Research

Statistical analysis on egalitarian land redistribution in Ethiopia: policy evaluation using repeated cross-sectional data

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Abstract

Rural livelihood in Ethiopia is dependent on subsistence agriculture that has been challenged by farmland shrinkage as a result of rapid population growth. The Amhara regional state government has implemented egalitarian farmland redistribution in 1997 in the region for small-scale and landless farmers. This study aimed to seek new insights from the perspective of equity, rather than efficiency such as agricultural investment and productivity which other previous studies have focused on, and quantitatively evaluated the effect of the land redistribution on the size of farmland holdings of subsistence farmers. Large-scale repeated cross-sectional national statistics, the Ethiopian Agricultural Sample Survey (AgSS) from 1995 to 1999 were used as the data of this analysis. The difference-in-differences (DiD) estimation was applied to evaluate how the land redistribution affected farmers' farmland holdings. The results showed that farmland holding size per farmer in the Amhara Region has significantly decreased after the land redistribution, therefore, this policy achieved certain results from the egalitarian perspective since national land endowments were redistributed from large-scale farmers to small-scale and landless farmers. However, this study focused on only the short-term effect of the land redistribution and more studies are needed to clarify the long-term effect.

Keywords Quasi-experiment · Difference-in-differences estimation · Repeated cross-sectional data · Land redistribution · Ethiopia

1 Introduction

In recent years, the rapid population growth that resulted farmland shortages on the subsistence farmers has been challenging the rural livelihood in Ethiopia where 80% of the population is living, and more than 70% of them are dependent on agriculture [1]. Moreover, about 42% of the country's GDP and about 90% of its total export value are dependent on agricultural products, while about 95% of domestic agricultural products are produced by over 15 million small-scale farmers [2]. Meanwhile, the arable land in Ethiopia is only 15.2% of the total land [1]. Insufficient farmland supply for the growing population may worsen landholdings size inequality among subsistence farmers in Ethiopia due to an increase in the number of landless farmers. Therefore, optimization of land use and distribution is currently a priority concern for the Ethiopian government.

Since the adoption of Sustainable Development Goals (SDGs) by the United Nations in 2015, laws and policies worldwide are required to be formulated and implemented in accordance with the SDGs. The SDGs comprised 17 goals and 169 targets. The Land Portal [3] pointed out that the SDGs contain land-related targets and indicators under

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SDGs Goal 1, 2, 5, 11 and 15. Moreover, the issues of inequality are also important. Goal 10 aims to reduce inequalities in income as well as inequalities related to age, sex, disabilities, race, ethnicity, origin, religion, and economic status or other status within a country. This point is especially relevant to Goal 1, which aims to end poverty and Goal 2, which aims to end hunger and achieve food security. The current land use situation in Ethiopia involves the risk of inequality in landholding; hence, careful discussion in light of the SDGs is required [4].

The land policy in African countries provokes various types of discussions owing to the unique backgrounds of these countries, such as their experience of colonization, common law, and unwritten law. In particular, land distribution policies aimed at equalizing landholdings have been widely discussed not only in Ethiopia but also in other African countries. Land distribution can have various objectives, such as to serve as a countermeasure against population growth and the resulting land shortages, to return land to rightful parties following decolonization, and elimination of land ownership inequality among races. However, they can be divided into two main purposes: efficiency and equity [5].

These policies share a common point in the distribution of resources to vulnerable groups through land equalization. Although the background of policy implementation varies per country, modern Africa should correct inequalities by implementing land equalization to achieve the purpose of equity, as stated in Goal 10 of SDGs. However, policies tend to be evaluated only for their economic outcomes as the purpose of efficiency. Policies that are intended to correct inequalities such as those in SDGs should also be evaluated from an egalitarian perspective. Therefore, this study focuses on policies that aim to reduce land use inequality due to population growth and land shortage and discusses the significance of the egalitarian policy and its future necessity.

Land reforms including land redistributions in African countries such as Kenya, Mozambique, and Zimbabwe have been implemented with the demise of colonial rule [6]. On the other hand, Ethiopia has never been colonized and has established its own unique land policies with two political changes in the last 50 years, including the Ethiopian Empire, the Derg espousing Marxist-Leninist socialism and Ethiopian People's Revolutionary Democratic Front (EPRDF), promoting economic liberalization. Under the Derg and the EPRDF, Ethiopian farmers can enjoy only holding rights granted by the state as all land is owned by the state. This system was established under the Derg, but the EPRDF officially declared its continuation of land nationalization in 1995.

Ethiopia also implemented land redistribution several times since the Derg period to counter rapid population growth and land shortage by taking the advantage of the Ethiopian land that belongs to the state. However, problems due to tenure insecurity and land fragmentation was noted, and the campaign of farmers against land redistribution was also actively promoted. Thus, in 1989, the Derg, which was about to collapse, officially prohibited land redistribution to prevent land fragmentation. Initially, the EPRDF implemented land redistribution, but the government also terminated it in 1991 [7, 8]. However, in 1997, exceptional land redistribution was implemented in the population-dense Amhara Region; that is, land shortage and the need for land redistribution remain the critical problems in Ethiopia. In other words, unlike other African countries that have experienced colonization, land redistributions in Ethiopia have been carried out under the political turmoil associated with several revolutions and a top-down nationalized land use system that does not permit farmers' land ownership. Therefore, in discussing land redistribution in Ethiopia, it is necessary to understand the land use system and its historical background. Furthermore, even in recent years, many studies have pointed out the challenges related to land use in Ethiopia. For example, the demand for land in Ethiopia is still increasing, and the issue of land scarcity and conflict in rural areas has expanded to the discussion of land intervention or informal settlements in peri-urban area [9, 10]. Therefore, discussions of land use in Ethiopia are now very crucial.

Based on the aforementioned background, this study assesses the impact of the land redistribution policy particularly implemented in Amhara Region in 1997 on farmland holding size through statistical analysis using micro data. The main aim of this study is to evaluate the objectives of this policy, namely, land shortage countermeasures and land use equalization by seeking new insights from the perspective of equity, rather than efficiency such as agricultural investment and productivity which other previous studies have focused on. The study applied difference-in-difference method (DiD) using repeated cross-sectional data that can enhance our understanding on the land management policies in Ethiopia. Moreover, the outcomes of the study can be used as a reference for rural farmland policy makers in cases where land redistribution is considered.

2 Literature review

2.1 Historical context of Ethiopian land policy

The Amhara people played a crucial role in expanding and unifying the early Ethiopian Empire's territory by incorporating the surrounding ethnic groups mainly in the current Amhara Region and Tigray Region. The territory then almost doubled in size due to the invasion of the southern regions by Menelik II (period of reign: 1889–1913), growing to the same size as that of present-day Ethiopia in the latter half of the nineteenth century [11, 12]. Hence, land management was then one of the most important issues for the government. In 1930, the last emperor of Ethiopia, Haile Selassie I (period of reign: 1930–1974) ascended the throne. During this period, there were institutional differences between the northern regions, where the Amhara people mainly lived, and the southern regions, which were conquered and became part of Ethiopia. The types of land by ownership were then diverse, including national, aristocratic, church, large-scale landowner, private, and common land [13, 14]. However, most of the land was cultivated by a large number of peasants who received their land from their large-scale landlords, such as in the *Gult* system across Ethiopia and the *Gebbar* system in the south. The *Gult*, a system that existed throughout Ethiopia at that time under the influence of the emperor, was one of the taxation rights on specific lands given to vassals by the emperor as a reward for their military service [12]. Meanwhile, the *Gebbar* was a special case of the *Gult* in the southern regions. As the farmers, who originally lived in the southern regions, and the new landlords, who came from the northern regions, had completely different ethnic, linguistic, and cultural backgrounds, the *Gebbar* was more exploitative than the *Gult* [8]. Another system—in which land use rights are inherited through a divided succession system—such as the *Rist* in the northern regions, also exists [15].

After the Italian occupation, the government built a more authoritarian system by introducing a bureaucratic system in place of weakened local landlords. The revised 1955 Constitution of Ethiopia states that “*The Empire of Ethiopia comprises all the territories, including the islands and the territorial waters, under the sovereignty of the Ethiopian Crown. Its sovereignty and the territory are individual. Its territories and sovereign rights therein are inalienable. All Ethiopian subjects, whether living within or without the Empire, constitute the Ethiopian people.*” Clearly, the emperor had great power over the land. However, at the end of the Ethiopian Empire, the government had difficulty maintaining its political power owing to oil crisis and famine, and it collapsed after the military-led revolution in 1974, and the Derg took power [8, 12, 16].

The land reform implemented in 1975 was the most notable economic policy of the Derg. Many people who participated in the revolution at that time, such as soldiers, students, and workers, demanded for land reform, and agricultural experts, government officials, and international organizations also argued that the size of land ownership should be limited, and the landlord-tenant relations should be regulated [17]. In 1975, the Derg issued “Public Ownership of Rural Lands Proclamation No. 31/1975” (Proclamation No. 31/1975), and a large-scale land reform was implemented with the slogan “Land to the Tiller.” With this reform, all land in Ethiopia was nationalized without any compensation. The landlord-tenant relations were abolished, employment of wage workers by farmers was prohibited, and the government redistributed the land to farmers, so the farmers were given only land use rights (holding rights) with the size of less than 10 ha [17]. Basically, since the state owned the land redistributed in this reform, farmers acquired only land use rights and not land ownership rights. Exploiting the land ownership rights of the state, the Derg also implemented resettlement policy and villagization policy. The Derg referred to resettlement in Proclamation No. 31/1975. According to Chapter 4, Article 18 of this proclamation, “*The Government shall have responsibility to settle peasants or to establish cottage industries to accommodate those who, as a result of the distribution of land in accordance with the provisions of this proclamation, remain with little or no land.*” However, the resettlement policy under the Derg regime was used to counter famine by correcting imbalances of population and resources and by helping the people affected by drought, rather than providing compensation for land redistribution [18]. Meanwhile, the villagization policy began in the southern regions and the border regions with Somalia for security reasons, and a large-scale villagization policy was started in 1985 to improve conventional agriculture in dispersed villages and to use resources efficiently [8]. However, such compulsory resettlement policies have difficulty obtaining public support.

In 1991, control of the government was transferred to the EPRDF. However, contrary to the expectations of farmers and experts, the new government implemented land redistribution again in the early 1990s. This policy was intended (1) to demobilize soldiers after the revolution and (2) eliminate land inequality due to population growth [19].

However, the EPRDF declared the discontinuation of land redistribution following strong opposition from farmers. On the other hand, as mentioned in Sect. 1, in 1995, it was declared that the government would continue to nationalize the land. According to Chapter 3, Article 40 of “Proclamation of the Constitution of the Federal Democratic Republic of Ethiopia” (Proclamation No. 1/1995), “*The right to ownership of rural and urban land, as well as of all natural resources, is exclusively vested in the State and in the peoples of Ethiopia. Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange.*” Accordingly, “Federal Rural Land Administration Proclamation No. 89/1997” (Proclamation No. 89/1997) replaced Proclamation No. 31/1975. Proclamation No. 89/1997 was a short law with only 10 articles. Again, Article 4 stated that “*Land is a common property of the Nations, Nationalities and Peoples of Ethiopia shall not be subject to sale or to other means of exchange.*” On the other hand, Article 5 instructed each region to individually enact land laws to promote decentralization. Specifically, the proclamation called for each Regional Council to enact a law on land administration, and for these regional land management laws to confirm environmental protection and equal rights for women. Afterwards, the government stopped land distribution due to strong opposition, however, the Amhara Region exceptionally implemented large-scale land redistribution in 1997 due to decentralization and severe population density. This will be explained in detail in the next section.

2.2 The 1997 land redistribution in the Amhara Region

Ethiopia is a federal state with nine regional states and two chartered cities, and its administrative division units comprise the federal state, regional state, zone, *woreda*, *qebele*, and sub-*qebele*. The Amhara Region is located in an area that has been the center of the Ethiopian economy since ancient times, and many Amhara people live there.

Owing to its geographical environment, the Amhara Region is still actively farming and is called the granary of Ethiopia, but it often faces food-related problems, such as food shortages [20]. Furthermore, it is one of the most densely populated areas in Ethiopia (Table 1).

Under the EPRDF, Ethiopia’s population doubled, and exceptional land redistribution was implemented in 1997 in the densely populated the Amhara Region, as mentioned previously. This policy was implemented based on a “Proclamation to Provide for the Reallocation of the Possession of Rural Land in The Amhara National Region, Proclamation No. 16/1996” (Proclamation No. 16/1996) and its amended Proclamation No. 17. Under this policy, a Local Land Distribution Committee was formed for redistribution of lands expropriated from farmers who had political power or privileges during the Empire or the Derg periods and from other farmers who owned large-scale farmlands. Specifically, the land of these farmers was targeted for land expropriation if the former owned more than 4 *t’emad* (approximately 1 ha) or the latter owned more than 12 *t’emad* (approximately 3 ha) [7, 23]. These expropriated lands were redistributed to small-scale farmers and landless farmers. For extremely poor households, married couples, and households with extremely little land, the size of the redistributed land was set to 1 ha, whereas that for landless youths, divorced persons, and unmarried persons was 0.5 ha [24]. Furthermore, according to our interview survey conducted in June 2019, the staff who worked at the Environmental Protection, Land Administration and Use Office then testified that “the average size of redistributed land

Table 1 Population density in Ethiopia. Source: CSA [21, 22]

Region and chartered city	Population [21]	Area (km ²) [22]	Density (/km ²)
Tigray	4,316,988	53,638.00	80.48
Afar	1,390,273	72,052.78	19.30
Amhara	17,221,976	154,708.96	111.32
Oromia	26,993,933	284,537.84	94.87
Somali	4,445,219	279,252.00	15.92
Benishangul-Gumuz	784,345	50,698.68	15.47
SNNP	14,929,548	105,476.00	141.54
Gambela	307,096	29,782.82	10.31
Harari	183,415	333.94	549.25
Addis Ababa	2,739,551	526.99	5,198.49
Dire Dawa	341,834	1,558.61	219.32
Total	73,750,932	1,032,566.62	71.42

was about 0.5 ha." However, this policy was not necessarily welcomed because farmers who were worried about arbitrary redistribution that would only benefit certain people went to Addis Ababa to protest when this policy was proposed [25, 26]. It should be noted that land was redistributed in some areas prior to the implementation of this policy. For example, cases of redistribution in 1991 in South Gondar District [26] and South Wollo District [27] have been confirmed.

2.3 Impact evaluation of land redistribution

To the best of our knowledge, only a few studies have evaluated the impact of the 1997 land redistribution in the Amhara Region. According to Ege [23], the reform only benefited certain groups, notably women with children and young households that were not yet properly established. Both groups received more than they expected in a reform based on equal land distribution. Further, Benin and Pender [28] found that land redistribution in the Amhara Region has had a positive impact on land productivity by increasing access to land for farmers who are more interested or able to use purchased inputs, such as fertilizer and herbicides. Kefyalew [24] also highlighted that the reform correlated with an increase in the average intensity of short-term intermediate input use, short-term conservation practices, and crop yield in the region by the long run analysis. From the long-term perspective, those who received land are highly likely to build stone terraces. Meanwhile, Kodama [26] argued that despite the land redistribution, the problem of land shortage was barely resolved. Kefyalew [24] also emphasized that land productivity actually declined, based on a short-term evaluation. Holden and Yohannes [29] highlighted that the implementation of land redistribution may have reduced farmers' tenure security in other regions. Based on the previous studies mentioned above, the evaluation results of the land redistribution in 1997 are mixed. As for the evaluation of efficiency, the results show that, although there was a decrease in productivity in the short run analysis, the land redistribution contributed to the improvement of agricultural investment and productivity in the long run. On the other hand, as for the evaluation of equity has been reported based on valuable fieldwork, but no quantitative analysis has been conducted.

However, most previous studies are limited to specific areas. Hence, the results may be affected by the characteristics or backgrounds of each area. Studies with large-scale statistics, such as that of Kefyalew [24], barely exist. Hence, the effects of land redistribution on the entire Amhara Region, which was the target of this policy, have not been comprehensively evaluated. Furthermore, although both egalitarian and economic evaluations of this policy are necessary from the perspective of land redistribution to landless farmers, it cannot be said that previous studies paid sufficient attention to the egalitarian perspective. Therefore, the impact of land redistribution should be evaluated from an egalitarian perspective through quantitative analyses based on statistical data.

Although the evaluation of the Amhara Region land redistribution in 1997 itself is limited, this land redistribution is attributed to the decentralization in Ethiopia as discussed before, and studies on the decentralization have been accumulating for a long time. In terms of economic evaluation, according to Zimmermann-Steinhart and Bekele [30], the decentralization, which was implemented to improve efficiency in service delivery, achieved service expansion and equalization in the education and health sectors. With regard to the impact on the public, Snyder et al. [31] noted that the decentralization may help decision-making of local communities, but pointed out the problem of limited actual public participation. From a political point of view, Chanie [32] pointed out that the decentralization of Ethiopia has failed since the clientelistic relations existed between central and regional political leaders. As mentioned above, the impacts on a wide variety of fields have been confirmed by the decentralization which is one of the major events in Ethiopia. It is necessary to recognize that the land redistribution in 1997, which is discussed in this paper, is a part of such diverse impacts. Therefore, this study has important implications not only for the land redistribution itself, but also for the analyzing the impact of the decentralization, and will bring a new perspective to the evaluation of the decentralization.

3 Data and methodology

3.1 Data

This study uses data from the Agricultural Sample Survey (AgSS) conducted annually by Ethiopian Central Statistical Agency (CSA). The AgSS contains annual statistical data for the entire country, including information on farmland, landholders, and households, and data from 1995 to present are available from CSA. This study uses data acquired from the CSA office in Addis Ababa in June 2019. In addition, the notation of the survey year in AgSS is defined based on the Ethiopian Calendar Year as the survey conducted in the Ethiopian Calendar Year 1988 (A.D. 1995–1996) is described as

"1995/1996 (1988 E.C.)." However, for convenience, this study adopted the A.D. year format for the survey, and in the case of the "1995/1996 (1988 E.C.)" survey, the notation converted to "1995."

This study applies the DiD estimation; a detailed explanation of the DiD is provided in the next section, but in order to apply it, the samples need to cover both the years before and after the implementation of the land redistribution, and the regions where the land redistribution was implemented and not. Here, we discuss the classification of the years and the regions covered by the samples, and Table 2 shows a summary of these categories. In this analysis, first, a single-year comparison on the data of 1996 and 1997 before and after the policy implementation was made. Second, a multi-year comparison was made between the data of 1995 and 1996 (2 years before the policy implementation) and the data of 1997, 1998, and 1999 (3 years after the policy implementation). Furthermore, since an extreme change in landholding size was observed in 1997 immediately after the policy, it is slightly difficult to deny the possibility that this was caused by a survey or a response error owing to confusion in policy implementation. Third, as an additional option that takes into account the above possibilities, another multi-year comparison was made between the data of 1995 and 1996 (2 years before policy implementation) and the data of 1998 and 1999 (2 years after the policy implementation), except for 1997.

Although AgSS is a sample survey conducted annually, and individual landholder-level information can be manipulated, constructing a database as panel data is difficult because detailed information of each landholder, such as names and addresses, are concealed. Thus, this study attempted to combine the datasets for 5 years from 1995 to 1999 and constructed repeated cross-sectional data. The reason for selecting these 5 years is that major land-related policies were not implemented until 2000, except for land redistribution in the Amhara Region [24]. The Amhara Region was considered the treatment group, and to facilitate comparison, all eight regions and two chartered cities of Ethiopia (1st control group) as well as the Oromia Region (2nd control group) were considered as control groups. The reason for selecting only the Oromia Region as the 2nd control group is that it is adjacent to the Amhara Region, with both regions sharing a large boundary and being similar in terms of agro-ecological characteristics, particularly in the border-sharing zones [24]. In addition, as the targets of the land redistribution policy were individuals, this analysis extracted the basic attributes and landholding size (cultivated area) for each landholder from AgSS 1995 to AgSS 1999 and subsequently constructed a new dataset. The above research method can be considered a causal inference using observable data of a randomly assigned treatment and control group before and after policy implementation, that is, a quasi-experiment.

Table 3 provides the definition of the variables for this analysis. Landholding size, region, and year were used as variables for land redistribution, whereas sex, age, education level, household size, and type of agriculture were used as attribute variables for landholders. The landholding size is the area of farmland that the landholder has the right to use. The landholding size was physically measured using compasses and measuring tapes during the surveys [33]. It should be noted, however, that it is difficult to consider whether the surveyed land holdings are formal or informal, since the land registration and certification did not begin in the Amhara Region until 2003 certification [34]. Although AgSS was originally collected at the household level, since landholder data are registered for each plot, the landholding size at the landholder level was calculated based on that information. The treatment group dummy variable (the region dummy variable) indicates the region the land belongs to, and it is 1 for the treatment group and 0 for the control group to indicate whether land redistribution was implemented. For Models 1, 2, and 3, the Amhara Region is the treatment group, and all regions and chartered cities, except the Amhara Region, are the control group. For Models 4, 5, and 6, the Amhara Region is the treatment group, and the Oromia Region is the control group. The post-treatment dummy variable (the year dummy variable) indicates the year of the survey, and it is 1 for the post-treatment period and 0 for the pretreatment period to indicate before and after land redistribution was implemented. That is, post-treatment is 1997 and pretreatment is 1996 for Models 1 and 4; post-treatment is from 1997 to 1999 and pretreatment is from 1995 to 1996 for Models 2 and 5; and post-treatment is from 1998 to 1999 and pretreatment is from 1995 to 1996 for Models 3 and 6.

Table 2 Categories and sample size of DiD estimation models

	Single-year comparison	Multi-year comparison	
	Pre: 1996 Post: 1997	Pre: 1995, 1996 Post: 1997, 1998, 1999	Pre: 1995, 1996 Post: 1998, 1999
Amhara Region	Model 1 (N = 52,156)	Model 2 (N = 138,915)	Model 3 (N = 103,521)
The rest of Ethiopia			
Amhara Region	Model 4 (N = 24,520)	Model 5 (N = 65,821)	Model 6 (N = 50,035)
Oromia Region			

Table 3 Definition of variables

Variables	Definitions
Landholding size	Total farmland size of landholder (ha)
Treatment group	Region the survey was conducted The Amhara Region = 1, the rest of Ethiopia = 0 The Amhara Region = 1, the Oromia Region = 0
Post-treatment	Year the survey was conducted 1997 = 1, 1996 = 0 1997, 1998 and 1999 = 1, 1995 and 1996 = 0 1998 and 1999 = 1, 1995 and 1996 = 0
Sex	Sex of landholder Male = 1, Female = 0
Age	Age of landholder
Education level	Educational status or highest grade completed of landholder Illiterate = 1, Grades 1–3 = 2, 4–6 = 3, 7–8 = 4, 9–11 = 5, 12 = 6, Above 12 = 7
Household size	Number of members of landholder's household
Crop only	Type of agriculture Crop only = 1, Otherwise = 0
Livestock only	Type of agriculture Livestock only = 1, Otherwise = 0

Table 4 Summary statistics by year

	1995	1996	1997	1998	1999
Amhara					
Landholding size	1.202 (0.053)	1.208 (0.054)	0.978 (0.037)	1.258 (0.050)	1.285 (0.047)
Sex	0.836 (0.009)	0.845 (0.008)	0.848 (0.007)	0.832 (0.007)	0.816 (0.006)
Age	43.876 (0.369)	42.967 (0.331)	42.455 (0.288)	43.233 (0.286)	43.819 (0.282)
Education level	1.290 (0.020)	1.276 (0.014)	1.326 (0.018)	1.319 (0.016)	1.323 (0.016)
Household size	4.891 (0.053)	4.874 (0.052)	4.749 (0.043)	4.673 (0.039)	4.682 (0.042)
Crop only	0.214 (0.016)	0.181 (0.011)	0.260 (0.015)	0.181 (0.009)	0.184 (0.009)
Livestock only	0.001 (0.001)	0.000 (0.000)	0.015 (0.004)	0.015 (0.002)	0.020 (0.003)
The rest of Ethiopia					
Landholding size	0.952 (0.035)	0.909 (0.030)	0.952 (0.029)	1.168 (0.033)	1.172 (0.033)
Sex	0.829 (0.006)	0.849 (0.006)	0.857 (0.004)	0.821 (0.004)	0.804 (0.004)
Age	43.032 (0.222)	41.752 (0.245)	41.875 (0.187)	42.053 (0.182)	42.311 (0.172)
Education level	1.458 (0.019)	1.515 (0.019)	1.532 (0.017)	1.526 (0.017)	1.530 (0.016)
Household size	5.313 (0.042)	5.258 (0.036)	5.441 (0.038)	5.190 (0.029)	5.173 (0.033)
Crop only	0.161 (0.008)	0.162 (0.009)	0.180 (0.008)	0.134 (0.005)	0.141 (0.006)
Livestock only	0.000 (0.000)	0.000 (0.000)	0.015 (0.002)	0.017 (0.002)	0.018 (0.002)
Oromia					
Landholding size	1.231 (0.050)	1.176 (0.040)	1.197 (0.043)	1.435 (0.049)	1.450 (0.050)
Sex	0.839 (0.008)	0.863 (0.008)	0.866 (0.006)	0.831 (0.006)	0.817 (0.005)
Age	43.422 (0.306)	41.724 (0.315)	41.832 (0.248)	41.839 (0.243)	41.982 (0.219)
Education level	1.480 (0.026)	1.522 (0.024)	1.542 (0.023)	1.516 (0.022)	1.533 (0.022)
Household size	5.484 (0.055)	5.436 (0.046)	5.590 (0.047)	5.361 (0.040)	5.303 (0.040)
Crop only	0.150 (0.010)	0.164 (0.012)	0.182 (0.011)	0.133 (0.008)	0.143 (0.008)
Livestock only	0.000 (0.000)	0.000 (0.000)	0.015 (0.002)	0.020 (0.003)	0.022 (0.003)

Standard errors in parentheses

Table 4 presents the data for each region and year. However, the samples in the AgSS have different probabilities of being selected as they are sampled through multistage sampling. In AgSS, the sampling weights (the inverse probability weights) are calculated to reduce the bias of this sample survey and improve the representativeness of the sample to the population. According to Winship and Radbill [35], the sampling weights are constructed in two stages. The first stage is constructed using information about the design of the sample and response rates. These weights are approximately equal to $1/P_i$, where P_i is the probability of being selected as a sample. The second stage adjusts these weights through a poststratification process using population-based information. This is necessary because the information used in the first stage is probably imperfect, and the samples are not guaranteed to be representative of the population. Therefore, please note that the data in this study are already weighted by the sampling weights. The handling of the sampling weights is in accordance with UNSD [36].

The average landholding size per farmer tends to increase throughout the observation period. However, the Amhara Region observed a sudden decrease in 1997. This may be due to the land redistribution enabling landless farmers to begin farming anew. However, the average landholding size per farmer significantly increased again in 1998. Although no major fluctuations occurred in the other variables, the possibility that this major shift in landholding size in 1997 was caused by a survey error or a response error should be considered, which hindered the data collection because of the chaotic situation caused by the land redistribution implementation. Therefore, this study developed an analysis method that considers this concern by including the model without 1997.

3.2 Methodology

This study analyzes the changes in the landholding size of farmers after land redistribution and evaluates the impact of the land redistribution policy as a countermeasure to land shortage. For a more rigorous evaluation, this analysis applies DiD estimation through a multiple regression analysis. DiD estimation compares changes in outcomes over time between a population enrolled in a program (the treatment group) and a population that is not enrolled (the control group) by estimating the counterfactual [37]. The DiD estimator is defined as the difference in average outcome in the treatment group before and after treatment minus the difference in average outcome in the control group before and after treatment. In other words, the DiD estimator which can be taken as the effect of the land redistribution in this study can be explained as the difference in average landholding size in the Amhara Region before and after the land redistribution minus the difference in average landholding size in other regions before and after the land redistribution (but actually it was not implemented in other regions). This policy mainly aims to equalize land use and reduce the number of landless farmers by redistributing land from large-scale to small-scale farmers and landless farmers; therefore, the policy effect is considered a reduction in the average landholding size of farmers.

In DiD estimation, the impact of land redistribution is evaluated by the interaction term of the treatment group dummy variable and the post-treatment dummy variable. However, the attribute variables of landholders (sex, age, education level, household size, and agriculture type) are incorporated into the model because landholding size is influenced by the individual attributes of landholders. The model including the attribute variables is expressed by the following equation:

$$A_{it} = \beta_0 + \beta_1 T_i + \beta_2 AFTER_t + \beta_3 (T_i \times AFTER_t) + \beta_4 SEX_i + \beta_5 AGE_i + \beta_6 EDU_i + \beta_7 HH_i + \beta_8 CROP_i + \beta_9 LIVE_i + U_{it}, \quad (1)$$

where A_{it} represents the dependent variable, which takes the value of the landholding size for landholder i in year t , T_i is a treatment group dummy variable equal to 1 if landholder i is included in the treatment group, $AFTER_t$ is a post-treatment dummy variable equal to 1 if year t is the post-treatment period, SEX_i is a sex dummy variable equal to 1 if the landholder i is male, AGE_i is an age variable, EDU_i is an education level variable, HH_i is a household size variable, $CROP_i$ is a crop dummy variable equal to 1 if landholder i benefits only by crops, and $LIVE_i$ is a livestock dummy variable equal to 1 if landholder i benefits only by livestock.

To properly estimate β_3 in Eq. (1), the parallel trend (equal trend) assumption, that changes in landholding size should have the same trends between the treatment and control groups if the land redistribution is not implemented, must hold. According to Gertler et al. [37], while this assumption cannot be proven directly, the validity of the underlying assumption of a parallel trend can be assessed. The parallel trend assumption can be tested in four methods. The first validity check of the parallel trend assumption is to compare the changes in outcomes for the treatment and control group repeatedly before the program is implemented. That is, in the pretreatment periods between 1995 and 1996, whether the landholding size changes of the treatment group and the control group have the same trend can be tested. If this test result shows that the changes in landholding size between the treatment group and the control group have the

same trend before 1996, the unobserved counterfactual changes in landholding size between the treatment group and the control group can be considered to be the same in trend after 1997, when land redistribution was not implemented in the treatment group.

The second method to check the parallel trend assumption is to apply an additional DiD estimation using a “fake” treatment group that was not subjected to the treatment. There must be a zero impact if this method is applied to the estimation, as both the fake treatment group and the control group were not subjected to land redistribution. The SNNP Region (the Southern Nations, Nationalities, and Peoples’ Region), which is as densely populated as the Amhara Region and did not experience major land reform during that period, was selected as the fake treatment group.

The third method to check the parallel trend assumption is to apply an additional DiD estimation using different control groups. If both groups are valid control groups, the estimated impact is approximately the same in both calculations. This study already discussed two different control groups: the rest of Ethiopia and the Oromia Region.

This study checks the parallel trend assumption by using all the above methods and argues that the assumption in this analysis is sufficiently satisfied in the next section. And for purposes of these estimations, when standard errors must be calculated, we considered weight by way of the survey package on R [38–40].

4 Results and discussion

The parallel trend assumption must hold for DiD estimation to properly estimate β_3 in Eq. (1). From Table 4, the changes in landholding size seem to have similar trends in both the treatment and control groups. To clarify this, validity checks of the parallel trend assumption by the four methods described in the previous section were performed. First, an additional DiD estimation 2 years before the treatment was conducted to check the trend of changes in landholding size. According to Table 5, which shows the estimation results of the first check, the interaction terms are not significant in all models. This indicates that no significant differences exist in the trends of the changes in landholding size between the treatment and control groups.

Second, an additional DiD estimation using the fake treatment group was performed. From Table 6, showing the estimation results of the second check, the interaction terms are not significant in all models. Thus, no impact after 1997 is confirmed between the SNNP Region, which is the fake treatment group and two control groups. Specifically, this

Table 5 Parallel trend assumption check using the pretreatment period

	Landholding size	
	Amhara—The rest of Ethiopia	Amhara—Oromia
	1995–1996	1995–1996
Treatment group	0.307 (0.061)***	0.073 (0.071)
Time dummy	−0.038 (0.018)**	−0.046 (0.031)
Sex	0.252 (0.022)***	0.296 (0.031)***
Age	0.003 (0.001)***	0.004 (0.001)***
Education level	0.019 (0.012)	0.055 (0.015)***
Household size	0.104 (0.009)***	0.117 (0.013)***
Crop only	−0.284 (0.025)***	−0.359 (0.033)***
Livestock only	0.538 (0.178)***	0.434 (0.248)*
Interaction	0.038 (0.033)	0.044 (0.042)
Constant	0.066 (0.048)	0.139 (0.073)*
Observations	31,504	17,263
Log likelihood	−47,291.340	−24,368.590
AIC	94,602.680	48,757.190

Cluster robust standard errors in parentheses

*Significant at 10%

**Significant at 5%

***Significant at 1%

Table 6 Parallel trend assumption check using the fake treatment group

	Landholding size					
	SNNP—the rest of Ethiopia			SNNP—Oromia		
	1996–1997	1995–1999	Except 1997	1996–1997	1995–1999	Except 1997
Fake treatment group	−0.657 (0.037)***	−0.655 (0.037)***	−0.653 (0.037)***	−0.654 (0.045)***	−0.654 (0.048)***	−0.652 (0.048)***
Post-treatment	−0.044 (0.033)	0.127 (0.033)***	0.219 (0.034)***	0.026 (0.047)	0.188 (0.050)***	0.277 (0.053)***
Sex	0.230 (0.022)***	0.233 (0.018)***	0.252 (0.019)***	0.102 (0.026)***	0.134 (0.021)***	0.164 (0.023)***
Age	0.004 (0.001)***	0.005 (0.000)***	0.005 (0.001)***	0.007 (0.001)***	0.008 (0.001)***	0.008 (0.001)***
Education level	0.036 (0.009)***	0.046 (0.010)***	0.044 (0.012)**	0.048 (0.010)***	0.053 (0.009)***	0.050 (0.010)***
Household size	0.070 (0.009)***	0.094 (0.008)***	0.109 (0.009)***	0.075 (0.009)***	0.091 (0.009)***	0.096 (0.011)***
Crop only	−0.328 (0.022)***	−0.401 (0.018)***	−0.391 (0.020)***	−0.329 (0.025)***	−0.400 (0.024)***	−0.396 (0.026)***
Livestock only	−0.841 (0.036)***	−0.983 (0.029)***	−1.035 (0.032)***	−0.870 (0.057)***	−1.043 (0.045)***	−1.116 (0.050)***
Interaction	0.066 (0.042)	0.007 (0.042)	−0.022 (0.045)	−0.003 (0.054)	−0.055 (0.056)	−0.084 (0.060)
Constant	0.418 (0.044)***	0.269 (0.040)***	0.185 (0.044)***	0.386 (0.054)***	0.234 (0.054)***	0.185 (0.059)***
Observations	52,155	138,914	103,521	24,948	71,384	54,847
Log likelihood	−90,199.960	−265,450.200	−197,241.800	−35,502.550	−120,382.800	−94,319.570
AIC	180,419.900	530,920.400	394,503.600	71,025.110	240,785.600	188,659.100

Cluster robust standard errors in parentheses

*Significant at 10%

**Significant at 5%

***Significant at 1%

Table 7 Main DiD estimation results of land redistribution in 1997

	Landholding size					
	Amhara—the rest of Ethiopia			Amhara—Oromia		
	1996–1997	1995–1999	Except 1997	1996–1997	1995–1999	Except 1997
Treatment group	0.333 (0.060)***	0.329 (0.058)***	0.335 (0.058)***	0.101 (0.066)	0.104 (0.065)	0.115 (0.065)*
Post-treatment	0.043 (0.033)	0.184 (0.033)***	0.265 (0.035)***	0.024 (0.047)	0.187 (0.049)***	0.280 (0.052)***
Sex	0.237 (0.023)***	0.243 (0.018)***	0.260 (0.019)***	0.258 (0.029)***	0.259 (0.022)***	0.283 (0.024)***
Age	0.005 (0.001)***	0.005 (0.001)***	0.005 (0.001)***	0.006 (0.001)***	0.006 (0.001)***	0.006 (0.001)***
Education level	0.025 (0.010)***	0.031 (0.011)***	0.030 (0.013)**	0.058 (0.013)***	0.074 (0.016)***	0.079 (0.018)***
Household size	0.073 (0.009)***	0.098 (0.008)***	0.114 (0.009)***	0.090 (0.011)***	0.122 (0.008)***	0.137 (0.009)***
Crop only	−0.309 (0.023)***	−0.385 (0.019)***	−0.375 (0.020)***	−0.382 (0.028)***	−0.456 (0.024)***	−0.448 (0.026)***
Livestock only	−0.751 (0.034)***	−0.862 (0.027)***	−0.896 (0.030)***	−0.849 (0.042)***	−0.962 (0.034)***	−1.001 (0.038)***
Interaction	−0.227 (0.061)***	−0.178 (0.059)***	−0.162 (0.063)***	−0.200 (0.070)***	−0.176 (0.069)**	−0.173 (0.073)**
Constant	0.131 (0.048)***	−0.007 (0.043)	−0.094 (0.047)**	0.203 (0.065)***	0.021 (0.056)	−0.087 (0.059)
Observations	52,155	138,914	103,521	24,520	65,821	50,035
Log likelihood	−91,853.440	−268,473.600	−199,379.700	−36,643.150	−114,874.600	−88,968.690
AIC	183,726.900	536,967.100	398,779.400	73,306.310	229,769.100	177,957.400

Cluster robust standard errors in parentheses

*Significant at 10%

**Significant at 5%

***Significant at 1%

suggests that no significant difference might exist in the changes in landholding size between the real treatment and control groups, even if the real treatment group was not treated.

Third, the additional DiD estimation using different control groups as the fourth check should be discussed, but it will be mentioned after obtaining the main DiD estimation results of this analysis. Table 7 presents the main estimation results of Eq. (1) through DiD estimation using multiple regression analysis, with the Amhara Region as the treatment group and the rest of Ethiopia and the Oromia Region as the control groups. The coefficients of the interaction terms showing the policy impact are negative values, such as -0.227 , -0.178 , -0.162 , -0.200 , -0.176 , and -0.173 , in all models. Therefore, the impact of the land redistribution policy in the Amhara Region was confirmed. As expected, due to the significant decrease in average landholding size in 1997 in the Amhara Region, a greater policy impact was observed in the models of single-year comparisons between the Amhara Region and the rest of Ethiopia and between the Amhara Region and the Oromia Region. Meanwhile, the significant policy impact was similarly confirmed in the estimation, excluding 1997, considering the possibility of a survey error or a response error. Moreover, comparing the coefficients of the interaction terms between each model using two different control groups during the same period, the results are -0.227 and -0.200 for Models 1 and 4, -0.178 and -0.176 for Models 2 and 5, and -0.162 and -0.173 for Models 3 and 6. Each result shows very close values and, suggesting that the results can reinforce the validity of the fourth test of the parallel trend assumption.

In addition, sex, age, education level, and household size were significantly positive, while the crop dummy and livestock dummy were significantly negative. Specifically, male farmers, elder farmers, well-educated farmers, or large household farmers tend to hold larger land, while farmers without livestock or growing crops tend to hold smaller land.

5 Conclusion

The study evaluated the effect of the exceptional land redistribution implemented in 1997 in the Amhara Region on farmers land holding size through DiD estimation. The landholding size was the impact indicator of the land redistribution applied in this estimation. The estimation results showed a significant decrease in landholding size in the Amhara Region from both comparisons with the rest of Ethiopia and the Oromia Region.

This policy was implemented with the egalitarian aim of reducing landless farmers by redistributing the farmland drawn from a relatively large-scale farmers to small-scale farmers and landless farmers as a measure for remarkable population growth and land shortage in the Amhara Region. And it achieved certain results from the egalitarian perspective. Furthermore, it was confirmed that the landholding size is also highly dependent on landholders' sex, age, education level, household size, and agriculture type. According to these results, this land redistribution policy seems to have achieved certain results regarding the correction of inequality, which is one of the goals of SDGs (Goal 10). However, although the land redistribution in 1997 was described as an egalitarian policy, global goals for equity such as the SDGs and the Millennium Development Goals (MDGs) had not been fully developed yet at the time. As for the previous studies, they focused mostly on the effects of the land redistribution on agricultural investment such as fertilizer input and agricultural productivity, that is, the effects on efficiency rather than equity. On the other hand, the case of the land redistribution in 1997 is not an outdated research subject when we look at the recent global interest in the importance of equity. Therefore, the policy evaluation of the egalitarian land redistribution focused on in this study has important implications for policy making to promote the equalization of land holdings or economic assets among farmers.

This paper only referred to the relative decrease in average landholding size compared to the control group since 1997. However, the increase in landholding size was again confirmed after 1997. This indicates that land "re-accumulation" might have occurred against the egalitarian purpose of the policy, immediately after land redistribution. Considering that, this phenomenon is beyond the scope of this study, it leaves doubts from a policy sustainability perspective.

Finally, several limitations of this study can be mentioned. First, the DiD regression analysis can only estimate the average treatment effect in the entire Amhara Region where the land redistribution was implemented. Therefore, it is difficult to clarify what specific actions farmers took after experiencing the land redistribution. So, it is necessary to support the results of this study through qualitative analysis involving field surveys. Second, the impact of land reforms on land management such as land conservation against soil degradation is likely to appear also in the long term, but this study could only capture the short-term impact of the land redistribution. In recent years, a discussion of environmental conservation is also one of the crucial topics for policy makers and the consequences of such conservation investments will be long-term. One of the reasons why this study could not capture a long-term impact is the existence of confounding factors with land redistribution and certification started from 2003 in the Amhara Region [34]. In other words, the data

used in this study do not allow us to discriminate between the long-term effect of the land redistribution in 1997 and the effect of land registration and certification since 2003 on the factors that have affected farmers' land management. However, it is interesting since the results of this study clearly show the short-term significant effects of the land redistribution. So, additional studies on both the short- and long-term effects of the land redistribution are needed in the future.

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Data availability Data cannot be shared publicly because of the access policy of the Central Statistical Agency (CSA) in Ethiopia. Contact CSA for further information.

Code availability Not applicable.

Declarations

Competing interests The authors declare that they have no competing interests.

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References

1. CIA (Central Intelligence Agency). Africa: Ethiopia. The world factbook. 2019. <https://www.cia.gov/library/publications/the-world-factbook/geos/et.html>. Accessed 19 June 2020.
2. CSA. Key findings of the 2017/2018 (2010 E.C) agricultural sample survey. Addis Ababa: Central Statistical Agency; 2018.
3. Land Portal. Land and the sustainable development goals (SDGs). 2022. <https://landportal.org/book/sdgs>. Accessed 16 Jan 2022.
4. UN General Assembly. Sustainable development goals (SDGs): transforming our world: the 2030 agenda for sustainable development. New York: United Nations; 2015.
5. Ghatak M, Roy S. Land reform and agricultural productivity in India: a review of the evidence. *Oxf Rev Econ Policy*. 2007;23(2):251–69.
6. Binswanger HP, Deininger K, Feder G. Power, distortions, revolt and reform in agricultural land relations. *Handb Dev Econ*. 1995;3:2659–772.
7. Ege S. Peasant participation in land reform. In: Zewde B, Pausewang S, editors. Ethiopia: the challenge of democracy from below. Uppsala: Nordic Africa Institute; 2002. p. 71–86.
8. Kodama Y. Changes in relationship between state and society in Ethiopia: an analysis of historical land policies. In: Takeuchi S, editor. Land and the state in Africa: the evolution of land policies. Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO): Chiba; 2015. p. 225–54 (In Japanese).
9. Adam AG. Informal settlements in the peri-urban areas of Bahir Dar, Ethiopia: an institutional analysis. *Habitat Int*. 2014;43:90–7.
10. Wubie AM, De Vries WT, Alemie BK. A socio-spatial analysis of land use dynamics and process of land intervention in the peri-urban areas of Bahir Dar City. *Land*. 2020;9(11):445.
11. Schwab P. Ethiopia politics, economics and society. London: Frances Pinter; 1985.
12. Bahru Z. A history of modern Ethiopia, 1855–1991. 2nd ed. Addis Ababa: Addis Ababa University Press; 2002.
13. Abegaz B. Escaping Ethiopia's poverty trap: the case for a second agrarian reform. *J Mod Afr Stud*. 2004;42(3):313–42. <https://doi.org/10.1017/S0022278X04000217>.
14. Crewett W, Bogale A, Korf B. Land tenure in Ethiopia: continuity and change, shifting rulers, and the quest for state control. CAPRI Working Paper No. 91. Washington, D.C.: International Food Policy Research Institute; 2008.
15. Dunning HC. Land reform in Ethiopia: a case study in non-development. *UCLA Law Rev*. 1970;18(2):271–307.
16. Marcus HG. A history of Ethiopia. Berkeley: University of California Press; 1994.
17. Mulatu W, Yohannis A. Ethiopia transition and development in the horn of Africa. Boulder: Westview Press; 1988.
18. Kloos H. Health aspects of resettlement in Ethiopia. *Soc Sci Med*. 1990;30(6):643–56. [https://doi.org/10.1016/0277-9536\(88\)90250-X](https://doi.org/10.1016/0277-9536(88)90250-X).
19. Devereux S, Teshome A, Sabates-Wheeler R. Too much inequality or too little? Inequality and stagnation in Ethiopian agriculture. *IDS Bull*. 2005;36(2):121–6. <https://doi.org/10.1111/j.1759-5436.2005.tb00208.x>.
20. Teshome TT. Food security situation in Ethiopia: the case of Amhara national regional state. *Ryukoku J Econ Stud*. 2010;50(1):55–74.
21. CSA. The 2007 population and housing census of Ethiopia: Part I: population size and characteristics. Addis Ababa: Central Statistical Agency; 2007.
22. CSA. Ethiopia statistical abstract 2011/12: section B: population. Addis Ababa: Central Statistical Agency; 2011.

23. Ege S. The promised land: the Amhara land redistribution of 1997. Working Papers on Ethiopian development no. 12. Trondheim: Centre for Environment and Development, Norwegian University of Science and Technology; 1997.
24. Kefyalew EA. Essays on the effects of land redistribution, agricultural extension, and social learning on technology adoption and agricultural productivity in Ethiopia. Doctoral dissertation, Tokyo: National Graduate Institute for Policy Studies; 2015.
25. Kodama Y. State territorialization in rural Ethiopia: a case of land tenure system in Amhara region. In: Takeuchi S, editor. Land and power in Africa: understanding drastic rural changes in the age of land reform. Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO): Chiba; 2017. p. 107–37 (**In Japanese**).
26. Kodama Y. Effects of the 1991 land redistribution on women's right to land in the Amhara Region, Ethiopia. *Sophia J Asian Afr Middle East Stud*. 2018;36:9–22.
27. Abate T. Land, capital and labour in the social organization of farmers: a study of household dynamics in Southwestern Wollo, 1974–1993 (No. 4). Addis Ababa: Department of Sociology and Social Administration, College of Social Sciences, Addis Ababa University; 1998.
28. Benin S, Pender J. Impacts of land redistribution on land management and productivity in the Ethiopian highlands. *Land Degrad Dev*. 2001;12(6):555–68. <https://doi.org/10.1002/ldr.473>.
29. Holden S, Yohannes H. Land redistribution, tenure insecurity, and intensity of production: a study of farm households in southern Ethiopia. *Land Econ*. 2002;78(4):573–90. <https://doi.org/10.2307/3146854>.
30. Zimmermann-Steinhart P, Bekele Y. The implications of federalism and decentralisation on socio-economic conditions in Ethiopia. *Potchefstroom Electron Law J/Potchefstroomse Elektroniese Regsblad*. 2012. <https://doi.org/10.4314/pelj.v15i2.5>.
31. Snyder KA, Ludi E, Cullen B, Tucker J, Zeleke AB, Duncan A. Participation and performance: decentralised planning and implementation in Ethiopia. *Public Adm Dev*. 2014;34(2):83–95.
32. Chanie P. Clientelism and Ethiopia's post-1991 decentralisation. *J Mod Afr Stud*. 2007;45(3):355–84.
33. CSA. Agricultural sample survey 1995/96 (1988 E.C.) volume 1 report on area and production for major crops. Addis Ababa: Central Statistical Agency; 1996.
34. Deininger K, Ali DA, Holden S, Zevenbergen J. Rural land certification in Ethiopia: process, initial impact, and implications for other African countries. *World Dev*. 2008;36(10):1786–812.
35. Winship C, Radbill L. Sampling weights and regression analysis. *Sociol Methods Res*. 1994;23(2):230–57. <https://doi.org/10.1177/0049124194023002004>.
36. UNSD (United Nations Statistics Division). Designing household survey samples practical guidelines. New York: United Nations; 2005.
37. Gertler PJ, Martinez S, Premand P, Rawlings LB, Vermeersch CM. Impact evaluation in practice. Washington, D.C: The World Bank; 2016.
38. Lumley T. Survey: analysis of complex survey samples. R package version 4.0; 2020.
39. Lumley T. Complex surveys: a guide to analysis using R. New York: Wiley; 2010.
40. Lumley T. Analysis of complex survey samples. *J Stat Softw*. 2004;9(1):1–19. <https://doi.org/10.18637/jss.v009.i08>.

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