the indices for all years were normalized to a 0–1 range, facilitating a uniform scale for comparing agribusiness activity and development across time and space, as per (Hu et al., 2019).

Figure 1. Nigeria cluster index by state in 2010 (left) and 2018 (right).
Dark red indicates values close to 1.

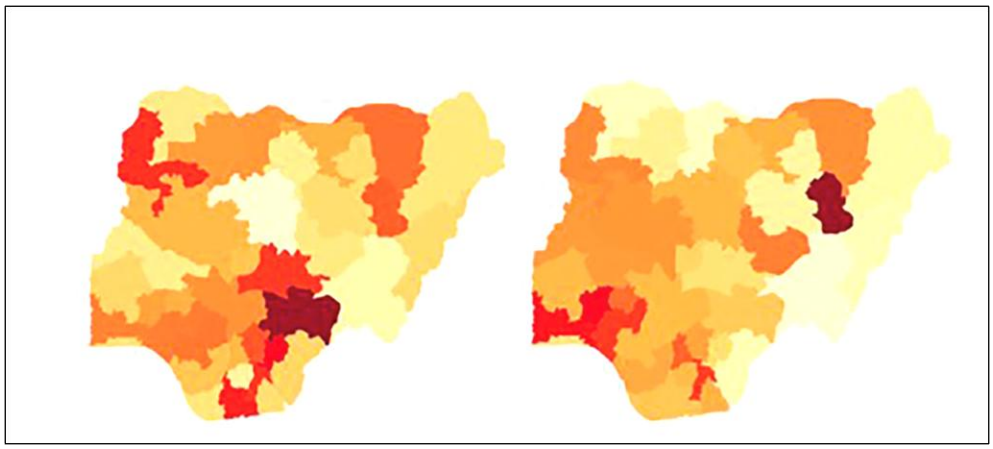
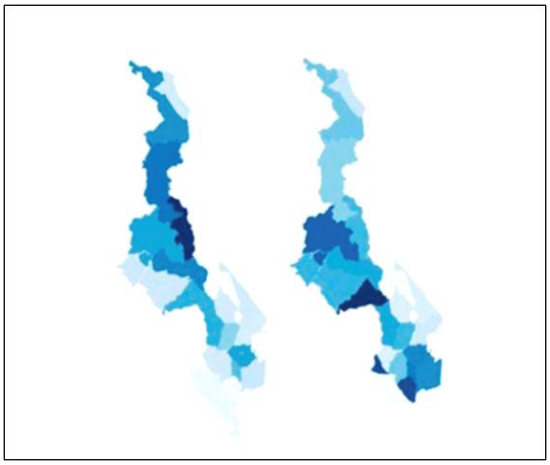


Figure 2. Malawi cluster index by territory in 2010 (left) and 2019 (right).
Dark blue indicates values close to 1.



For countries with district-level data, we aggregate districts into larger spatial units termed "territories," defined based on geographic adjacency, to calculate the Cluster Index. [3]These territories typically average around 20 to 30 per country. Specifically, territories correspond to administrative states for Nigeria, whereas they align with administrative regions in Ghana.

Figures 1 and 2 showcase choropleth maps presenting the Cluster Index distribution for Nigeria and Malawi. These maps show a slight increase in clustering over time, with heterogeneity present, as some states in Nigeria (Figure 1) and territories in Malawi (Figure 2) either become more or less clustered compared to 2010. In Malawi, we observe a shift of clustering from the north to the center/south between 2010 and 2019.

3.2.3 Night lights data

This study uses satellite-derived night-time light imagery to quantify average radiance over defined administrative areas during specific survey rounds. For each area outlined in our geographic boundaries, we extract all available VIIRS images corresponding to the time window of a given survey round. These images are combined to produce a composite representing the mean radiance over that period. This composite provides a spatial depiction of average illumination, from which we derive a single numerical value that summarizes the overall radiance of the region, expressed in nanoWatts per square centimeter per steradian (nW/cm2/sr).

Several studies provide strong methodological justification for using VIIRS night-time lights as proxies for economic activity and socioeconomic conditions. Pérez-Sindín et al. (2021) confirm the suitability of VIIRS imagery to accurately capture regional variations in economic performance, especially within middle and low-income countries. Similarly, Gibson et al. (2021) emphasize that VIIRS data significantly improves upon earlier night-time light datasets by reducing measurement error and capturing finer spatial details, particularly in less densely populated regions. Chen and Nordhaus (2019) further validate the robustness of VIIRS imagery for accurately estimating cross-sectional GDP variations, highlighting its effectiveness in capturing the relative scale and economic output across regions. Additionally, Falchetta et al. (2020) demonstrate how VIIRS data effectively monitor electrification progress and reveal disparities in infra- structure development and service reliability, particularly in contexts where traditional data are limited. Finally,

Zheng et al. (2022) illustrate methodological advances that enable VIIRS imagery to reliably detect urban expansion and land-use changes, providing precise measurements of human settlement patterns and spatial development.

The resulting composite images are archived in a standardized GeoTIFF format for further spatial analysis and visualization, and the aggregated radiance values are compiled into a dataset for statistical evaluation. By applying this consistent process across multiple survey rounds and countries, we generate a robust dataset for assessing regional variations in urban development, electrification, and socioeconomic activity.

One limitation of including the average radiance as a covariate is that observations from the VIIRS are only available from 2013 onwards. Removing the first two waves of data would significantly reduce the sample size. For this reason, we include separate regressions when analyzing night-time lights.

3.2.4 Road density estimation

Road density estimates were derived from OpenStreetMap (OSM) data retrieved through an automated query of available road network features. For each administrative or geographic unit, relevant road classes (motorways, trunk, primary, secondary, and tertiary highways) were identified and aggregated

[3] We acknowledge the potential differences in results by country when working with different administrative levels. However, this decision was taken based on data representativeness concerns. Future analyses will explore different area units.

based on official boundaries, as defined by the corresponding shapefiles. The geometry of each area was first projected to a metric coordinate reference system to ensure precise land area calculation. Road lengths, measured in meters, were then converted to kilometers, and density was expressed per 100 km2 of land.

3.2.5 Data limitations and methodological adaptations

Although established frameworks (RIMA-II, A-WEAI, WFP) support methodological rigor, data availability shaped each index's final composition. In several countries, only partial asset inventories were collected, limiting the scope of variables used in the women's empowerment index. Similarly, some social safety nets or healthcare access measures required recalibration across countries, given the unavailability of specific modules in some waves for Uganda and Tanzania. Despite these constraints, each index was carefully coded to preserve conceptual validity while maximizing cross-country comparability. The incremental adaptations—particularly in asset ownership measures for women's empowerment—were designed to minimize bias and enhance the interpretability of the results within and across national contexts.

These combined methodological steps—from aligning OSM-based road density data with survey years to building multidimensional indices of resilience, women's empowerment, and poverty—were undertaken to provide a holistic view of the spatial and socioeconomic factors that characterize households and their surrounding environments.

3.3 Econometric model specification

The primary objective of this study is to assess whether farmers' participation in commercial agriculture or MSME activities is associated with positive, inclusive development outcomes, and whether this relationship is strengthened in areas with high densities of both cSSPs and MSMEs or in regions that have experienced greater economic dynamism.

Examining these relationships requires addressing potential unobserved heterogeneity that could bias the estimates. Time-invariant, unobserved factors–such as cultural attitudes or intrinsic entrepreneurial abilities–may simultaneously influence the decision to engage in commercialization and the inclusion outcome of interest. Wooldridge (2010) noted that fixed effects models are especially effective at eliminating bias from omitted variables by differencing these constant factors. Incorporating household fixed effects allows us to control for unobserved heterogeneity that does not vary over time, while time-fixed effects capture common shocks or trends affecting all households in a given period.

We therefore employ panel data of households observed across multiple time periods and a two-way fixed effects model, which includes both household-specific and time-specific effects. [4]We examine the relationship between participation in commercial agriculture or MSME activities and inclusive development outcomes. We test this link by estimating the following regression equation for each country:

$$Yit = \alpha 1 + \beta 1 Partit + X'it\gamma 1 + W'kt\varphi 1 + \delta i + \tau t + \varepsilon it \quad (1)$$

In Equation (1) Y_{it} denotes one of the inclusion outcomes for household *i* at time *t*, such as the resilience index score, food consumption score, empowerment binary, poverty binary, log non-farm income cash, or the inclusion index. The variable $Part_{it}$ is a binary indicator equal to 1 if a household either sold any crops or operated an MSME at any time in year t and zero otherwise. The term X_{it} is a vector of time-varying control variables such as the household head's age and gender, workforce years of education, household size, dependency ratio, cultivated area (ha.) and its squared value, and the share of off-farm income (with the latter omitted when Y_{it} is log non-farm income cash). The vector W_{kt} captures the meso-level control for road density, which is calculated at the lowest administrative level possible k, in many cases, districts. The household fixed effects δ_i account for time-invariant characteristics unique to each household, and the time fixed effects τt capture common shocks affecting all households at each time period. Finally, ε_{it} is the idiosyncratic error term. As the model includes household fixed effects, we employed cluster-robust standard errors at the household level to assess inference. [5]

We then adjust Equation (1) to assess whether the link between participation in commercial agriculture or MSMEs and inclusive development outcomes is reinforced in areas with high densities of both cSSPs and MSMEs. We do so by including an interaction term between our Cluster Index and our binary participation indicator. This equation can be expressed as follows:

$$Yit = \alpha 2 + \beta 2Partit + \beta 3Cmt + \beta 4(Partit \times Cmt) + X'\gamma 2 + W'\phi 2 + \delta t + \tau t + \varepsilon it \qquad (2)$$

In Equation (2), all variables are the same as in Equation (1), while the C_{mt} term represents our territorial Cluster Index at the territorial level *m*, capturing meso conditions that are common to all households within a given time period. The interaction term $Part_{it} \times C_{mt}$ explores whether the effect of participation varies with these territorial conditions. We also estimate a similar specification, replacing the Cluster Index with the average nighttime light radiance for region *m* at $time_t$. As in Equation (2) with the cluster index, we employed robust standard errors clustered at the household level for Ethiopia, Malawi, Nigeria, Tanzania, and Uganda, and robust standard errors clustered at the enumeration area level for Ghana.

As part of our robustness checks, we implement an instrumental variable approach, using the Territorial Cluster Index as an instrument to predict participation, alongside our rich set of controls. This strategy is detailed in Equations (3a) and (3b):

$$Partit = \gamma 0 + \gamma 1Cmt + Xit'\beta + \delta i + \tau t + \varepsilon it \qquad (3a)$$

$$Yit = \alpha 0 + \alpha 1Pdartit + Xit'\beta + \delta i + \tau t + \upsilon it \qquad (3b)$$

[4] We use this panel-data specification for Ethiopia, Malawi, Nigeria, Tanzania, and Uganda. In the case of Ghana, as a pooled dataset rather than a panel dataset was available, we included enumeration area fixed effects instead of household-level fixed effects.

[5] For Ghana, we included enumeration area fixed effects and considered robust standard errors clustered at the enumeration unit.

Additional analyses include kernel-weighted local polynomial regressions, a nonparametric method employed to capture the non-linear relationship between the Cluster Index and our inclusion index across both participation groups. By comparing these curves, we can observe how the inclusion index evolves with changes in the Cluster Index, using non- participants as a counterfactual. This approach illustrates how the inclusion index would be expected to change for households that do not engage in selling crops and/or operating MSMEs as the Cluster Index increases in their territories.

While our analysis establishes robust associations between participation (selling any crop and/or owning an MSME) and various welfare outcomes, we acknowledge the potential endogeneity between these variables. Participation decisions may be influenced by unobserved household characteristics that simultaneously affect participation and welfare out- comes. Additionally, reverse causality may be at play, whereby improved welfare enables participation, rather than participation leading to improved welfare. To address these concerns, we conducted an instrumental variable (IV) analysis using our Cluster Index as an instrument for selling crops and/or owning an MSME, as a supplementary analysis. However, because we cannot rule out all potential violations of the exclusion restriction, the IV estimates should be interpreted cautiously.

IV. RESULTS

4.1 Descriptive analyses and definitions

In this study, we define "participants" as those who either sell any amount of crops (commercial), own an MSME, or both simultaneously. By participation, we intend to capture the effect of being engaged with the hidden middle and, in turn, being part of a territory with a specific density and economic activity between cSSPs and MSMEs.

4.1.1 Commercial small-scale producers and participation in output markets and/or MSMEs

Table 2 presents country-average participation measures in commercial agriculture and/or owning an MSME. These figures reveal that most small-scale producers are engaged in the output market, which is defined as selling any amount of crop produced, contrary to the conventional belief that most small producers in Africa are subsistence-oriented. On average, 48-69% of the farmers in the sample, depending on the country, engage in commercial agriculture. These values increase when we measure the percentage of farmers engaging in commercial agriculture and/or operating their own MSME. Furthermore, these crop sellers, on average across time, sell more than 20% of their production in low-income countries and over a third in middle- and high-income countries (up to half in Ghana) (See Tables B1 and B2 in Appendix B for detailed statistics by survey year and country).

Taking advantage of the panel structure, in Table B3 (Appendix B), we first limit the sample to only households present in all survey waves and analyze three groups: those who were always participants (always sold some crop and/or owned an MSME), those who never did, and those who fluctuated between participating and not throughout the survey.

Next, Table 3 provides descriptive statistics on inclusion outcomes and relevant control variables across six countries, grouped broadly by income stratum: low-income (Ethiopia, Malawi), middle-income (Tanzania, Uganda), and higher- income (Nigeria, Ghana). Starting with the inclusive development dimensions, we observe notable variations across countries. Higher-income countries like Nigeria and Ghana generally perform better across most inclusion indicators. For instance, Nigeria and Ghana report the highest resilience scores (0.43 and 0.64), average food consumption scores (49.9 in Nigeria, and not estimable for Ghana, respectively), and off-farm income rates (0.76 and 0.87), along with lower poverty headcounts (0.32 and 0.43). In contrast, Ethiopia records the weakest outcomes across most indicators, including the lowest food consumption (39.7), off-farm income rate (0.46), and one of the highest poverty rates (0.66). These patterns broadly align with the country's income levels, suggesting a correlation between structural economic conditions and household well-being.

Household-level characteristics also differ across contexts. For example, average educational attainment of the house- hold's head is lowest in Ethiopia (1.8 years) and highest in Uganda (5.6 years). At the same time, household size is generally larger in high-income countries such as Ghana (6.2 members) and Nigeria (6 members). Off-farm income shares are substantially higher in Malawi (0.8) and Uganda (0.72) compared to Ethiopia (0.16), reflecting differences in labor market diversification. Farm characteristics reveal that cultivated land area varies widely, with Ghana showing the largest average farm size (2.15 ha) and Malawi the smallest (0.57 ha). Finally, meso-level variables capturing local economic and infrastructure conditions, such as the Cluster Index, road density, and average radiance, highlight substantial heterogeneity across countries. For instance, Ghana and Uganda score highest on the Cluster Index (0.56 and 0.48). Road density is highest in Malawi (0.73), while average nightlight radiance is highest in Ghana (12.47).

4.2 Econometric findings

4.2.1 Engagement in commercial agriculture or MSME activities and wellbeing

We begin by presenting the results from estimating Equation (1) separately for each of the six countries. The dependent variable is the "Inclusion Index," which consolidates the five inclusive development outcomes discussed earlier— resilience, empowerment, poverty, food security, and non-farm employment—into a single composite measure.

Table 2. Descriptive statistics of participants, crop sellers, MSME owners, and commercialization index, time average.

Variable	Ethiopia	Malawi	Tanzania	Uganda	Nigeria	Ghana
Sells Crops (A)	0.68 (0.006)	0.48 (0.008)	0.56 (0.006)	0.69 (0.006)	0.54 (0.006)	0.69 (0.004)
Operates an MSME (B)	0.20 (0.005)	0.34 (0.008)	0.38 (0.006)	0.44 (0.006)	0.63 (0.006)	0.47 (0.005)
Sells crops (A) and/or operates an MSME (B)	0.76 (0.005)	0.64 (0.007)	0.73 (0.005)	0.83 (0.005)	0.86 (0.004)	0.86 (0.003)
Share of crops produced sold in value terms	0.24 (0.004)	0.23 (0.005)	0.44 (0.004)	0.38 (0.004)	0.42 (0.005)	0.53 (0.003)

Notes: Values represent means with standard deviations in parentheses below. The share of crops sold is conditional on selling..

Table 3. Descriptive statistics of inclusion outcomes and control variables by country. Time averages. Standard error in parentheses.

Income stratum	**Low**	**Low**	**Middle**	**Middle**	**High**	**High**
Variable	**Ethiopia**	**Malawi**	**Tanzania**	**Uganda**	**Nigeria**	**Ghana**
Inclusive Development Dimensions						
Food Consumption Score (0–112)	39.71 (0.24)	46.95 (0.32)	51.94 (0.26)	48.67 (0.27)	49.92 (0.31)	—
Resilience Index (0–1)	0.27 (0.00)	0.38 (0.00)	0.19 (0.00)	0.30 (0.00)	0.43 (0.00)	0.64 (0.00)
Empowered (0/1)	0.59 (0.01)	0.66 (0.01)	0.54 (0.01)	0.82 (0.01)	0.62 (0.01)	0.71 (0.01)
Has Off-farm Income (0/1)	0.46 (0.01)	0.88 (0.00)	0.73 (0.01)	0.85 (0.00)	0.76 (0.01)	0.87 (0.00)
Below Poverty Line (0/1)	0.66 (0.01)	0.36 (0.01)	0.55 (0.01)	0.68 (0.01)	0.32 (0.01)	0.43 (0.01)
Household-level Control Variables						
Household Head's Age	46.06 (0.23)	44.03 (0.25)	46.80 (0.20)	47.87 (0.20)	52.51 (0.21)	48.58 (0.14)
Male Head (0/1)	0.81 (0.01)	0.72 (0.01)	0.73 (0.01)	0.69 (0.01)	0.85 (0.00)	0.79 (0.00)
Avg. Education of head (years)	1.79 (0.04)	5.31 (0.06)	4.80 (0.04)	5.60 (0.06)	4.00 (0.07)	5.07 (0.05)
Dependency Ratio	3.14 (0.03)	1.19 (0.01)	1.21 (0.01)	1.83 (0.02)	1.03 (0.01)	1.16 (0.01)
Household Size	5.18 (0.03)	4.88 (0.03)	5.07 (0.03)	5.73 (0.04)	5.97 (0.04)	6.20 (0.04)
Off-farm Income Share	0.16 (0.00)	0.80 (0.00)	0.57 (0.01)	0.72 (0.01)	0.54 (0.01)	0.48 (0.00)
Farm-level Control Variables						
Cultivated Area (ha)	1.14 (0.01)	0.57 (0.01)	1.32 (0.01)	1.03 (0.01)	0.72 (0.01)	2.15 (0.02)
Meso-level Variables						
Cluster Index (0–1)	0.31 (0.00)	0.36 (0.00)	0.30 (0.00)	0.48 (0.00)	0.36 (0.00)	0.56 (0.00)
Road Density	0.11 (0.00)	0.73 (0.02)	0.40 (0.01)	0.29 (0.00)	0.35 (0.01)	0.33 (0.01)
Average Radiance	7.07 (0.02)	9.74 (0.14)	7.83 (0.08)	6.98 (0.04)	8.14 (0.09)	12.47 (0.16)

Notes: Values represent means across all survey waves with standard deviations in parentheses below. Malawi uses the lowest three deciles of the asset index as a poverty indicator. The food consumption score for Ghana could not be computed due to data constraints. Road density is measured per one hundred squared kilometers and average radiance in nanoWatts per square centimeter per steradian.

To ensure comparability across countries, the index was standardized to have a zero mean and a standard deviation of one. The key explanatory variable is a binary indicator capturing household participation in either commercial agriculture or MSME activities. Additional controls include household and household head characteristics, farm attributes, road density, and both time and household fixed effects.

Table 4 shows a positive and statistically significant association between engagement in commercial agriculture or MSME activities and higher scores on the Inclusion Index. This relationship is strongest in Nigeria and Tanzania, followed by Malawi and Ghana, and is weakest in Ethiopia and Uganda. Regarding magnitude, participation in commercial agriculture or MSME activities is associated with an increase of 0.3 and 0.2 standard deviations in the Inclusion Index in Nigeria and Tanzania, respectively. The point estimate is smaller, ranging from 0.14 to 0.16 standard deviations in Malawi and Ghana, and declines further to 0.06-0.08 standard deviations in Ethiopia and Uganda.

Most of the additional control variables display the expected signs. For example, the average years of education among working-age household members is positively associated with higher Inclusion Index scores in Malawi, Nigeria, Uganda, and Ghana. Similarly, the dependency ratio is negatively related to the Inclusion Index in Malawi, Tanzania, and Ghana. Other variables positively correlated with higher Inclusion Index scores include cultivated land area (in all countries except Ethiopia) and the share of non-farm income (in all countries except Uganda). In contrast, variables negatively associated with the Inclusion Index include the square of cultivated area (in Nigeria, Tanzania, Uganda, and Ghana) and a binary indicator for female-headed households (in Malawi, Uganda, and Ghana).

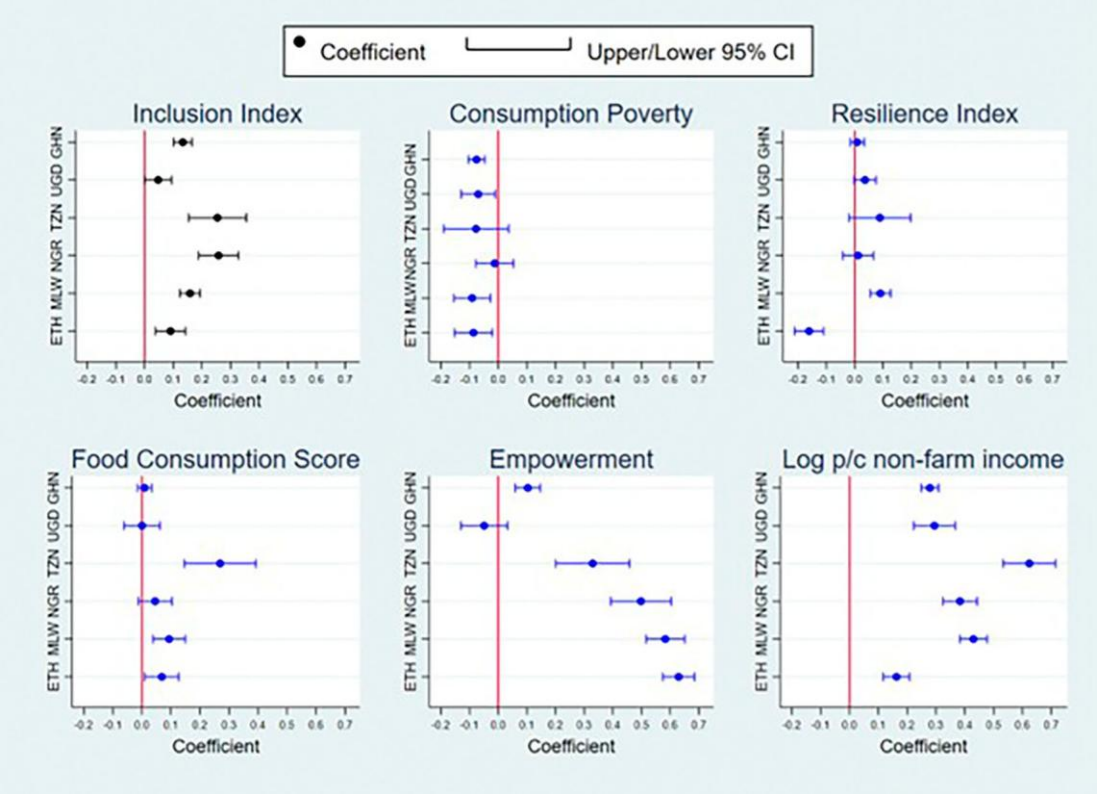
4.2.2 Breakdown results by inclusion dimension

In this subsection, we disaggregate the previous results by individual dimensions of inclusive development. As previously discussed, the Inclusion Index is a composite measure that combines five key outcomes: (i) consumption poverty, (ii) a resilience index, (iii) food consumption score, (iv) a binary indicator of empowerment, and (v) the log of per capita non-farm income. To better understand the drivers of the positive relationship between participation in commercial agriculture or MSME activities and the Inclusion Index, we re-estimate Equation (1), using each of the five inclusive development outcomes as separate dependent variables. For comparison purposes, we also report the point estimates for the Inclusion Index itself.

Figure 3 presents the point estimates and 95% confidence intervals for the association between participation in commercialization or MSME activities and each evaluated outcome. These effects are estimated separately for each country and include the complete set of control variables listed in Table 4 (further details are included in Table C1, Appendix C). The results show a positive relationship between participation and four of the five outcomes—empow- erment, non-farm income, resilience (negative in Ethiopia), and food consumption—and a negative relationship with consumption poverty. These patterns are consistent across most countries, and the estimates are statistically significant at the 95% confidence level in many cases.

For example, participation in commercial agriculture or MSME activities is associated with an increase in empowerment of 0.63 standard deviations in Ethiopia, 0.6 and 0.5 standard deviations in Malawi and Nigeria respectively, 0.36 standard between participation and improvements in food consumption and resilience, particularly in Malawi and Tanzania. A significant negative association is also observed between participation and consumption poverty in Ethiopia, Malawi, Uganda, and Ghana.

Figure 3. Two-way fixed effect regressions, inclusion dimensions on participation, household controls, by country



Notes: Each coefficient and confidence interval represents a separate two-way fixed effect regression model by country and outcome. All the outcomes were normalized to mean zero and unit standard deviation. All regressions control for characteristics of the head of the household (age and gender), the household (family size, workforce education, dependence ratio, share of non-farm income), and the farm (farm size and squared farm size), as well as for road density and household and year of survey fixed effects. In the case of Ghana, we included the same controls but used enumeration area FE rather than household FE (pooled model). We excluded the share of non-farm income as a control variable for regressions that use the log of per-capita non-farm income as the outcome variable. Cluster 95% confidence intervals at the household level are reported for all the countries but Ghana, for which we report cluster 95% confidence intervals at the enumeration area level instead.

Table 4. Two-way fixed effect regressions, inclusion index on participation, by country.

Dep. Variable: Inclusion Index	(1)	(2)	(3)	(4)	(5)	(6)
	ETH	MLW	NGR	TNZ	UGD	GHN
Commercial or/and MSME	0.081***	0.155***	0.307***	0.194***	0.061***	0.139***
	(0.028)	(0.018)	(0.036)	(0.043)	(0.025)	(0.019)
Head's age	0.005**	-0.001	0.002	0.002	0.001	-0.002***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)
Head's gender is female	-0.072	-0.180***	-0.088	-0.040	-0.230***	-0.216***
	(0.074)	(0.030)	(0.068)	(0.171)	(0.054)	(0.016)
Av. yrs of education in the workforce	-0.016**	0.035***	0.036***	0.008	0.048***	0.009***
	(0.007)	(0.004)	(0.005)	(0.008)	(0.004)	(0.002)
Dependency ratio	0.010	-0.049***	-0.019	-0.032*	0.001	-0.035***
	(0.011)	(0.009)	(0.018)	(0.017)	(0.006)	(0.007)
Household size	-0.053***	0.012	0.009	0.044***	0.001	-0.034***
	(0.010)	(0.007)	(0.009)	(0.010)	(0.006)	(0.003)
Cultivated area	0.006	0.094***	0.023**	0.052***	0.037***	0.043***
	(0.011)	(0.028)	(0.011)	(0.016)	(0.011)	(0.005)
Cultivated area (squared)	0.000	-0.004	-0.001***	-0.002***	-0.001***	-0.001***
	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)
Share of off-farm income	0.602***	0.257***	0.696***	0.306***	0.027	0.951***
	(0.059)	(0.028)	(0.038)	(0.058)	(0.027)	(0.030)
Road Density	-0.174	0.005	0.083*	-0.074*	0.074	
	(0.298)	(0.021)	(0.043)	(0.042)	(0.065)	
Constant	-0.093	-0.499***	-1.021***	-0.833***	-0.411***	-0.265***
	(0.136)	(0.081)	(0.134)	(0.122)	(0.138)	(0.028)
Observations	6,721	6,215	5,156	2,968	7,411	12,354
Year of survey FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	No
Territorial administrative unit FE	No	No	No	No	No	Yes
Cluster SE at the household- level	Yes	Yes	Yes	Yes	Yes	No
Cluster SE at the enumeration area -level	No	No	No	No	No	Yes
Number of clusters	2,511	1,770	2,243	1,484	2,149	1,497
R-squared	0.697	0.826	0.779	0.788	0.750	0.628
Adjusted R-squared	0.515	0.749	0.606	0.574	0.647	0.576
Adjusted within R-squared	0.039	0.113	0.141	0.058	0.045	0.184

Notes: The dependent variable in all regressions is the Inclusion Index, standardized to have a mean of zero and unit standard deviation. Cluster SE at the household level is in parentheses in columns (1) to (5), and Cluster SE at the region/district level is in parentheses in column
(6). Coefficients significantly different from zero are denoted by:
***p < 0.01,
**p < 0.05,
*p < 0.1.

Supplementary analyses on the quality of diets reveal that participation is associated with an increase in our Adapted Global Diet Quality Score of 0.07 standard deviations in Ethiopia, with no significant effect in Nigeria and Tanzania. This suggests that, in Ethiopia, owning an MSME and/or selling crops is not only associated with greater food security (food consumption score), but also with better quality of diets within the household.

Overall, the disaggregated analysis confirms that the positive association between participation in commercial agriculture or MSME activities and inclusive development is not driven by a single outcome but rather reflects improvements across multiple dimensions. The strongest and most consistent effects are observed for empowerment and non-farm income, with more modest but still meaningful associations for resilience and food consumption. The negative correlation with consumption poverty further reinforces the inclusive nature of these livelihood strategies. While effect sizes and significance levels vary across countries, the general pattern suggests that commercial and MSME participation can contribute to broader development goals through multiple complementary pathways.

4.2.3 Heterogeneous effects by farm size

To further explore the heterogeneity in the relationship between engagement in commercial agriculture or MSME activities and inclusive development outcomes, we disaggregate the analysis by farm size. This step is motivated by the idea that the inclusive potential of commercialization and MSMEs may differ between smaller, more subsistence-oriented farmers and those operating larger farms. Understanding whether the benefits are concentrated among a specific segment or shared more broadly across farm sizes can provide critical policy and program targeting insights.

We estimate two-way fixed effects regressions separately by country, interacting the binary indicator for participation in commercial agriculture or MSME activities with five mutually exclusive categories of cultivated land area: (i) 0–0.25 ha, (ii) 0.25–1 ha, (iii) 1–3 ha, (iv) 3–5 ha, and (v) more than 5 ha. Figure 4 displays the estimated interaction coefficients along with 95% confidence intervals for each land size category across the six countries. These coefficients reflect the association between participation and the Inclusion Index within each farm size group, allowing us to assess whether commercialization and MSME engagement's benefits vary by landholding scale.

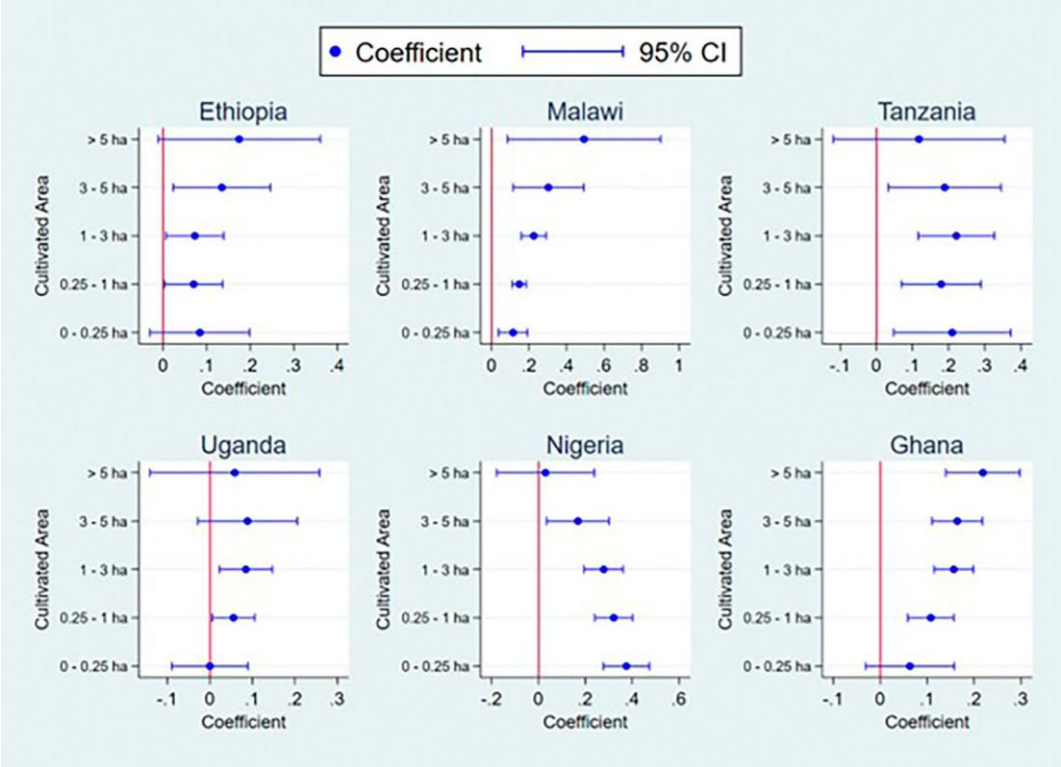
The results indicate positive associations between participation and the Inclusion Index across most farm size categories. However, the magnitude and statistical significance of these effects vary by country. In Nigeria, for example, participation in commercial agriculture or MSME activities is positively associated with inclusive development across all landholding groups except for those with more than 5 hectares of cultivated land, with the strongest effects among smaller farmers cultivating less than 3 hectares, and in some cases, even less than 1 hectare. While the differences in coefficients across size categories are not statistically significant based on the overlapping confidence intervals, the results provide suggestive evidence that small-scale farmers, in particular, stand to benefit from commercialization and MSME engagement. A similar pattern emerges in Uganda, where the association remains positive and statistically significant, especially among smallholders cultivating between 0.25 and 3 hectares.

Together, these findings suggest that engagement in commercial agriculture or MSME activities is associated with improved inclusive development outcomes across various farm sizes. Importantly, the benefits are not limited to farmers with larger landholdings. Smaller-scale farmers in several countries—particularly Malawi, Uganda, Tanzania, Ethiopia and Nigeria—experience gains, indicating that crop commercialization and non-farm entrepreneurship can serve as inclusive strategies, not just growth-enhancing ones. However, the degree to which these gains materialize is context- specific and influenced by broader country-level dynamics.

4.2.4 Heterogeneous effects by cluster context and economic activity

We now examine how the effects of commercialization and engagement with MSMEs in the hidden middle vary in contexts characterized by increasing activity and interconnection among agricultural businesses. We capture this concept using the Cluster Index. This composite measure reflects the dynamism of agrifood value chains by incorporating indicators related to the density and activity of commercial farmers, traders, and MSMEs within a given territorial unit. To assess whether changes in cluster activity influence the association of commercialization and MSME engagement on farmers' well-being, we estimate Equation (2), with results presented in Panel A of Table 5.

Figure 4. Two-way fixed effect regressions, Inclusion Index on participation x land size, by country.



Notes: Each plot represents a separate two-way fixed effects regression model estimated by country. The dependent variable is the Inclusion Index, standardized to have a mean of zero and a standard deviation of one. The main independent variables are five

interaction terms between a binary indicator for participation in commercial agriculture or MSME activities and five mutually exclusive categories of cultivated land area. In addition, the regressions control for household and farm characteristics, road density, and time and household fixed effects. The plots display the point estimates of the interaction terms along with clustered 95% confidence intervals—clustered at the household level for Ethiopia, Malawi, Nigeria, Tanzania, and Uganda, and at the enumeration area level for Ghana.

We also present similar results in Panel B using average night-light radiance instead of the Cluster Index. This alternative specification allows us to explore whether broader economic dynamism—either within the hidden middle or the broader economy—modifies or reinforces the relationship between commercialization, MSME participation, and inclusive development outcomes.

Based on Table 5 and in line with the preceding discussion, the results provide suggestive evidence that the effects of commercialization and MSME participation on inclusive development are shaped by the local economic context, particularly the density and dynamism of agrifood clusters. Panel A shows that the interaction term between the Cluster Index and participation in commercial agriculture or MSME activities is positive and statistically significant in Ethiopia, suggesting that in this country, farmers benefit more from engaging in commercialization or MSMEs when operating within dynamic agrifood clusters. It is also noteworthy that the Cluster Index alone shows a significant and positive association with the Inclusion Index in Nigeria and Malawi, which suggests spillover benefits for both participants and non-participants.

Panel B presents an alternative specification using average night-time light radiance as a proxy for local economic dynamism. Here, participation in commercialization or MSMEs remains positively and significantly associated with the Inclusion Index across all five countries except Ethiopia, with the most significant effects observed in Tanzania (0.22) and Nigeria (0.38). However, the interaction between radiance and commercialization/MSME participation is only signif- icant in Ethiopia and not robust in the other countries.

These findings highlight that the benefits of commercialization and MSME participation for inclusive development may be amplified in territorially clustered agrifood systems. Still, such complementarities are context-specific and not uniformly observed across countries.

Table 5. Composite inclusion index and participation in clusters.

	(1)	(2)	(3)	(4)	(5)
	ETH	**MLW**	**NGR**	**TNZ**	**UGD**
Panel A. *Dep. var: Inclusion Index*					
Cluster Index	0.046	0.190*	0.729***	-0.114	0.025
	(0.131)	(0.098)	(0.274)	(0.274)	(0.115)
Commercial or/and MSME	-0.039	0.226***	0.244***	0.105	0.010
	(0.054)	(0.041)	(0.076)	(0.088)	(0.056)
Cluster Index x comm/MSME	0.347**	-0.155	0.120	0.335	0.106
	(0.147)	(0.098)	(0.231)	(0.270)	(0.105)
Observations	6,721	3,795	5,156	2,968	7,402
Adj. R-squared	0.517	0.749	0.609	0.574	0.647
Panel B. *Dep. var: Inclusion Index*					
Average radiance (nighttime lights)	-0.030*	0.002	-0.004	-0.011	0.007
	(0.015)	(0.083)	(0.008)	(0.021)	(0.014)
Commercial or/and MSME	-0.129	0.136***	0.381***	0.216*	0.156**
	(0.101)	(0.030)	(0.066)	(0.131)	(0.076)
Radiance x comm/MSME	0.027**	0.002	-0.012	-0.003	-0.012
	(0.014)	(0.003)	(0.007)	(0.018)	(0.010)
Observations	6,340	4,759	5,025	2,968	5,307
R-squared	0.512	0.761	0.148	0.573	0.646

Notes: The dependent variable in all regressions is the Inclusion Index, standardized to have a mean of zero and unit standard deviation. Cluster SE at the household level in parentheses. Coefficients significantly different from zero are denoted by:
***p < 0.01,
**p < 0.05,
*p < 0.1.

4.2.5 Inclusion index by participation in the clusters

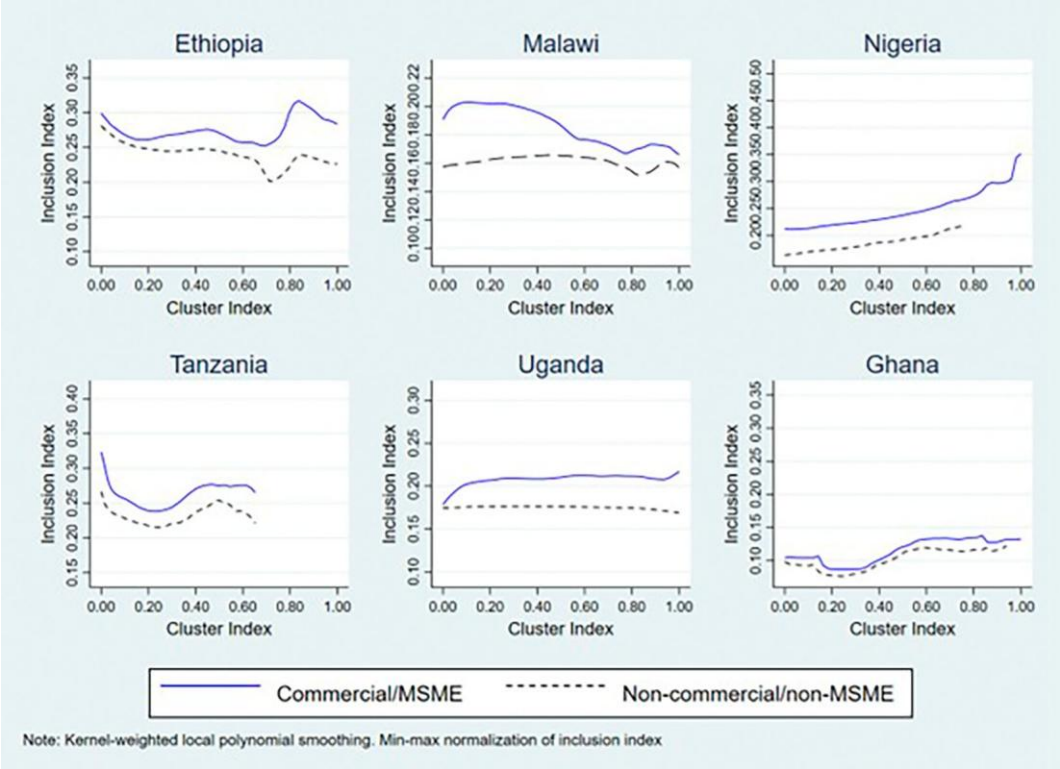
To further explore how dynamic agrifood clusters reinforce the effect of commercialization and MSME participation on farmers' well-being, we carried out a supplementary analysis based on nonparametric methods. In particular, we examined the relationship between the Cluster Index and the Inclusion Index across two distinct groups: individuals participating in commercial agriculture or engaging in MSME and those not participating in either activity. Our analysis aims to determine whether and how territorially clustered agrifood systems influence inclusion outcomes according to participation status. By examining the locally smoothed curves generated through local polynomial regression, we can explore baseline differences in inclusion outcomes between participants and non-participants. This approach allows us to capture and compare potential nonlinear patterns and localized variations in inclusion associated with cluster development among participants and non-participants.

Figure 5 reveals distinct patterns in inclusion outcomes across participants and non-participants in commercial agriculture or MSME activities as a function of the Cluster Index. In upper and middle-income strata countries like Nigeria, Uganda, and to a lesser extent, Ghana, inclusion scores steadily increase with the Cluster Index for both groups. Still, the gap between participants

and non-participants widens at higher levels of cluster activity, suggesting that dynamic agrifood clusters amplify the inclusive benefits of commercialization and MSME engagement. A similar but more moderate pattern is visible in Ethiopia, where the advantage of participants is most notable at intermediate-to-high levels of cluster development. Although both groups show relatively flat or decreasing inclusion trends across the cluster distribution in Tanzania, participants consistently exhibit higher inclusion scores, particularly in mid-range cluster contexts.

Meanwhile, Malawi displays a relatively small and inconsistent gap between groups. Overall, these nonparametric results provide visual support to the idea that agrifood clustering can reinforce the positive effects of commercialization and MSME participation. However, the strength and shape of this relationship vary significantly depending on the country's context.

Figure 5. Nonlinear relationship between cluster index and inclusion index by participation in MSME/commercial agriculture, by country.



Time Average.

4.3 Robustness checks and supplementary analysis

4.3.1 Robustness checks

We conducted two additional analyses to assess the robustness of our primary estimates. First, we examined the sensitivity of our results to alternative definitions of participation in commercial agriculture or MSME ventures. Second, we tested the robustness of our findings to the inclusion

of household-reported shocks that could directly influence both the decision to commercialize or engage in MSME activities and the inclusive development outcomes.

Table C2 (Appendix C) presents the results of the first robustness analysis, testing whether the positive relationship between participation in commercialization or MSME activities and inclusive development holds under alternative definitions of participation. Panel A replicates the baseline results from Equation (1), using a binary indicator for commercial agriculture or MSME engagement. Panels B through F then introduce alternative specifications. Panel B uses a binary indicator for commercial agriculture alone, while Panel C isolates MSME participation. Panel D simultaneously includes commercial agriculture and MSME indicators to capture their separate effects. Panel E substitutes the binary indicator with the share of agricultural output sold, providing a more continuous measure of commercialization intensity. Finally, Panel F broadens the definition to include participation in commercial agriculture, MSMEs, or input markets (e.g., purchasing or hiring labor).

Across all model specifications, the results remain consistent: participation, however defined, is positively and significantly associated with higher Inclusion Index scores in nearly all countries. Notably, MSME participation alone (Panel C) shows a stronger and more consistent association with inclusion outcomes than commercial agriculture alone, with larger and more significant point estimates across countries, especially Malawi, Tanzania, and Uganda. The MSME effect remains strong when both are included (Panel D). At the same time, the coefficient for commercial agriculture is somewhat reduced, suggesting that MSME engagement may be a more robust driver of inclusive development. The commercialization share specification (Panel E) also shows significant and positive associations, indicating that greater agricultural market orientation correlates with higher inclusion. The expanded participation definition in Panel F yields similar conclusions, with stable and significant effects across contexts.

Table C3 (Appendix C) depicts the results of the second robustness analysis, this time incorporating a binary indicator for household-reported shocks as an additional control variable. In particular, the model includes a variable denoting whether the household experienced any shock (household, agricultural, or weather-related) during the preceding 12 months, except in Tanzania, where the reference period extends to two years. This specification addresses potential omitted variable bias concerns, as exogenous shocks such as losing a primary income earner, unusually low output prices, or droughts could temporarily disrupt household participation in MSME activities or agricultural commercialization within a given survey period.

The results demonstrate that our primary findings remain robust to the inclusion of this additional control variable. The coefficients for participation across all sampled countries retain their magnitude, direction, and statistical significance, indicating that the relationship between market participation and inclusion is not substantially affected by the experience of household shocks.

Appendix D also explores the non-linear relationship between crop commercialization and the Inclusion Index. The findings suggest a concave relationship in Nigeria, with Inclusion peaking at roughly one-half of production sold, while in the other countries the relationship appears more linear.

4.3.2 Instrumental variable approach

This subsection presents our exploratory IV analysis, using the Cluster Index as an instrument for participation (selling crops and/or owning an MSME). As shown in Table 6, results remain strong and statistically significant in Ethiopia, Malawi, and Nigeria, relative to our baseline two-way fixed effects specification. The instrument demonstrates sufficient strength in these countries based on the first-stage Kleibergen-Paap F-statistics. In contrast, we find no significant effects in Tanzania and Uganda, which aligns with the weakness of the instrument in the case of Tanzania. Overall, these patterns support the robustness of our findings, where the instrument provides strong explanatory power for participation.

Table 6. Two-way fixed effect regressions, inclusion index on participation, by country. Instrumental Variables approach using the territorial cluster index as an instrument for participation.

	(1)	(2)	(3)	(4)	(5)
	ETH	**MLW**	**TZN**	**UGD**	**NGR**
Panel A: Baseline specification— Inclusion Index on participation					
Dep. var.: Inclusion Index.					
Participates (0/1)	0.081***	0.155***	0.194***	0.061***	0.306***
	(0.028)	(0.018)	(0.043)	(0.025)	(0.036)
Observations	6,721	6,215	2,968	7,411	5,156
R-squared	0.697	0.826	0.788	0.750	0.779
Panel B: IV First Stage — Participation in Territorial Cluster Index					
Dep. var.: Participates (0/1)					
Cluster Index (Territorial)	0.229***	0.250***	0.071	0.199***	0.756***
	(0.048)	(0.057)	(0.108)	(0.049)	(0.094)
Kleibergen-Paap F statistic	22.8	18.7	0.44	16.01	64.8
Observations	6,721	3,795	2,968	7,402	5,156
Panel C: IV Second Stage — Inclusion Index on Instrumented Participation					
Dep. var.: Inclusion Index					
Participates (0/1)	1.39***	0.484*	2.32	0.618	1.384***
	(0.54)	(0.28)	(4.276)	(0.436)	(0.274)
Upper 95% CI	[2.452	[1.036	[10.24	[1.47	[1.925
Lower 95% CI	0.335]	-0.069]	-5.59]	-0.233]	0.846]
Observations	6,721	3,795	2,968	7,402	5,156
Centered R-squared	-0.433	0.069	-1.45	-0.04	-0.0693

Figure 6. Gini index by high- and low-clustering.

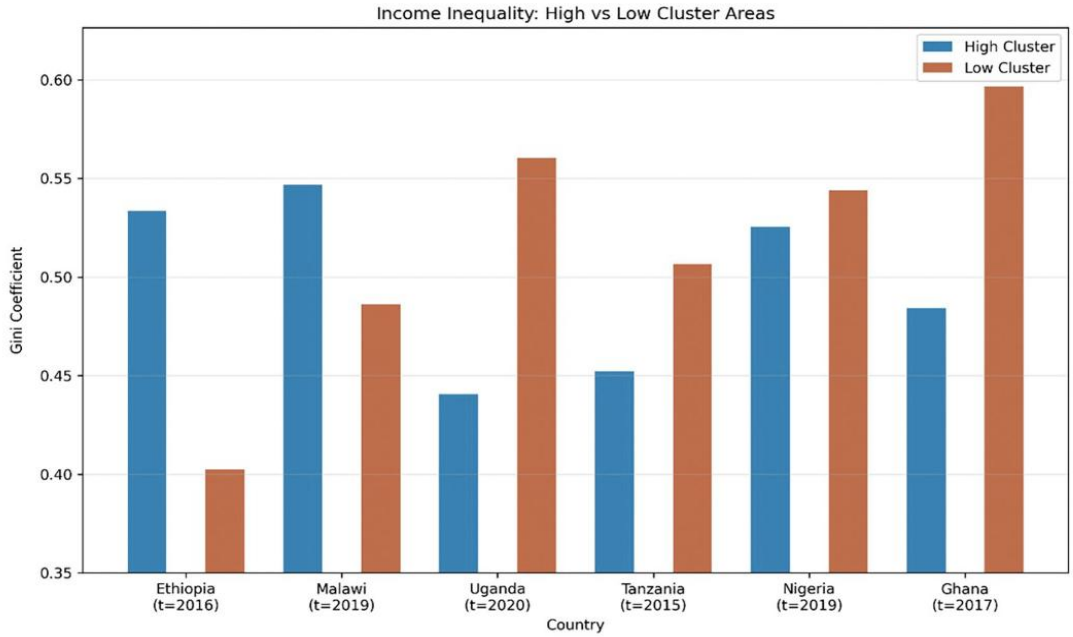
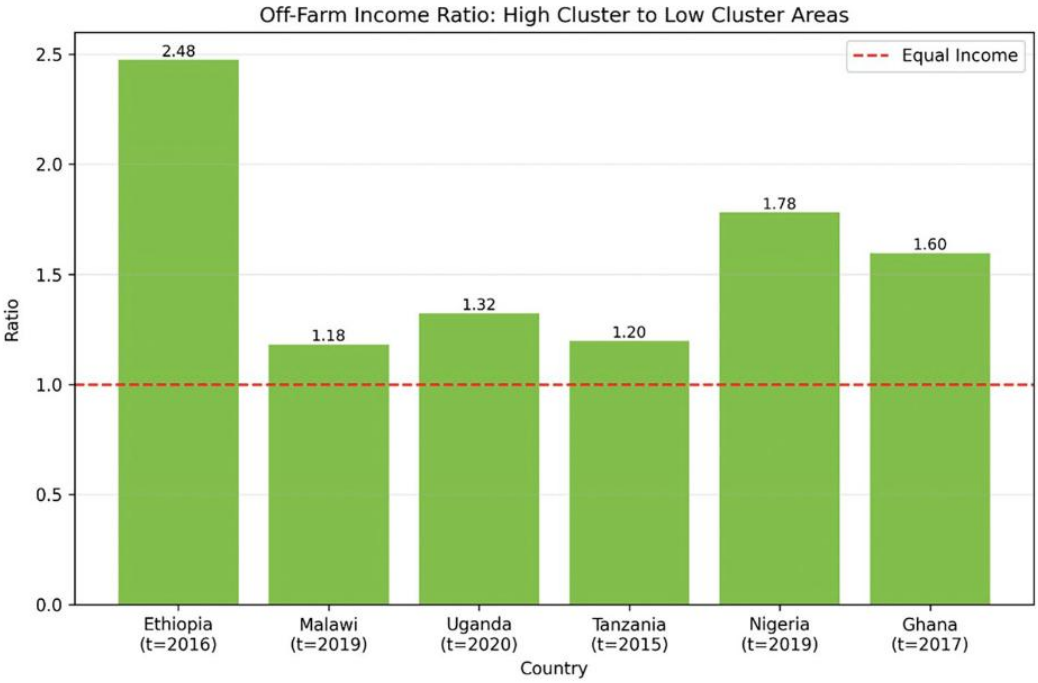


Figure 7. Off-farm income ratio: high cluster to low cluster areas.



Appendix (Table C5) reports analogous results using a Cluster Index calculated at a lower administrative level—typically districts—but due to concerns over representativeness at that scale, our primary analysis focuses on the territorial-level Cluster Index.

Several recent papers deploy spatial- or social-density instruments that parallel our cluster-index strategy for identifying the welfare effects of market participation (Krishnan & Patnam, 2014; Abdulai & Huffman, 2014; Verkaart, Munyua, Mausch, & Michler, 2017; Liverpool-Tasie, Nuhu, Awokuse, & Kabwe, 2021).

Figure 8. Poverty rates and share of MSMEs owned by women by Cluster Index at the State-level in Nigeria (2018).

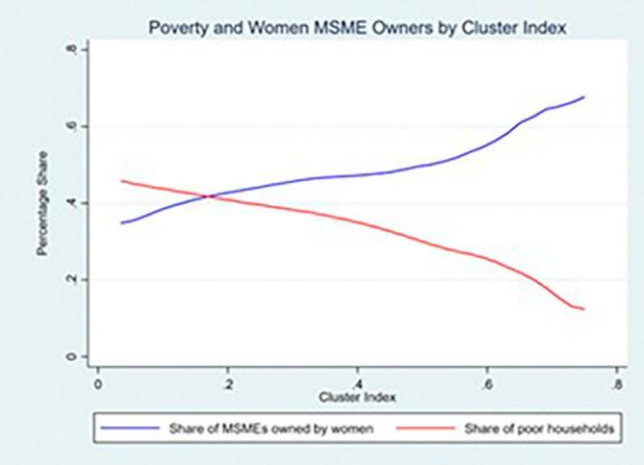
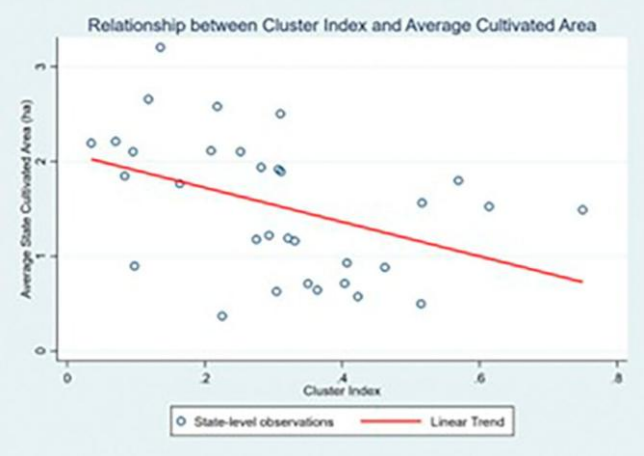


Figure 9. Relationship between Cluster Index and average cultivated area by State, Nigeria 2018.



A clear example is Liverpool-Tasie et al. (2021), who instrument the decision to sell soybeans to large mid-stream buyers with the district share of neighbouring households that grow soybeans. They argue—much as we do—that a high local producer density primarily lowers buyers' per-unit search and procurement costs, thereby raising the opportunity for individual farmers to participate while having no independent pathway to household welfare once rich agro-ecological and infrastructure controls are absorbed.

In our setting, the Cluster Index—a principal-component measure of the per-capita density of commercial small-scale producers (cSSPs), downstream agri-MSMEs, and their aggregate sales—serves as an external source of variation in market participation. The mechanism is straightforward: a higher local concentration of sellers and MSMEs lowers household search and entry costs and expands the opportunity to commercialize crops or launch a micro-enterprise. Crucially, once we control for infrastructure (road density) and other district fixed effects, the Cluster Index has weak direct channels to household welfare. Its influence on poverty status, women's economic empowerment, resilience, food- consumption scores, and off-farm income can materialize only if the household chooses to sell crops and/or operate an MSME, satisfying the exclusion restriction underpinning our IV approach.

5. DISCUSSION

5.1 Interpretation of main findings

Our analysis reveals several important insights about the relationship between participation in commercial agriculture and MSME activities, territorial conditions, and inclusive development outcomes across countries at different income levels.

First, we find consistent evidence that households, when engaged in commercial agriculture and/or operating MSMEs, experience better inclusion outcomes than non-participating households across all six countries. This result supports our first hypothesis that engagement in these activities positively contributes to well-being and inclusive development. However, the magnitude of these effects varies considerably. The strongest associations with our inclusion index are observed in Nigeria and Tanzania (0.19-0.31 standard deviations), with more modest effects in Malawi and Ghana (0.14- 0.16 standard deviations), and the smallest effect in Ethiopia and Uganda (0.06-0.08 standard deviations). This variation suggests that while participation generally yields benefits, country-specific factors influence the extent to which commercialization and MSME activities translate into improved well-being.

To address endogeneity concerns, we also conduct an additional IV analysis using the Cluster Index as an instrument. The IV results broadly confirm the positive associations between participation and inclusion outcomes in Ethiopia, Malawi, and Nigeria, where the instrument is sufficiently strong. Nevertheless, we recognize the limitations of this approach, particularly the potential violation of the exclusion restriction, as the instrument may not be entirely exogenous. In Tanzania, weak first-stage results underscore the need for caution in interpreting the IV findings.

When we disaggregate results by inclusion dimension, we find that participation most consistently and strongly affects empowerment (particularly in Ethiopia, Malawi, and Nigeria) and non-farm income generation. This finding aligns with previous findings by Hoque et al. (2020) and Noor et al. (2021) regarding the empowerment effects of entrepreneurship, especially for women. The

more modest effects on food security and resilience, alongside the negative association with consumption poverty, suggest that participation works through multiple complementary pathways to enhance well- being.

The findings by farm size highlight that the positive relationship between participation in commercial agriculture or MSME activities and inclusive development is not confined to farmers with larger landholdings. Even smallholders benefit meaningfully from these forms of engagement across several countries, notably Malawi, Uganda, Tanzania, and Nigeria. This highlights the potential of commercialization and non-farm entrepreneurship as engines of economic growth and as vehicles for broad-based inclusion. That said, the extent and consistency of these benefits vary by context, reflecting the influence of country-specific structural and institutional conditions.

Another key finding concerns the territorial dimension of inclusion. We find a significant positive interaction between the Cluster Index and participation in commercial agriculture or MSME activities in Ethiopia. In Tanzania the interaction term is also positive but not statistically significant. This indicates that the benefits of commercialization and MSME activities are amplified in territories with higher densities of commercial small-scale producers and agribusiness enterprises. This result supports our second hypothesis about the enhancing effects of territorial conditions, albeit not uniformly across all countries. The strength of this interaction in Tanzania and Ethiopia suggests that territorial synergies can substantially enhance the inclusion benefits of participation in appropriate contexts.

In contrast, Nigeria presents a different pattern: the Cluster Index shows a large positive association with inclusion outcomes regardless of participation status, while the interaction term is insignificant. This result suggests that in Nigeria, the broader territorial dynamics of agrifood clusters benefit all households, including non-participants in commercial agriculture or MSME activities, possibly through spillover effects in local labor markets and economic opportunities. This finding aligns with Trinh et al.'s (2024) work in Vietnam, which shows how enterprise growth creates employment benefits extending beyond immediate boundaries.

The different patterns observed across income strata in our additional analyses of the Cluster Index are particularly revealing. In low-income countries (Ethiopia and Malawi), high-clustered areas exhibit greater income inequality, while clusters in middle and high-income countries are associated with more equal income distribution. All this suggests that the inclusivity of agrifood clusters may evolve with broader economic development, potentially transitioning from initially exacerbating inequalities to later contributing to more equitable growth.

The consistently higher off-farm income in clustered territories (1.2 to 2.5 times higher than in less clustered areas) highlights how agrifood dynamism creates opportunities beyond farming itself. This effect is especially pronounced in Ethiopia, suggesting that clusters may be significant for generating non-farm employment in lower-income contexts even as they initially contribute to greater inequality.

For countries where smaller farms benefit less from commercialization and MSME engagement (Malawi, Ghana, Ethiopia), policies should focus on farmers with less than 1 hectare. Meanwhile,

resources should target removing broader systemic barriers to market participation in contexts like Nigeria and Uganda, where benefits are evident across farm sizes.

Finally, our finding that clustered territories across most countries have smaller average farm sizes and higher shares of women-owned MSMEs indicates that these territorial dynamics can create opportunities for traditionally marginalized groups. Commercial clusters may provide pathways for inclusion that extend beyond simple income measures to encompass structural transformation and social equity dimensions.

5.2 Policy implications

Our findings suggest several important implications for policies promoting inclusive agricultural transformation.

First, the consistent positive relationship between participation in commercial agriculture/MSME activities and inclusion outcomes across all countries supports policies that facilitate market engagement by small-scale producers and encourage entrepreneurship in rural areas. Such policies include investments in market infrastructure, business development services, and financial inclusion initiatives targeted at small-scale producers and rural entrepreneurs. Our disaggregated results suggest that programs designed to enhance women's empowerment through entrepreneurship could be partic- ularly effective, given the strong relationship between participation and empowerment measures. With our IV approach, robust causal gains emerge in Ethiopia, Malawi, and Nigeria; additional interventions may be needed in Uganda and Tanzania to convert territorial clustering into realised household benefits.

Second, the territorial dimension of our findings indicates that spatially-targeted approaches may enhance policy effectiveness. The significant interaction between territorial clustering and participation benefits in Ethiopia and Tanzania suggests that concentrating support in areas with existing agrifood dynamism could yield greater returns on investment in these contexts. However, policymakers should be mindful of the equity implications, particularly in low- income settings where clusters initially appear to exacerbate inequality.

Third, the finding that Nigeria's clusters benefit both participants and non-participants suggests that territorial approaches to agrifood development in middle and high-income contexts may generate broader spillover effects. This points to the value of area-based development programs that strengthen the overall economic ecosystem rather than focusing exclusively on direct participants in value chains. Investment in connective infrastructure and public services in these emerging clusters could help maximize these spillover benefits.

Fourth, the contrast in inequality patterns between low-income and middle/high-income clusters indicates that policy approaches should be tailored to a country's development stage. Careful attention to inclusive growth principles is needed in lower-income settings when promoting commercial clusters, potentially including preferential support for disadvan- taged groups and strengthening social capital among smaller producers. In more advanced economies, policies

focus on scaling and deepening existing cluster dynamics while ensuring continued broad-based participation.

Finally, the association between clustering, smaller farm sizes, and higher shares of women-owned MSMEs suggests that territorial agrifood development can accommodate and benefit diverse enterprise structures. Policies that recognize this diversity and support small-scale producers and micro-enterprises, rather than focusing exclusively on larger commercial farms or businesses, may be more effective at fostering inclusive transformation.

5.3 Limitations and future research directions

Our analysis cannot fully address potential endogeneity concerns despite employing panel data and fixed effects models. Unobserved time-varying factors may influence participation decisions and inclusion outcomes, and reverse causality remains possible.

To address endogeneity concerns, we implemented an instrumental variable (IV) approach using the Cluster Index as an instrument for participation. While this strategy aims to mitigate potential bias, we acknowledge its limitations, particularly the possibility that the exclusion restriction may be violated. As such, the results from this approach should be interpreted with caution.

Our Cluster Index, while innovative, captures only specific dimensions of territorial agrifood dynamism and does not directly measure interaction patterns or knowledge flows. Data limitations also restricted our analysis, with some variables unavailable for particular countries and waves.

Other territorial variables beyond our Cluster Index could enhance our understanding of inclusion dynamics. Agro- ecological zones likely influence both clustering patterns and inclusion outcomes through crop suitability and production systems. Also, climatic shocks or long-term climate variability may shape smallholders' expectations about production risks and market volatility, which in turn affect participation decisions. Incorporating these territorial dimensions could better isolate the relationship between participation (through crop selling and/or own-MSME operation) and clustering on inclusion outcomes.

Future research could employ experimental or quasi-experimental approaches to isolate causal relationships better, develop more nuanced measures of clustering that incorporate qualitative aspects, explore differential impacts across demographic groups, and examine the dynamic evolution of clusters and their inclusion characteristics over time.

6. CONCLUSION

This study investigated the relationship between participation in commercial agriculture or MSME activities and inclusive development outcomes across six African countries at different income strata. Using panel data and spatially defined measures, we tested whether engagement in

these activities contributes positively to inclusive development and whether these effects are amplified in territories with higher densities of commercial small-scale producers and agrifood MSMEs. Instrumental variable estimates, using the Cluster Index, suggest inclusion index gains of 0.5 to 1.4 standard deviations in countries where the instrument demonstrates strong explanatory power for participation.

Our findings confirm that households engaged in commercial agriculture and/or MSME activities experience signifi- cantly better inclusion outcomes than non-participating households across all countries examined. The strength of this relationship varies by country and income level, with stronger effects observed in middle and higher-income countries. When disaggregated by inclusion dimensions, participation most consistently and strongly affects empowerment and non-farm income generation, with more modest but still meaningful associations for resilience, food security, and consumption poverty.

The territorial dimension of inclusion emerges as an important mediating factor. In Ethiopia and Tanzania, the benefits of commercialization and MSME activities are significantly amplified in regions with higher MSME and cSSP density, supporting our hypothesis that territorial clustering enhances inclusion effects. In higher-income contexts like Nigeria, clustered territories benefit all households regardless of participation status, suggesting broader spillover effects of territorial dynamism.

Interestingly, the inclusiveness of these clusters evolves with economic development. In low-income countries, high- clustered areas exhibit greater income inequality, while middle and high-income countries are associated with more equitable income distribution. Across all income strata, however, clustered territories consistently generate higher off- farm incomes and opportunities for traditionally marginalized groups, as evidenced by smaller average farm sizes and higher shares of women-owned MSMEs.

These findings have important implications for inclusive agricultural transformation strategies. They suggest that approaches targeting both commercial engagement by small-scale producers and territorial clustering of agrifood activities can yield substantial benefits. However, these strategies must be tailored to each country's development stage, particularly equity considerations in lower-income settings.

In conclusion, while commercialization and MSME engagement offer pathways to improved well-being, their effec- tiveness is significantly enhanced when embedded within dynamic territorial ecosystems of concentrated agrifood activity. Future policy should therefore adopt integrated approaches that simultaneously support small-scale producer market participation and foster the development of territorially clustered agrifood systems, with careful attention to inclusivity across different farm sizes, genders, and socioeconomic groups.

Software/code

Repository: Replication code for: INCATA Working Document "Welfare and Opportunities for Small-Scale Producers and MSMEs in Rural Africa: An Econometric Analysis". Harvard Dataverse. https://doi.org/10.7910/DVN/LNGTLM

This project contains the following replication code:

- **RIMISP-Inclusion-Doc-Regressions.do:** Stata script to construct variables, estimate all econometric models, and reproduce the main tables and figures.

- **Codes-Inclusion-WD.ipynb:** Jupyter notebook with additional descriptive analyses, and figure production.

All code is made available under a Creative Commons CC0 1.0 Universal Public Domain Dedication.

Data and software availability

Underlying data

Repository: Replication Data for: INCATA Working Document "Welfare and Opportunities for Small-Scale Producers and MSMEs in Rural Africa: An Econometric Analysis". Harvard Dataverse. https://doi.org/10.7910/DVN/LNGTLM

This project contains the following underlying data:

- **EthPanel-5.dta:** Country-level panel data for Ethiopia used in all econometric analyses.

- **MalPanel-5.dta:** Country-level panel data for Malawi used in all econometric analyses.

- **TanPanel-5.dta:** Country-level panel data for Tanzania used in all econometric analyses.

- **UgaPanel-6.dta:** Country-level panel data for Uganda used in all econometric analyses.

- **NigPanel-6.dta:** Country-level panel data for Nigeria used in all econometric analyses.

- **GhaData-6.dta:** Country-level panel data for Ghana used in all econometric analyses.

- **panel_0325-2.dta:** Pooled multi-country panel dataset used for cross-country regressions and descriptive statistics.

Data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 1.0 Public Domain Dedication).

Extended data

Fuica, Andres, 2025, "Replication Data for: INCATA Working Document Welfare and Opportunities for Small-Scale Producers and MSMEs in Rural Africa: An Econometric Analysis", https://doi.org/10.7910/DVN/LNGTLM , Harvard Dataverse, V2 File name: **Annex_Tables_EXTDATA.docx**. DOI: https://doi.org/10.7910/DVN/LNGTLM . License: CC0 1.0.

Extended data include:

- **Table A1.** Pillars and indicators used for the resilience index (Access to Basic Services, Assets, Social Safety Nets, Adaptive Capacity).
- **Table A2.** Pillars and indicators of women's empowerment (production, resources, income, time).
- **Tables B1–B5.** Additional descriptive statistics on SSPs' crop sales and participation in clusters by income stratum, country and survey wave, dynamics of participation (always, never, mixed), and summary statistics by commercialization tertiles.
- **Tables C1–C5.** Additional regression results: engagement in commercial agriculture or MSME and wellbeing outcomes, robustness checks with alternative participation definitions, two way fixed effects models with and without the cluster index and shocks, and instrumental variables estimations using the district level cluster index.
- **Appendix D material.** Data used to estimate non linear relationships between the share of crop value sold and the Inclusion Index, and to construct Figure 10.

All extended data files are provided in reusable formats (for example, Excel) under a CC0 waiver. No information that can directly identify survey participants is included.

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