Spatial analysis of the effect of microfinance on poverty and inequality in Ghana

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Abstract
Although microfinance is usually delivered with a spatial outlook, the literature is so far silent on the potential spatial effect of microfinance delivery. The aim of this study was, therefore, to examine the effect of microfinance intensity on spatial inequality and poverty in Ghana. Using the 6th (2012/2013) and 7th (2016/2017) rounds of data from a national survey on living standards in Ghana, the study first examined the pattern of district-level poverty and inequality in Ghana and then adopted spatial econometric techniques to explore the spatial correlation between microfinance, inequality, and poverty. The results revealed that microfinance has a significant negative impact on spatial inequality and poverty in Ghana. The spatial effect of microfinance intensity on poverty and inequality is characterized by both direct and spillover effects on neighbours. It was identified that the outreach of microfinance drives within-district disparity, whereas the disparity in microfinance credit distribution powers between-district disparity. Additionally, while there is evidence of an indirect effect, the indirect effect diffuses monotonically as the number of neighbours increases. The study’s findings advocate for a complementary approach to microfinance delivery, as well as the elimination of institutional barriers that limit access, availability, and operational delivery of microfinance services in order to achieve spatially optimal microfinance delivery.

Keywords Ghana · Inequality · Poverty · Microfinance · Spatial analysis · Clustering

Introduction
Over the past two decades, remarkable growth in the demand for microfinance services has been observed around the globe. Statistics show that between 1997 and 2013, the demand for microfinance services has grown by at least 19%, generating an excess of 3,000 microfinance institutions and 200 million borrowers by 2016 (Buera et al. 2018). According to the Microfinance Barometer report in 2019, a total of 139.9 million borrowers benefited...
from microfinance worldwide in 2018 alone, representing an annual growth of 11.5% since 2014.

Despite the rising microfinance market, the literature suggests an enduring income disparity and poverty (Hisako and Shigeyuki 2009) across the globe. Reducing poverty and inequality has been the central focus of global development efforts, and microfinance has been one of the flagship developmental tools that have been deployed by policymakers to achieve this objective. Sub-Saharan Africa is acknowledged as one of the world’s economic zones with the highest income inequality and poverty (Agyire-Tettey et al. 2018), albeit also one of the regions with a growing microfinance market (Microfinance Barometer 2019). Rogerson and Nel (2016) argue that spatial economic disparities remain fixed rather than disappearing, despite developmental efforts. This has raised serious concerns for policymakers, particularly due to the socio-political problems that can originate from spatial socio-economic imbalances. For instance, a high level of spatial disparity may lead to conflicts over resources, which will likely undermine economic, social, and political developments (Østby et al. 2009), fuel a contraction in long-run aggregate demand, and lead to structural violence, crime, and social injustice (Hseih and Pugh 1993; Roelen, Sabates-Wheeler and Devereux 2016; Featherstone 2016).

In the context of Ghana, Cooke et al. (2016) observe an upsurge in income inequality despite rapid economic growth. However, Ghana is the second biggest West African economy after Nigeria. However, the majority of the national wealth is concentrated within the 10% rich population, who consume 32% of the total share of consumption. This is more than the consumption of the bottom 60% of the population. The very poor 10% of Ghanaians, on the other hand, consume 2% of the total household consumption (OXFAM 2019). The poverty trends also suggest a rising poverty rate since 2006 (Cooke et al. 2016). This has induced several concerns among policymakers about the optimal national approach to tackle inequality and poverty in the country. Despite this, one cannot fail to recognize the growing size of the microfinance market in the country (Appietu et al. 2020; Yeboah et al. 2022). For instance, between 2000 and 2013, the total number of microfinance clients in Ghana grew at an annual compound rate of 16 percent, while deposits and loans grew by 21 percent and 25 percent respectively (GHAMFIN 2014; World Bank 2016). Given the social intermediation mission of microfinance interventions, it is instructive to examine the extent to which trends in microfinance activities contribute to the observed disparity in poverty and income across and within districts in Ghana.

To address this spatial poverty and inequality, it is important to understand the factors that account for its occurrence and persistence. Until now, researchers have generally attributed the enduring spatial differences in economic activity, poverty, and regional development to globalization (Ezcurra and Rodriguez-Pose 2013), decentralization (Kyriacou et al. 2015), government quality (Rodriguez-Poze and Ezcurra 2013), and the uneven distribution of population-centred policy interventions (Pallares-Barbera et al. 2012; Rogerson and Nel 2016). However, the influence of microfinance on spatial inequality and poverty has attracted no attention. While several studies have examined the effect of microfinance on inequality and poverty, adopting either a microeconomic or macroeconomic perspective (Bangoura et al. 2016), none of these studies has explored the spatial effect of microfinance delivery on income inequality and poverty. Yet, there are two economic reasons why the spatial analysis of the effect of microfinance on poverty and income inequality is important. First, regional shocks (eg. infrastructural development, conflicts, etc) can affect the application of microfinance products and the intensity of economic activity (Ganle et al. 2015). Second, differences in regional attributes can leverage the effectiveness of microfinance service delivery. Spatial analysis can capture these interactions and provide an
accurate account of the effect of microfinance on poverty and inequality, relative to a non-spatial outlook. Ganle et al. (2015) also argued that the environmental context can limit the impact of microfinance delivery. Perhaps, this might explain why the results of extant studies do not converge. For example, Bakhtiari (2006); Hadj Miled and Rejeb (2018); Imai et al. (2012); and Bhuiya et al. (2018) suggest that access to microfinance services reduces poverty and, by extension, income inequality. However, Duvendack et al. (2011), Banerjee et al. (2010), Ganle et al. (2015), and Seven and Coskun (2016) found that there is a positive relationship between microfinance, poverty, and inequality.

The mixed empirical findings, plus the fact that these studies employ non-spatial methodologies, make it difficult to tease out any meaningful conclusion about the potential contribution of microfinance to the spatial distribution of income, economic activity, and poverty. This begs for an empirical investigation. The expected findings will be particularly significant to the achievement of the Sustainable Development Goals (SDGs) since tracking and measuring spatial decompositions in socio-economic inequalities and poverty is a useful step in addressing regional inequalities and poverty, a key component of the SDGs (Smith and Rey 2017). Such empirical findings are also necessary to inform the pursuit of an appropriate interventionist spatial policy approach to microfinance delivery. The conclusions gleaned will also benefit policymakers’ understanding of how to ensure spatially optimal microfinance service delivery, improve the quality of life among subpopulations, and minimize spatial socioeconomic disparities.

There are two transmission mechanisms under which access to microfinance can correlate with spatial differences in socio-economic conditions. First, the development of microfinance services can directly affect the intensity and growth of economic activities, thereby affecting community-level productivity and output. This expresses a homogeneous economic value for all members of the population. The possible outcome is between-region variations in wealth and development. Second, by targeting specific vulnerable groups, that is, the poor, the income level of the poor can be increased. This affects within-region income distribution and poverty levels. (Bangoura, Diaw, Lessoua, and Mbow 2016). In either of these two channels, it is expected that microfinance will have an impact on the spatial distribution of income and poverty. Moreover, microfinance service delivery is undertaken with a spatial strategic outlook based on either a group-targeting model or a location-based model. Thus, its intensity can play a key role in shaping spatial imbalances in economic welfare and living standards. In the light of no existing research on these spatial inter-linkages, plus the policy relevance of such an empirical investigation, we sought to examine the impact of microfinance on spatial consumption poverty and income inequality.

In our contribution to the existing literature, the question we try to answer is whether the scope and intensity of microfinance activities influence the spatial differences in socio-economic development in Ghana. We relied on district-level data extracted from a national representative survey on living conditions in Ghana. The data we used is unique because, like most other developing and transitional economies, a growing sense of rising spatial and regional inequalities in living conditions is being observed in Ghana. Again, since the use of microfinance among households is also context-driven, the nationally representative survey on living standards is a reliable source for tracking the outcomes of microfinance access across communities and localities. It is also intuitive that differences in poverty and inequality levels across space originate from differences across households.

Until now, an increasing level of regional imbalance and poverty have been detected in the country, and this coincides with a growing microfinance industry and economy (Annim et al. 2012). Nonetheless, it is not clear the extent to which microfinance contributes to this
development. Due to this, the current paper adopts a family of spatial econometric models to examine the effect of microfinance on poverty and income inequality. A key advantage of this approach is that the study can control for both the exogenous and endogenous interactions that might affect poverty, inequality, and microfinance service delivery in Ghana.

Our findings reveal that there are significant differences in poverty, income inequality, and microfinance activities between districts in Ghana. We also find that the level of microfinance intensity significantly and negatively contributes to spatial poverty and inequality in Ghana. The rest of this paper is organized as follows: the literature review is presented in Sect. 2. We present the details of the study design and empirical strategy in Sect. 3. The results are then presented and discussed in Sect. 4, and the conclusion is presented in Sect. 5.

**Literature review**

Generally, poverty is defined as the state where a household unit lives at or below the standard income level sufficient to meeting their basic needs. It, therefore, emphasizes a material deprivation in income or consumption which makes it difficult for a proportion of a given population to meet their basic human needs on a sustainable basis, even when economy-wide resources are equally distributed (UNCTAD 2002). In the context of this study, every household within an administrative district whose annual consumption expenditure is below the national average is considered poor.

Income inequality, on the other hand, represents the uneven distribution of income within a population. Inequality as a concept is broader than poverty, and its focus is on the relative standard of living of a whole populace (Diallo 2009). Thus, inequality exists in a society where people are not treated the same way. The concept of inequality is central to social justice theories and expresses the standard with which social arrangements should be constructed and viewed in order to conform to tenets of morality, ethics, and fairness (D’Odorico et al. 2019). According to Sen (1992) and Atkinson (2015), the general frame within which inequality issues are usually discussed concerns income, rights, opportunities, wealth, health, education, and power. It is, however, a common feature for economists and development theorists to centre the scale of measurement or comparison on income or consumption. The excessive inclination towards income-related inequality may have been inspired by the unwavering attention to cross-country differences in economic growth and per-capita income. McKay (2002) also discusses the tendency of researchers to define inequality in terms of differences between individuals in a population, usually a country. An evolving issue, however, has been to focus on groups of people, household classes, regions, or communities within a country, which is noted to provide richer information on the extent of inequalities that exist. This study focuses on income inequality within districts in Ghana.

According to Bastagli et al. (2012) and Beegle et al. (2016), the level of inequality in Ghana is staggering and a concern. Excessive regional, location-based, gender, and income-related differences in poverty have been observed (Cooke et al. 2016). Growing evidence suggests that unchecked inequality can have a range of negative impacts on a country’s development, including social cohesion, political and economic stability, and growth (van den Berg et al. 2012; Dabla-Norris et al. 2015).

The recognition of microfinance as a major tool for fighting poverty and inequality began following the success story of Grameen Bank and the subsequent 2005 UN declaration. According to proponents, microfinance service delivery, which provides small-scale
financial products to the poor, is expected to reduce liquidity constraints and lift clients out of poverty (Duvendack et al. 2011). Access to microfinance products is predicted to increase the household income of the poor and mobilize their capacity to engage in economic activities (Rudd 2011; Seven and Coskun 2016; Imai et al. 2012). The financial resources which are gathered from the income-generating activities of the poor can be used to hedge against socio-economic shocks, smooth consumption outlays and accumulate more assets in the future (Ksoll, Lilleor, Lonborg and Rasmussen 2016; Imai et al. 2012). According to Duvendack et al. (2011), the importance of microfinance as a development tool is emphasized by the fact that it engenders social, economic, and political benefits that the poor require to escape the poverty trap.

In recent times, controversies have erupted over the catalytic property of microfinance schemes as a poverty-alleviating instrument and, by extension, their capacity to reduce inequality. Accompanying the heart-warming reports of successful microfinance models are scandalous reports about profiteering and exploitative operational mechanisms that render the poor worse off (Rudd 2011). In Ghana, the Bank of Ghana revoked the licenses of 347 microfinance institutions in 2019 for various malpractices. Several empirical studies have consequently been conducted to examine the effect of microfinance on poverty. However, the subsequent findings are mixed (see Imai et al. 2012; Mazumder and Lu 2015; Bhuiya et al. 2018; Duvendack et al. 2011; Banerjee et al. 2010; Ganle et al. 2015; van Rooyen et al. 2012). This highlights a complex synergy between microfinance, poverty and inequality. Oteng-Abayie et al. (2011); Steel and Andah (2008) show that understanding this synergistic relationship is becoming more and more important for policy direction on how to fight poverty and inequality.

Microfinance ecosystem in Ghana

Microfinance has been in Ghana for decades. Asiamah and Osei (2007) pointed out that even before the establishment of the first credit union in Northern Ghana in 1955, Ghanaians cultivated the culture of saving unconsumed resources, sought the assistance of close relations in self-help arrangements, and obtained support from local creditors to sustain household livelihoods. It was not until the 1960s that microfinance was formally institutionalized by the government. The evolution started with the establishment of institutional frameworks that saw the creation of the Agricultural Credit and Cooperative Bank (1965), known currently as ADB Bank; the Rural and Community Bank (1976); the introduction of biased lending (the 1980s); enactment of the financial structural adjustment program (1986); the institution of non-bank financial institutions (1993) and universal banking (2003). From a total of 1.3 million clients in 2001, 8 million Ghanaians benefited from the microfinance market in Ghana as of 2013, which is 46% of the estimated total clients in 2010 (World Bank 2016). Recently, Oxford Business Group (2021) estimated the asset size of some 253 registered MFIs to be in the region of $194 million. This may represent a smaller figure given the relatively large percentage of unregistered microfinance institutions in the country. The recent financial clean-up, which resulted in the revocation of licenses for 347 registered institutions, as well as the novel coronavirus, have slowed the microfinance market’s growth trajectory (Yeboah et al. 2022).

Traditionally, microfinance services operate through three main product channels: microcredit; microsavings (susu); and microinsurance. In Ghana, microcredit accounts for the majority of microfinance services with an estimated outreach of 15 percent of the population (Dziwornu and Anagba, 2018). Though there are several innovative product
offerings on the market, these products are variants of the three traditional products. It must be stressed that the majority of lending institutions combine credit schemes with compulsory savings as collateral for loans. Those who do not require compulsory savings, however, adopt the group-based lending approach to provide micro-loans to clients. The group-based approach is usually implemented in villages and peri-urban communities where there is an appreciable level of economic activity. The average group size in Ghana is between 5 and 10 members, with the group jointly liable for the loans of the individual members. While microinsurance products are not widely available, the Ghanaian market is gradually embracing them, with some insurance companies collaborating with microfinance firms to provide micro- and small insurance packages to protect property, provide health insurance coverage, life insurance, and pension. A few microinsurance products target support for child education and major life events such as funerals. The premiums are usually small and are collected through a registered susu account. Microinsurance products in Ghana are offered in two general ways: (1) a microfinance institution partnering with an insurance company to provide insurance cover to its clients; and (2) an insurance company providing complete microinsurance cover to clients. The target of microinsurance products is mostly market women, farmers, small-scale miners, and artisans. In recent times, the majority of microfinance institutions have also taken to the use of digital technologies, particularly mobile apps and unstructured supplementary service data (USSD), with mobile money technology to engage clients. Microfinance institutions are using such platforms to provide customer feedback and loan application services, disburse loans, collect repayment of loans and check withdrawals from accounts. This is not only enhancing the digital and financial inclusion drive but also reducing the cost of transactions. Collins et al. (2009) mention that the variety of microfinance products on the market has been accounted for by the demand for more than microcredit by the poor.

The microfinance legal framework supervised by the Bank of Ghana (BOG) projects the microfinance sector as a four-tiered financial market (Bank of Ghana 2011; Anku-Tsede 2014; Ayayi and Peprah 2018). The tiers are distinguished on the basis of minimum capital required, risk level, and licensing. Tier One institutions comprise deposit-taking institutions such as rural and community banks (RCBs), Finance Houses and Savings and Loans (S&L) companies. These institutions are regulated under the existing Banking Act, 2004 (Act 673) (Peprah and Obeng 2015). According to the Bank of Ghana (2022), a total of 11 Finance Houses, 25 savings and loans companies and 144 RCBs operate in the market. Tier two institutions, on the other hand, are comprised of all microfinance companies and credit unions (CUs), with a minimum capital requirement of 100,000 Ghana Cedis for one unit office while maintaining a minimum capital adequacy ratio of 10%. Though tier 2 institutions are permitted to open branches, this is subject to approval from the Bank of Ghana and compliance with a higher capital requirement as determined by BOG. According to official statistics, there are 137 registered MFIs and 490 credit unions in Ghana as of September, 2022. Tier three institutions are comprised of all money lending companies and financial NGOs (categorized into deposit-taking and non-deposit-taking institutions). Tier three institutions are required to maintain a minimum capital of 60,000 Ghana Cedis. These institutions have generally contributed immensely to the delivery of microfinance in Ghana due to their focus on the informal sector. They include profit-oriented and non-profit-oriented NGOs with pro-poor initiatives, thereby achieving greater penetration in poor and rural communities (Steel and Andah 2003). There are currently 12 FNGOs and 31 micro-lending institutions in the sector (Bank of Ghana 2022). Tier four institutions, on the other hand, are comprised of individual money lenders and “susu” companies. Although tier four institutions are not required to maintain a minimum paid-up capital, they are,
however, required to register with a respective apex institution, including the Ghana Cooperative Susu Collectors Association (GCSCA), the Ghana Association of Microfinance Companies (GAMC), and the Money Lenders Association of Ghana (MLAG). The activities of tier four institutions are predominantly centred on the informal sector. Tier 4 institutions are also usually owned by private individuals interested in micro-lending or rotatory savings (susu). Peprah and Obeng (2015) recount how the activities of these institutions have heightened the mobilization of rural savings and the integration of poor households into the financial system, with rural and community banks providing the platform through which these positive outcomes are harnessed.

It must be emphasized that microfinance activities are not delivered solely through private initiatives. There are a number of government programmes and donor-assisted interventions (including initiatives from the World Bank, African Development Bank, DANIDA, GTZ, etc.), which are delivered either through a community-based approach or a district assembly initiative. Such initiatives have contributed significantly to job creation, entrepreneurial development, and poverty reduction (Antwi 2015). Because they focus on social goals, donor-supported interventions and government programs tend to be more common in rural and poor communities. This is a very important fact. However, private initiatives are major in urban and peri-urban centres where economic activities are relatively vibrant.

Poverty and inequality in Ghana

The Ghanaian economy has achieved sustained growth, averaging about 6% annually since 2001. In terms of poverty and food security, Ghana met its Millennium Development Goal (MDG) of halving the proportion of hungry people in 2002 and was scheduled to achieve its MDG poverty target in 2015. Based on this remarkable achievement, the World Bank re-classified Ghana as a lower middle-income country (Ravallion 2012). However, these achievements were uneven across the country. In Ghana, poverty rates are observed to be lower in Accra metropolis and the rural forest localities. On the other hand, poverty rates are higher in rural areas than in urban areas (Gallardo 2002), as well as in the northern part of Ghana relative to the southern part of Ghana.

A recent report by the IMF indicated that Ghana is among the countries with faster growth in inequality (Bastagli et al. 2012). Molini (2015) also identifies that the critical issues that confront Ghana’s economy despite its success in halving poverty are the growing inequality and polarization in household consumption, large spatial disparities in welfare, and the deteriorating macroeconomic environment. A significant increase in Ghana’s Gini index has been observed; from 37.5 in 1991 to 40.8 in 2013. While the level of inequality has increased homogeneously across all regions, inequality in rural communities continues to dominate (Cooke et al. 2016). Molini (2015) also notes that regional imbalances in socio-economic development largely account for the increased inequality in the country. Imai et al. (2012) attribute the regional variations in socio-economic development to differences in regional level policy interventions and implementation strategies. In summary, there is an evident spatial variation in poverty and inequality in Ghana. Disparities can be found regionally, north–south, and between urban and rural centres.

According to Addae-Korankye (2012), one of the key strategies that the government has used in tackling poverty and inequality in Ghana is microfinance. The Presidential Special Initiative (PSI), Local Enterprise and Skills Development Programme (LESDEP), the Ghana Youth Enterprise and Entrepreneurial Development Agency
GYEEDA, Microfinance and Small Loans Centre (MASLOC), and Livelihood Empowerment Against Poverty (LEAP) are some of the government-supported initiatives designed to reduce poverty and income inequality in the country through microfinance and capacity building. These initiatives are geared towards helping the poor start businesses, build on already existing ones, and achieve overall wealth creation (Odoro-Ofori et al. 2014). According to Amankwah et al. (2022) and Odoom et al. (2019), the microfinance market is dominated by the informal sector, which accounts for more than 70% of Ghana’s private output. By providing minimalist credit facilities to low-income households and to the informal sector, the microfinance sector assists clients to gain access to the financial system, develop their capacity and build assets, which goes a long way to reducing poverty and income inequality.

Methods

Data

The Ghana Living Standards Survey (GLSS), a nationally representative survey data set, was employed for this study. Two survey rounds from GLSS 6 (2012–2013) and GLSS 7 (2016–2017) were used. Three reasons motivate the choice of the two survey periods. First, they capture relevant information on current living standards in Ghana. Second, they represent a post-oil-discovery stage in Ghana. This stage has been interspersed with strong economic prosperity and enduring energy crisis, which potentially slowed down the economy. Third, both survey periods represent a phase where the Millennium Development Goals (MDGs) policy was close to its full cycle and a transition to the Sustainable Development Goals (SDGs) was propelled. Between these two surveys, which were done 5 years apart, enough changes in living conditions could have happened.

District-level data were collected from a sample of 170 districts in Ghana for each period, yielding 340 total observations over the two periods. The primary surveys were conducted using a two-stage random sampling technique. Households in each district were stratified into census enumerated areas based on the population distribution of ten (10) regions in Ghana. Households living in each enumerated area (EAs) were then randomly sampled after randomly selecting some EAs across the ten regions in Ghana. The data set contained information of 16,771 households in GLSS 6 and 14,009 households in GLSS 7. Since the unit of analysis is at the district level, the poverty and inequality measurements were executed for each district sampled in the surveys. The spatial analysis of the level of poverty and inequality was then conducted, focusing on the districts. The computation was executed for each round of the survey, which captured the socioeconomic wellbeing of households within the 170 sampled districts.

The spatial inequality, poverty, microfinance access, and other district-level covariates were calculated for each district and each specific survey round. Summary statistics of the district level covariates used in this study are reported in Table 1. The descriptive statistics show a significant difference in the number of active microfinance clients between the two sample periods. Other socioeconomic development indicators, such as access to water, access to electricity, and the availability of formal banks, have been found to vary significantly over time. The standard deviations hint at potential differences across districts.
Measurement of poverty and inequality

The first block of investigation for this study involved examining the dynamics of spatial poverty and inequality in Ghana, focusing on 170 districts. While many empirical attempts (Cooke 2016; Senadza 2011; Novignon et al. 2015) have been made to measure poverty and inequality at the national and regional levels in Ghana, a district-level assessment has been unexplored. Intuitively, district-level poverty and inequality estimates will provide a piece of richer information on the effectiveness of national policies to tackle inequality and poverty. The logic is that they represent estimates of poverty and inequality at the local level, which are then averaged to the regional or national level. More importantly, national policies on poverty and inequality are rolled out on a district-by-district basis, and therefore, district-level assessment will reveal local level patterns in poverty alleviation efforts and effectiveness. When district-level poverty rates and inequality improve, it stands to reason that national and regional level poverty and inequality estimates will also improve.

The analysis begins by calculating the level of income inequality at the district level. An initial top of the envelop calculation shows that there are at least 9,902 households in 54 districts where average annual household income fell below the 25th percentile of the annual household income distribution. Following some key literature (Annim et al. 2012; Owens 2019; Camporeale et al. 2019), the generalized entropy (GE) measure (Theil index) was used. According to Khandker and Haughton (2005), GE is a robust measure of inequality. Higher values of GE indicate increasing levels of inequality. GE ranges from 0 to infinity (∞). The GE formula for estimating inequality can be expressed as follows:

\[
GE(\alpha) = \frac{1}{\alpha^2 - \alpha} \left[ \frac{1}{j} \sum_{i=1}^{j} \left( \frac{y_i}{\bar{y}} \right)^{\alpha} - 1 \right]
\]

Table 1  Descriptive summary of district covariates

| Variable                                           | GLSS 7 (2016–2017) | GLSS 6 (2012–2013) |
|----------------------------------------------------|---------------------|--------------------|
| Number of microfinance clients                     | 631.17 [179.01]     | 1111.60 [244.60]   |
| No. land owners                                    | 198.041 [192.409]   | 216.087 [185.177]  |
| Tropical livestock units                           | 19.017 [14.035]     | 27.257 [18.612]    |
| Value of agriculture output (in local currency unit) | 1909.35 [14069.26]  | 766.881 [1581.239] |
| Rural household units                              | 345.884 [510.11]    | 370.483 [487.664]  |
| Average dependency                                 | 6.821 [0.881]       | 6.630 [0.542]      |
| No. Female headed households                       | 312.80 [86.78]      | 611.80 [84.19]     |
| No Household heads with some education [Literacy]   | 295.373 [407.380]   | 314.58 [381.246]   |
| Number of communities with banks                   | 613 [89.974]        | 374 [91.905]       |
| No. traditional cooking fuel                       | 111.40 [24.31]      | 611.67 [64.77]     |
| No. of communities with access to piped water/borehole | 93.701 [65.313]    | 83.111 [47.240]    |
| No. Huts/Kiosks/uncompleted houses                 | 227.710 [277.212]   | 214.456 [240.969]  |
| No. self-employment                                | 138.225 [129.474]   | 150.414 [117.155]  |
| Number of communities with electricity             | 1,001 [156.546]     | 1,193 [113.59]     |

Note all the values are in average counts, unless otherwise stated. Standard deviations in parenthesis.
where $y_t$ and $\bar{y}$ are the annual household real per-capita expenditure and the average real per-capita household expenditure per annum of the population, respectively. $\alpha$, which takes on the value of 0, 1 and 2, accounts for the differences in household expenditure at various parts of the income distribution. We used $\alpha$ value of 1 to estimate income inequality. This is known as the Theil index. Conceicao and Ferreira (2000) suggest that the Theil index has unique properties that make it a powerful instrument to analyse patterns and dynamics of inequality. According to Atkinson and Bourguignon (2015), the Theil index places equal weight over the income distribution and is less sensitive to the distribution of income in the population.

The second part of the analysis focused on measuring the level of poverty within each district. Poverty was measured based on the real per-capita household expenditure per annum (or per-adult equivalent). The total household expenditure per adult equivalent was computed based on expenditure on food and non-food items. The expenditure on food includes purchases of food and non-alcoholic beverages, whereas expenditure on non-food items comprises purchases of clothing and footwear, housing, energy, furniture, health, transport, education, recreation, restaurants and hotels, as well as miscellaneous goods and services. The real per-capita household expenditure was used since it is cluster-adjusted for differences in prices. To estimate headcount poverty, two upper poverty lines were used: GHC 1,314 for GLSS 6 (2012–2013) and GHC 1760.86 for GLSS 7 (2016–2017). The headcount poverty rate, which measures the percentage of the population living below the estimated poverty line, was applied. The poverty lines were calculated by the Ghana Statistical Service (GSS) based on the household data on living conditions obtained in the two rounds of national surveys. Following Novignon et al. (2015), the Foster–Greer–Thorbecke FGT (Foster et al. 1984) poverty decomposable index was used to measure poverty. The FGT index is given by:

$$P_a = \frac{1}{n} \sum_{i=1}^{q} \left( \frac{z - y_i}{z} \right)^a$$

where $a \geq 0$

According to Foster et al. (1984), the vector of income for the $n$ population of households is represented by $y$. $z$ represents the poverty line, whereas $q$ is the number of economic units reflecting the weight placed on the welfare levels of the poorest among the poor, and $a$ is the parameter of poverty aversion, respectively. The FGT index has a range between 0 and 2, for which the FGT index captures the poverty headcount ratio (when $a = 0$), the average poverty gap (when $a = 1$), and the severity of poverty (when $a = 2$). Higher FGT values, therefore, represent high poverty incidence within the district. With special attention to headcount poverty (where $a = 0$), Eq. (2) reduces to:

$$P_0 = \frac{q}{n}$$

**Exploratory spatial analysis**

First, we utilized an exploratory spatial analysis that begins with quartile maps that show the district level distribution of microfinance intensity, poverty, and inequality for each survey period [GLSS 6 (2012–2013) and GLSS 7 (2016–2017)]. Further analysis using global and local spatial autocorrelation was employed to examine clustering patterns in poverty.
and inequality. Global spatial autocorrelation was tested using the global Moran’s I, which examines whether there is an overall spatial dependency in regional development (Moran 1950; Cliff & Ord 1981). The global spatial autocorrelation is given by:

$$I = \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} (y_i - \bar{y}) (y_j - \bar{y})}{\frac{1}{N} \sum_{i=1}^{N} (y_i - \bar{y})^2 \sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij}}$$  \hspace{1cm} (4)

where \(y_i\) is the attribute of the district, \(i\), and the corresponding \(y_j\) represents the attribute of the nearest district or neighbour, \(j\). The mean of the attribute is captured by \(\bar{y}\). \(w_{ij}\) represents the spatial weight. The spatial weight measures the degree of proximity between the districts. The numerator of Eq. (4) represents the degree of similarity between the districts, which is the covariance between the districts weighted by the spatial weight. The denominator, on the other hand, measures the variance of the attribute for the district, \(i\). Dividing the numerator by the denominator yields the global Moran’s I, which can be either positive or negative. When the estimated value is positive (or negative), it means that the pattern or value of the attribute of interest, \(Y\), is the same (or different) in nearby districts.

Because the global Moran’s I is restricted to the test of spatial dependence, it is relevant to also employ a measure that will convey relevant information about the state of spatial heterogeneity (David et al. 2018). For this purpose, the Local Moran’s I statistics, which capture where low and high values of the attribute variable (inequality and poverty) are spatially clustered, were used. The local Moran’s I is specified as:

$$I_i = \sum_{j=1}^{N} w_{ij}^{std} \left( \frac{y_i - \bar{y}}{\sigma_y} \right) \left( \frac{y_j - \bar{y}}{\sigma_y} \right)$$  \hspace{1cm} (5)

where \(\sigma_y\) represents the standard deviation of the attribute variable, \(y\) and \(w_{ij}^{std}\) captures the row-standardized spatial weight matrix (Pisati 2012). A positive value for the local Moran I statistic indicates that a given district has neighbouring districts with similarly high or low poverty or inequality estimates (identifying clustering), while a negative value indicates that a district has a neighbouring district with dissimilar poverty or inequality estimates (identifying an outlier). The Z-score of the Local Moran’s I index and \(p\)-value are then used to test whether either the clustering or the outlier features are statistically significant.

**Panel spatial autoregressive model**

The effect of microfinance delivery on spatial inequality and poverty was examined using a family of spatial panel econometric models. The general spatial econometric model applied in this study followed the Manski model and was specified as:

$$y_{it} = p Wy_{it} + a_1 Y + X_{it} \beta + WX_{it} \theta + \mu_{it} + \nu_{it} \sim (0, \sigma^2 I)$$  \hspace{1cm} (6)

where \(y_{it}\) captures the indicators of poverty and inequality levels for each district. \(X_{it}\) represents the microfinance intensity as well as the district level covariates that affect poverty and inequality. For parsimony, microfinance intensity was calculated as the total number of microfinance clients divided by the population in each district in the sample (Hermes
W is the spatial weight matrix, which is row-normalized form. That is, the sum of each row equals one. A contiguity spatial weight matrix captures only the effects from adjacent districts (which share the common border). \( \nu \) represents the vector of i.i.d error terms across the districts. \( W_y \) denotes the endogenous interactions in the dependent variables. \( W_X \) on the other hand, represents the exogenous interaction effects among the variables, whereas \( W_\mu \) captures the interaction effects among the disturbance terms of different spatial units (Elhorst 2010).

\( \rho \) and \( \lambda \) capture the spatial autoregression coefficient and the residual autoregression coefficient, respectively. \( \rho \) captures the spatial effects of poverty and income inequality. A significant \( \rho \) therefore shows that poverty and income inequality spillover at the district level. If on the other hand \( \lambda \) is significant but \( \rho \) is not; then Eq. (6) reduces to a spatial Durbin error model (SDEM) which captures the unobserved shocks that affect the level of poverty and inequality in the district. Thus, Eq. (6) reduces to Eq. (7).

\[
\text{SDEM} : y_{it} = \rho Y_{it} + X_{it}\beta + WX_{it}\theta + \mu_{it} \\
\mu_{it} = \lambda W\mu_{it} + \nu_{it} ; \nu_{it} \sim (0, \sigma^2 I)
\]  

(7)

A significant \( \rho \) while \( \lambda = 0 \) transforms Eq. (6) to a spatial Durbin model (SDM) which contains the endogenous interaction effects of the dependent variable as well as the exogenous interaction effects in the independent variables. The econometric specification of the SDM is given as:

\[
\text{SDM} : y_{it} = \rho Y_{it} + X_{it}\beta + WX_{it}\theta + \mu_{it} ; \mu_{it} \sim (0, \sigma^2 I)
\]  

(8)

\( \theta \) captures the effect of neighbouring district’s attributes on a district’s poverty and inequality level. LeSage and Pace (2010) argue that the SDM yields unbiased estimates even in the case of omitted variable bias. To account for common shocks that influence all districts within a region, we included region-fixed effects in all the spatial models. All the three models (Manski, SDEM, and SDM) contain both econometric and economic properties that make them suitable for this study. On the economic side, the inclusion of the spatial lagged values of microfinance intensity controls for the spatial shocks that affect the placement and growth of microfinance delivery within and across localities. From the econometric point of view, the three models are suitable for examining spatial spillovers. Moreover, the previous level of microfinance intensity may influence current microfinance intensities within the districts. If these conditions exist, then microfinance intensity is endogenous. Whitten, Williams, and Wimpy (2019) argue that to produce meaningful inferences from the coefficients of the spatial models, it is best to compute the partial derivatives of the coefficients. This allows the study to examine the total effect of a change in a district’s attributes on itself (direct effect) and on neighbouring districts (indirect or spillover effect). Following Whitten et al. (2019), we were also able to calculate the average total, direct and indirect effects, which allowed the study to make insightful inferences concerning the percentage of the total effect that is attributable to spatial dependence. We conducted the econometric estimations by using alternative contiguity matrices that capture first-order and second-order neighbours. This allowed the study to describe the proportion of the higher-order effects that are due to feedback from neighbours. We used the log-likelihood and the R^2 to test for model fitness.
Robustness

We test the robustness of results in two ways. First, by examining the role microfinance plays in each observed spatial cluster. To execute this, we initially grouped the districts into clusters based on the local Moran’s I results. We then adopted Wang, Kockelman and Damien’s (2014) spatial autoregressive multinomial probit model (SAR MNL) to examine the extent to which microfinance determines the probability that a district falls within a particular spatial cluster with its neighbours [GLSS 6 (2012/2013) and GLSS 7 (2016/2017)]. According to Wang et al. (2014), the SAR MNL model accounts for both spatial clustering and cross-sectional dependence. The general model is given as:

\[
\bar{y}^* = pW\bar{y}^* + X\beta + \bar{\mu}
\]  

Equation (9) assumes that the latent attributes in district, \(i\), associated with the class of territorial distribution in poverty and inequality its exhibits can be expressed as a weighted sum of district, \(i\)’s neighbours latent attributes associated with the same class of poverty and inequality patterns. The weighted sum is giving as an \(NJ \times 1\) vector of attributes, \(\bar{y}^* = (y_{1j}^*, y_{2j}^*, \ldots, y_{Nj}^*)\). \(p\) in Eq. (9) gives the spatial autocorrelation. \(W\) is the \(NJ \times NJ\) spatial weight matrix, which is a row-normalized weight by construction with \(X\) representing \(NJ \times KJ\) vector of explanatory variables, while \(K\) gives the number of covariates and \(N\) denotes the number of observations (Wang et al. 2014). \(\bar{\mu}\) is the \(N \otimes \Sigma\) independent and identical error terms over space, (Wang et al. 2014).

The marginal effects from the SAR MNL model are then calculated. This expresses the change in the probability of membership to a particular spatial cluster type due to a one standard deviation change in microfinance intensity, all things constant. The marginal effect decomposes to direct and indirect spatial effects (see Wang et al. 2014). Second, we test the robustness of the results by examining whether disparity in credit distribution in the microfinance market contributed to spatial poverty and inequality. We follow Hermes (2014) and divide the total value of loans disbursed in each district by the total district level output (measured as the total value of harvest).

Empirical results

Scope and depth of microfinance activities

It is important to first understand the importance of microfinance in powering socio-economic development at the grassroot level before analysing its spatial role. As shown in Fig. 1, patronage of susu accounts is high compared to the other forms of microfinance products on the market. The emphasis on susu is highlighted by the fact that the majority of microfinance institutions use compulsory savings as collateral for loans and a means to collect loan repayment. This procedure has been found to be effective and flexible in improving access to the informal sector and integrating the poor, who generally receive meagre incomes from their income-generating activities. This does not only have an implication for financial inclusion but also emphasizes the prime lending approach used by microfinance institutions to reach the poor. The lending methodologies are also based on a group-based approach which focuses on mostly women in the
informal sector. In terms of access to microcredit, the evidence shows that, on average, loan applications were higher in 2012/2013 than in the 2016/2017 period. The loan success rate is also higher (92.7 to 95.6%), with the average loan size significantly higher in the 2016/2017 sample than in the 2012/2013 period. In terms of repayment,

![Graph showing trends of active clients of microfinance services](image)

**Fig. 1** Trends of active clients of microfinance services

| Table 2 | Scope of microfinance activities |
|---------|----------------------------------|
| Activity | 2012/2013 | 2016/2017 |
| **Access to credit facilities** | | |
| No. Loans applied | 2,109 | 1,143 |
| No. Loans granted | 2,016 | 1,059 |
| Loan amount (in local currency unit) | 1,408.56 | 2,881.47 |
| Total loan repayment (% repayment) | 1,585 (78.6%) | 812 (71%) |
| **Characteristics of microfinance clients** | | |
| Age | | |
| 18–35 | 2,282 (31.2%) | 1,575 (22.9%) |
| 36–59 | 3,873 (53.0%) | 3,070 (44.7%) |
| 60+ | 1,152 (15.77%) | 1,113 (16.2%) |
| Gender | | |
| Male | 3,008 (39.6%) | 2,876 (41.9%) |
| Female | 4,585 (60.4%) | 3,990 (58.1%) |
| Economic status | | |
| Not economically active | 566 (7.5%) | 1,037 (15.1%) |
| Employee public/Govt | 904 (11.9%) | 714 (10.4%) |
| Employee private | 729 (9.6%) | 1,037 (15.1%) |
| Self-Employed | 5,394 (71.0%) | 4,078 (59.4%) |
| Sector or industry | | |
| Agriculture | 3,685 (48.5%) | 2,680 (39.0%) |
| Non-Agric | 3,908 (51.5%) | 4,186 (61.0%) |
| Poverty Status | | |
| Very poor | 616 (8.1%) | 1578 (23.0%) |
| Poor | 1160 (15.3%) | 2765 (40.3%) |
| Non-Poor | 5817 (76.6%) | 2524 (36.8%) |
computation shows that repayment is higher (78%) in the 2012/2013 sample period as compared to the 71% repayment rate in the 2016/2017 period (see Table 2).

In terms of scope, it can be deduced from Fig. 1 that microfinance activities in the 2012/2013 season tended to be more widespread compared to the 2016/2017 season. Table 2 further indicates that the large percentage of microfinance clients are economically active and self-employed. It is also clear that at least two-thirds of the microfinance clients in the sample are women. Improving access to women has a direct impact on poverty and inequality since women are marginalized, restricted by cultural norms and form a greater percentage of the poor and vulnerable in Ghana (Memon et al. 2020). According to Diaz-Serrano and Sackey (2018), microcredit institutions tend to offer special treatment to women as a strategy to achieve social development goals. Figure 2 shows the pattern of loan utilization among the microfinance clients. Analysis shows that the majority of clients use loans acquired for productive activities such as starting a business, business expansion, purchasing agricultural equipment, and investing in education. Given that the majority of clients are self-employed, with a greater percentage of loans used for productive activities, the direct role of microfinance in providing opportunities for clients to enhance their economic participation for purposes of raising incomes and consumption is also discernible. This illustrates how microfinance drives income and poverty at the grassroots level. Essentially, Table 2 shows that access to microfinance among relatively poor households improved in the 2016/2017 season as compared to the 2012/2013 season. This is expected to drive down income inequality and poverty over the sample period.

**Spatial distribution of poverty and inequality**

Figures 3 and 4 reveal the quantile map of the spatial distribution of poverty and inequality for districts in the sample. Figure 3 reveals that poverty is prevalent in the
Fig. 3  Spatial quartile distribution of district level poverty in Ghana

Fig. 4  Spatial quartile distribution of district level inequality in Ghana
northern part of Ghana. The analysis shows a reduction in poverty rates over the period, particularly for districts in the Western corridor (e.g. Ellembelle, Nzema East, Takwansuaem, Wassa East), Ashanti (e.g. Atwima Mponua, Adansi South, Kwabre East) and Greater Accra (e.g. Ga West, Ga East, Accra) Regions. Generally, the national average of the poverty index indicates that between the two survey periods, headcount poverty has fallen from 29.5 in 2012–2013 to 13.6% in 2016–2017. This shows an annual average reduction of headcount poverty by 3.8 percentage points per year. Regarding the spatial distribution of income (Fig. 4), it was observed that income inequality was at least 20.2% in 2012–2013 and 22.4% in 2016–2017 across all districts. This suggests a moderate annual average increase of 0.44 percentage points in income inequality. Concerning the spatial variation in income inequality, Fig. 4 suggests that income inequality is high in pockets of districts in the northern, middle belt, and southern parts of Ghana (particularly in the Western Region). A breakdown of the pattern of microfinance intensity in Ghana at the district levels was also conducted. The evidence points to a spatial variation in the intensity of microfinance delivery at the district level. A concentration of microfinance participation in the Ashanti and Greater Accra regions is observed. This may be explained by the intensity of economic activity in the two regions.

Global and local spatial autocorrelation (Moran’s I)

Table 3 presents global Moran’s I estimate of income inequality and poverty in Ghana. The coefficient estimate is positive and statistically significant for poverty. This implies that there is a significant and positive spatial dependence in the distribution of poverty across the districts. The coefficient estimate is also positive and significant for income inequality and microfinance intensity, thereby suggesting significant spatial similarities in income inequality and microfinance intensity. We also examined the local Moran’s I statistics to test spatial heterogeneities (Anselin 1995). The Z-score of the Local Moran’s I index, and p-value suggested that the clustering or the heterogeneities in poverty, inequality and microfinance intensity are statistically significant for some districts. Scatter plot reports for the local Moran’s I estimates suggest significant clusters (see Appendix Fig. 1A–B).

It is found that the districts fall into one of four district groups: those with high poverty and inequality (high-high), affluence (low-low), and groups with a mix of high poverty (inequality) and low poverty (inequality) districts. Accounting for the results of the spatial clustering, Table 4 presents the number of districts falling into either of the unique clusters. The results suggest a correlation between microfinance activities and spatial clusters. For example, districts in the high-high cluster have small loan amounts and a small number of participants compared to districts in the low-low cluster.

**Table 3** Measures of global spatial autocorrelation, Moran’s I

| Variables          | I     | E(I)  | sd(I) | Z     | p-value* |
|--------------------|-------|-------|-------|-------|----------|
| Income Inequality  | 0.010 | 0.003 | 0.007 | 1.873 | 0.031    |
| Poverty            | 0.044 | 0.003 | 0.007 | 6.959 | 0.000    |
| Microfinance Intensity | 0.043 | 0.003 | 0.007 | 6.881 | 0.000    |
Table 4  Spatial clusters of poverty and inequality—districts

|                        | GLSS 6 (2012-2013) | GLSS 7 (2016 – 2017) | Global |
|------------------------|---------------------|-----------------------|--------|
|                        | High–High | High–Low | Low–High | Low–Low | High–High | High–Low | Low–High | Low–Low | High–High | High–Low | Low–High | Low–Low |
| Inequality (%)         | 60.58     | 30.73    | 20.00    | 12.19   | 67.64     | 30.57    | 20.15    | 13.85   | 65.11     | 30.89    | 20.07    | 12.9    |
| Microfinance clients (%)| 23.23    | 19.8     | 29.42    | 27.55   | 15.38     | 35.51    | 20.59    | 28.52   | 19.77     | 21.7     | 20.12    | 38.41   |
| Huts/Kiosks/uncompleted houses (%) | 31.27 | 19.2     | 24.29    | 25.24   | 17.05     | 36.17    | 19.04    | 27.74   | 25        | 34.67    | 19.17    | 21.16   |
| Traditional fuel (%)   | 25.49     | 22.5     | 30.11    | 21.9    | 13.02     | 31.85    | 25.37    | 29.76   | 18.34     | 28.48    | 26.59    | 26.59   |
| Access to water (%)    | 26.86     | 34.85    | 19.64    | 18.65   | 13.23     | 32.94    | 33.51    | 20.32   | 24.83     | 23.92    | 28.81    | 22.44   |
| Self-employment (%)    | 18.56     | 14.04    | 21.76    | 45.64   | 29.09     | 21.56    | 28.02    | 21.33   | 25        | 15.14    | 30.42    | 29.44   |
| Access to Electricity (%) | 35.97   | 17.33    | 14.09    | 32.61   | 28.56     | 20.55    | 30.80    | 20.09   | 23.42     | 24.93    | 24.11    | 27.54   |
| Access to banks (%)    | 22.88     | 28.90    | 24.78    | 23.44   | 20.20     | 13.23    | 33.79    | 32.78   | 23.80     | 22.50    | 30.65    | 23.05   |
| Average loan amount    | 1353.57   | 3378.49  | 2423.06  | 2035.82 | 1057.19   | 3578.59  | 2501.17  | 1732.85 | 1500.22   | 3054.65  | 2454.01  | 2110.38 |
| Dependents (mean)      | 5.59      | 5.03     | 5.32     | 4.09    | 6.03      | 5.56     | 5.11     | 4.37    | 6.75      | 4.90     | 5.20     | 5.44    |
| Number of districts    | 25.00     | 22.00    | 37.00    | 86.00   | 14.00     | 32.00    | 49.00    | 75.00   | 10.00     | 22.00    | 40.00    | 98.00   |
| Poverty (%)            | 49.92     | 25.75    | 11.58    | 6.13    | 60.14     | 56.72    | 37.55    | 15.36   | 61.53     | 36.19    | 19.58    | 11.17   |
| Microfinance clients (%) | 12.08   | 22.48    | 44.85    | 20.59   | 5.02      | 4.81     | 29.07    | 61.10   | 16.81     | 12.68    | 27.68    | 42.83   |
| Huts/Kiosks/uncompleted houses (%) | 29.07 | 20.59    | 28.04    | 22.3    | 23.34     | 27.95    | 22.80    | 25.91   | 27.66     | 21.1     | 22.75    | 28.49   |
| Traditional fuel (%)   | 12.61     | 28.18    | 24.83    | 34.38   | 39.51     | 27.17    | 17.33    | 15.99   | 27.05     | 25.72    | 23.64    | 23.59   |
| Access to water (%)    | 23.35     | 27.36    | 28.13    | 21.16   | 22.64     | 31.11    | 29.93    | 16.32   | 27.54     | 31.16    | 21.22    | 20.08   |
| Self-employment (%)    | 29.07     | 20.59    | 28.04    | 22.30   | 23.47     | 28.15    | 22.88    | 25.5    | 27.66     | 21.1     | 22.75    | 28.49   |
| Access to electricity (%) | 10.58   | 15.65    | 22.32    | 51.45   | 28.35     | 21.09    | 24.25    | 26.31   | 12.33     | 16.32    | 23.77    | 47.58   |
Table 4 (continued)

|                        | GLSS 6 (2012 -2013) | GLSS 7 (2016 – 2017) | Global |
|------------------------|---------------------|----------------------|--------|
|                        | High–High | High–Low | Low–High | Low–Low | High–High | High–Low | Low–High | Low–Low | High–High | High–Low | Low–High | Low–Low |
| Access to banks (%)    | 18.71      | 35.09    | 22.12    | 24.08   | 19.32     | 26.00    | 25.09    | 29.59   | 19.02     | 30.53    | 23.61    | 26.84   |
| Average loan amount    | 1418.73    | 2734.78  | 2388.29  | 2488.55 | 1422.50   | 1869.23  | 1959.28  | 2629.42 | 1481.51   | 2523.95  | 2259.42  | 2565.07 |
| Dependents (mean)      | 5.68       | 4.35     | 4.98     | 4.88    | 5.99      | 4.01     | 4.76     | 4.96    | 6.01      | 5.21     | 4.88     | 5.66    |
| Number of districts    | 38.00      | 24.00    | 41.00    | 67.00   | 3.00      | 8.00     | 20.00    | 82.00   | 34.00     | 14.00    | 21.00    | 101.00  |

Note: Average credit provided is measured in GHC
Effect of microfinance on spatial poverty and inequality

The next objective of this study was to ascertain the correlates of spatial poverty and inequality, with particular attention to the effect of microfinance intensity. A spatial econometric analysis was executed to understand the role of microfinance in the distribution of poverty and inequality across districts. The validity of spatial models is supported by the significance of the autoregressive terms, including the spatial autoregressive coefficients ($\rho$), the residual autoregressive coefficient ($\lambda$) and the spatial autoregressive component of the independent variable (microfinance intensity). From the literature, the presence of the autocorrelation terms may cause OLS to yield spurious results; thus, the essence of spatial econometric estimation. For all estimations, the row normalized binary spatial weight matrix based on contiguity spatial weights was used. As a baseline estimation, an OLS regression without spatial terms was estimated (see the appendix Table 1A). The OLS results suggest potential presence of spatial autocorrelation.

Tables 5 and 6 provide the parameter estimates of the effect of microfinance on inequality and poverty, controlling for other district covariates, respectively. We estimated several models to analyze the impact of microfinance intensity on inequality and poverty. The models differ in three accounts: whether spatial autocorrelation exists (Models 1, 4 and 7), whether higher-order effects are possible (Models 2, 5 and 8), and whether feedback effects exist (Models 3, 6, and 9). As reported in Tables 5 and 6, the effects of microfinance intensity, poverty and inequality were analyzed using the Manski, SDM, and SDEM models. The model fitness statistics prescribe the Manski model as superior. It was therefore selected as the more appropriate model to examine the spatial correlation between microfinance, inequality and poverty in Ghana (Amidi, Majidi, and Java-heri 2020). It can be detected that microfinance has a statistically significant negative effect on inequality and poverty. This, therefore, provides support to the argument that microfinance reduces inequality and poverty significantly (Hisako and Shigeyuki 2009; Mazumder and Lu, 2015; Lacalle-Calderon, Larrú, Garrido, and Perez-Trujillo, 2019; Bhuiya et al. 2018; Hermes 2014). As reported in Table 7, we also computed the average sum of the direct, indirect, and total effects of microfinance on poverty and inequality to extract some insightful information from the spatial estimates derived (Whitten et al. 2019).

First, it is identified that while microfinance exhibits both a direct and indirect effect on poverty, its impact on inequality is vastly reduced by its average direct effect [66.7% (0.012/0.018)]. We also deduced that close to one-third of the spillover effect of microfinance on poverty is attributable to positive shocks in neighbouring districts [33.3% (0.001/0.003)]. Regarding spatial inequality, it is identified that a 1% increase in microfinance intensity reduces the level of inequality experienced within a district by 0.02%. The proportion of the spillover effect of microfinance on income inequality is, however, small [33.3% (0.006/0.018)], with an increasingly small proportion of the indirect effect produced by neighbours. Second, the results suggest that the poverty reduction effect of microfinance intensity diffuses at a decreasing proportion as the degree of geographic contiguity increases. The spillover effect of microfinance impact on poverty experienced
Table 5  Effect of microfinance on spatial poverty in Ghana

| Table 5 | Effect of microfinance on spatial poverty in Ghana |
|---------|---------------------------------------------------|
|         | Manski model                                      | Spatial Durbin model | Spatial Durbin error model |
|         | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
| Microfinance intensity | $-0.006^{**}$ | $-0.006^{**}$ | $-0.006^{**}$ | $-0.006^{**}$ | $-0.001^{**}$ | $-0.002^{**}$ | $-0.001^{**}$ | $-0.002^{**}$ |
| Population density | $0.028^{*}$ | $0.022$ | $0.020$ | $0.029^{*}$ | $0.026^{*}$ | $0.002$ | $0.003$ | $0.001$ | $0.002$ |
| Uncompleted houses | $0.003^{**}$ | $0.003^{**}$ | $0.003^{**}$ | $0.003^{**}$ | $0.003^{**}$ | $0.002^{**}$ | $0.001^{**}$ | $0.001^{**}$ | $0.001^{**}$ |
| Traditional fuel | $0.024^{***}$ | $0.024^{***}$ | $0.023^{***}$ | $0.024^{***}$ | $0.024^{***}$ | $0.002$ | $0.002^{**}$ | $0.002^{**}$ | $0.002^{**}$ |
| Rural household units | $0.005^{**}$ | $0.004^{**}$ | $0.004^{**}$ | $0.004^{**}$ | $0.004^{**}$ | $0.003^{**}$ | $0.001^{***}$ | $0.000^{*}$ | $0.001^{***}$ |
| Self-employment | $-0.002$ | $-0.002$ | $-0.002$ | $-0.002$ | $-0.002$ | $0.000$ | $0.000$ | $0.001$ | $0.000$ |
| Access to water | $-0.045^{**}$ | $-0.042^{**}$ | $-0.045^{**}$ | $-0.044^{**}$ | $-0.042^{**}$ | $-0.045^{**}$ | $-0.048^{**}$ | $-0.036^{*}$ | $-0.048^{**}$ |
| Access to electricity | $-0.082^{***}$ | $-0.087^{***}$ | $-0.090^{***}$ | $-0.083^{***}$ | $-0.087^{***}$ | $-0.089^{***}$ | $-0.075^{***}$ | $-0.156^{***}$ | $-0.084^{***}$ |
| Access to banks | $0.024$ | $0.024$ | $0.023$ | $0.024$ | $0.023$ | $0.024$ | $0.028$ | $0.006$ | $0.026$ |
| Dependents | $0.036^{***}$ | $0.033^{***}$ | $0.032^{***}$ | $0.033^{***}$ | $0.032^{***}$ | $0.032^{***}$ | $0.035^{***}$ | $0.019^{***}$ | $0.033^{***}$ |
| Female headed households | $-0.002$ | $-0.002$ | $-0.002^{***}$ | $-0.002$ | $-0.002$ | $0.000$ | $0.001$ | $0.001$ | $0.001$ |
| Literacy rate | $-0.001$ | $-0.001$ | $-0.001$ | $-0.001$ | $-0.001$ | $0.000$ | $0.001$ | $0.000$ | $0.001$ |
| Tropical livestock units | $0.001$ | $0.001$ | $0.001$ | $0.001$ | $0.001$ | $0.000$ | $0.001^{**}$ | $0.000^{*}$ | $0.001^{***}$ |
| Average value of harvest | $-0.005^{**}$ | $-0.005^{**}$ | $-0.006^{**}$ | $-0.006$ | $-0.006$ | $-0.004^{**}$ | $-0.008^{**}$ | $-0.008^{**}$ | $-0.008^{**}$ |
| W_Microfinance Intensity | $-0.013^{**}$ | $-0.012^{**}$ | $-0.019^{**}$ | $-0.012^{**}$ | $-0.011^{**}$ | $-0.012^{**}$ | $-0.015^{**}$ | $-0.005$ | $-0.009$ |
| W^2_Microfinance intensity | $-0.022^{*}$ | $-0.045^{*}$ | $-0.027^{*}$ | $-0.027^{*}$ | $-0.022$ | $-0.006$ | $-0.006$ | $-0.003$ | $-0.000^{*}$ |
| Rho | $0.187^{**}$ | $0.222^{***}$ | $0.202^{**}$ | $0.222^{**}$ | $0.220^{***}$ | $0.213^{***}$ | $0.305^{***}$ | $0.205^{**}$ | $0.321^{**}$ |
| Lambda | $0.055^{*}$ | $0.069^{*}$ | $0.052^{*}$ | $0.203^{***}$ | $0.220^{***}$ | $0.213^{***}$ | $0.305^{***}$ | $0.205^{**}$ | $0.321^{**}$ |

**Diagnostics**

| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| District fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.488 | 0.482 | 0.486 | 0.482 | 0.481 | 0.485 | 0.469 | 0.492 | 0.468 |
| Wald chi | 726.85 | 755.31 | 741.93 | 776.51 | 765.06 | 780.83 | 496.49 | 271.95 | 480.65 |
| P-Value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
Table 5 (continued)

|                       | Manski model |                       | Spatial Durbin model | Spatial Durbin error model |
|-----------------------|--------------|-----------------------|----------------------|---------------------------|
|                       | Model 1      | Model 2               | Model 3              | Model 4                  | Model 5                  | Model 6                  | Model 7                  | Model 8                  | Model 9                  |
| −2Log–Likelihood      | 119.491      | 119.068               | 120.248              | 119.459                  | 119.067                  | 120.233                  | 117.798                  | 124.209                  | 118.91                   |
| Wald test of spatial terms | 17.98***     | 17.42***              | 19.63***             | 18.20*                   | 17.37***                 | 19.88***                 | 15.61***                 | 14.10***                 | 15.75***                 |

* p < 0.05; ** p < 0.1; *** p < 0.01
| Table 6 Effect of microfinance on spatial inequality in Ghana | Manski Model | Spatial Durbin model | Spatial Durbin error model |
|-------------------------------------------------------------|-------------|---------------------|---------------------------|
| Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
| Microfinance intensity | $-0.004^{**}$ | $-0.004^{**}$ | $-0.004^{**}$ | $-0.004^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.002^{**}$ | $-0.003^{**}$ | $-0.004^{***}$ |
| Population density | 0.001 | 0.001 | 0.011 | 0.010 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 |
| Uncompleted houses | 0.001* | 0.002* | 0.001* | 0.001 | 0.001 | 0.001* | 0.001 | 0.001 | 0.000* |
| Traditional fuel | 0.001** | $-0.004^{***}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.004^{***}$ | $-0.004^{***}$ | $-0.002^{*}$ |
| Rural household units | 0.001** | $-0.004^{***}$ | $-0.005^{***}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.004^{***}$ | $-0.004^{***}$ | $-0.002^{*}$ |
| Self-employment | $0.000^{***}$ | $-0.004^{***}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.003^{**}$ | $-0.004^{***}$ | $-0.004^{***}$ | $-0.002^{*}$ |
| Access to water | $-0.011$ | $-0.007$ | $-0.099$ | $-0.011$ | $-0.007$ | $-0.010$ | $-0.011$ | $-0.007$ | $-0.010$ | $-0.011$ |
| Access to electricity | $0.080^{***}$ | 0.014 | 0.076^{***} | 0.080^{***} | 0.079^{**} | 0.075^{***} | 0.086^{***} | 0.013 | 0.084^{***} |
| Access to banks | 0.064^{**} | 0.048* | 0.063^{**} | 0.065^{**} | 0.064^{**} | 0.064^{**} | 0.070^{**} | 0.047^{**} | 0.072^{***} |
| Dependents | 0.014^{**} | 0.002 | 0.013^{**} | 0.015^{**} | 0.014^{**} | 0.014^{**} | 0.016^{**} | 0.002 | 0.016^{**} |
| Female headed households | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.0002 | 0.002 | 0.0002 | 0.001 |
| Literacy rate | 0.001 | $-0.001*$ | $-0.001$ | $-0.005$ | 0.000 | $-0.001$ | $-0.005$ | $-0.001$ | 0.001 |
| Tropical livestock units | 0.001* | 0.003^{**} | 0.003* | 0.003 | 0.002* | 0.003* | 0.003* | 0.0003^{**} | 0.003^{**} | 0.001^{**} |
| Average value of harvest | $-0.001^{**}$ | $-0.002^{*}$ | $-0.002^{*}$ | $-0.001^{*}$ | $-0.002^{*}$ | $-0.001^{*}$ | $-0.001^{*}$ | $-0.002^{*}$ | $-0.001^{*}$ | $-0.002^{*}$ |
| W_Microfinance intensity | $-0.015^{***}$ | $-0.025^{**}$ | $-0.017^{**}$ | $-0.002^{***}$ | $-0.002^{***}$ | $-0.022^{***}$ | $-0.002^{***}$ | $-0.002^{***}$ | $-0.023^{***}$ |
| W_{2nd}-Microfinance intensity | $-0.018^{**}$ | $-0.021^{**}$ | $-0.017^{***}$ | $-0.013^{***}$ | $-0.015^{***}$ | $-0.016^{**}$ | $-0.016^{***}$ | $-0.023^{***}$ | $-0.023^{***}$ |
| W_{2nd}^2-Microfinance intensity | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ | $-0.033^{***}$ |
| Rho | 0.118^{**} | 0.210^{***} | 0.177^{**} | 0.103 | 0.187^{**} | 0.153^{***} | 0.041 | 0.041 | 0.041 |
| Lambda | 0.065^{**} | 0.121^{*} | 0.365^{***} | 0.103 | 0.187^{**} | 0.153^{***} | 0.041 | 0.041 | 0.041 |
| Time fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| District fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo R^2 | 0.132 | 0.144 | 0.132 | 0.132 | 0.114 | 0.132 | 0.131 | 0.148 | 0.126 |
| Wald Chi | 297.99 | 256.36 | 384.93 | 1205.32 | 1206.94 | 1215.79 | 1130.44 | 282.492 | 1095.85 |
| −2Log–Likelihood | 274.025 | 281.892 | 364.94 | 273.925 | 266.261 | 273.74 | 272.802 | 252.94 | 270.989 |
|                      | Manski Model | Spatial Durbin model | Spatial Durbin error model |
|----------------------|--------------|----------------------|----------------------------|
|                      | Model 1      | Model 2              | Model 3                    |
|                      |              | Model 4              | Model 5                    | Model 6                    |
|                      |              | Model 7              | Model 8                    | Model 9                    |
| Wald test of spatial terms | 25.37***     | 19.66**              | 25.89***                   | 24.58***                   | 24.35***                   | 21.90***                   |
|                      |              |                      |                            | 13.38***                   | 18.11**                    | 13.38***                   |

*p < 0.05; **p < 0.1; ***p < 0.01
## Table 7 Spatial partitioning of average direct, indirect and total effect—Manski model

| Impact on Poverty                  | Direct effect | Indirect effect | Total effect |
|-----------------------------------|--------------|----------------|--------------|
|                                   | $W^{1st}$    | $W^{2nd}$      | $W^2$ | $\sum W^q$ | $W^{1st}$ | $W^{2nd}$ | $W^2$ | $\sum W^q$ | $W^{1st}$ | $W^{2nd}$ | $W^2$ | $\sum W^q$ |
| Microfinance intensity            | -0.011       | -0.005         | -0.002 | -0.018 | -0.001     | -0.001     | -0.001 | -0.003 | -0.012     | -0.006     | -0.003     | -0.021 |
| Population density                | 0.029        | 0.022          | 0.020  | 0.071  | 0.005      | 0.005      | 0.004  | 0.014  | 0.034      | 0.027      | 0.024      | 0.085  |
| Uncompleted houses                | 0.003        | 0.003          | 0.003  | 0.009  | 0.001      | 0.001      | 0.001  | 0.003  | 0.004      | 0.004      | 0.004      | 0.012  |
| Traditional fuel                  | 0.024        | 0.024          | 0.023  | 0.071  | 0.005      | 0.006      | 0.005  | 0.016  | 0.029      | 0.030      | 0.028      | 0.087  |
| Rural household units             | 0.005        | 0.004          | 0.004  | 0.013  | 0.001      | 0.001      | 0.009  | 0.011  | 0.006      | 0.005      | 0.013      | 0.024  |
| Self-employment                   | -0.002       | -0.002         | -0.002 | -0.006 | -0.004     | 0.001      | 0.002  | -0.001 | -0.060     | -0.054     | -0.001     | 0.007  |
| Access to water                   | -0.045       | -0.043         | -0.045 | -0.133 | -0.009     | -0.041     | -0.010 | -0.060 | -0.054     | -0.084     | -0.055     | -0.193 |
| Access to Electricity             | -0.083       | -0.087         | -0.090 | -0.260 | -0.016     | -0.021     | -0.019 | -0.056 | -0.099     | -0.108     | -0.109     | -0.316 |
| Access to banks                   | 0.024        | 0.024          | 0.023  | 0.071  | 0.005      | 0.006      | 0.005  | 0.016  | 0.029      | 0.030      | 0.028      | 0.087  |
| Dependents                        | 0.034        | 0.033          | 0.032  | 0.099  | 0.006      | 0.008      | 0.007  | 0.021  | 0.040      | 0.041      | 0.039      | 0.120  |
| Female-headed households          | -0.002       | -0.002         | -0.002 | -0.006 | -0.004     | -0.005     | -0.004  | -0.013 | -0.006     | -0.007     | -0.006     | -0.019 |
| Literacy rate                     | -0.001       | -0.001         | -0.002 | -0.004 | -0.003     | -0.003     | -0.003  | -0.009 | -0.004     | -0.004     | -0.005     | -0.013 |
| Tropical livestock units          | 0.009        | 0.001          | 0.001  | 0.011  | 0.002      | 0.001      | 0.016  | 0.019  | 0.011      | 0.002      | 0.017      | 0.030  |
| Average value of harvest          | -0.010       | -0.006         | -0.008 | -0.024 | -0.006     | -0.005     | -0.005  | -0.016 | -0.016     | -0.011     | -0.013     | -0.040 |
| Impact on Inequality              |             |                |        |        |            |            |        |        |            |            |            |        |
| Microfinance intensity            | -0.006       | -0.004         | -0.002 | -0.012 | -0.005     | -0.002     | 0.001   | -0.006 | -0.011     | -0.006     | -0.001     | -0.018 |
| Population density                | 0.010        | 0.001          | 0.001  | 0.012  | 0.001      | 0.002      | 0.002   | 0.005  | 0.011      | 0.003      | 0.003      | 0.017  |
| Uncompleted houses                | 0.001        | 0.002          | 0.001  | 0.004  | 0.001      | 0.003      | 0.000   | 0.004  | 0.002      | 0.005      | 0.001      | 0.008  |
| Traditional fuel                  | -0.005       | -0.003         | -0.001 | -0.009 | 0.001      | -0.005     | 0.000   | -0.004 | -0.004     | -0.008     | -0.001     | -0.013 |
| Rural household units             | 0.005        | 0.004          | 0.005  | 0.014  | 0.001      | 0.007      | 0.001   | 0.009  | 0.006      | 0.011      | 0.006      | 0.023  |
| Self-employment                   | -0.003       | -0.004         | -0.003 | -0.010 | 0.001      | -0.001     | -0.001  | -0.001 | -0.002     | -0.005     | -0.004     | -0.011 |
| Access to water                   | -0.010       | -0.007         | -0.010 | -0.027 | -0.001     | -0.001     | -0.002  | -0.004 | -0.011     | -0.008     | -0.012     | -0.031 |
| Access to electricity             | 0.080        | 0.014          | 0.076  | 0.170  | 0.009      | 0.024      | 0.014   | 0.047  | 0.089      | 0.038      | 0.090      | 0.217  |
| Access to banks                   | 0.064        | 0.048          | 0.064  | 0.176  | 0.007      | 0.008      | 0.011   | 0.026  | 0.071      | 0.056      | 0.075      | 0.202  |
|                          | Direct effect |                          | Indirect effect |                          | Total effect |
|--------------------------|---------------|--------------------------|-----------------|--------------------------|--------------|
|                          | $W^{1st}$   | $W^{2nd}$   | $W^2$   | $\Sigma W^q$   | $W^{1st}$   | $W^{2nd}$   | $W^2$   | $\Sigma W^q$   | $W^{1st}$   | $W^{2nd}$   | $W^2$   | $\Sigma W^q$   |
| Dependents               | 0.014        | 0.002        | 0.013   | 0.029          | 0.002        | 0.004        | 0.002   | 0.008          | 0.016        | 0.006        | 0.015   | 0.037          |
| Female –households       | 0.002        | 0.002        | 0.002   | 0.006          | 0.001        | 0.003        | 0.000   | 0.004          | 0.003        | 0.005        | 0.002   | 0.010          |
| Literacy rate            | −0.001       | −0.001       | −0.001  | −0.003         | 0.001        | −0.002       | 0.000   | −0.001         | 0.000        | −0.003       | −0.001  | −0.004         |
| Tropical livestock units | 0.003        | 0.003        | 0.003   | 0.009          | 0.001        | 0.006        | 0.001   | 0.008          | 0.004        | 0.009        | 0.004   | 0.017          |
| Average value of harvest | 0.002        | 0.001        | 0.000   | 0.003          | 0.002        | −0.002       | 0.001   | 0.001          | 0.004        | −0.001       | 0.001   | 0.004          |

*p < 0.05; **p < 0.1; ***p < 0.01
among the first-order and second-order neighbours is identical at 33% (0.001/0.003), respectively.

The implication is that a shock to microfinance intensity in a district contributes significantly to the direct impact of microfinance in surrounding or neighbouring districts. We can, therefore, infer that the spread of microfinance services within a locality reduces the number of people living below the poverty line not only in that locality but in neighbouring districts. On the other hand, the spread of microfinance services has a stronger degenerating effect on within-district differences in poverty and income. This is because, on average, microfinance has a stronger direct effect on inequality and poverty with a measured spillover effect.

Table 8  SAR MNL results—parameter estimates (inequality clusters)

|                          | 20,212/2013 Sample | 2016/2017 Sample |
|--------------------------|--------------------|------------------|
|                          | High–Low          | Low–High         | High–High        | High–Low          | Low–High         | High–High        |
| Microfinance intensity   | −0.001            | −0.006**         | −0.003**         | 0.005**           | −0.012**         | −0.029**         |
| Population density       | −0.036*           | −0.001           | 0.008            | 0.004             | 0.024**          | 0.019            |
| Uncompleted houses       | 0.003             | 0.004            | 0.002***         | 0.002             | 0.003**          | −0.008           |
| Traditional fuel         | 0.014**           | 0.007            | −0.001           | 0.019***          | 0.018***         | −0.005**         |
| Rural household units    | −0.002            | −0.006           | 0.003***         | 0.001**           | 0.005**          | 0.010**          |
| Self-employment          | 0.004             | 0.002            | −0.003**         | −0.001            | −0.002           | −0.006**         |
| Access to water          | −0.222            | −1.037***        | −0.050           | 0.081*            | −0.157***        | 0.563***         |
| Access to electricity    | −0.046            | −0.387           | 0.366***         | −0.390***         | −0.832***        | −1.238***        |
| Access to banks          | 1.141*            | −0.048           | 0.383*           | −0.240***         | −0.350***        | 0.410***         |
| Dependents               | 0.259**           | −0.134           | 0.076***         | 0.161***          | 0.037*           | −0.477***        |
| Female headed households | 0.001             | −0.008**         | 0.001            | 0.001             | −0.01**          | 0.007            |
| Literacy rate            | −0.002            | −0.002           | −0.001**         | −0.002**          | −0.003**         | −0.001           |
| Tropical livestock units | −0.007            | 0.003            | 0.003**          | 0.005**           | 0.007**          | 0.013**          |
| Average value of harvest | −0.001*           | −0.002*          | −0.002           | 0.018             | 0.014            | 0.103**          |
| σ\textsubscript{11}     | 1.000             |                  |                 |                  |                  |                  |
| σ\textsubscript{12}     | −0.001            |                  |                 |                  |                  |                  |
| σ\textsubscript{13}     | 0.041             |                  |                 |                  |                  |                  |
| σ\textsubscript{22}     | 1.021             |                  |                 |                  |                  |                  |
| σ\textsubscript{23}     | −0.014            |                  |                 |                  |                  |                  |
| σ\textsubscript{33}     | 0.067             |                  |                 |                  |                  |                  |
| Rho                      | 0.209**           |                  |                 |                  |                  |                  |
| Mean log–likelihood      | −2944.31          |                  |                 |                  |                  |                  |

MCMC Sample = 3000, # of draws = 4,000, burn-in = 1,000 *p < 0.05; **p < 0.1; ***p < 0.01
Robustness analysis

We endeavoured to test the validity of the results by examining the role microfinance plays in each observed spatial cluster. The result is suggestive of the effect of microfinance on the spatial clustering of poverty and inequality. Results are presented in Tables 8, 9 and 10. The SAR MNL results confirm the existence of spatial autocorrelation demonstrative of likely spatial clustering in poverty and inequality. The results also suggest that microfinance intensity correlates significantly with the observed spatial clusters. Estimates of marginal effects suggest that a one-standard deviation in microfinance intensity reduces the probability of forming a high-high spatial poverty cluster with neighbours by 0.005 – 0.006 while raising the low–low spatial poverty cluster by 0.003 – 0.004 (see Table 10). In terms of its spillover effect, microfinance intensity is estimated to exert more influence on high–high outcomes compared to the alternative forms of spatial clustering of poverty.

| Table 9  | SAR MNL results—parameter estimates (Poverty clusters) |
|----------|--------------------------------------------------------|
|          | 20,212/2013 Sample                                    | 2016/2017 Sample |
|          | High–Low    | Low–High    | High–High    | High–Low    | Low–High    | High–High    |
|          | Microfinance intensity | 0.007** | 0.005*** | −0.017† | 0.011*** | −0.014*** | 0.003    |
|          | Population density        | 0.019   | 0.048*** | 0.015  | 0.004    | −0.009    | 0.019    |
|          | Uncompleted houses         | 0.002   | 0.004*** | 0.001  | 0.007*** | 0.004**  | −0.008*  |
|          | Traditional fuel           | 0.024***| 0.021*** | 0.048***| −0.012   | −0.005    | −0.005    |
|          | Rural household units      | 0.000   | 0.000    | 0.001  | −0.002   | −0.001    | 0.010†   |
|          | Self-employment            | −0.001  | −0.002   | −0.008**| −0.003   | −0.015*** | −0.006   |
|          | Access to water            | −0.040  | −0.302   | −1.110† | −0.087   | −0.892*** | 0.563    |
|          | Access to Electricity      | −0.404  | −0.790** | −1.497***| 0.104    | 0.174    | −1.238***|
|          | Access to Banks            | −0.294  | −0.650   | 2.721***| −0.120   | −0.696    | 0.410    |
|          | Dependents                 | 0.271***| 0.265*** | 0.583***| −0.074   | −0.153    | −0.177   |
|          | Female headed households    | 0.001   | −0.006   | −0.002 | −0.005   | 0.002     | 0.007**  |
|          | Literacy rate              | −0.002**| −0.003***| −0.013***| −0.002   | 0.002     | −0.001***|
|          | Tropical livestock units    | 0.006*  | 0.010*** | 0.002  | 0.005    | 0.014***  | 0.013**  |
|          | Average value of harvest    | −0.002* | −0.006*  | −0.004*| 0.001†   | −0.002*   | −0.001*  |
|          | σ11                       | 1.000    |          |        |          |          |          |
|          | σ12                       | 0.002    |          |        |          |          |          |
|          | σ13                       | 0.004    |          |        |          |          |          |
|          | σ22                       | 0.001    |          |        |          |          |          |
|          | σ23                       | −0.001   |          |        |          |          |          |
|          | σ33                       | 0.099    |          |        |          |          |          |
|          | Rho                       | 0.376*** |          |        |          |          |          |
|          | Mean log–likelihood        | −6220.6  |          |        |          |          |          |

MCMC Sample = 3000, # of draws = 4,000, burn-in = 1,000 * p < 0.05; ** p < 0.1; *** p < 0.01
| Average effect | Poverty clusters |                |                |                | Inequality clusters |                |                |                |
|----------------|------------------|----------------|----------------|----------------|---------------------|----------------|----------------|----------------|
|                |                  |                |                |                | High–High | High –Low | Low –High | Low–Low | High–High | High –Low | Low –High | Low–Low |                |
| 2012/2013      |                  |                |                |                | Direct     | −0.006    | −0.006    | 0.004     | −0.005    | −0.004    | −0.004    | 0.005    |                |
|                |                  |                |                |                | Indirect   | −0.004    | 0.004     | −0.001    | −0.001    | −0.003    | −0.002    | −0.001    | −0.001   |
|                |                  |                |                |                | Total      | −0.010    | −0.002    | −0.007    | 0.003     | −0.008    | −0.006    | −0.005    | 0.004    |
| 2016/2017      |                  |                |                |                | Direct     | −0.005    | −0.003    | 0.004     | 0.003     | −0.005    | −0.004    | −0.003    | 0.006    |
|                |                  |                |                |                | Indirect   | 0.002     | −0.004    | −0.002    | 0.000     | −0.002    | −0.001    | −0.002    | −0.001   |
|                |                  |                |                |                | Total      | −0.003    | −0.007    | 0.004     | 0.003     | −0.007    | −0.005    | −0.005    | 0.005    |
With reference to inequality, Table 10 reports how a one standard deviation in microfinance intensity lowers the predicted probability of being affiliated with a high-high, high-low and low–high cluster while increasing the probability of a low-low spatial inequality cluster outcome. The spillover effect it generates is negative and contributes approximately 20 – 50% of its total effect. This suggests that a one-standard deviation in microfinance intensity may be associated with the reduction of income inequality among neighbours. Such an effect is plausible because economic activities may upscale to neighbouring districts since the evidence suggests that the majority of microfinance loans acquired are used for business development and to facilitate agriculture production (see Fig. 2).

Furthermore, the study also attempted to examine the effect of the disparity in credit size on spatial inequality and poverty. Due to space limitation, the results are reported in the online supplementary appendix. The results were generally consistent with the baseline results. It was found that differences in credit distribution have a negative but smaller impact on spatial inequality. Nonetheless, the contribution of the spillover effect to the total effect of credit size is stronger at 74% (0.032/0.043) on inequality compared to the 73% (0.048/0.066) for spatial poverty. Specifically, the poverty level in an observed district reduces by roughly 0.01% if there is a 1% positive shock to the credit disbursement in neighbouring districts. On the other hand, income inequality in a district is found to decrease by 0.004% for every 1% positive shock to credit size in a neighbouring district. Thus, on average, each district experiences feedback from influencing the microfinance intensity of its neighbouring districts. This is intuitively plausible owing to the substantial inter-district trade, migration, or seasonal job migration that occurs in Ghana. The implication is that the diffusion effect of microfinance product uptake plays a significant role in the total effect of microfinance intensity on spatial inequality and poverty. This stresses the importance of product design and disparity in credit distribution in the effect of microfinance on spatial poverty and inequality in Ghana.

**Conclusion and policy implication**

This study has investigated the impact of microfinance on inequality and poverty in Ghana. The evidence reveals that microfinance has a negative impact on spatial poverty and inequality in Ghana. The spatial effect of microfinance intensity on poverty and inequality is characterized by both direct and spillover effects on neighbours. We identified that the direct effect is superior when the emphasis is on outreach (that is the number of microfinance clients in the district). The indirect effect, in contrast, is higher when the impact of microfinance intensity is computed in terms of the value of credit disbursed. The indirect effect diffuses monotonically as the number of neighbours increases. This demonstrates the role of microfinance in powering the spatial clustering of district-level poverty rates and income inequality. The significance of this role is determined by the number of neighbours a district has and whether the district is a first- or second-order neighbour.

Additionally, the nature, scope, and size of the impact of microfinance on poverty and inequality vary depending on the strategy used in delivering the microfinance service. Our
findings reveal that when the objective of microfinance delivery emphasizes outreach, it is likely to engender superior within-district differences in income and economic activity. However, when the operational strategy underscores product design or credit delivery, it is likely to produce greater between-district differences in income and economic activity compared to within-district income disparity and poverty.

The findings of this current study have several policy implications on the application of microfinance to achieve sustainable development goals. One, the evidence reveals the important role microfinance plays in the observed spatial differences in income and economic activity in Ghana. Specifically, increasing the intensity of microfinance activities in a district is associated with the reduction of poverty and inequality between and within districts. A complementary approach to microfinance service delivery is, however, recommended, focusing on reaching a large proportion of the district population with large loan sizes. This is because the shortfalls of an outreach-oriented microfinance objective can, for instance, be offset by the product design service strategy. This will generate adequate direct, spillover, and feedback effects necessary for reducing district-level poverty and income inequality. There is also a need to streamline the market to reduce inefficiencies and remove institutional barriers that limit access, availability, and use of loans; to reinforce the returns on access. With women making up a significant proportion of the vulnerable and the underprivileged, the focus on women clients is essential to reduce poverty and address gender inequality in socio-economic development. Policy initiatives that support the microfinance market through reforms and capacity can greatly influence the intensity of microfinance activities, which can then translate into poverty reduction and positive income distribution in the districts. With the government targeting 75% financial inclusion by 2023, the importance of ensuring the growth and robustness of the microfinance sector in Ghana cannot be overemphasized. Currently, financial inclusion in Ghana sits at 58%, and with the ability of microfinance institutions to reach different markets in the country, inclusion can be propelled with stronger microfinance activity through capacity building and regulatory reforms. The results of this study show that Ghana can have less income inequality and less poverty if it has a strong microfinance economy.

Appendix

See Table 11.
### Table 11: Definition of district covariates

| Variable                  | Details                                                                 | A priori sign |
|---------------------------|-------------------------------------------------------------------------|---------------|
| Microfinance intensity    | The total number of microfinance clients divided by the population in each district in the sample | –             |
| Population density        | The total population in the district per square kilometre                | +             |
| Uncompleted houses        | The total number of Huts/Kiosks/Uncompleted houses in a district         | +             |
| Traditional fuel          | The total number of households using firewood, charcoal, crop residue and sawdust as fuel for cooking | +             |
| Rural household units     | Total number of households in rural settlements                          | +             |
| Self-employment           | Total number of individuals engaged in self-employment in the district  | –             |
| Access to water           | Total number of communities with access to piped or borehole water      | –             |
| Access to electricity     | Total number of communities with access to electricity in the district  | –             |
| Access to banks           | Total number of communities in the district which have commercial bank  | –             |
| Dependents                | Average count of dependents in a household in the district              | +             |
| Female headed households  | Total number of households with a woman as a household head             | –             |
| Literacy rate             | Total number of household heads in the district with some level of formal education | –             |
| Tropical livestock units  | Total number of livestock owed by livestock owners in the district      | –             |
| Average value of harvest  | Average annual crop harvest in local currency unit                      | –             |
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