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Assessing the Welfare Impact of Financial Inclusion through Consumption Diversification in West Africa: A Parametric and Non-Parametric Approach

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Abstract

This study investigates the causal impact of financial inclusion on household welfare in West Africa by analyzing consumption diversification using Living Standards Measurement Study (LSMS) data from the World Bank on 51,851 households across seven countries of the West African Economic and Monetary Union (WAEMU). Instrumental Variables (IV) and Propensity Score Matching (PSM) were used for causal inference. The findings show that financial inclusion operates through distinct channels: it promotes food expenditure concentration via quality upgrading, expands non-food consumption into areas such as education and health, and induces structural reallocation from food to non-food budgets, with effects varying by financial modality. The results demonstrate that formal banking and microfinance drive long-term structural change. In contrast, mobile banking primarily facilitates short-term liquidity, offering targeted policy insights for enhancing financial inclusion strategies in the region.

JEL Classification: G21, O16, I32, D12, O55.
Keywords: Financial Inclusion, Theil entropy, consumption diversification, welfare, West Africa.

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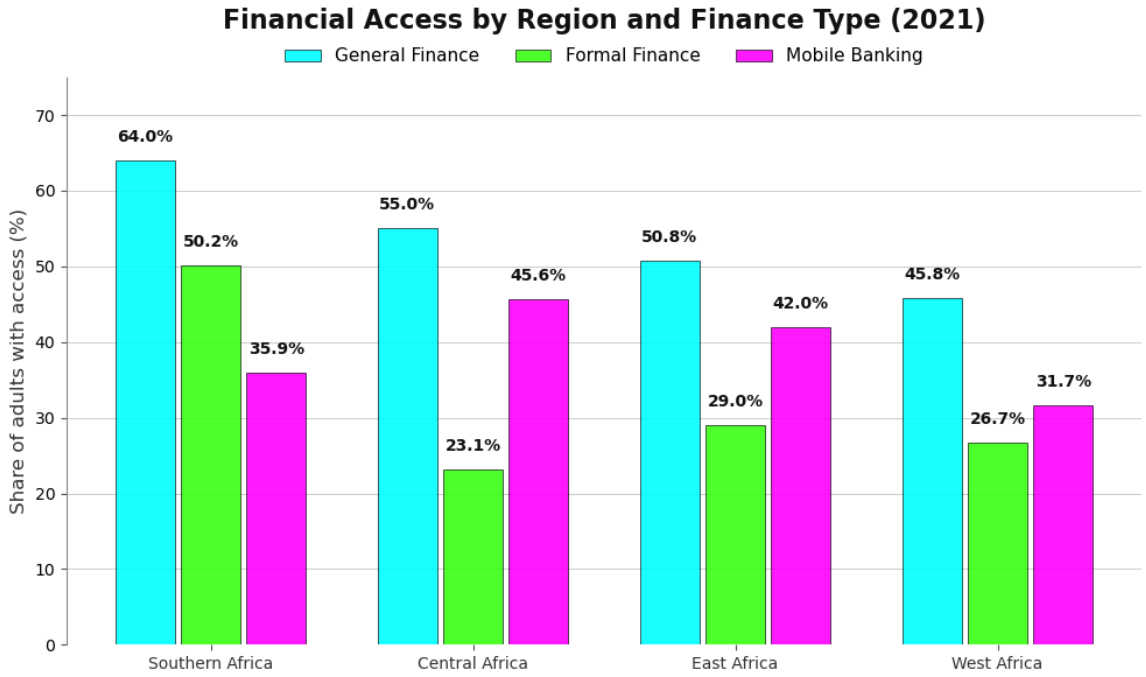
Introduction

Financial inclusion is a multidimensional concept involving access to and effective use of formal financial services (Demirgüç-Kunt et al., 2016). Its welfare implications are grounded in constrained intertemporal optimization, in which households maximize lifetime utility subject to budget constraints, credit limits, and income uncertainty (Deaton, 1991; Browning & Lusardi, 1996). In low-income settings, liquidity and credit constraints force consumption to closely track volatile income and skew spending toward immediate subsistence needs, primarily food. Financial inclusion relaxes these constraints by expanding the household choice set, enabling consumption smoothing and re-optimization of intratemporal expenditure. This shift predicts structural changes in the consumption basket—from food to non-food and from quantity to quality—which this study empirically investigates. Despite global progress, financial exclusion remains severe, with Sub-Saharan Africa lagging substantially and West Africa recording the lowest access rates (World Bank, 2022), motivating a focused assessment of its welfare effects.

Although a growing literature examines financial inclusion and welfare, key gaps remain for West Africa. Macro-level studies using bank branch density or aggregate credit obscure household heterogeneity and demand-side mechanisms (Park & Mercado, 2015; Inoue, 2018; Schubert, 2019), while micro-level studies in Sub-Saharan Africa primarily evaluate welfare using aggregate outcomes such as total income, total consumption, or poverty status (Atieno & Mwangi; Mohammed et al., 2017; Ofori-Abebrese et al., 2020). Even recent evidence on nonlinear and modality-specific effects of digital finance (Sulemana et al., 2025; Ahmat-Tidjani, 2025) continues to focus on aggregate welfare, overlooking how financial access reshapes the internal structure of consumption across food and non-food categories and financial modalities. Against this background, this study makes three contributions. First, it shifts the focus from aggregate welfare to the internal structure of consumption by employing Theil entropy indices to decompose diversification within and between food and non-food budgets. Second, it disaggregates financial modalities to demonstrate heterogeneous effects, showing that banks and microfinance drive long-run structural reallocation, while mobile banking facilitates short-term liquidity. Third, it employs a leave-one-out peer-group instrument to identify peer-driven financial inclusion, delivering Local Average Treatment Effects and providing rare multi-country evidence for the underexplored WAEMU region.

Figure 1: Access to Finance by region across Africa



Sources: Created by the author from the Findex 2021 data.

Theoretical Framework: Financial Access and the Structure of Household Consumption

The theoretical foundation of this study is based on the intertemporal consumption–savings framework, in which households maximize lifetime welfare subject to income risk, liquidity limitations, and binding credit constraints (Friedman, 1957; Modigliani & Brumberg, 1954). In low-income environments, these constraints compress households into short-horizon, subsistence-oriented consumption choices, limiting reallocation across time and categories. Financial inclusion relaxes these frictions by expanding access to formal financial services (Demirgüç-Kunt & Klapper, 2012; Dupas & Robinson, 2013), thereby altering both the level and internal structure of consumption. To formalize these mechanisms, consider a household that maximizes the expected present discounted value of utility from food C_t^F and non-food C_t^N consumption over a finite horizon:

$$\max_{\{C_t^F,\, C_t^N,\, A_{t+1}\}} \mathbb{E}_0 \sum_{t=0}^{T} \beta^t \, U(C_t^F, C_t^N)$$

where $\beta \in (0,1)$is the subjective discount factor and $U(\cdot)$is increasing and concave. The intertemporal budget constraint is:

$$A_{t+1} = (1+r)(A_t + Y_t - C_t^F - C_t^N - \tau(I_t)) + \Gamma(I_t)$$

where $A_t$denotes asset holdings, $r$is the risk-free interest rate, and $Y_t$is stochastic income. Financial inclusion status $I_t \in \{0,1\}$governs access to financial services and affects two components of the constraint set. The term $\tau(I_t)$represents transaction costs. Financial inclusion substantially reduces these costs, such that $\tau(1) \ll \tau(0)$, by lowering spatial, time, and risk-related costs associated with saving, payments, and transfers. Financial access also

expands the opportunity set through $\Gamma(I_t)$: when included, $\Gamma(1) \geq 0$reflects secure savings, potential credit access, and enhanced risk management, whereas under exclusion $\Gamma(0) = 0$. The household may further face a liquidity constraint:

$$A_t \geq -L(I_t)$$

where $L(1) > L(0) \geq 0$, indicating that financial access relaxes borrowing limits relative to near-zero liquidity under exclusion. This structure provides clear implications for consumption allocation. Reductions in transaction costs and expansions in financial opportunity enable households to re-optimize intratemporal expenditure by concentrating food spending on fewer, higher-quality items as subsistence constraints relax, accumulating savings for lumpy non-food expenditures such as education and health, and reallocating budgets from food toward non-food goods in a manner that depends on the depth of financial intermediation. This process is consistent with Engel's Law (1857), whereby the food budget share declines as economic capacity rises, formalized by Deaton (1997). Financial inclusion is interpreted as the institutional mechanism that enables this transformation by relaxing liquidity and transaction constraints. As a result, financial access is expected to induce food quality upgrading and non-food portfolio expansion. Consumption diversification is measured using Theil entropy indices (Theil, 1967), which capture expenditure dispersion across categories. The analysis distinguishes food, non-food, and between-group diversification to separately identify stabilization, expansion, and structural reallocation effects, leading to the three hypotheses below.

H1 (Food Quality-Upgrading Channel).
Financial inclusion reduces food expenditure entropy by enabling households to concentrate spending on fewer, higher-quality staples under relaxed liquidity constraints, rather than broadening food variety.

H2 (Non-Food Capability-Expansion Channel).
Financial access causally increases non-food consumption diversification as households expand expenditure into welfare-enhancing categories such as education, health, and housing, thereby strengthening long-run resilience.

H3 (Structural Reallocation Channel).
The ability of financial inclusion to reallocate household budgets from food to non-food consumption depends on the depth of intermediation: banks and microfinance drive this shift, whereas mobile money has negligible structural effects.

Literature Review

The literature on financial inclusion and welfare is grounded in intertemporal consumption theory and broader capability-based welfare frameworks. The Permanent Income and Life-Cycle Hypotheses (Friedman, 1957; Modigliani and Brumberg, 1954) posit that access to savings and credit enables households to smooth income shocks and stabilize consumption over time, while experimental micro-evidence confirms that relaxing liquidity constraints stimulates productive investment and income growth (Dupas and Robinson, 2013). Sen's Capabilities Approach (1985) further extends this framework by shifting welfare evaluation from income levels to the expansion of real choices, resilience, and economic security. Within this space, Chakrabarty and Mukherjee (2022) operationalize consumption diversification using Theil entropy indices for India, showing that financial inclusion induces a structural

reallocation of expenditure from food to non-food goods, interpreted as a qualitative welfare improvement. A second strand examines financial inclusion using macro and regional panel data, with emphasis on digital finance. Geng and He (2021) show that digital financial inclusion increases employment across Belt and Road economies, while Sun et al. (2023) and Dong et al. (2023) link financial development to broader indicators such as energy use and "high-quality" growth. For Latin America, Roa (2015) documents widening access but persistent inequality in usage. In Sub-Saharan Africa, Mohammed et al. (2017) find that financial inclusion reduces poverty across thirty-eight countries, with larger gains among poorer households. However, these macro studies rely on aggregate inclusion indices and macro-level instruments, such as legal origins or system-GMM, which are weakly connected to household-level behavioural mechanisms and provide limited insight into how financial inclusion translates into changes in household consumption structure.

A third, micro-level strand focuses on African households and reveals heterogeneous welfare effects across instruments and contexts. In Ghana, Iddrisu and Danquah (2021) show that formal financial inclusion raises household income and consumption, with disproportionately large gains for poorer households. In Burkina Faso, N'dri and Kakinaka (2020) find that both formal finance and mobile money reduce poverty and improve non-monetary welfare—including nutrition, health, and education—especially in rural areas where banking infrastructure is thin. Amendola et al. (2016) report that access to credit in Mauritania increases non-durable consumption and education spending, while Bocher et al. (2017) document that credit improves food security and total consumption among rural Ethiopian households. Manja and Badjie (2022), using Gambian data, highlight that formal and informal finance can simultaneously raise income and non-food consumption yet lower subjective welfare due to psychological and financial burdens. More recent Sub-Saharan African evidence underscores the complexity of digital finance: Sulemana et al. (2025) show that digital saving strengthens financial resilience, whereas digital borrowing weakens it, and Ahmat-Tidjani (2025) finds nonlinear threshold effects of financial inclusion on consumption across twenty-eight countries. Parallel work on the determinants of inclusion identifies education, income, gender, and digital and physical infrastructure as key drivers of both bank and mobile money adoption (Zins and Weill, 2016; Lotto, 2018; Okoroafor et al., 2018). Within the West African Economic and Monetary Union (WAEMU), Oumarou and Celestin (2021) document similar determinant patterns, but their focus remains on who is financially included rather than on the downstream welfare mechanisms of inclusion.

Methodology

Construction of Consumption Diversification Measures

Following Chakrabarty and Mukherjee (2021), I constructed three Theil entropy indices: expenditure diversity in food, in non-food, and between food and non-food groups, to capture different dimensions of household consumption diversity. These indices are computed from household-level expenditure shares and provide a measure of how evenly consumption is distributed across various items. Below is the framework of the Theil indices. Let (E_{ik}) denote the proportion of total household expenditure by household (i) allocated to item (k), where the sum over all (k) in the relevant group equals 1. The general entropy index is defined as:

$$D_i = -\sum_k E_{ik} * log(E_{ik})$$

This index takes a value of 0 when all expenditure is concentrated in a single item and reaches a maximum of log(n) when the household spreads spending equally across (n) items. In this study, food items were classified into 10 subcategories, and non-food items were also classified into 10 subcategories. These classifications were based on the United Nations International Classification of Individual Consumption According to Purpose (COICOP) used in the LSMS data, with only minor adjustments made during the analysis to ensure cross-country consistency. The entropy indices for consumption diversification of food items, non-food items, and between (entropy) food and non-food items were respectively computed using the equations below:

$$D_i^F = \left(\frac{E_i^F}{E_i}\right) \times \left[-\sum_{f=1}^{10} s_{if} \cdot \ln(s_{if})\right]$$

Where:
D_i^F is the Theil index of food consumption diversification for household *i*
E_i^F is the total food expenditure of household *i*
E_i is the total food and nonfood expenditure of household *i*
s_{if} is the share of food item *f* in the food expenditure of household *i*

$$D_i^N = \left(\frac{E_i^N}{E_i}\right) \times \left[-\sum_{n=1}^{10} s_{in} \cdot \ln(s_{in})\right]$$

Where:
D_i^N is the Theil index of non-food consumption of household *i*
E_i^N is the total non-food expenditure of household *i*
E_i is the total food and nonfood expenditure of household *i*
s_{in} is the share of non-food item *n* in the household's non-food budget

$$D_i^B = \left(\frac{E_i^F}{E_i}\right) \cdot \ln\left(\frac{E_i^F}{E_i}\right) + \left(\frac{E_i^N}{E_i}\right) \cdot \ln\left(\frac{E_i^N}{E_i}\right)$$

Where
D_i^B is the Theil index across food and non-food consumption (between-group entropy). This captures the structural shift of household consumption between food and nonfood items. Although there are other measures of inequality, such as the Gini coefficient, I choose entropy-based measures due to certain methodological advantages. The Theil entropy index was introduced by Henri Theil (1967) to measure income inequality using the concept of information theory. The Theil index directly captures intra-household allocation patterns, which are decomposable into within- and between-group components, and are more sensitive to shifts across the entire distribution. This makes it more suitable for consumption diversification analyses. To proxy for household wealth, I constructed an asset index on 43 types of household assets from the data. These include items like televisions, refrigerators, mobile phones, motorcycles, land, houses, etc. A binary indicator for ownership (1 if owned, 0 otherwise) was created for each household. The final index was computed as the unweighted average of all 43 binary ownership indicators, resulting in a score between 0 and 1, where higher values indicate greater asset ownership. The index was constructed as below:

$$\text{Asset Index}_h = \frac{1}{N}\sum_{i=1}^{43} A_{ih}$$

Where:
Asset Index$_h$ is the asset index score for household *h,* A_{ih} is a binary variable that equals 1 if household *h* owns asset *i*, and 0 otherwise, **N** is the total number of asset types included in the index (in this study, N = 43).

Instrumental Variables (IV) Approach

Establishing a causal relationship between household financial access and consumption diversification is subject to standard endogeneity concerns. Access to financial services is not randomly assigned and is likely jointly determined with income, preferences, financial literacy, and the local economic environment, which could bias conventional estimates. To address these challenges, this study employed a two-stage least squares (2SLS) instrumental variable (IV). A valid IV must satisfy relevance and the exclusion restriction. In spatially clustered low-income environments such as West Africa, commonly used external instruments based on geographic proximity or infrastructure are intrinsically correlated with local development and market integration, making the exclusion restriction difficult to justify. I therefore exploit within-cluster peer variation using a leave-one-out (LOO) cluster-level financial inclusion rate as a source of quasi-exogenous variation. For each household *i* in cluster *c*, the LOO instrument is defined as the mean financial inclusion status of all other households in the same cluster, excluding household *i*. This construction eliminates simultaneity between the individual household's financial decision and the instrument. The approach is grounded in the peer-effects and social-interactions literature (Angrist, 2014; Lin, 2010; Sacerdote, 2001; Bramoullé et al., 2009; De Giorgi et al., 2010).

Instrument relevance follows from the localized nature of financial service provision in rural and semi-urban West Africa. The placement of banks, microfinance institutions, and mobile money agents is spatially concentrated, and adoption is shaped by peer exposure, information spillovers, and shared transaction costs. As a result, peer financial participation predicts individual take-up. First-stage regressions confirm this empirically: the LOO instrument is highly significant across bank accounts, microfinance access, and mobile banking usage, with first-stage F-statistics exceeding conventional weak-instrument thresholds of 10. The key identifying assumption is that, conditional on observables, cluster-level peer financial inclusion affects household consumption diversification only through the household's own financial participation. Threats arise if peer financial inclusion is correlated with unobserved local development or infrastructure that directly influences consumption. To address this possibility, the specification includes an extensive set of household-level and local controls capturing wealth, service access, and market integration, including the household asset index, electricity and piped water access, paved roads, access to market, hospital availability, urban–rural location, demographic composition, and head-of-household education and employment characteristics. Country fixed effects absorb all time-invariant national heterogeneity in macroeconomic conditions, institutional quality, regulatory environments, and financial system development. Under these assumptions, the 2SLS estimates using the LOO instrument identify a local average treatment effect (LATE) of financial inclusion on consumption diversification for households whose participation is influenced by peer exposure within their local cluster. The LOO instrument is defined as:

$$Z_{ic} = \left(\frac{1}{n_c - 1}\right) \sum_{j \neq i} FI_{jc}$$

Where:

Z_{ic} is the LOO instrument computed from the average financial inclusion status in cluster *c* for household *i,* FI_{jc} is a binary financial inclusion indicator for household j , and n_c is the number of households in a cluster c . This approach captures exogenous variation in access to financial services at the local level while avoiding reflection bias.

Two-Stage Least Squares Specifications

In the first stage, household financial inclusion is instrumented using the leave-one-out (LOO) cluster-level financial inclusion rate. Three separate first-stage regressions were estimated—one for each financial inclusion indicator (bank account ownership, microfinance access, and mobile banking)—in which the respective endogenous financial inclusion variable was regressed on the LOO instrument and the full set of controls. Two complementary fixed-effects structures were estimated to capture different dimensions of identifying variation.

(1) Country and Infrastructure Fixed Effects (Baseline Specification).
In this specification, the first stage includes the LOO instrument, the vector of household controls, country fixed effects, and detailed local infrastructure controls (market access, hospital availability, paved roads, electricity, urban–rural location, head-of-household characteristics). The first-stage equation is:

$$FI_i = \alpha + \pi Z_{ic} + X_i'\delta + \theta_c + \varepsilon_i$$

where FI_idenotes household *i*'s financial inclusion status, $Z_{ic}$is the LOO instrument (mean financial inclusion of all other households in cluster *c*), X_i is the vector of household-level controls, α is the intercept, π is the coefficient on the instrument, δ is the coefficient vector on controls, $\theta_c$represents country and infrastructure fixed effects, and $\varepsilon_i$is the first-stage error term. This design absorbs cross-country differences and systematic local development factors that may otherwise violate the exclusion restriction.

(2) Cluster Fixed Effects (Within-Cluster Specification).
To isolate identification from purely within-cluster peer variation, a second specification replaces country and infrastructure fixed effects with cluster fixed effects:

$$FI_i = \tilde{\alpha} + \tilde{\pi} Z_{ic} + X_i'\tilde{\delta} + \mu_c + \varepsilon_i$$

where $\mu_c$denotes enumeration-area fixed effects (cluster). This specification eliminates all between-cluster variation—including geographic access, institutional and infrastructure availability, ensuring that identification comes exclusively from peer-driven within-cluster variation. Across both specifications, the fitted values $\widehat{FI}_i$ capture the component of financial inclusion driven by quasi-exogenous peer exposure. In the second stage, household consumption diversification is regressed on the predicted financial inclusion variable from the corresponding first-stage specification. Three sets of second-stage regressions are estimated (food entropy, non-food entropy, and between-group entropy), each for the three financial inclusion measures:

Country + Infrastructure FE specification:

$$D_i = \beta_0 + \beta_1 \widehat{FI}_i + X_i'\gamma + \theta_c + u_i$$

Cluster FE specification:

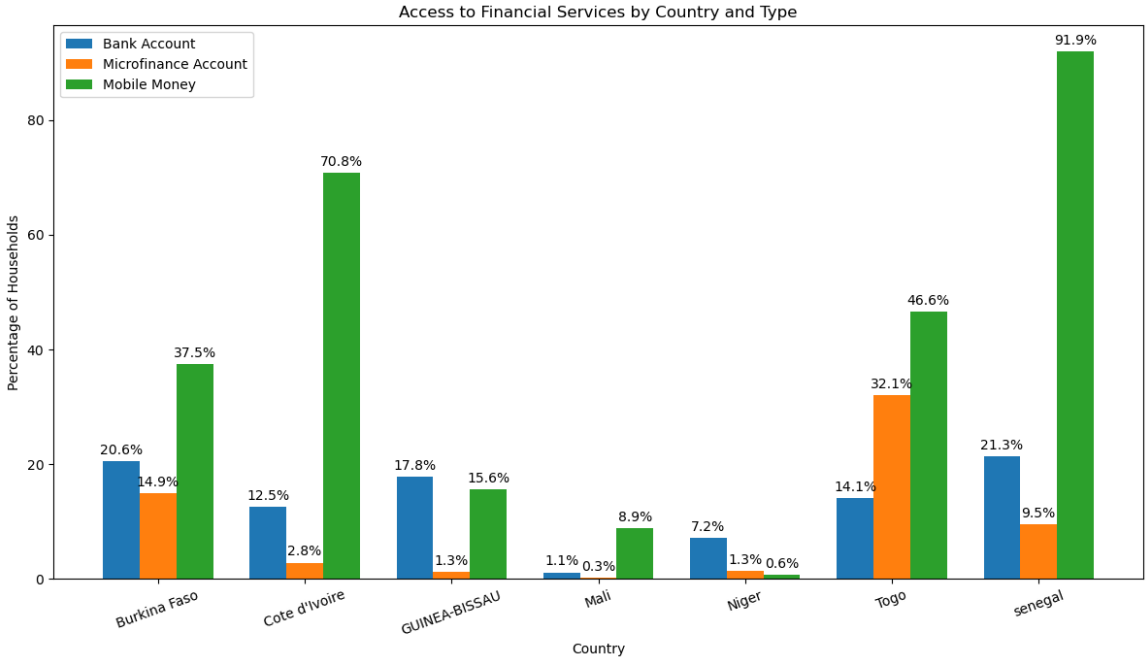
$$D_i = \tilde{\beta}_0 + \tilde{\beta}_1 \widehat{FI}_i + X_i' \tilde{\gamma} + \mu_c + u_i$$

where $D_i$denotes the Theil consumption diversification indices (food, non-food, between-group), $X_i$is the full set of household controls, and fixed effects correspond to the specification used in the first stage. Standard errors are clustered at the enumeration-area level to account for within-cluster correlation. The country-and-infrastructure FE specification is the study's main identification strategy, as the hypotheses and theoretical framework concern structural mechanisms that operate across communities rather than exclusively within clusters. The cluster FE specification is therefore estimated as a complementary robustness check that restricts identification to within-cluster contrasts and yields more conservative magnitudes.

Data Description

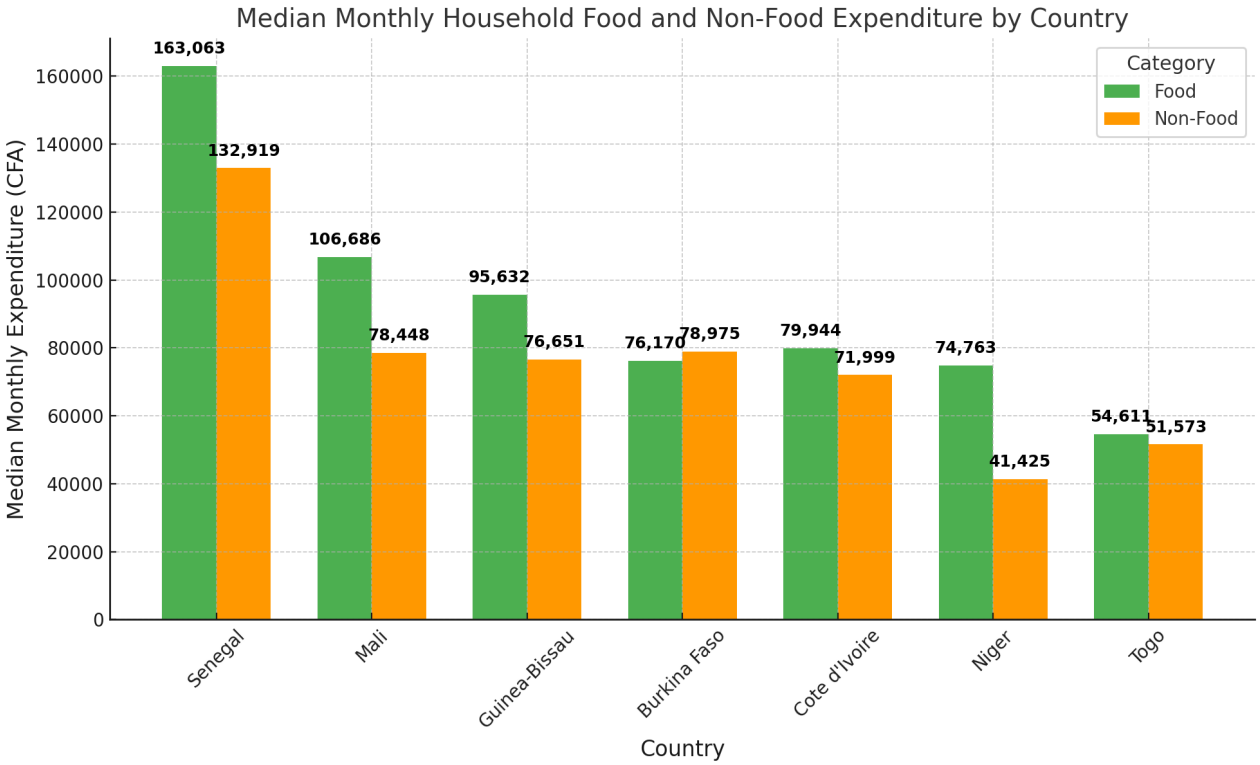
I used the World Bank's 2022 Living Standards Measurement Study (LSMS) data from seven West African Economic and Monetary Union (WAEMU) countries. The data are nationally representative and provide information on household demographics, education, consumption, expenditure, financial access, and community infrastructure. After cleaning and harmonization, the pooled sample contains 51,851 households across Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo. Financial inclusion is measured using three LSMS indicators: ownership of a formal bank or post office account ("Est-ce que [NOM] possède un compte dans une banque classique ?"; "…dans une poste ?"), participation in microfinance ("…dans une Caisse rurale d'épargne, IMF ?"), and use of mobile banking ("Est-ce que [NOM] fait du Mobile Banking ?"), each coded as a binary variable; [NOM] denotes the referenced household member. Access to financial services varies widely across countries. Bank account ownership ranges from 1.1% in Mali to over 20% in Senegal, while microfinance participation is highest in Togo (32.1%) and very limited in Mali, Guinea-Bissau, and Niger. Mobile money usage is widespread in Senegal (91.9%) and Côte d'Ivoire (70.8%) but remains low in Niger and Mali. Households average 6.25 members, 57% reside in rural areas, and formal educational attainment is low. Access to basic infrastructure such as electricity and piped water also varies substantially, underscoring significant heterogeneity in household welfare conditions across the WAEMU region.

Figure 2: Financial access by country



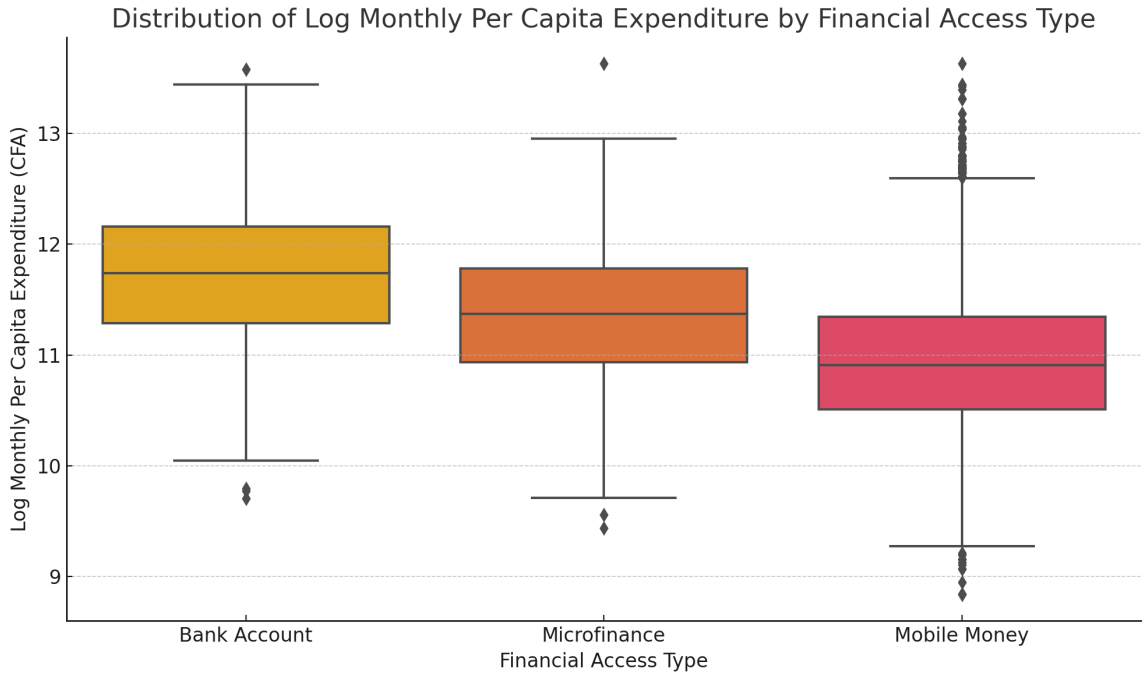
Sources: Created by the author based on the Living Standard Measurement Survey 2022 data

Figure 3: Monthly Household Food and Non-food Expenditure by Country



Sources: Created by the author based on the Living Standard Measurement Survey 2022 data

Figure 4: Log monthly per capita household expenditure by financial access type



Source: Created by author based on the Living Standard Measurement Survey 2022 data

Table 1: Summary Statistics

Variable	Definition	N	Min	Mean	Std Dev	Max
Dependent Variables						
Food consumption diversification	Theil food consumption diversification index	51,851	0	0.845	0.346	2.008
Non-food consumption diversification	Theil non-food diversification index	51,851	0	0.602	0.258	1.635
Between-group diversification	Between-component Theil index	51,851	0	0.536	0.208	0.693
Financial Inclusion Indicators						
Bank account	1 if household has formal bank account	51,851	0	0.136	0.342	1
Mobile money account	1 if household uses mobile banking services	51,851	0	0.441	0.496	1
Microfinance account	1 if household has microfinance account	51,851	0	0.084	0.278	1
Household Socioeconomic Controls						
Asset index (0–1)	Proportionate asset ownership score	51,851	0	0.132	0.082	0.667
Internet connection	1 if household has internet access	51,851	0	0.021	0.143	1
Head literate	1 if head can read/write	51,851	0	0.5	0.5	1
Secondary education (head)	1 if head completed secondary education	51,851	0	0.167	0.373	1
Tertiary education (head)	1 if head completed tertiary education	51,851	0	0.057	0.232	1

Piped water available	1 if nearest water source is piped	51,851	0	0.343	0.475	1
Concrete dwelling	1 if main structure is concrete	51,851	0	0.423	0.494	1
Household size	Number of household members	51,851	1	6.25	4.001	60
Dependency ratio	Dependents ÷ working-age members	51,851	0	0.732	0.851	20
Children under age 6	Number of children <6 years	51,851	0	1.75	2.876	39
Electricity access	1 if grid/clean electricity available	51,851	0	0.528	0.499	1
Head employed	1 if household head is employed	51,851	0	0.875	0.331	1
Employed in agriculture (head)	1 if employment in agriculture	51,851	0	0.48	0.5	1
Employed in services (head)	1 if employment in services	51,851	0	0.304	0.46	1
Community & Infrastructure Controls						
Urban residence	1 if in urban area	51,851	0	0.428	0.495	1
Paved road available	1 if paved road exists nearby	51,851	0	0.367	0.482	1
Periodic market available	1 if weekly/occasional market exists	51,851	0	0.358	0.479	1
Permanent market available	1 if permanent market exists	51,851	0	0.382	0.486	1
Travel time to periodic market	Minutes to nearest periodic market	51,851	0	46.967	372.819	240.00
Travel time to permanent market	Minutes to nearest permanent market	51,851	0	56.066	480.389	300.00
Hospital available	1 if hospital exists nearby	51,851	0	0.327	0.469	1

First Stage IV Results

The first-stage regressions in Table 2 evaluate the strength of the leave-one-out (LOO) peer mean instrument in predicting household financial inclusion in the pooled sample. Specifically, each financial inclusion indicator—bank account ownership, mobile banking usage, and microfinance participation—is regressed on its corresponding LOO instrument while controlling for household socioeconomic characteristics, infrastructure, and geographic factors. The first-stage results from the specification with country fixed effects and infrastructure controls demonstrate very strong instrument relevance, with F-statistics of 402.6 for bank accounts, 1,418.0 for mobile banking, and 151.8 for microfinance, all exceeding the conventional weak-instrument threshold of 10. The alternative specification with cluster fixed effects yields similarly strong or even stronger first-stage relationships, with F-statistics of approximately 2,251 for bank accounts, 2,790 for mobile banking, and 1,682 for microfinance, and these results remain robust across the urban and rural subsamples, where F-statistics consistently exceed 700. Across both specifications, the estimated instrument coefficients are highly precise with relatively small standard errors, confirming that local peer financial participation is a powerful predictor of individual financial access. Because each endogenous financial inclusion variable is instrumented with a single excluded instrument, the IV system is exactly identified, and overidentification tests such as the Hansen

J test are not applicable. Under exact identification, instrument validity must be justified on theoretical and institutional grounds, while weak-instrument concerns are appropriately assessed through the first-stage F-statistic, which is consistently large across all specifications.

Table 2: First-Stage IV Estimates for Financial Inclusion (Cluster FE and Country+Infrastructure FE Specifications)

Treatment	Sample	IV (C+Infra FE): Instrument (SE)	F-stat (C+I)	R^2 (C+I)	IV (Cluster FE): Instrument (SE)	F-stat (Clust.)	R^2 (Clust.)	N
Bank account	Full sample	0.241*** (0.016)	402.6	0.317	-18.539*** (0.391)	2251.255	0.754	51,851
	Urban	0.362*** (0.026)	327.9	0.277	-18.410*** (0.512)	1292.38	0.743	22,201
	Rural	0.134*** (0.022)	60.91	0.185	-17.896*** (0.514)	1214.07	0.755	29,650
Mobile banking	Full sample	0.509*** (0.014)	1418	0.469	-23.215*** (0.440)	2790.008	0.819	51,851
	Urban	0.693*** (0.024)	337.3	0.368	-22.274*** (0.677)	1082.526	0.835	22,201
	Rural	0.442*** (0.021)	449.1	0.327	-22.716*** (0.553)	1687.615	0.828	29,650
Microfinance	Full sample	0.358*** (0.021)	151.8	0.192	-29.517*** (0.720)	1682.099	0.814	51,851
	Urban	0.558*** (0.038)	83.18	0.129	-30.327*** (1.010)	901.201	0.836	22,201
	Rural	0.149*** (0.032)	40.03	0.098	-27.853*** (1.037)	722.062	0.798	29,650

Second-Stage IV Results: Financial Inclusion and Consumption Diversification

The second stage of the 2SLS estimation examines the causal effect of household financial inclusion on consumption diversification. Each Theil entropy index—food consumption diversification, non-food consumption diversification, and the between-group Theil index—was regressed on the instrumented household financial inclusion indicators while controlling for household demographics, socioeconomic status, infrastructure, and country fixed effects. This design isolates exogenous variation in financial access generated by the leave-one-out cluster instrument. For robustness, a specification with cluster fixed effects is also estimated; this version controls for unobserved cluster-level heterogeneity and therefore relies on within-cluster rather than between-cluster variation.

Hypothesis 1 (Food Stabilization Channel) posits that financial access increases food expenditure concentration. The results in Table 3 support this hypothesis for bank accounts and microfinance under both IV specifications. Under the country-and-infrastructure FE model, bank accounts ($\beta = -0.2317$, $p < 0.01$) and microfinance ($\beta = -0.2577$, $p < 0.01$) significantly reduce the food Theil index. Cluster FE estimates remain negative and precisely estimated—bank accounts ($\beta \approx -0.017$) and microfinance ($\beta \approx -0.057$)—though smaller in magnitude, consistent with identification from localized within-cluster variation. Mobile

banking exhibits specification sensitivity: the baseline model shows a negative effect ($\beta = -0.1575$), whereas the cluster FE coefficient is positive ($\beta \approx 0.024$). Overall, formal banking and microfinance robustly induce food concentration, while mobile finance is more sensitive to how local heterogeneity is controlled. Hypothesis 2 (Non-Food Portfolio Expansion Channel) predicts that financial inclusion increases non-food diversification. Under the baseline specification, bank accounts ($\beta = 0.2453$, $p < 0.01$), microfinance ($\beta = 0.4032$, $p < 0.01$), and mobile banking ($\beta = 0.1365$, $p < 0.01$) all significantly increase non-food diversification. Under the cluster FE specification, however, the coefficients for bank accounts ($\beta \approx -0.006$) and mobile banking ($\beta \approx -0.003$) are small and statistically indistinguishable from zero, while microfinance continues to have a positive and significant effect ($\beta \approx 0.037$). Thus, this hypothesis is supported for all three modalities under the country-and-infrastructure FE specification, but under the cluster FE specification only microfinance generates robust non-food diversification.

Hypothesis 3 (Structural Reallocation Channel) states that financial intermediation induces budgetary reallocation between food and non-food consumption. Under the country-and-infrastructure FE model, bank access increases the between-group index ($\beta = 0.0431$, $p < 0.05$), microfinance sharply reduces it ($\beta = -0.1761$, $p < 0.01$), and mobile banking has no detectable effect. Under the cluster FE specification, all modalities produce negative and significant effects—bank accounts ($\beta \approx -0.055$), microfinance ($\beta \approx -0.091$), and mobile banking ($\beta \approx -0.021$)—indicating that once cluster-level heterogeneity is controlled for, financial access tends to compress the food–non-food gap. Hence, support for this hypothesis is instrument-specific in the baseline specification but consistent across modalities under cluster FE. A notable feature of the results is the close alignment in the signs of the urban estimates across both IV specifications for bank accounts and microfinance. Urban households face less unobserved heterogeneity in market access, prices, and financial penetration, reducing discrepancies between cross-cluster and within-cluster identifying variation. Because financial access varies more smoothly within urban clusters, both specifications recover similarly signed effects even when identification is restricted to within-cluster contrasts. Differences in magnitude arise because the cluster FE specification removes between-cluster variation—where most level differences in financial development lie—leaving only lower-variance within-cluster differences to identify the effect. As a result, the direction of the effect remains stable in urban areas, while the coefficients become mechanically smaller when cluster-level heterogeneity is fully controlled. Throughout the analysis, the country-and-infrastructure FE specification serves as the primary IV model, as it exploits meaningful cross-cluster variation in financial development and market conditions while controlling for key observed heterogeneity. The cluster FE specification is treated as a stricter robustness check that restricts identification to within-cluster contrasts and therefore yields more conservative magnitudes.

Table 3: Effect of Financial Inclusion on Consumption Diversification (Theil Index), Full-Sample IV Second-Stage Results.

Outcome (Theil Entropy Index)	Instrumnented Financial Inclusion	Country + Infra FE	Cluster (FE)	Adj. R^2 (C+I)	Adj. R^2 (Clust.)	N
Food diversification	Instrumnented Bank account	−0.232*** (0.076)	−0.017*** (0.005)	0.386	0.355	51,851
Non-food diversification	Bank account	0.245*** (0.057)	−0.006 (0.004)	0.405	0.357	51,851
Between-group diversification	Bank account	0.043** (0.021)	−0.055*** (0.004)	0.855	0.423	51,851
Food diversification	Microfinance	−0.258*** (0.089)	−0.057*** (0.006)	0.378	0.357	51,851
Non-food diversification	Microfinance	0.403*** (0.066)	0.037*** (0.005)	0.329	0.36	51,851
Between-group diversification	Microfinance	−0.176*** (0.025)	−0.091*** (0.004)	0.823	0.423	51,851
Food diversification	Mobile banking	−0.158*** (0.023)	0.024*** (0.005)	0.396	0.356	51,851
Non-food diversification	Mobile banking	0.137*** (0.018)	−0.003 (0.003)	0.454	0.358	51,851
Between-group diversification	Mobile banking	−0.001 (0.007)	−0.021*** (0.004)	0.858	0.422	51,851

Table 4: Effect of Financial Inclusion on Consumption Diversification (Theil Index), Urban-Rural-Samples IV Second-Stage Results.

Outcome Variable	Instrumented Financial Inclusion Indicator	Urban: Country+ Infra FE	Urban: Cluster FE	Rural: Country+Infra FE	Rural: Cluster FE	Adj. R^2 (Urban C+I / Clust.)	Adj. R^2 (Rural C+I / Clust.)	N (Urban / Rural)
Food diversification	Bank account	−0.548*** (0.131)	−0.016*** (0.006)	0.012 (0.184)	−0.029*** (0.009)	0.048 / 0.378	0.438 / 0.391	22,201 / 29,650
Non-food diversification	Bank account	0.317*** (0.083)	0.006 (0.005)	0.718*** (0.190)	0.011 (0.007)	0.354 / 0.416	0.004 / 0.316	22,201 / 29,650
Between-group diversification	Bank account	−0.037 (0.026)	−0.043*** (0.005)	0.110* (0.058)	−0.006 (0.005)	0.888 / 0.569	0.824 / 0.577	22,201 / 29,650

Food diversification	Microfinance access	−0.715*** (0.174)	−0.031*** (0.007)	0.068 (0.190)	−0.073*** (0.009)	−0.020 / 0.379	0.437 / 0.391	22,201 / 29,650
Non-food diversification	Microfinance access	0.393*** (0.107)	0.025*** (0.006)	0.629*** (0.153)	0.052*** (0.007)	0.340 / 0.417	0.070 / 0.320	22,201 / 29,650
Between-group diversification	Microfinance access	−0.091** (0.036)	−0.065*** (0.005)	−0.117** (0.050)	−0.057*** (0.005)	0.879 / 0.566	0.827 / 0.580	22,201 / 29,650
Food diversification	Mobile banking	−0.141*** (0.029)	0.005 (0.007)	−0.146*** (0.036)	0.037*** (0.007)	0.372 / 0.378	0.419 / 0.391	22,201 / 29,650
Non-food diversification	Mobile banking	0.078*** (0.020)	−0.005 (0.005)	0.188*** (0.028)	0.008* (0.004)	0.507 / 0.416	0.323 / 0.316	22,201 / 29,650
Cross-group diversification	Mobile banking	−0.003 (0.006)	−0.037*** (0.007)	0.004 (0.011)	0.002 (0.005)	0.892 / 0.569	0.836 / 0.577	22,201 / 29,650

Testing the Exclusion Restriction: Reduced-Form Approach

A critical identifying assumption of my instrumental variable strategy is that peer financial inclusion affects household consumption diversification only through its effect on the household's own financial inclusion. I validate this exclusion restriction using reduced-form regressions of consumption diversification directly on the leave-one-out peer financial inclusion instrument, without instrumenting for own financial inclusion:

$$D_i = \alpha + \beta^{RF} Z_{ic} + X_i'\gamma + \theta_c + \varepsilon_i,$$

where $D_i$is household i's consumption diversification index, $Z_{ic}$is the LOO peer financial inclusion measure for cluster c, $X_i$is the vector of household-level controls, $\theta_c$denotes country (and infrastructure) fixed effects, and $\varepsilon_i$is the idiosyncratic error term. If the exclusion restriction holds, the reduced-form coefficient must satisfy $\beta^{RF} = \pi \times \beta^{IV}$, where $\pi$is the first-stage coefficient and $\beta^{IV}$the IV estimate, implying that $\beta^{RF}/\pi \approx \beta^{IV}$. Table 5 confirms this condition: reduced-form coefficients exhibit the same sign pattern as the IV estimates across all modalities and outcomes (e.g., peer bank access lowers food entropy, $\beta = -0.054, p < 0.01$, and increases non-food entropy, $\beta = 0.058, p < 0.01$), and the implied IV effects closely match the actual ones (e.g., $-0.054/0.241 = -0.224$vs. IV estimate -0.232). Statistical significance aligns as well, with outcomes showing significant IV effects also exhibiting significant reduced-form effects, and insignificant IV outcomes (e.g., mobile on between-group entropy) yielding insignificant reduced-form coefficients. Urban–rural heterogeneity mirrors the IV patterns, with strong urban effects and muted rural effects, explaining earlier specification sensitivity. Since violations of the exclusion restriction would generate departures from proportionality, the consistency of $\beta^{RF}/\pi \approx \beta^{IV}$across all nine outcome–modality combinations provides strong evidence that the instrument operates solely through own financial inclusion.

Table 5: Reduced-Form Estimates Using Leave-One-Out Peer Financial Inclusion Instruments

Peer Financial Inclusion (LOO Instrument)	Sample	Outcome	Reduced-form coefficient (β_RF)	Adj. R^2	N
Bank account	Full sample	Food diversification	−0.054*** (0.017)	0.419	51,851
Bank account	Urban	Food diversification	−0.124*** (0.024)	0.393	22,201
Bank account	Rural	Food diversification	0.006 (0.028)	0.439	29,650
Bank account	Full sample	Non-food diversification	0.058*** (0.013)	0.47	51,851
Bank account	Urban	Non-food diversification	0.073*** (0.016)	0.51	22,201
Bank account	Rural	Non-food diversification	0.106*** (0.021)	0.374	29,650
Bank account	Full sample	Between-group diversification	0.010** (0.005)	0.858	51,851
Bank account	Urban	Between-group diversification	−0.009 (0.006)	0.892	22,201
Bank account	Rural	Between-group diversification	0.017** (0.008)	0.837	29,650
Microfinance access	Full sample	Food diversification	−0.091*** (0.031)	0.419	51,851
Microfinance access	Urban	Food diversification	−0.206*** (0.040)	0.393	22,201
Microfinance access	Rural	Food diversification	0.017 (0.047)	0.439	29,650
Microfinance access	Full sample	Non-food diversification	0.144*** (0.022)	0.471	51,851
Microfinance access	Urban	Non-food diversification	0.116*** (0.028)	0.51	22,201
Microfinance access	Rural	Non-food diversification	0.156*** (0.031)	0.374	29,650
Microfinance access	Full sample	Between-group diversification	−0.063*** (0.008)	0.858	51,851
Microfinance access	Urban	Between-group diversification	−0.027** (0.010)	0.892	22,201
Microfinance access	Rural	Between-group diversification	−0.029** (0.012)	0.837	29,650
Mobile banking	Full sample	Food diversification	−0.080*** (0.011)	0.42	51,851
Mobile banking	Urban	Food diversification	−0.078*** (0.015)	0.393	22,201
Mobile banking	Rural	Food diversification	−0.063*** (0.016)	0.44	29,650
Mobile banking	Full sample	Non-food diversification	0.069*** (0.009)	0.472	51,851
Mobile banking	Urban	Non-food diversification	0.043*** (0.011)	0.51	22,201
Mobile banking	Rural	Non-food diversification	0.084*** (0.011)	0.376	29,650
Mobile banking	Full sample	Between-group diversification	−0.001 (0.003)	0.858	51,851
Mobile banking	Urban	Between-group diversification	−0.001 (0.003)	0.892	22,201
Mobile banking	Rural	Between-group diversification	0.002 (0.005)	0.836	29,650

Propensity Score Matching (PSM) Results and Comparison with IV Estimates

To reinforce the causal interpretation of the IV estimates, Propensity Score Matching (PSM) is used as a complementary robustness check. Although IV exploits peer-driven exogenous variation (LATE) and PSM relies on selection on observables (ATT), the two approaches yield highly consistent patterns for the core outcomes. For bank accounts, IV shows a −0.232 effect on food entropy and a 0.245 effect on non-food entropy, while PSM produces effects of

−0.079 to −0.033 for food and 0.041 to 0.130 for non-food, with fully aligned signs. For microfinance, both methods show small or weak food effects and consistently positive, significant non-food effects. For mobile banking, PSM finds near-zero to weakly positive food effects and positive non-food effects under nearest-neighbor and radius matching, mirroring the IV pattern of stronger non-food impacts. The larger IV magnitudes reflect the fact that LATE identifies more responsive compliers, while PSM is attenuated by imperfect common support. Divergence appears only for the between-group Theil index: IV shows bank access increases it, microfinance reduces it, and mobile banking has no effect, whereas PSM yields negative bank effects and small positive mobile effects, though both agree on a negative microfinance effect. These differences are consistent with PSM's sensitivity to residual spatial market correlation, while IV isolates peer-induced exogenous variation.

Table 6: PSM Estimates of the Effect of Financial Access on Consumption Diversification (Full Sample)

Outcome Variable	Instrumented Financial Inclusion Indicator	Matching Method	ATT (SE)	Treated N	Control N (Effective)
Food Diversification	Bank Account	Nearest Neighbor	-0.033*** (0.005)	7,030	7,030
Food Diversification	Bank Account	Radius	-0.079*** (0.004)	7,030	42,144.97
Food Diversification	Bank Account	Kernel	-0.078*** (0.004)	7,030	42,579.90
Food Diversification	Mobile Money	Nearest Neighbor	0.001 (0.003)	22,851	22,851
Food Diversification	Mobile Money	Radius	0.005** (0.002)	22,850	2,890,000
Food Diversification	Mobile Money	Kernel	0.062*** (0.004)	22,851	14,720.45
Food Diversification	Microfinance	Nearest Neighbor	0.006 (0.007)	4,362	4,362
Food Diversification	Microfinance	Radius	-0.004 (0.006)	4,362	7,966
Food Diversification	Microfinance	Kernel	-0.016*** (0.006)	4,362	8,707.47
Non-Food Diversification	Bank Account	Nearest Neighbor	0.041*** (0.004)	7,030	7,030.00
Non-Food Diversification	Bank Account	Radius	0.130*** (0.003)	7,030	42,144.97
Non-Food Diversification	Bank Account	Kernel	0.128*** (0.003)	7,030	42,579.90
Non-Food Diversification	Mobile Money	Nearest Neighbor	0.015*** (0.003)	22,851	22,851
Non-Food Diversification	Mobile Money	Radius	0.018*** (0.002)	22,850	2,890,000
Non-Food Diversification	Mobile Money	Kernel	0.000 (0.003)	22,851	14,720.45
Non-Food Diversification	Microfinance	Nearest Neighbor	0.020*** (0.006)	4,362	4,362.00

Non-Food Diversification	Microfinance	Radius	0.026*** (0.005)	4,362	7,966.04
Non-Food Diversification	Microfinance	Kernel	0.033*** (0.005)	4,362	8,707.47
Cross-Group Diversification	Bank Account	Nearest Neighbor	-0.014*** (0.004)	7,030	7,030.00
Cross-Group Diversification	Bank Account	Radius	-0.042*** (0.003)	7,030	42,144.97
Cross-Group Diversification	Bank Account	Kernel	-0.043*** (0.003)	7,030	42,579.90
Cross-Group Diversification	Mobile Money	Nearest Neighbor	0.010*** (0.002)	22,851	22,851.00
Cross-Group Diversification	Mobile Money	Radius	0.010*** (0.001)	22,850	2,890,000
Cross-Group Diversification	Mobile Money	Kernel	0.033*** (0.002)	22,851	14,720.45
Cross_Group Diversification	Microfinance	Nearest Neighbor	-0.008 (0.005)	4,362	4,362
Cross-Group Diversification	Microfinance	Radius	-0.010** (0.005)	4,362	7,966.04
Cross-Group Diversification	Microfinance	Kernel	-0.019*** (0.005)	4,362	8,707.47

Note: For Radius and Kernel matching, the Control N (Effective) denotes the sum of matching weights ($\sum w_i$) rather than unique control households and may exceed the raw sample size due to fractional weighting.

Table 7 below presents Lewbel (2012) IV estimates as a robustness check. The Breusch–Pagan test confirms heteroskedasticity in first-stage residuals for all three treatments (LM > 9,195; $p < 0.001$), satisfying the Lewbel identification condition, and first-stage F-statistics exceed conventional weak-instrument thresholds. The sign and significance patterns are consistent with the main LOO-IV results: bank account ownership is associated with lower food entropy, all three modalities increase non-food diversification, and between-group effects remain modality-specific. Lewbel coefficients are smaller than the LOO-IV estimates in Table 3, as expected — the two strategies identify LATEs for distinct complier populations defined by different margins of financial adoption, and there is no theoretical basis for magnitude equivalence. The Sargan–Hansen J statistic rejects across specifications; however, this reflects the tendency of standard overidentification tests to over-reject under heteroskedasticity and many instruments (White, 1982; Baum, Schaffer, and Stillman, 2007; Roodman, 2009), which Lewbel identification requires. Coefficient sign stability across instrument counts from three to eight and large first-stage F-statistics provide evidence of instrument validity. Taken together, the Lewbel results corroborate the qualitative conclusions of the main analysis under an independent identification strategy.

Table 7: Lewbel (2012) Heteroskedasticity-Based IV Estimates — Robustness Check (N = 51,835)

	Coef. (SE)	**t-stat**	**First-stage F**	**R^2**	**Sargan-Hansen J**	**J p-value**
Panel A: Bank Account						

Food diversification	-0.022*** (0.006)	-4.025	7826.776	0.418	63.134	0.000
Non-food diversification	0.039*** (0.004)	9.921	7826.776	0.470	246.975	0.000
Between-group diversification	0.005*** (0.002)	2.859	7826.776	0.858	43.949	0.000
Panel B: Microfinance Account						
Food diversification	0.002 (0.005)	0.300	17518.270	0.418	71.040	0.000
Non-food diversification	0.033*** (0.004)	8.616	17518.270	0.470	212.211	0.000
Between-group diversification	-0.019*** (0.002)	-11.849	17518.270	0.858	145.668	0.000
Panel C: Mobile Banking						
Food diversification	6.190e-4 (0.004)	0.154	9520.188	0.418	53.988	0.000
Non-food diversification	0.026*** (0.003)	9.174	9520.188	0.470	85.824	0.000
Between-group diversification	-3.800e-4 (0.001)	-0.316	9520.188	0.858	255.064	0.000

Notes: *Standard errors in parentheses. Internal instruments follow Lewbel (2012): $Zk = (Xk - \bar{X}k) \times \hat{v}$, where $\hat{v}$ are first-stage OLS residuals; the top 8 instruments ranked by absolute correlation with the treatment are retained. Breusch-Pagan LM statistics confirm heteroskedasticity in first-stage residuals for all three treatments ($LM > 9{,}195$; $p < 0.001$), satisfying the Lewbel identification condition. First-stage F-statistics are computed on excluded instruments only; all far exceed the Stock-Yogo (2005) weak-instrument threshold of 10. R^2 is computed from true IV residuals using the observed (not instrumented) treatment variable. Very small coefficients are reported in scientific notation.*

Sargan-Hansen J: *The reported statistic is a standard $n \cdot R^2$ Sargan-type overidentification test. Under heteroskedasticity — which the Breusch-Pagan results confirm and which Lewbel identification explicitly requires — this statistic is known to over-reject (White, 1982; Baum et al., 2007). It is reported for completeness; coefficient sign stability across instrument counts (n = 3 to 8) and first-stage F-statistics are the primary validity diagnostics. Country fixed effects and the full set of household socioeconomic and infrastructure controls are included in all specifications.*

Significance: **** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

Discussions

The results reveal a sharply differentiated welfare impact of financial inclusion in the WAEMU, depending on both the type of financial instrument and the consumption domain considered. When welfare is measured through Theil entropy indices rather than aggregate expenditure, financial inclusion does not operate through a uniform consumption-expansion channel. Instead, it generates food concentration through quality upgrading, non-food diversification through portfolio expansion, and heterogeneous structural reallocation across instruments. This confirms that financial access affects not only the level of welfare but its composition and resilience, with distinct transmission mechanisms across food and non-food domains. The negative causal effects of financial inclusion on food entropy remain strong for bank accounts and microfinance across both IV specifications, indicating greater concentration of food expenditure rather than horizontal diversification. Given the entropy structure, this reflects specialization toward fewer, higher-value food items, consistent with a quality-upgrading and stabilization mechanism under binding liquidity constraints. Under the cluster FE specification, these concentration effects remain negative but smaller, reflecting reliance on within-cluster variation; mobile banking becomes weakly positive in this model, underscoring that its food effects depend on whether identification stems from cross-community or within-community contrasts.

By contrast, the effects on non-food entropy are strongly positive in the baseline IV and PSM frameworks, confirming that financial access expands households' non-food expenditure sets. Bank access, microfinance, and mobile banking enable households to spread spending across education, health, housing, transportation, communication, and productive assets—categories characterized by indivisibilities and high liquidity sensitivity. Under cluster FE, however, only microfinance retains a robust positive effect on non-food entropy, highlighting its uniquely strong role in easing localized liquidity and investment constraints, particularly in rural areas. Structural reallocation patterns, captured by the cross-group Theil index, remain modality-specific: in the baseline IV, bank access widens the food–non-food dispersion, microfinance compresses it, and mobile banking has no significant effect; under cluster FE, all modalities compress the gap. These differences reflect whether identification is driven by broader cross-community financial conditions or narrowly within-community contrasts. Overall, the findings demonstrate that financial access shapes both the structure and resilience of household welfare in ways consistent with the study's theoretical framework and with WAEMU's dual urban–rural financial ecosystem.

Policy Implications

These findings yield direct, instrument-specific policy implications for regional development in WAEMU and the broader ECOWAS region. Because formal banking is a key driver of non-food diversification and long-run household upgrading under the baseline IV and PSM models, regional financial-sector reforms under the WAEMU Financial Inclusion Strategy and the ECOWAS Monetary Cooperation Programme should prioritize expansion of regulated banking services beyond capital cities through agent networks and simplified account-opening systems. The equalizing and consistently positive role of microfinance across all empirical models—particularly its robust non-food diversification and gap-compressing effects under both IV specifications—implies that micro-credit and micro-savings should be systematically embedded within national food-security and rural-resilience programmes, directly supporting SDG 2's objectives on nutrition and vulnerability reduction. In contrast, the limited structural role of mobile banking indicates that ECOWAS digital-finance strategies must evolve beyond basic payment diffusion toward formal integration of mobile platforms with regulated savings, credit, and merchant-payment infrastructures if

mobile finance is to contribute to durable welfare transformation. The dominance of asset endowments in explaining diversification further implies that financial access alone is insufficient without complementary asset-building initiatives, reinforcing the African Development Bank's emphasis on productive asset accumulation, rural infrastructure, and human-capital investment as necessary complements to financial-sector expansion. In conclusion, the analysis provides an operational framework for aligning instrument-specific financial-sector reforms with SDG 1, SDG 2, and the financial-inclusion components of SDG 8 while supporting long-run poverty reduction, food security, and inclusive structural change in West Africa.

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Appendices

Note on the Sign of First-Stage Coefficients under Cluster Fixed Effects in Table 2.

This note clarifies the interpretation of the first-stage coefficients reported in Table 2 for specifications including cluster fixed effects (FE), where the leave-one-out (LOO) peer financial inclusion instrument enters with large negative coefficients. These estimates do not indicate misspecification or contradict the peer-effects rationale. Rather, they arise mechanically from the interaction between the within-cluster construction of the LOO instrument and the within transformation induced by cluster fixed effects.

Let D_{ic}be a binary indicator equal to one if household $i$in cluster $c$has access to a given financial service. The LOO instrument is defined as

$$Z_{ic} = \frac{S_c - D_{ic}}{n_c - 1},$$

where $S_c = \sum_i D_{ic}$is total adoption in cluster c, and $n_c$is cluster size. Rearranging gives

$$D_{ic} = S_c - (n_c - 1)Z_{ic}.$$

With cluster fixed effects, all cluster-level constants—including S_c—are absorbed, so identification relies solely on within-cluster variation. After demeaning, the relationship becomes approximately

$$D_{ic} - \bar{D}_c \approx -(n_c - 1)(Z_{ic} - \bar{Z}_c).$$

Thus, under cluster FE, the first-stage coefficient on $Z_{ic}$is mechanically negative and roughly proportional to cluster size minus one. Coefficients between −18 and −30 are therefore consistent with average cluster sizes and reflect a scaling property of the LOO construction, not a negative peer effect. Instrument relevance is evaluated using the country and infrastructure FE specification, where the instrument enters positively with strong first-stage F-statistics. The cluster-FE model serves only as a robustness check that restricts identification to within-cluster contrasts. In short, the negative first-stage coefficients under cluster FE are mechanical and do not undermine the validity of the IV strategy.

Table A1: First-Stage Estimates Using Leave-One-Out (LOO) Instruments — Full Sample

Variable	**Bank Account**	**Mobile Banking**	**Microfinance**
Constant	0.004 (0.008)	0.018 (0.014)	0.008 (0.007)
Asset index (0–1)	1.048*** (0.030)	0.613*** (0.031)	0.538*** (0.023)
Internet connection	0.089*** (0.016)	−0.027 (0.015)	0.000 (0.011)
Head literate	0.018*** (0.003)	0.042*** (0.004)	0.020*** (0.003)
Secondary education (head)	0.107*** (0.005)	0.027*** (0.006)	0.014*** (0.004)
Tertiary education (head)	0.348*** (0.010)	0.001 (0.009)	−0.033*** (0.006)
Piped water available	−0.018*** (0.005)	0.006 (0.008)	−0.012** (0.005)

Concrete dwelling	0.042*** (0.004)	−0.011 (0.007)	−0.004 (0.003)
Household size	0.002** (0.001)	0.001 (0.001)	0.003*** (0.000)
Urban residence	0.004 (0.004)	0.033*** (0.006)	0.012*** (0.004)
Electricity access	0.037*** (0.005)	0.038*** (0.009)	0.004 (0.004)
Head employed	−0.037*** (0.005)	0.017*** (0.005)	0.015*** (0.004)
Employed in agriculture	0.004 (0.004)	−0.034*** (0.006)	−0.002 (0.004)
Employed in services	0.054*** (0.005)	0.001 (0.005)	0.014*** (0.004)
Dependency ratio	−0.011*** (0.002)	−0.012*** (0.002)	−0.002 (0.002)
Children under age 6	0.003*** (0.001)	0.011*** (0.001)	−0.001 (0.001)
Paved road available	0.028*** (0.005)	0.020*** (0.007)	0.016*** (0.004)
Periodic market available	−0.018*** (0.004)	0.003 (0.007)	−0.024*** (0.004)
Permanent market available	0.023*** (0.005)	0.012 (0.008)	0.023*** (0.004)
Hospital available	0.014*** (0.005)	−0.015** (0.008)	0.005 (0.004)
Côte d'Ivoire	−0.155*** (0.008)	0.253*** (0.016)	−0.132*** (0.007)
Guinea-Bissau	−0.127*** (0.008)	−0.058*** (0.015)	−0.125*** (0.007)
Mali	−0.247*** (0.009)	−0.235*** (0.016)	−0.158*** (0.007)
Niger	−0.133*** (0.009)	−0.381*** (0.015)	−0.141*** (0.007)
Togo	−0.122*** (0.009)	0.014 (0.016)	0.159*** (0.010)
Senegal	−0.125*** (0.010)	0.420*** (0.017)	−0.094*** (0.008)
Instrument coefficient	**0.241*** (0.016)	**0.509*** (0.014)	**0.358*** (0.021)
F-statistic	**402.6**	**1418**	**151.8**
R-squared	0.317	0.469	0.192
Log-Likelihood	−8126.000	−20865.000	−1576.400
Observations	51,851	51,851	51,851

The Urban–Rural LOO IV first-stage results table was omitted due to space constraints and will be made available upon request.

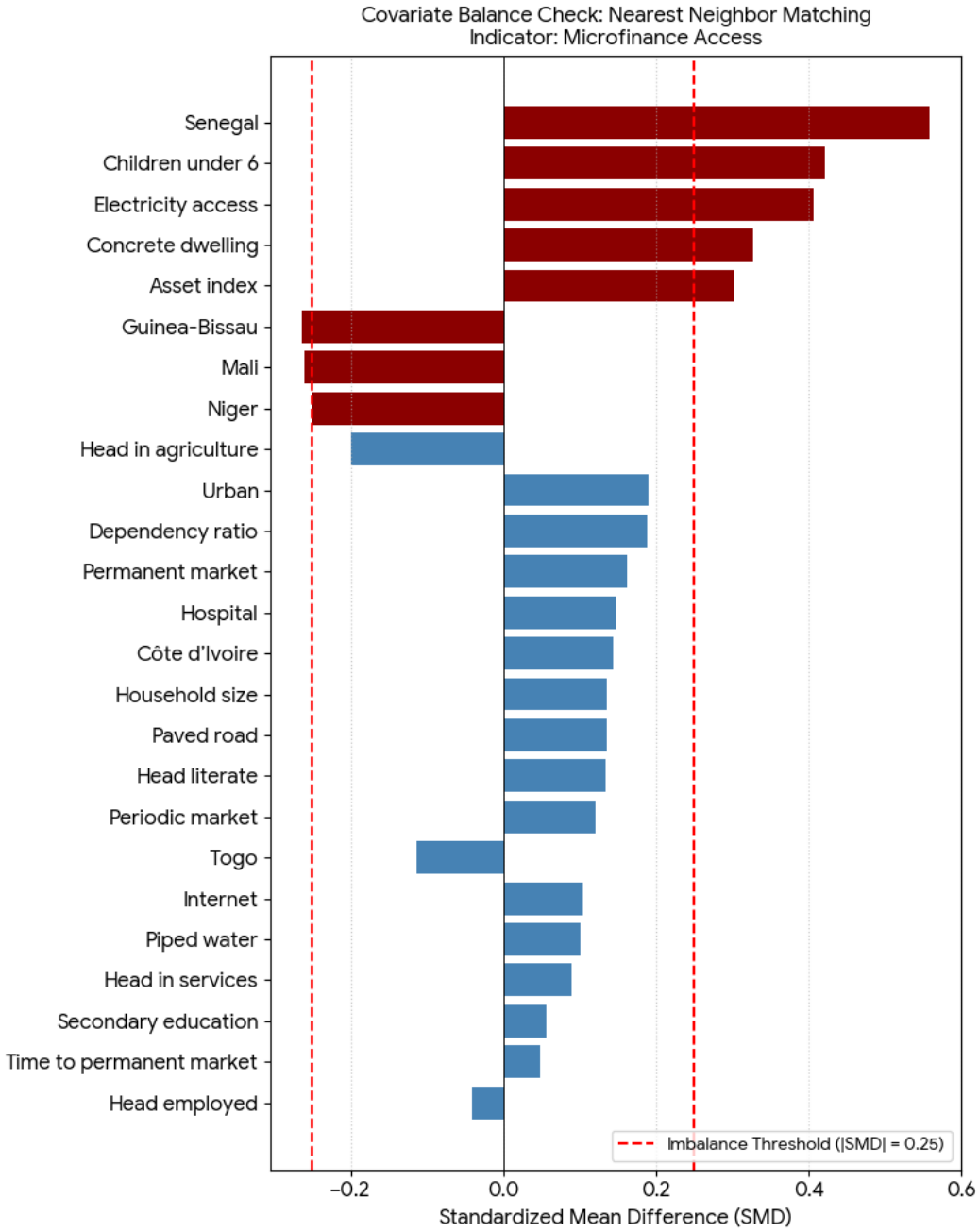
Table A2: PSM Logit Results (Full Sample)

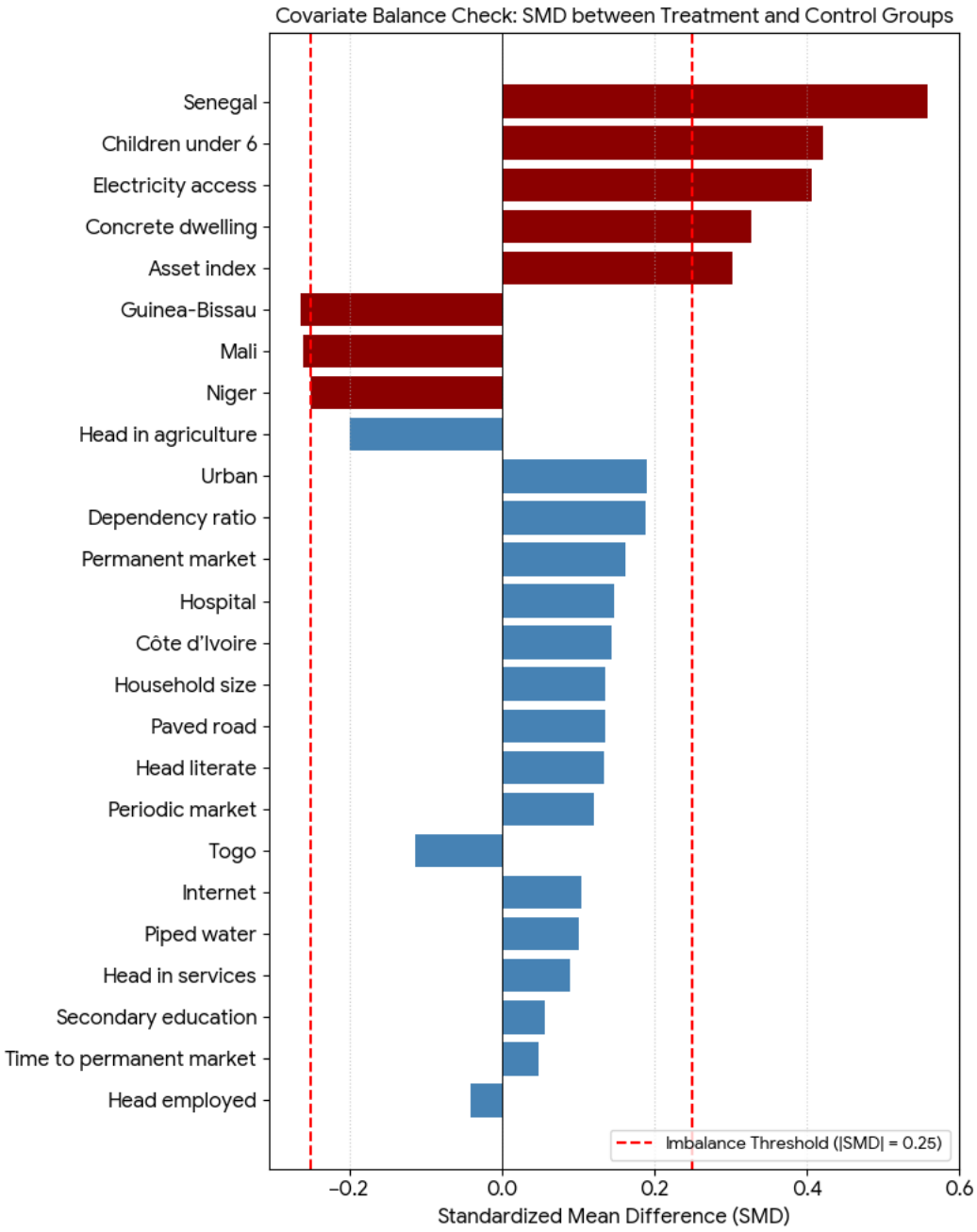
Variable	Bank Account	Mobile Banking	Microfinance
Constant	−3.624*** (0.087)	−1.591*** (0.062)	−3.836*** (0.098)
Asset index (0–1)	9.774*** (0.218)	4.849*** (0.187)	6.626*** (0.247)
Internet connection	0.302*** (0.084)	−0.137 (0.094)	−0.127 (0.098)
Head literate	0.575*** (0.044)	0.349*** (0.030)	0.467*** (0.046)

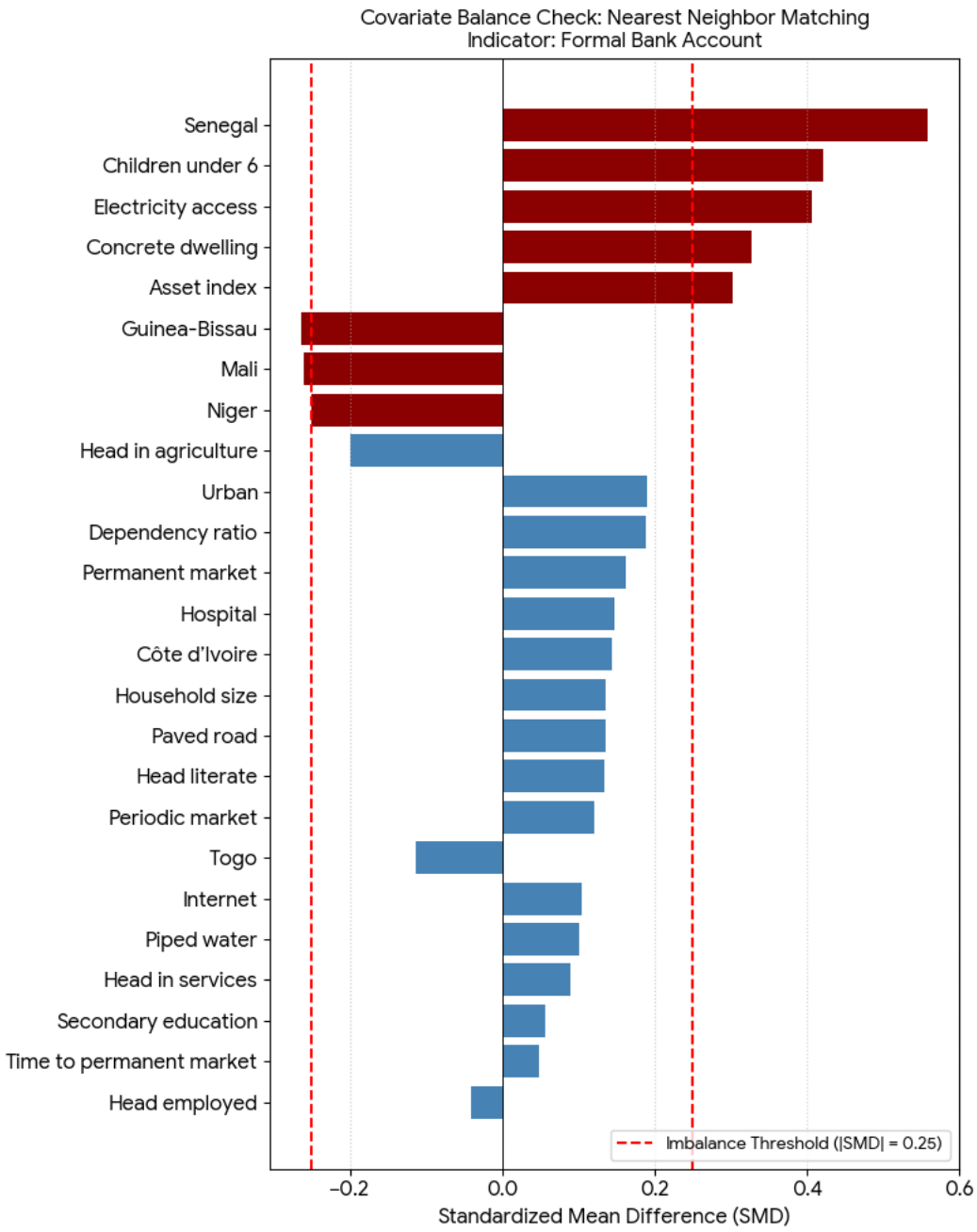
Secondary education (head)	0.822*** (0.042)	0.118*** (0.037)	0.000 (0.048)
Tertiary education (head)	2.021*** (0.059)	−0.021 (0.058)	−0.468*** (0.080)
Piped water available	−0.272*** (0.046)	0.002 (0.033)	0.032 (0.043)
Concrete dwelling	0.211*** (0.063)	−0.145*** (0.036)	−0.029 (0.095)
Household size	0.038*** (0.005)	0.014*** (0.004)	0.056*** (0.005)
Urban residence	0.491*** (0.044)	0.421*** (0.034)	0.355*** (0.048)
Electricity access	0.237*** (0.052)	0.124*** (0.036)	0.019 (0.065)
Head employed	−0.405*** (0.054)	0.131*** (0.045)	0.322*** (0.068)
Employed in agriculture (head)	−0.347*** (0.057)	−0.308*** (0.039)	−0.191*** (0.060)
Employed in services (head)	0.531*** (0.045)	−0.015 (0.040)	0.120** (0.052)
Dependency ratio	−0.118*** (0.024)	−0.085*** (0.017)	−0.060** (0.027)
Children under age 6	0.022** (0.009)	0.074*** (0.008)	−0.013 (0.011)
Paved road available	0.114*** (0.041)	0.044 (0.031)	0.052 (0.044)
Periodic market available	−0.012 (0.042)	0.093*** (0.028)	−0.057 (0.043)
Permanent market available	0.067 (0.042)	0.036 (0.031)	0.123*** (0.047)
Travel time to periodic market	−0.000 (0.000)	0.000 (0.000)	0.000* (0.000)
Travel time to permanent market	0.000 (0.000)	−0.000 (0.000)	−0.000 (0.000)
Hospital available	−0.023 (0.042)	−0.187*** (0.032)	0.007 (0.047)
Côte d'Ivoire	−1.128*** (0.088)	1.293*** (0.059)	−1.722*** (0.113)
Guinea-Bissau	−0.867*** (0.100)	−1.130*** (0.069)	−2.685*** (0.167)
Mali	−4.721*** (0.155)	−1.869*** (0.067)	−4.350*** (0.256)
Niger	−1.562*** (0.085)	−4.624*** (0.160)	−2.388*** (0.126)
Togo	−1.194*** (0.072)	0.272*** (0.050)	1.226*** (0.069)
Senegal	−0.984*** (0.093)	2.698*** (0.071)	−0.852*** (0.119)
McFadden pseudo-R^2	**0.371**	**0.392**	**0.288**

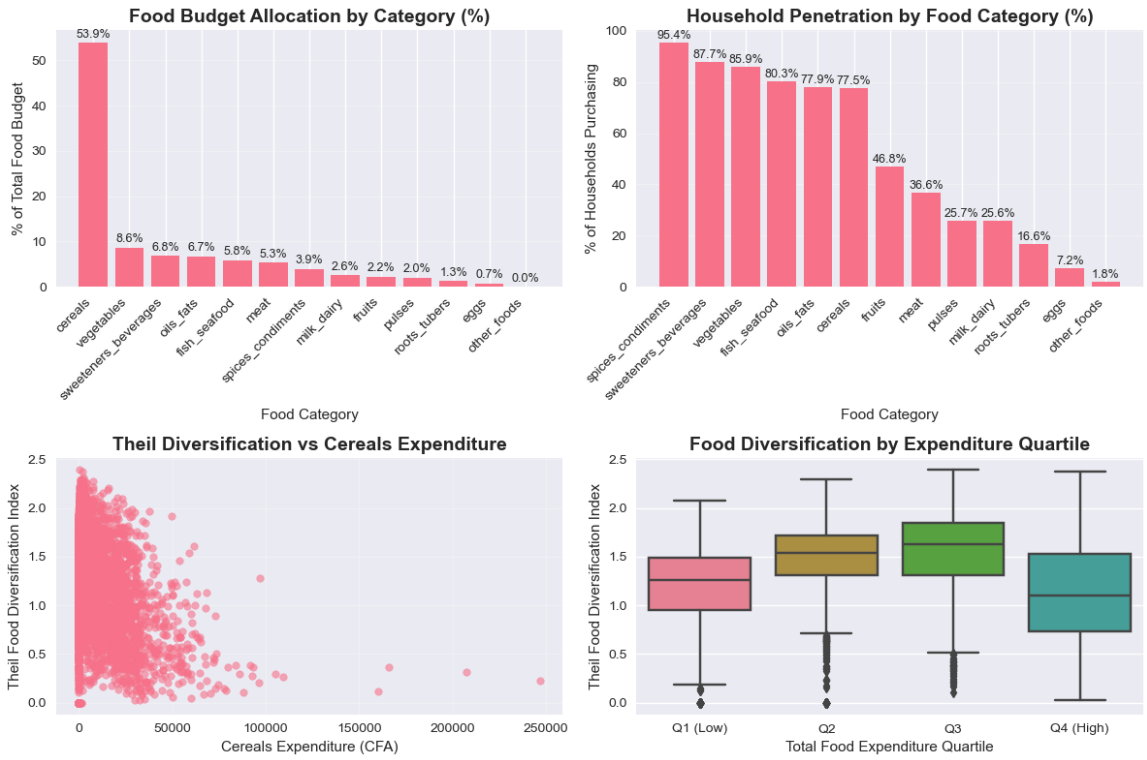
Log-Likelihood	**−12947.880**	**−21643.500**	**−10659.900**
N	**51,851**	**51,851**	**51,851**

Due to space constraints, the PSM results for the urban and rural subsamples are omitted but are available from the author upon request.




Covariate Balance Check: SMD between Treatment and Control Groups
Senegal
Children under 6
Electricity access
Concrete dwelling
Asset index
Guinea-Bissau
Mali
Niger
Head in agriculture
Urban
Dependency ratio
Permanent market
Hospital
Côte d'Ivoire
Household size
Paved road
Head literate
Periodic market
Togo
Internet
Piped water
Head in services
Secondary education
Time to permanent market
Head employed
Imbalance Threshold (|SMD| = 0.25)
−0.2
0.0
0.2
0.4
0.6
Standardized Mean Difference (SMD)


Covariate Balance Check: Nearest Neighbor Matching
Indicator: Formal Bank Account
Senegal
Children under 6
Electricity access
Concrete dwelling
Asset index
Guinea-Bissau
Mali
Niger
Head in agriculture
Urban
Dependency ratio
Permanent market
Hospital
Côte d'Ivoire
Household size
Paved road
Head literate
Periodic market
Togo
Internet
Piped water
Head in services
Secondary education
Time to permanent market
Head employed
Imbalance Threshold (|SMD| = 0.25)
−0.2
0.0
0.2
0.4
0.6
Standardized Mean Difference (SMD)



Grouped Food Items Grouped Non-food Items

Cereals and grains Roots and tubers Vegetables Fruits Meat & poultry Fisha dn sea food Milk & dairy products Oils & fats Legumes and pulses Others (sweets, beverages, drinks, tec)	Houseing & rent Utilities (electricity, water, etc) Helath Education Transportation Clohing &footwear Personal care & hygiene Household goods (furniture, tools, etc) Communication & media (phone, internet, TV, etc Social, religious & leisure expenses