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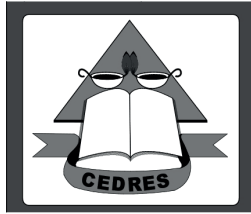
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Urbanization and Health Status in the West African Economic and Monetary Union : Is there a threshold effect ?

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Abstract

This paper investigates the effects of increased urbanization on health status for members of the West African Economic and Monetary Union. Using a panel threshold regression technique, we find that an increase in the urban growth above a critical threshold of 3.7 percent is not beneficial for selected health indicators, namely life expectancy, mortality rates among adult females and children under-five years old. Additionally, above the threshold, we also find empirical evidence of a stronger and positive impact of improved access to sanitation facilities and health expenditures on health outcomes. This finding has two significant health policy implications. First, designing policies to ameliorate access to improved sanitation facilities is essential in reducing the effect of uncontrolled urbanization on health status. Second, health expenditures stemming from non-profit organizations is effective and therefore should encouraged.

Keywords : Health, Urbanization, threshold regression, panel data

JEL codes: C23; C24; I15; R10

1. Introduction

The percentage of total population living in urban areas within the West African Economic and Monetary Union (WAEMU) continues to grow each year; the average urban population of the WAEMU zone has increased to 41.3 percent in 2022. The academic literature suggests that there are many risk factors associated with increased urbanization. One of these factors is changing health status, which appears to be a significant unintended consequence of rapid urbanization, especially for developing countries (Eckert and Kohler, 2014). According to Barrett (2010), developing countries are more likely to suffer from the consequences of rapid urbanization, due to the lack of adequate infrastructure and economic opportunities. This may be most significant for the WAEMU zone, where poor health infrastructures are prominent (Salem and Fournet, 2003).

Interestingly, empirical findings on the impact of increased urbanization on health status varies extensively in the literature, especially for developing countries. For instance, while most study find a negative effect of increased urbanization on health status (Antràs et al., 2023; Maiga and Bocquier 2016), some studies find both positive and negative effects of increased urbanization on health status in developing countries (Ngounou et al., 2024; Jiang et al., 2021; Eckert and Kohler, 2014). It is worth noting that these studies proxy health status by several health outcomes, including life expectancy and mortality rate (Ngounou et al., 2024; Jiang et al., 2021; Eckert and Kohler, 2014).

Furthermore, some studies concluded that when the urbanization rate is faster than the infrastructure development, the services capacities are outstripped, and may negatively impact health status. Also, in urban areas with low job absorption, it may lead to an increase in delinquency or to poor living condition due to the development of slums. Consequently, for pecuniary reasons, this may affect individuals' health.

WAEMU countries are less likely to benefit from rapid urbanization. With an urbanization rate of 41.5 percent on average in 2022, WAEMU countries are experiencing a rapid urbanization (with an average annual growth rate of 4.4 percent over the last 15 years).,

In addition to the rapid urbanization, WAEMU countries have high urban unemployment rates (see AGEPE, 2013 for the case of Côte d'Ivoire) and workers are more likely to have low-pay jobs (Moussa, 2017). This situation limits the individual capability to face health expenditures. Furthermore, an inappropriate health care system, characterized by informal health care or traditional health care, is widespread in urban areas in WAEMU countries (Salem and Fournet, 2003) and worsens the urban dwellers' health. The precariousness of the urban environment in these countries (De Silva and Marshall, 2012) characterized by the lack of access to safe drinking water, the slum-like living conditions, the lack of access to health and social services, and the concentration of poverty (Antoine and Manou-Savina, 1988; Antoine and Diouf, 1989; Rossier et al., 2014) increases the risk of illnesses such as malaria and the children mortality. In such a context, it is important to assess the effect of urbanization of health outcomes in WAEMU countries. The goal of this paper is to investigate the relationship between urbanization and health in the WAEMU by investigating the conditions under which WAEMU countries could benefit from the rapid urbanization they are experiencing.

The main argument in this paper is that the ambiguity surrounding the relationship between urbanization and health status can be thoroughly addressed by using threshold effects estimation method. For example, Jiang et al. (2021) show that the effect of urbanization on health is higher for low-income regions than in others. Consequently, this paper investigates the relationship between urbanization and health status in the WAEMU zone, by using a threshold regression technique as means to provide a meaningful interpretation of the relationship between urbanization and health status.

Three key empirical results can be derived from this study. First, it confirms that an increase in urban population growth above a critical threshold of 3.7 percent does not improve life expectancy and mortality rates among both male and female adults, and mortality rate among children under five. Second, above the critical threshold of 3.7 percent, improved access to health-related infrastructure (for example, adequate sanitation facilities) is effective in alleviating the impact of uncontrolled urbanization on health status; this finding is consistent with Kohler (2013),

who concluded that improved urban-health related infrastructure provided beneficial health effects. Lastly, another meaningful contribution of this paper is that it finds a positive effect of non-profit health expenditures on health status; this effect also does appear to be stronger above the critical threshold.

The rest of this paper is organized in five sections. Section 2 describes the empirical methodology. Section 3 describes the source of data. Section 4 exposes the key empirical findings and section 5 provides a brief conclusion.

2. Empirical Framework

This paper uses the panel threshold regression technique developed by Hansen (1999). Panel threshold regression is widely used in the literature to investigate the non-linear effects of urbanization on several outcomes including health (Shao et al., 2022; Jiang et al., 2021). Let consider the following equation:

$$y_{it} = \beta_1 X_{it} I_{[q_{it} \leq \gamma]} + \beta_2 X_{it} I_{[q_{it} > \gamma]} + \beta_3 Z_{it} + \mu_i + \epsilon_{it} \quad (1)$$

where y_{it} represents the health outcome, q_{it} is the threshold variable, X_{it} denotes a vector regime-specific of independent variables, and Z_{it} is the vector of regime invariant variables for individual i ($1 \leq i \leq N$) at period t ($1 \leq t \leq T$). $I_{[\cdot]}$ is the indicator function. The parameter γ denotes the threshold value, while β_1 and β_2 are coefficients of interests that give the effects of regime-specific variables on health respectively below and above the threshold. Finally, the variables μ_i are countries fixed effects.

The estimation process consists of two steps. The first step consists of finding a value of $\hat{\gamma}$ that minimizes the sums of squared errors $S_1(\gamma)$. The test statistics used to estimate this critical threshold is given by :

$$F1 = \frac{S_0 - S_1(\gamma)}{\frac{1}{N(T-1)} S_1(\gamma)} \quad (2)$$

As the statistic $F1$ does not have a standard distribution, following Wang's (2015) approach, a bootstrap procedure is utilized to estimate the critical value. The second step of the estimation process consist of estimating Equation 1 with the estimated value of $\hat{\gamma}$; using the least squares dummy variables approach.

3. Data

This paper uses annual data from the World Development Indicators (WDI). The data is collected for the founding members of the WAEMU, namely Burkina Faso, Benin, Cote d'Ivoire, Mali, Niger, Senegal, and Togo. Guinea-Bissau was excluded from the analysis due to data unavailability. Due to data availability constraints, the period under study in this manuscript covers 1995 to 2022.

This paper uses three indicators for measuring urbanization: (i) the urban population in percent of total population (URBPOP), (ii) the urban population growth rate (URBPOPR), and (iii) the population in the largest city (POPLARG).

The health outcomes used in the analysis include (i) the life expectancy at birth (LIFEXP), (ii) the mortality rate per thousand male adults (MORTMAL), (iii) the mortality rate per thousand live births (MRATE) for children under-five years old, and (iv) mortality rate per thousand female adults (MORTFEM).

Following the related literature, the control variables include the rate of access to improved sanitation facilities in urban areas (FACESS), the public health expenditures per capita (HEXPCAP), the GDP per capita (GDPCAP), the youth unemployment rate (YUNEMP), the CO2 emissions in kilogram per dollar of GDP (CO2KG), the primary school completion rate (PRIMCOMP), the total alcohol consumption in liter per capita (ALCOHOL), the private health care expenditure (PRIVHEAL), the rate of access to clean fuels and technologies for cooking in urban areas

(CLEANFUEL), and the rate of access to electricity in urban areas (URBELECT)¹.

Table 1 provides the description of the variables and some descriptive statistics of the sample. The average urbanization rate in the WAEMU zone, over the period under study, is 34.9 percent with a minimum of 15.1 percent and a maximum of 52.7 percent. The urban population grows at an annual average rate of 4.2 percent; and the annual growth rate varies between 2.65 and 6.87 percent.

In terms of health outcome, the average life expectancy at birth is 56.9 years and the mortality rates are high; 121.6 per thousand live births for the children under five, and 314 and 272 per thousand for male and female adult respectively.

¹ See Table 3 in the appendix for panel unit root tests.

Table 1: Descriptive statistics on the pooled sample

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
URBPOP	Urban population in percent of total population	196	34.94	11.19	15.13	52.66
URBPOPGR	Urban population growth rate	196	4.22	0.94	2.65	6.87
POPLARG	Population in the largest city (in percentage of urban population)	196	39.06	11.52	14.76	65.44
LIFEXP	Life expectancy at birth (in year)	196	56.90	4.62	45.77	68.53
MORTFEM	Male adult mortality rate (per thousand)	196	272.01	62.23	131.10	443.19
MORTMAL	Female adult mortality rate (per thousand)	196	314.05	51.82	213.15	462.07
MORTUNDER	Under-five mortality rate (per thousand live births)	196	121.61	44.77	37.00	281.30
GDPCAP	GDP per capita (constant 2015 US\$)	196	909.70	459.07	355.99	2399.70
UNEMP	Youth unemployment rate	196	4.24	2.28	0.47	9.96

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
CO2	CO2 emissions in kilogram per dollar of GDP	196	0.30	0.14	0.06	0.69
PRIMCOMP	Primary school completion rate	196	51.15	17.86	13.11	93.82
HEALTHEXP	Health expenditure per capita (constant 2015 US\$)	196	33.98	20.44	2.93	85.52
PRIVHEALTH	Private health care expenditures (constant 2015 US\$)	196	20.39	14.08	1.91	57.08
FACCESS	Access to improved sanitary facilities in urban areas	196	11.47	5.90	1.91	20.61
CLEANFUEL	Access to clean fuels and technologies for cooking in urban areas	196	22.01	22.80	0.13	74.20
URBELEC	Access to electricity in urban areas	196	64.61	19.80	19.29	99.70
ALCOHOL	Alcohol consumption per capita	196	3.19	3.17	0.11	12.02

4. Key Empirical Results

The key empirical results are presented in Table 2. Additional empirical results are presented in the appendix robustness check to the empirical estimates reported in Table 2 (See Table 4, Table 5 and Table 6). There is strong evidence of CO₂ emission is not useful in explaining health status for the WAEMU zone. We find that alcohol consumption only affects mortality rate for male; with an increase in alcohol consumption resulting in an increase in mortality rate. We also find that primary school completion rate improves health status (positive effect on life expectancy and negative effects on mortality rate).

All estimated critical threshold values ($\hat{\gamma}$) are statistically significant at the five percent level; the estimated critical threshold value for urban population growth is approximately 3.7 percent. For the regime-specific variables, there is strong empirical evidence of threshold effects on all the relevant health indicators.

An increase in urban growth above the critical threshold is not beneficial for health status: even if it is not statistically significant, life expectancy falls by 0.09 year and mortality rates among under five years old increases by 2.91 points. However, there is a reduction of 3.54 and 4.19 points in mortality rates of male and female respectively. These results are fairly consistent with Antoine and Manou-Savina's (1998) findings. Additionally, when urban population growth exceeds the critical threshold, the effects of health expenditures per capita on life expectancy and mortality rate among under five years do not remain significant, while the effects on mortality rate among female and male adults reduce by up to the half.

Nilsson (2010) founds no evidence of a positive effect of urbanization on life expectancy, but this study contradicts this finding when controlling for threshold effects. consistent with Jiang et al. 2021, we find that below the critical threshold, an increase in urban growth improves life expectancy by approximately one year and reduces mortality rates by 13.89, 6.45, and 12.15 among female adults, male adults, and under five years, respectively.

This implies that there are some benefits associated with migrating to urban areas, provided that this urbanization process is not excessive or uncontrolled.

Table 2 : Estimations with urban population annual growth rate as threshold variable

Variables	Life expectancy at birth	Female adult mortality rate	Male adult mortality rate	Under-five mortality rate
Alcohol consumption per capita	-0.0408 (0.255)	2.3991 (3.0894)	4.6107** (2.3046)	-0.8254 (2.1654)
Primary school completion rate	0.0687** (0.0294)	-0.7868** (0.3483)	-0.7174*** (0.2536)	-0.419* (0.2377)
CO2 emissions in kilogram per dollar of GDP	3.0771 (1.9082)	-30.8005 (23.3922)	-20.1559 (16.7162)	-16.9426 (15.7468)
Private health care expenditures	-0.1695*** (0.0362)	2.8198*** (0.4749)	-	1.1779*** (0.3181)
Urban population growth rate				
Under threshold	1.0792*** (0.3659)	-13.8918*** (4.6982)	-6.4481** (3.137)	-12.1488*** (3.1435)
Above threshold	-0.0854 (0.2107)	-4.1879 (2.5747)	-3.5409* (1.8183)	2.9066 (1.8142)
Health expenditure per capita				
Under threshold	0.1332*** (0.0278)	-1.99*** (0.3366)	-1.2213*** (0.1601)	-0.5566** (0.2262)
Above threshold	0.0393 (0.0374)	-1.2317*** (0.417)	-0.638*** (0.21)	-0.0577 (0.3073)
GDP per capita				
Under threshold	-0.00004 (0.0034)	-0.0806* (0.041)	-0.1469*** (0.0294)	0.0436 (0.0281)
Above threshold	0.003 (0.0047)	-0.1063* (0.0618)	-0.0257 (0.0412)	0.0028 (0.0421)

Access rate to improved sanitary facilities in urban areas				
	0.61	26.1882**	10.9089	-17.3443**
Under threshold	(0.8828)	(10.6635)	(7.8158)	(7.261)
	8.3763***	-60.9271***	14.0815	-52.6249***
Above threshold	(1.4194)	(22.2369)	(11.7957)	(15.1486)
Access to clean fuels and technologies for cooking in urban areas				
	-0.0975***	1.0415*** (0.2914)	-0.5652*** (0.1738)	0.9101***
Under threshold	(0.0233)			(0.1941)
	0.0754**	-0.8292** (0.3916)	-0.6555**	-0.3452
Above threshold	(0.0329)		(0.2825)	(0.282)
Access to electricity in urban area				
	-0.0427	-0.4914	0.0426	0.6545***
Under threshold	(0.0296)	(0.3351)	(0.2322)	(0.2175)
	0.0133	-0.4271** (0.1725)	-0.1327	0.0628
Above threshold	(0.0142)		(0.1228)	(0.1154)
Youth unemployment rate				
	-0.1215	3.8973*** (1.1402)	3.7789***	0.9149
Under threshold	(0.104)		(0.8904)	(0.7212)
	-0.3276***	0.147	1.0302	1.6266**
Above threshold	(0.0764)	(0.9775)	(0.6482)	(0.6769)
Intercept	51.5103***	343.3067***	381.3737***	163.7062***
	(1.3511)	(16.5316)	(10.9053)	(10.8879)
Time dummies	Yes	Yes	Yes	Yes
Threshold value	3.7739**	3.7935**	3.6771**	3.6771**
[L. bound – U. bound]	[3.7345 - 3.7859]	[3.7641 - 3.7943]	[3.6765 - 3.6893]	[3.6765 - 3.6893]
Threshold test F1 stat [1% – 5% level crit. val.]	81.35**	99.62**	56.41**	89.05**
	[72.43 - 85.67]	[99.04 - 128.64]	[54.77 - 70.40]	[87.82 - 108.81]
	68.24***	74.48***	194.46***	44.34***
Individual effects test F statistics [p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
	37.79***	83.91***	46.68***	71.29***
Global significance F-statistics [p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level; Standard errors are in parenthesis; crit. val.: critical value; U. bound: Upper bound; L. bound : Lower bound

Figure 1 reveals that Burkina Faso, Mali and Niger are the members of WAEMU with urban growth rates that are well above the estimated critical threshold. This implies that the health costs resulting from uncontrolled or excessive urbanization would be higher for Burkina Faso, Mali and Niger in contrast to Benin, Cote d'Ivoire, Senegal, and Togo. Consequently, this result also implies that Burkina Faso, Mali and Niger are likely to benefit more from increasing health expenditures and increased access to adequate health-related infrastructure to curb the health costs of uncontrolled urbanization. In summary, the key empirical findings indicate that the use threshold effects are necessary to fully understand the relationship between urbanization and health status. Controlling for threshold effects reduces the uncertainty surrounding the direction of causality between urbanization and health status.

5. Conclusion

This paper uses a panel threshold regression model to investigate the effects of the urbanization on health status for the WAEMU zone. The empirical literature highlighting the effect of urbanization on health status indicates that there are both positive and negative effects of urbanization on health status. The present paper uses threshold effects to estimate the relationship between urbanization and health to provide a more meaningful causal interpretation of the relationship between the latter two.

There are two key empirical findings in this study. Firstly, threshold effects are statistically essential for interpreting the relationship between urbanization and health status: an increase in urban population growth above the 3.7 percent critical threshold worsens health status, whereas below this threshold, a moderate expansion of urban growth does not necessarily impede health status; in fact, the causality is positive.

Secondly, above the critical threshold, increased health expenditure per capita and increased access to better health infrastructure are more useful in alleviating the impact of excessive urban population growth on health status.

As urbanization continues to increase, there is clearly an acute need to strengthen the public health infrastructure apparatus of the WAEMU zone; devising a social plan to improve access to clean and safe health related infrastructure should be a matter of the utmost importance for WAEMU's authorities. Additionally, this study finds health expenditures stemming from non-profit organization to be very effective in reducing the impact of rapid urbanization on health status, this reinforces the need to increase cooperation with non-profit organization to combat health related issues in the WAEMU zone.

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Appendices

Table 3: Panel unit root tests

Variable	Type	IPS	LLC	ADF-F	PP-F	KT
Urban population in percent of total population	Level	-3.9165***	-2.7397***	51.3809***	64.4619***	-1.7049***
	1st diff	NA	NA	NA	NA	NA
Urban population growth rate	Level	-2.861***	-2.0398**	69.1405***	49.2862***	-1.1149
	1st diff	NA	NA	NA	NA	-7.0397***
Population in the largest city	Level	-1.3497*	-2.1036**	30.0331***	4.5687	-0.4851
	1st diff	NA	NA	NA	10.6858	-3.9526***
Life expectancy at birth	Level	1.2957	0.2476	12.9247	6.2439	-3.2587***
	1st diff	-5.4668***	-4.9055***	25.6016**	95.4442***	NA
Male adult mortality rate	Level	0.1479	-2.0278**	20.7016	5.1379	-2.1648***
	1st diff	-6.827***	NA	30.3482***	138.0134***	NA
Female adult mortality rate	Level	0.5544	-2.1228**	10.7581	9.9782	-5.3861***
	1st diff	-7.2963***	NA	48.8532***	166.9089***	NA
Under-five mortality rate	Level	0.9721	-0.6958	93.5637***	7.41	-3.4401***
	1st diff	-7.025***	-7.2908***	NA	7.8745	NA
GDP per capita	Level	2.9037	1.0585	7.5608	4.4066	-1.7437*
	1st diff	-6.2635***	-6.5048***	56.8611***	78.1454***	NA
Youth unemployment rate	Level	0.0983	-1.4322*	21.8202*	12.7625	-0.8179
	1st diff	-8.2597***	NA	NA	97.8224***	-8.7717***
CO2 emissions in kilogram per dollar of GDP	Level	-1.4441*	-2.8368***	13.3789	23.0978*	-5.2099***
	1st diff	NA	NA	99.4503***	NA	NA

Variable	Type	IPS	LLC	ADF-F	PP-F	KT
Primary school completion rate	Level	-0.5743	-1.5789*	7.8527	5.2156	-0.4202
	1st diff	-4.4206***	NA	27.6399**	63.1198***	-8.3201***
Health expenditure per capita	Level	-2.2881**	-2.7747***	16.2524	31.79***	-7.0121***
	1st diff	NA	NA	113.9832***	NA	NA
Private health care expenditures	Level	-0.8744	-2.1819**	18.0625	17.3189	-3.5309***
	1st diff	-8.5596***	NA	60.5378***	143.4187***	NA
Access to improved sanitary facilities in urban areas	Level	0.8355	-2.3502***	10.0659	2.4676	-1.0356
	1st diff	2.0356	NA	2.909	4.9246	-4.031***
Access to clean fuels and technologies for cooking in urban areas	Level	-3.7615***	-5.7326***	32.1001***	1.565	0.4199
	1st diff	NA	NA	NA	8.247	0.9535
Access to electricity in urban areas	Level	-3.5449***	-3.8085***	25.8616**	55.8154***	-7.7682***
	1st diff	NA	NA	NA	NA	NA
Alcohol consumption per capita	Level	-0.3519	-1.9357**	15.1088	3.9215	-1.6993
	1st diff	-3.4349***	NA	18.1272	30.8615***	-3.5679***

PS: Im, Pesaran and Shin (2003); LLC: Levin, Lin and Chu (2002); ADF-F: Augmented Dickey-Fuller F test (Choi, 2001); PP-F: Phillips-Perron F test (Choi, 2001); KT: Karavias and Tzavalis panel unit root test with breaks (Chen et al., 2022)

NA: Not Applicable. The test has not been applied since the variable is stationary without differentiation; *** no unit root at 1% level; ** no unit root at 5% level; * no unit root at 10% level.

Table 4: Estimations with urban population in percent of total population as threshold variable

Variables	Life expectancy at birth	Female adult mortality rate	Male adult mortality rate	Under-five mortality rate
Alcohol consumption per capita	0.0227 (0.1746)	-1.2133 (2.9555)	0.433 (2.15)	1.2878 (1.3806)
Primary school completion rate	0.046** (0.0205)	-0.7119** (0.3517)	-0.5107** (0.2436)	-0.2526 (0.157)
CO2 emissions in kilogram per dollar of GDP	1.8761 (1.3121)	-27.4842 (22.4619)	-19.2967 (15.665)	-12.5422 (10.4436)
Private health care expenditures	-0.109*** (0.0231)	1.4865*** (0.3902)	-	0.6982*** (0.1724)
Urban population in percent of total population				
Under threshold	-0.4491*** (0.0688)	1.3909 (1.1713)	0.1712 (0.7747)	5.4738*** (0.5192)
Above threshold	-0.1138 (0.0759)	-2.8806** (1.3304)	-2.5756*** (0.7161)	2.3353*** (0.5507)
Health expenditure per capita				
Under threshold	0.2993*** (0.0268)	-3.2042*** (0.4618)	-1.4582*** (0.2714)	-1.879*** (0.2186)
Above threshold	0.1251*** (0.021)	-1.8322*** (0.3557)	-0.8788*** (0.1182)	-0.4792*** (0.1598)
GDP per capita				
Under threshold	0.006 (0.0073)	-0.0724 (0.1291)	-0.0265 (0.0864)	-0.0517 (0.0425)
Above threshold	0.0035* (0.002)	-0.1478*** (0.034)	-0.1079*** (0.0244)	0.0136 (0.0161)

<u>Access rate to improved sanitary facilities in urban areas</u>				
	7.2024**	-15.4437	7.4706	-40.418**
Under threshold	(2.8271)	(48.3997)	(32.5665)	(16.8603)
	-2.7947***	60.4598***	28.5816***	4.4174
Above threshold	(0.6309)	(10.6853)	(7.5845)	(4.8817)
<u>Access to clean fuels and technologies for cooking in urban areas</u>				
	-0.0998***	0.641	0.6146	1.4647***
Under threshold	(0.0326)	(0.5937)	(0.3885)	(0.2324)
	-0.0345***	0.2303	-0.4813***	0.5428***
Above threshold	(0.013)	(0.22)	(0.1487)	(0.1081)
<u>Access to electricity in urban area</u>				
	0.1135***	-1.4617***	-0.7756*** (0.2504)	-1.3391***
Under threshold	(0.0252)	(0.4455)		(0.1825)
	0.0061	0.2394	0.7314*** (0.1465)	-0.2484**
Above threshold	(0.0133)	(0.2259)		(0.1072)
<u>Youth unemployment rate</u>				
	-0.1002	2.7872	0.9232 (1.3384)	-5.7392***
Under threshold	(0.1096)	(1.8705)		(0.7789)
	-0.0732	2.5056***	3.6982***	0.5324
Above threshold	(0.05)	(0.8575)	(0.5818)	(0.423)
	54.9853***	360.4559***	396.8664***	118.527***
Intercept	(1.9706)	(34.5678)	(18.8376)	(14.2612)
Time dummies	Yes	Yes	Yes	Yes
Threshold value [L. bound –	30.5470***	29.3580**	30.5470**	32.0160**
U. bound]	[29.9800 - 30.6070]	[28.6045 - 29.8060]	[29.9800 - 30.6070]	[31.7265 - 32.0600]

Threshold test F1 stat [1% – 5% level crit. val.]	198.84*** [70.3602 - 92.9643]	87.46** [77.7484 - 91.2714]	63.96** [59.8541 - 82.7425]	298.35** [118.720 - 155.144]
Individual effects test F statistics [p-value]	50.30*** [0.0000]	70.17*** [0.0000]	164.36*** [0.0000]	163.28*** [0.0000]
Global significance F-statistics [p-value]	153.00*** [0.0000]	33.27*** [0.0000]	51.79*** [0.0000]	199.23*** [0.0000]

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level; Standard are in parenthesis; crit. val.: critical value; U. bound: Upper bound; L. bound : Lower bound

Table 5: Estimations with population in largest city as threshold variable

Variables	Life expectancy at birth	Female adult mortality rate	Male adult mortality rate	Under-five mortality rate
Alcohol consumption per capita	0.0688 (0.1798)	-1.3515 (3.0934)	0.0948 (1.8916)	-1.0178 (1.7488)
Primary school completion rate	0.065*** (0.0209)	-0.5838 (0.3588)	-0.4911** (0.2125)	-0.4704** (0.1964)
CO2 emissions in kilogram per dollar of GDP	1.4694 (1.3238)	-23.1615 (22.6235)	-17.6792 (13.6102)	-7.4459 (12.577)
Private health care expenditures	-0.071** (0.0282)	1.6859*** (0.4855)	-	0.1661 (0.2672)
Population in largest city				
Under threshold	0.1813*** (0.0476)	-1.5749** (0.7837)	-1.03** (0.5015)	-1.3849*** (0.4644)
Above threshold	0.1288** (0.0504)	0.0354 (0.8552)	-0.1101 (0.515)	-1.5078*** (0.4803)

Health expenditure per capita				
	-0.0054	-0.5969	0.2933	0.2933
Under threshold	(0.0343)	(0.6118)	(0.3084)	(0.3388)
	0.1131***	-1.7044***	-0.3238*	-0.5768***
Above threshold	(0.0225)	(0.3884)	(0.1784)	(0.2106)
GDP per capita				
	-0.0081	-0.0129	0.0163	0.0333
Under threshold	(0.0062)	(0.1151)	(0.06)	(0.0577)
	0.0044**	-0.1399***	-0.1087***	-0.0137
Above threshold	(0.002)	(0.0343)	(0.021)	(0.0196)
Access rate to improved sanitary facilities in urban areas				
	3.5496*	64.4774*	52.9758***	-66.5417***
Under threshold	(1.982)	(33.3151)	(18.8679)	(18.48)
	-1.9111***	47.6738***	23.7843***	5.7177
Above threshold	(0.6243)	(10.5751)	(6.4916)	(6.1404)
Access to clean fuels and technologies for cooking in urban areas				
	0.0556	0.0192	0.5537	0.3169
Under threshold	(0.0367)	(0.658)	(0.3717)	(0.3463)
	-0.0201	0.0264	-0.5484***	-0.0026
Above threshold	(0.0148)	(0.2494)	(0.1351)	(0.1427)
Access to electricity in urban area				
	0.0513***	-0.2467	0.2921**	-0.5468***
Under threshold	(0.0126)	(0.2225)	(0.1307)	(0.1241)
	-0.0112	0.079	0.575***	0.1354
Above threshold	(0.0183)	(0.3053)	(0.1592)	(0.1771)

Youth unemployment rate				
	-0.211**	0.4611	3.5671***	0.414
Under threshold	(0.1047)	(1.8685)	(1.0168)	(0.9943)
	0.0468	0.1527	2.0944***	-1.4533**
Above threshold	(0.0606)	(1.0284)	(0.599)	(0.5717)
	44.9618***	306.5041***	344.242***	258.3416***
Intercept	(2.3338)	(39.6224)	(24.014)	(22.1712)
Time dummies	Yes	Yes	Yes	Yes
Threshold value [L. bound – U. bound]	35.8136*** [35.7358 - 35.8308]	35.6108** [35.4513 - 35.7358]	35.8308** [35.4879 - 35.8915]	35.8136** [35.7358 - 35.8308]
Threshold test F1 stat [1% – 5% level crit. val.]	257.61*** [63.2652 - 80.5514]	80.03** [75.8276 - 105.2504]	68.04** [56.4049 - 67.1159]	145.90** [113.527 - 143.772]
Individual effects test F statistics [p-value]	147.33*** [0.0000]	135.28*** [0.0000]	347.32*** [0.0000]	130.49*** [0.0000]
Global significance F-statistics [p-value]	151.22*** [0.0000]	33.06*** [0.0000]	69.07*** [0.0000]	127.74*** [0.0000]

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level; Standard errors are in parenthesis; crit. val.: critical value; U. bound: Upper bound; L. bound : Lower bound

Table 6: Least Square Dummy Variables estimations for robustness check

Variables	Life expectancy at birth	Female adult mortality rate	Male adult mortality rate	Under-five mortality rate
Urban population growth rate	0.4047* (0.2223)	-8.7212*** (2.736)	-2.9858* (1.8009)	-0.0535 (1.9072)

GDP per capita	-0.0003 (0.0033)	-0.12*** (0.0398)	-0.1238*** (0.0271)	0.0235 (0.028)
Access rate to improved sanitary facilities in urban areas	0.2177 (0.9977)	41.3676*** (11.9083)	14.7031* (8.2157)	-14.9283* (8.6937)
Alcohol consumption per capita	-0.0151 (0.2937)	2.5103 (3.5792)	1.617 (2.437)	-0.1419 (2.5814)
Primary school completion rate	0.0506 (0.0344)	-0.5328 (0.4072)	-0.7691*** (0.2805)	-0.3639 (0.2891)
CO2 emissions in kilogram per dollar of GDP	3.9073* (2.222)	-53.7336** (27.1377)	-36.6771** (18.1404)	-28.8736 (18.8814)
Health expenditure per capita	0.1048*** (0.0318)	-1.373*** (0.3614)	-1.0471*** (0.1179)	-0.6258** (0.2681)
Private health care expenditures	-0.0874** (0.035)	1.6564*** (0.4244)	-	0.613** (0.2915)
Access to clean fuels and technologies for cooking in urban areas	-0.0481** (0.0214)	-0.0542 (0.2544)	-0.4809*** (0.1643)	0.4154** (0.1806)
Access to electricity in urban area	-0.0052 (0.014)	-0.3199* (0.1713)	0.0388 (0.1058)	-0.0003 (0.1182)
Youth unemployment rate	-0.2247*** (0.0715)	1.5257* (0.8789)	2.4475*** (0.5809)	0.4517 (0.6105)
Time dummies	Yes	Yes	Yes	Yes
Test for global significance F-test [p-value]	64.16 [0.0000]	35.12 [0.0000]	47.91 [0.0000]	66.76 [0.0000]
Test for individual fixed effects F-test [p-value]	33.12 [0.0000]	87.50 [0.0000]	257.17 [0.0000]	58.33 [0.0000]

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level; Standard errors are in parenthesis

Figure 1: Countries under and above the urbanization growth rate' estimated threshold

