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THE IMPACT OF URBANIZATION ON FOOD IN SECURITY IN AMHARA REGIONAL STATE METROPOLITAN CITIES: MONITORING AGRICULTURAL FOODSTUFF PRODUCTION AS A MEDIATING VARIABLE

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A b s t r a c t

The process of urbanization in developing nations is attended without fast industrialization processes. As a result of this, the urbanization and urban process are accompanied by diverse problems. Hence this paper is aimed at identifying the effect of urbanization on citizens' food insecurity by monitoring agricultural foodstuff production as a mediating variable. A quantitative research methodology or approach has been used to depict out urban problems associated with unmanaged urbanization in the Ethiopian, particularly in Amhara regional state. Structural Equation Modelling was employed to run a mediation analysis by decomposing the direct and indirect effects of one variable on the other. Correlation and regression analyses were executed to measure the direction and magnitude of the effect of the independent variable on the dependent. Regression analysis results indicated the existence of a significant direct effect of urbanization on food insecurity of citizens. The mediation analysis result shows agricultural foodstuff production doesn't play a mediating role between urbanization and food insecurity.

The paper, having traced out the effect of the urbanization on food insecurity, provides possible recommendations. The regional government should be very considerate about the pace of unmanaged, unindustrialized and unemployment induced urbanization. The regional government should address all pushing factors that are dragging farmers into the urban areas. So, it is important to find ways to make farmers beneficial from their farm activities. In this regard, the problem raised by farmers is the inability to settle the debt from fertilizers and improved seeds or at least what they get from selling what they have produced is used to settle their farm debt. Some policy measures such as subsidizing the farmer or extending the repayment period of their debt are then essential to help farmers lead a stable life and lead their families. The government/concerned body need to make a cost-benefit analysis by weighing the pressure from the migration of the farmers and the cost of subsidizing the farmers: compare prevention with curative. Moreover, as a short-term solution, the regional government should identify food unsecured urban households and embrace them in food security packages like urban safety-net programs. And enhancing the limited income generation capacity of food insecure households.

1. Introduction

As cities expand, prime agricultural land is converted into residential or industrial areas. For Example, in conception, a Chilean city of about 500000 inhabitants, 1734 hectares of wetlands and 1417 hectare of agricultural land and forests were transformed into residential areas over the period 1975 to 2000 (Pauchard et al. 2006). In Accra (Ghana), it is estimated that 2006 hectares of agricultural land are converted every year (Maxwell et al. 2000). Similar patterns were observed in China and Indonesia (Verburg 1999; Weng 2002). An immediate consequence is the crowding out of pre-urban agriculture, which often plays a significant role in supplying perishable foodstuffs to cities (FAO 2008). Agricultural production will be further challenged by the expanding cities' substantial thirst for water. This has great effect on food security. "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life".(World Food Summit, 1996). This widely accepted definition points to the food availability, access, utility and stability as the dimensions of food security: For food security objectives to be realized, all four dimensions must be fulfilled simultaneously. Weather variability, price fluctuations, political, and economic factors are key factors.

The 2015 Global Food Security Index (GFSI) shows global food insecurity remains a challenge. In particular, increased volatility of agricultural production, and also lower urban absorption capacity (as urban migration in many countries continues to rise and as GDP growth slows in over half the countries included in the index), are constraints on food security progress in almost every region. Food security challenges of developed and developing countries differ considerably. Investment in infrastructure and food systems in low-income and lower-middle income countries is the key to narrowing the gap. Developing countries often lack basic infrastructure, including storage, road and port facilities, while smaller incomes inhibit access to and affordability of nutritious food. Political risk and corruption frequently compound structural difficulties in these countries. Advanced, rich-world countries generally outperform developing countries, but they too experience food security challenges. Although developed Western countries continued to have the highest levels of food security and Sub-Saharan African countries remained at the bottom of the rankings, the gap between the best and worst performers narrowed.

Amhara region is one of the regions that show rapid urbanization process in Ethiopia. The region has an urban population growth rate of 4.9% from 1995-2000 which is above the rate of urban population growth at the national level. The region had an urban population growth rate which is ranked second next to the Oromia region. From 2001-2005 the region has 4.4% of urban population growth rate. In 2007 it had a total of 208 cities and towns which is contributing 11.7% of urban population in the same year. This is higher than the 1994 urban population percentage that was around 8.5 %. In 1994 census result, In the region, Semen Gondar zone has the highest urban population proportion (18.7%) followed by South Wollo (16.7%), North Shoa (11.6%) and East Gojjam (11.5 %). South Gonder and West Gojjam have also 9.2% and 8.5% of the urban population followed by Bahir Dar special Zone which has 7.6% of urban population proportion (Antonio Golini, 2001, (BoFED 2014).

The population of Bahir Dar city has increased from 54,800 in 1984 to 96,140 in 1994 with an average growth rate of 5.6% and in 2007 the population increased to 155,428 with a 3.7 average growth rate. In 2014, it reached 226,713. On the other hand, Gondar city had 80,886 population. In the year the population raised to 112,249 with an average growth rate of 3.3 from 1984-1994. The population growth has shown tremendous upsurge to 207,044 in 2007 with an average growth rate of 4.7. The other major cities in the Amhara region is Dessie. Alike Gondar and Bahir Dar city administration, Dessie has also experienced a fast-growing urban population. In the year 1984 the population was 68,848 and in 1994 it turns to 97,314 with an average growth rate of 3.5 and in 2007 it reached 120,095 with an average growth rate of 1.6. Therefore, there have been fast growing urbanization processes in the region comparatively (MUDHCo and ECSU, 2015). This fastgrowing urbanization is nowadays accompanied by multitudes of problems. Among these, declining agricultural foodstuff production and food insecurity are the main ones. As a result of urban expansion to peri-urban agriculture, which often plays a significant role in supplying perishable foodstuffs to cities, and weak tenure system, agricultural productive lands may shift to

less productive areas, which could, ceteris paribus, result in yield losses (FAO 2008). Hence, declined agricultural production can be attributed to urban expansion. On the other hand, WFP and UNICEF (2009) stated that the three metropolitan cities in Amhara region named Bahir Dar, Dessie, and Gonder, which are the focus of this study, have ranked 15th, 9th,7th in food security status by registering 0.434,0.522, 0.559 food security index respectively. As a result of this, the cities are leveled as the most food insecure cities in the country. Hence, urbanization is considered as having negative impacts on agricultural foodstuff production. The decline in the volume of agricultural foodstuff production amounts to the decline in availability of food items in the market posing trouble on food security. Generally, the very essence or objective of this paper is to investigate the effect of urbanization on food insecurity. It also examined agricultural foodstuff production as a mediating role in the relationship between urbanization and food insecurity.

2. Data Collection and the Method of Analysis

A household survey was conducted in 2009 in three cities of Amhara region: Bahir Dar (the capital of the region), Gondar, and Dessie, with a sample of 622 households. These sample units were chosen from a total population of 170456 household using a proportionate stratified sampling method. All households of metropolitan cities are stratified by using kebele units. After being stratified researchers used systematic random sampling techniques. The number of elements in each stratum is determined in K^{th} value, which is calculated based on the formula $\left(\frac{N}{n}\right)^{Th}$. Hence the K^{th} value in the study is 217. So, in every 217 from each stratum, proportional to its population, samples were drawn. Finally, questioner was distrusted to 622 samples but as the return rate is 80.39 percent, the total sample respondent who were participated in the study were 500.

When determining sample size for household respondents Slovin's Sample Size calculation is used at 95% confidence level and 4% level of precision as follows.

$$n = \frac{N}{1+(N\times e^2)} \qquad n = \frac{134946}{1+(134946\times 0.04^2)} \approx 622$$

n= is sample size

N=total number of households

e= level of precision

2.1. Specification of the Model:

A logistic regression model has been estimated to elicit the effect of urbanization on income generating capacity of households. The model uses income generating capacity among the households as the dichotomous dependent variable. The model is given by;

$$\ln\left[\frac{p}{1-p}\right] = b_0 + b_1(x)$$

Where: Ln = the natural logarithm

P= the short form of p(y=1)- the probability that the dependent variable exists $\frac{p}{1-p}$ = the odds for p(y=1)

$\ln\left[\frac{p}{1-p}\right]$ = natural logarithm of the odds for p(y=1)

The model is based on the following hypotheses: a) Urbanization is a factor influencing the food security status of urban residents. Thus, it is hypothesized that the ever-increasing urbanization would negatively affect or reduce citizens food security status. B) Agricultural foodstuff production mediates the relationship between urbanization and food Security status of urban residents. Concerning mediation analysis the approach used by Baron and Keny(1986) is followed. Four conditions must be fulfilled to evidence a mediating effect (Baron and Keny, 1986). First, the independent variable must significantly impact the dependent variable. Second, the independent variable must have impact on the mediator. Third, the mediator must impact the dependent variable. Finally, the effect of the independent variable on the dependent variable becomes less when the mediator is controlled, as shown by the change in regression coefficient. Full mediation exists when such an effect becomes non-significant.

As indicated in table 1, 2, and 3, before get distributed the questionnaire the researchers computed the reliability of the questionnaire for each variable. In doing so Cronbach's alpha is computed using stata 13 software program. Looking at the above tables the Cronbach's alphas for Urbanization, food security, Income generation capacity, housing problems, agricultural production and poverty are 0.794, 0.775, and 0.822 respectively. Therefore, the results indicated in the above tables confirmed that

there is high inter item consistency among questions as the results are higher than 0.70.

3. Results and Discussion

3.1. Urbanization and Food Security:

Based on the data obtained from 500 households, we have run the binary logistic regression to identify the effect of urbanization on food security. The researchers have also monitored agricultural foodstuff production as a mediator between urbanization and food security. From the regression analysis, in table 4 that contains the odds ratio, we observe that when there is urbanization (X = 1) the odds of food insecurity (Y=1) is 10.60571 times greater than the odds of food security (Y=0) without urbanization(X=0). This indicates that with the expansion of urbanization the probability of food insecurity is higher than the case where x=0. Hence, we conclude that urbanization intensifies food insecurity among the urban dwellers.

On the other table, table 5, it is clearly indicated that the odds ratio is 10.60571. In this case the regression equation is given by:

$$\ln\left[\frac{p}{1-p}\right] = b_0 + b_1\,(x)$$

Where: Ln = the natural logarithm

P= the short form of p(y=1)- the probability that y=1 rather than zero

$\frac{p}{1-p}$ = the odds for p(y=1) – the probability that y=1 for a given '' x'' value divided by the probability that y=0 for that ''x'' value

$\ln\left[\frac{p}{1-p}\right]$ = natural logarithm of the odds of food insecurity.

Therefore, b_o= ln of odds when x=0, 1.75: ln1.75 =0.5596 and b_1= ln of odds when x=1, 10.60571: ln10.60571=2.361393. To convert the coefficients into odds, the formula is e^{b0} for the odds when x=0 and e^{b1} for the odds x=1, hence $e^{0.5596}$ =1.75, $e^{2.361393}$=10.60571.

Hence, the regression model based on the odds will be developed as;

$\ln\left[\frac{p}{1-p}\right]$ = 0.5596 + 2.361393X- is indicated in the regression output showing the result of coefficients.

This tells us whenever there is urbanization the log of the odds of food insecurity is greater than the log of the odds of food insecurity when there is no urbanization. (y=1/x=1 or 0). But to make the analysis more plausible, we have to translate the model into probabilities as follows:

$\ln\left[\frac{p}{1-p}\right]$ = b_0 + b_1 (declining volume of agricultural food production) take ''e" to the power of both sides

$\frac{p}{1-p} = e^{b0 + b1(x)}$ then calculate the odds for x=1 and x=0 and compare the probabilities.

$P = \frac{e^{b0 + b1(x)}}{1+e^{b0 + b1(x)}}$ for X=1

$P = \frac{2.7182^{0.5596 + 2.361393}}{1+2.7182^{0.5596 + 2.361393(1)}} = \frac{18.5597}{19.5597}$ = 0.9488 this shows when there is urbanization the probability that there will be food insecurity is 0.9488.

For X=0, $P = \frac{e^{b0}}{1+e^{b0}} = \frac{2.7182^{0.5596}}{1+2.7182^{0.5596}} = \frac{1.75}{2.75}$=0.636. Hence, the probability that there will be a food insecurity even though no urbanization is 0.636. Based on this we can conclude that the existence of urbanization exacerbates the status of food insecurity in urban areas.

3.2. Urbanization and Declining volume of Agricultural foodstuff Production

The regression analysis has also been executed to find out the effect of urbanization on the declining volume of agricultural foodstuff production. Hence, table 6 which contains the odds ratio, we observe that when there is urbanization (X = 1) the odds of decline in volume of agricultural food production(Y=1) is 30.47 times greater than the odds of decline in volume of agricultural food production(Y=1) without urbanization(X=0). This indicates that if there is urbanization the probability that volume of agricultural food production will decline is higher than the case that x=0. Hence, we conclude that urbanization brings decline in volume of agricultural food production. As it is clearly indicated that in the table 6 the odds ratio is 30.474. In this case the regression equation is given by:

$\ln [\frac{p}{1-p}] = b_0 + b_1 (x)$

Where: Ln = the natural logarithm

P= the short form of p(y=1)- the probability that y=1 rather than zero

$\frac{p}{1-p}$ = the odds for p(y=1) – the probability that y=1 for a given '' x'' value, divided by the probability that y=0 for that ''x'' value

$\ln [\frac{p}{1-p}]$ = natural logarithm of the odds of declining volume of agricultural food production

Therefore, b_o= ln of odds when x=0, 1.75: ln1.75 = 0.5596 and b_1= ln of odds when x=1, 30.47: ln30.47=3.416946. To convert the coefficients into odds the formula is e^{b0} for the odds when x=0 and e^{b1} for the odds x=1, hence $e^{0.5596}$ =1.75.

Hence, the regression model based on the odds will be developed as;

$\ln [\frac{p}{1-p}]$= 0.5596 + 3.4169X- is indicated in the regression output in table 7 shows the result of coefficients. This confirms as whenever there is urbanization the log of the odds of declining volume of agricultural foodstuff production is greater than the log of the odds of declining volume of agricultural foodstuff production when there is no urbanization. (y=1/x=1 or 0). But to make the analysis more plausible, we translate the model into probabilities as follows:

$\ln [\frac{p}{1-p}] = b_0 + b_1$ (declining volume of agricultural food production) take ''e" to the power of both sides

$\frac{p}{1-p}$= $e^{b0 + b1(x)}$ then calculate the odds for x=1 and x=0 and compare the probabilities.

P=($e^{b0 + b1(x)}$ /1+ $e^{b0 + b1(x)}$) for X=1

P= $\frac{2.7182^{0.5596 + 3.4169(1)}}{1+2.7182^{0.5596 + 3.4169(1)}}$= $\frac{53.33}{54.33}$ = 0.981 this shows when there is urbanization the probability that there will be a decline in the volume of agricultural food production is 0.981.

For X=0, p= $\frac{e^{b0}}{1+e^{b0}}$ = $\frac{2.7182^{0.5596}}{1+2.7182^{0.5596}}$ = $\frac{1.75}{2.75}$=0.636 the probability that there will be a decline in the volume of agricultural food production though no urbanization. Based on this we can conclude that the existence of urbanization brings a decline in the volume of agricultural food production. This is because the outward expansion of cities into the suburbs converts agricultural lands to non-agricultural use and results in a declining ratio of food producers to food consumers as clearly stated by other researchers too.

Urbanization influences the food security and farming activities of an increasingly urbanized world and results in a declining ratio of food producers to food consumers. It has been underpinned by the rapid growth in the world economy and in the proportion of gross world product. Globally, agriculture has met the demands of this rapidly growing urban population, including food. But hundreds of millions of urban dwellers suffer under-nutrition (David Satterthwaite, Gordon McGranahan and Cecilia Tacoli, 2010).

Hardoy et al. (2001) and others in their article has indicated the effect of urbanization on agriculture as follows: "Urban expansion inevitably covers some agricultural land while changes in land values and land markets around cities often result in land left vacant as the owners anticipate the gains they will make from selling it or using it for non-agricultural uses. In most urban areas in low- and middle-income nations, the absence of any land-use plan or strategic planning framework to guide land-use changes lead urban areas to expand haphazardly. This expansion is determined by where different households, enterprises, and public sector activities locate and build, legally or illegally. In most cases, there is little effective control over land-use conversions from agriculture to non-agricultural uses. There may be regulations that are meant to limit this but these have often avoided by politicians and real estate interests (Hardoy et al. 2001 & Angel, et al, 2005).

There has been a lot of evidence whereby agricultural production would reduce as a result of urban expansions. F. Eigenbrod and et al., (2011) gave an experimental testimony in assuring that agricultural production would be reduced at a rate of directly proportional to the amount of new urbanization (dense urban or suburban) in a 1 x 1 km grid cell. It has also predicted that the losses of stored carbon and agricultural production were estimated to be higher in the sprawl scenario than in the densification scenario. This happened because the conversion of

non-urban land is three times higher in sprawl scenario the densification.

Therefore, the finding of this research consistent with others has shown that Urbanization is often considered as having negative impacts on agriculture, hence, agricultural foodstuff production.

3.3. Declining volume of agricultural food production and food insecurity

In the table 8, and 9 logistic regression and odds ratio are executed to depict out the effect of declining volume of agricultural foodstuff production on food insecurity. As the table indicates, the pseudo R^2 is 0.11, and the coefficient is 3.2 which is significant at $p<0.01$, this means that one unit of decrease in agricultural foodstuff production leads 3.2 unit of increases in food insecurity. On the other hand, in the table 9 that contains the odds ratio, we observe that when there is a decline in the volume of agricultural food production (X = 1) the odds of food insecurity (Y=1) is 24 times greater than the odds of food insecurity in the absence of decline in the volume of agricultural food production (X=0). This indicates that if there is a decline in the volume of agricultural food production the probability that citizens will be food insecured is higher than the case that x=0. Hence, we conclude that a decline in the volume of agricultural food production brings the problem of food security.

And the model is given by $\ln\left[\frac{p}{1-p}\right]$= -.1541 + 3.21X then

$p=\frac{2.7182^{-0.1541+3.2051}}{1+2.7182^{-0.1541+3.2051}}$ for x=0 p= 0.46, for x=1 p= 0.95

This shows the likely hood that a citizen will be food insecure if there is a decline in the volume of agricultural foodstuff production is 0.95 while it is only about 0.46 in case there is no problem in agricultural food production.

3.4. Mediation Analysis

The researchers execute a mediation analysis to depict out whether declining agricultural foodstuff production mediate the relationship between urbanization and food insecurity or not. Hence the result is presented, interpreted and analyzed in the following ways. The decomposition of the direct and indirect effect using Structural Equation Modeling (SEM) is run. Hence when we observe the mediating role of agricultural foodstuff production in the relationship between urbanization and food insecurity, which is indicated in the path diagram or figure 1 and the decomposition of direct and indirect effect in the table above, all the conditions to test mediation have fulfilled. Accordingly, the direct effect of urbanization on food insecurity is 0.158 and the indirect effect is 0.1542. Since the direct effect is greater than the indirect effect, it is possible to conclude that agricultural food production doesn't mediate the relationship between the variables.

4. Conclusion and Policy Implication

4.1. Conclusion:

The primary objective of this study was to investigate the effect of urbanization on food insecurity as mediated by the volume of agricultural foodstuff production with a particular reference to Bahir Dar, Dessie, and Gondar cities. To reach the conclusions that are asserted the study has used the appropriate data analysis method. Hence, binary logistic regression is the prominent data analysis that the study has used. The conclusions based on our empirical study can be summarized as follows:

1. Urbanization influences the food security status of urban households negatively. And there has been a reduction of agricultural foodstuff production in the region following the swift processes of urbanization.

2. Urbanization is found to be reducing the agricultural foodstuff production in the region and

3. Agricultural foodstuff production does not mediate the relationship between urbanization and food insecurity.

4.2. Policy Implications:

In this paper, urbanization is found to pose diverse problems in the region. As a result of this, the regional government or concerned bodies have to take necessary policy interventions so that the adversarial consequences of urbanization will be rectified. Henceforth, this paper has pointed out the following area of intervention.

In the study, it is concluded that urbanization has negatively impacted agricultural foodstuff production in Amhara region. This happened because of the outward expansion or expansion of urban cities into the pre-urban agricultural lands and unmanaged urban processes. In assuring this, it is only in Bahir Dar city administration that a total of 4119911 m2 and 4063084 m2 lands

were given for investors and real-estate and leaseholds from the year 2001 up to 2018(ANRS industry park development, 2018, Land Management Bureau, 2018). The total agricultural land that converted into non-agricultural uses reaches 8,182,995 m2 (818.2995hectar) (Amhara Regional State Bureau of Agriculture, 2009). Unmanaged and ever-growing urbanization, which is happening in the region, is currently attracting a large number of farmers from the rural sides. According to CSA (2007) census, in Amhara region, urban centers are comprised of 373,238 urban residents who already have migrated from rural areas. Farmers are migrating to urban cities because of push and pull factors. The push factors that lead farmers to migrate to urban areas are lack of agricultural land, less agricultural productivities and inability to settle agricultural financial debts. These ultimately contributed producers or farmers to be converted to consumers. Hence this paper recommends the regional government or concerned bodies to redress all push factors. The regional government must devise policy interventions like providing subsidies, the regional government by creating strong partnerships with micro financial institutions should arrange appropriate loan facilities (when we say appropriate it means that the period that loan is settled should be convenient to farming activities, the loan repayment and the amount of the loan given to the farmer should be appropriate to the farmer), Small and Micro Enterprises should effectively work in the rural areas to organize farmers, who are near to migration, to engage in different income generating activities, the regional government should support the farmers to enhance their productivity by introducing new technologies in the farming activities, and scaling up irrigations. These could deter the migration of farmers into urban areas and enhance the agricultural productions and productivities.

The other factors that contribute to less agricultural foodstuff production because of urbanization are attributable to pull factors. Instead of facing the challenges such as the decline in land productivity, and devising solutions by itself rural people or farmers consider migration to cities as the only and viable solution to the problems. Hence, awareness should be created that their problem could even worsen rather than being solved through migration. The regional government has restlessly worked on awareness creation on the dark side of international migrations (for instance migration to Arab countries). However, little has been made about internal migration. So, the regional government should aware the rural people about the challenges of urban lives.

Outward expansion into the pre-urban areas has also considered as one of the reasons that contribute to the reduction of agricultural foodstuff production. In different urban areas, particularly in metropolitan, cities are expanding into the neighboring agricultural areas. As a result of this, a priori agricultural lands are grabbed and converted into residential areas and partly to industrial areas. What makes it worse is, the agricultural lands seized from farmers for the purpose of industrial parks are not yet serving its purpose. There are a lot of plots of lands, which are redistributed to industries but yet idle. Hence the regional government needs to revise its investment policies.

The other conclusion made in this paper is urbanization has negatively affected the food security status of citizens in the region. This happened because of the existence of an increasing number of populations in urban areas. The increasing number of urban populations is attributed to internal migration. Therefore, the regional government needs to halt the rural-urban migration by redressing push factors in the countryside. So that, the regional government will be enabled to balance the available food stock with the urban population. Moreover, as the short-term solutions, the regional government should identify the food insecured urban households and embrace them in food security packages like urban safety-net programs, and enhancing the limited income generation capacity of food unsecured households.

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Appendices

Appendix-A Tables

Table 1 Questionnaire's reliability test result for urbanization

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
UR1	500	+	0.7720	0.7241	.4722945	0.7613
UR2	499	+	0.7376	0.6841	.4784243	0.7644
UR3	499	+	0.7353	0.6801	.4766943	0.7639
UR4	500	+	0.6903	0.6298	.4868524	0.7684
UR5	499	+	0.7728	0.7241	.470416	0.7607
UR6	499	+	0.7493	0.6968	.4751593	0.7630
UR7	500	+	0.7513	0.6965	.4706855	0.7616
UR8	500	+	0.5039	0.2304	.4860701	0.8449
UR9	500	+	0.7295	0.6742	.4790797	0.7648
UR10	500	+	0.4764	0.2006	.4988837	0.8482
UR11	499	+	0.7448	0.6908	.4745325	0.7630
Test scale					.4790077	0.7938

Table 2 Questionnaire's reliability test result for food insecurity

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
FS1	500	+	0.6156	0.5390	.1844391	0.7519
FS2	500	+	0.6032	0.5221	.1843902	0.7526
FS3	500	+	0.7086	0.6329	.1726602	0.7418
FS4	498	+	0.6767	0.5973	.1758895	0.7452
FS5	500	+	0.6041	0.5278	.1855756	0.7527
FS6	499	+	0.5558	0.4652	.1867585	0.7561
FS7	500	+	0.5297	0.4460	.1907017	0.7583
FS8	500	+	0.5758	0.5026	.1893343	0.7556
FS9	500	+	0.5007	0.4172	.193076	0.7603
FS10	499	-	0.1581	0.0325	.2154122	0.7872
FS11	499	+	0.1666	0.0563	.2140263	0.7830
FS12	498	+	0.3506	0.2415	.2013131	0.7717
FS13	496	+	0.2979	0.1862	.2050895	0.7754
FS14	500	+	0.1941	0.0796	.2122609	0.7822
FS15	499	-	0.1402	0.0144	.216742	0.7883
FS16	500	+	0.5805	0.5016	.1872986	0.7547
FS17	500	+	0.4581	0.3713	.1957119	0.7630
FS18	499	+	0.4196	0.3196	.1967959	0.7661
FS19	500	+	0.3865	0.2636	.1973061	0.7710
FS20	499	+	0.2060	0.1115	.2113501	0.7779
Test scale					.1958073	0.7745

Table 3 Questionnaire's reliability test result for agricultural foodstuff production

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
AG1	499	+	0.5692	0.4179	.3015328	0.8191
AG2	500	+	0.7082	0.6088	.2828068	0.7943
AG3	500	+	0.7806	0.6785	.2541821	0.7812
AG4	500	+	0.7431	0.6206	.2595124	0.7904
AG5	500	+	0.7295	0.6254	.2730707	0.7906
AG6	500	+	0.6068	0.4841	.3002409	0.8095
AG7	500	+	0.5759	0.4265	.3003075	0.8178
AG8	499	+	0.6271	0.4966	.2926721	0.8080
Test scale					.2830427	0.8223

Table 4 odds ratio of urbanization and food insecurity

Logistic regression — Number of obs = 500; LR chi2(1) = 9.63; Prob > chi2 = 0.0019; Pseudo R2 = 0.0435

Log likelihood = -105.89723

foss_cat	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
urr_cat	10.60571	6.995048	3.58	0.000	2.911562	38.63259
_cons	1.75	1.096871	0.89	0.372	.512294	5.978013

Table 5 Logistic regression results of urbanization and food insecurity

Logistic regression — Number of obs = 500; LR chi2(1) = 9.63; Prob > chi2 = 0.0019; Pseudo R2 = 0.0435

Log likelihood = -105.89723

foss_cat	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
urr_cat	2.361393	.6595546	3.58	0.000	1.06869	3.654096
_cons	.5596158	.6267832	0.89	0.372	-.6688567	1.788088

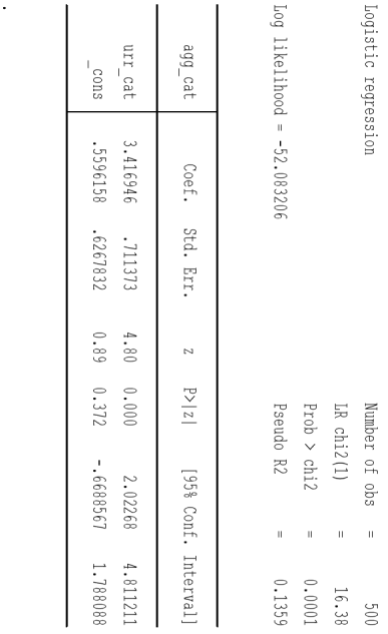
Table 6 odds ratio of urbanization and declining volume of agricultural food stuff production

Logistic regression — Number of obs = 500; LR chi2(1) = 16.38; Prob > chi2 = 0.0001; Pseudo R2 = 0.1359

Log likelihood = -52.083206

agg_cat	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
urr_cat	30.47619	21.67994	4.80	0.000	7.558556	122.8804
_cons	1.75	1.096871	0.89	0.372	.512294	5.978013

Table 7 Logistic regression results of urbanization and agricultural foodstuff production

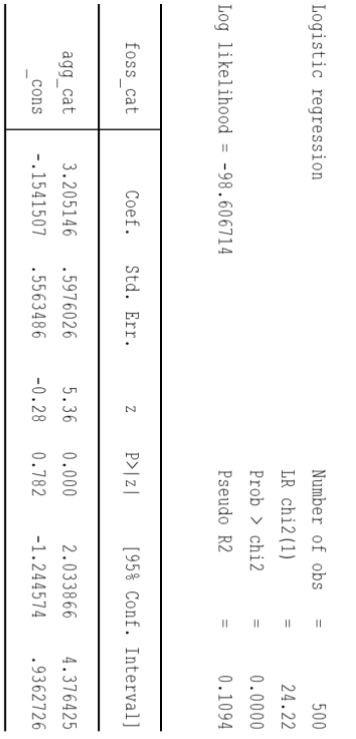


Logistic regression — Number of obs = 500; LR chi2(1) = 16.38; Prob > chi2 = 0.0001; Pseudo R2 = 0.1359

Log likelihood = -52.083206

agg_cat	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
urr_cat	3.416946	.711373	4.80	0.000	2.02268	4.811211
_cons	.5596158	.6267832	0.89	0.372	-.6688567	1.788088

Table 8 Logistic Regression Results of Declining volume of agricultural food production and food insecurity

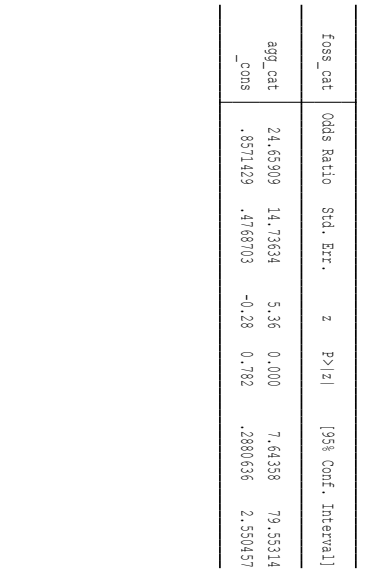


Logistic regression — Number of obs = 500; LR chi2(1) = 24.22; Prob > chi2 = 0.0000; Pseudo R2 = 0.1094

Log likelihood = -98.606714

foss_cat	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
agg_cat	3.205146	.5976026	5.36	0.000	2.033866	4.376425
_cons	-.1541507	.5563486	-0.28	0.782	-1.244574	.9362726

Table 9 odds ratio of declining volume of agricultural food production and food insecurity

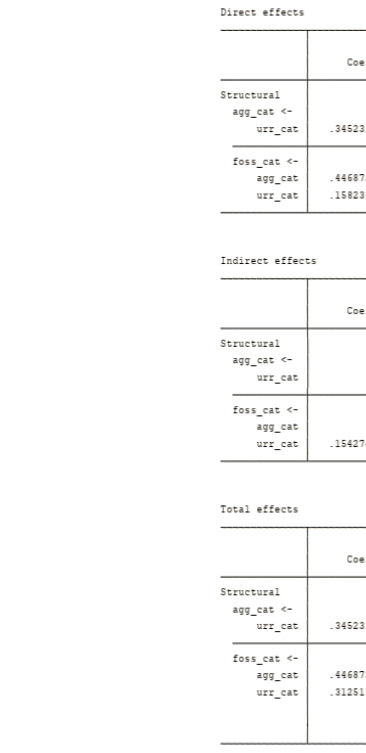


Logistic regression — Number of obs = 500; LR chi2(1) = 24.22; Prob > chi2 = 0.0000; Pseudo R2 = 0.1094

Log likelihood = -98.606714

foss_cat	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
agg_cat	24.65909	14.73634	5.36	0.000	7.64358	79.55314
_cons	.8571429	.4768703	-0.28	0.782	.2880636	2.550457

Table 10 The decomposition of the direct and indirect effect of the independent variable on the dependent



Direct effects

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
agg_cat <-						
urr_cat	.3452315	.0459956	7.51	0.000	.2550816	.4353813
foss_cat <-						
agg_cat	.4468732	.0649391	6.88	0.000	.3195948	.5741515
urr_cat	.1582369	.0704517	2.25	0.025	.0201541	.2963198

Indirect effects

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
agg_cat <-						
urr_cat	0	(no path)				
foss_cat <-						
agg_cat	0	(no path)				
urr_cat	.1542747	.0304153	5.07	0.000	.0946618	.2138875

Total effects

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
agg_cat <-						
urr_cat	.3452315	.0459956	7.51	0.000	.2550816	.4353813
foss_cat <-						
agg_cat	.4468732	.0649391	6.88	0.000	.3195948	.5741515
urr_cat	.3125116	.0698807	4.47	0.000	.175548	.4494753

Appendix B- Figure

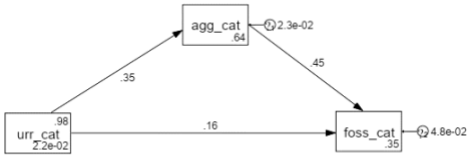


Figure 1 The Mediating role of declining volume of agricultural food production in the relationship between urbanization and food insecurity