Oxford Development Studies, 2015
http://dx.doi.org/10.1080/13600818.2015.1067292

Urbanisation and Food Insecurity Risks: Assessing the Role of Human Development

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ABSTRACT *The phenomenon of rapid urbanisation across the world has become a topic of increased scholarly inquiry. Yet, little attention has been paid to how urban growth affects countries' food security and whether this association is modified by a country's level of development. The present study aims to fill this lacuna by examining the association between urbanisation and food security using statistical modelling. The analysis uses country-level data, from the World Development Indicators and the United Nations' World Urbanization Prospects. Using a Food Insecurity Risk Index (FIRI) as the outcome variable, the results confirm a significant negative impact of urban growth on food security at the country level. It further finds that rapidly urbanising countries with the lowest levels of human development are most at risk of food insecurity.*

1. Introduction

Food insecurity constitutes a major threat in contemporary societies with both short- and long-term impacts on human survival and well-being. The relationships between population and food are well established and have benefited from in-depth scholarly investigation (Bongaarts, 2011; McNicoll, 1984; Pimentel, Harman, Pacenza, Pecarsky, & Pimentel, 1994; Pimentel, Huang, Cordova, & Pimentel, 1997). However, there is no systematic analysis of how urbanisation affects contemporary food insecurity risks or how these potential risks are likely to be mitigated by increases in human development. Yet, urbanisation constitutes a major present-day phenomenon, with more than half the world's population people already residing in urban areas.

Urbanisation is not an entirely new phenomenon. Historical data show evidence of a rapid increase in the urban population in England from 25.9% in 1776 to 65.2% in 1871, which coincided with significant industrial growth across Europe (Williamson, 1988). The development of industry triggered the need for cheap labour and hence produced migration flows into the cities, which was the primary cause of urban growth in England in the late 18th century (Williamson, 1988). Although income from agricultural production measured as GNP at factor cost remained unchanged throughout the 19th century, income from trade and transport as well as from mining, manufacturing and

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building continued to grow exponentially (Mitchell, 1988). The growing demand for food resulting from rapid urbanisation accompanied by poor harvests and the Napoleonic wars with France led to price hikes in food products, which in turn resulted in greater poverty.

Today, scholars have referred to urbanisation as the “real population bomb” (Buhaug & Urdal, 2013; Liotta & Miskel, 2012) and it is no longer possible to neglect the impact of urban dimensions of development. Globally, the percentage of the urban population—at 53.6% in 2014—is projected to increase to 67.2% by 2050 (UN, 2014b). This trend is explained by the unprecedented levels of urbanisation in developing countries, including the rise of megacities in Asia which in themselves hold more than half the share of the population of all megacities (UN, 2014b). Developing countries are likely to struggle to adapt their food production systems to meet the demand and needs of people living in urban areas, while adverse climate conditions and natural disasters exacerbate the problems of the production and availability of food. Developing countries are also severely affected by the volatility in global food prices (Alexandratos, 2008; Food and Agricultural Organization [FAO], 2011). These interactions between urbanisation and food security in different developmental contexts will be further discussed in Section 3.

We define urbanisation as an “increase in the proportion of a population living in urban areas” and the “process by which a large number of people becomes permanently concentrated in relatively small areas, forming cities” (Organisation for Economic Co-operation and Development [OECD], 2012). We use the terms urbanisation and urban growth interchangeably and focus on the speed of urban growth. This paper draws from the FAO’s definition of food security as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2003a, p. 28; FAO, WFP, & IFAD, 2012, p. 57). Conversely, food insecurity is here considered to exist when people lack physical, social or economic access to safe and healthy food. When quantifying food insecurity, we focus on food insecurity risks only and propose a new Food Insecurity Risk Index (FIRI) as an outcome variable.

To the best of our knowledge, no attempt has thus far been made to assess the impact of human development on the association between urbanisation and food security. An understanding of the interlinkages between urbanisation and food insecurity in different developmental contexts is particularly important within the practical context of setting up a comprehensive post-MDG agenda. For the purpose of this research, levels of human development are measured by the Human Development Index (HDI). The first two categories of the HDI (“very high development” and “high development”) are used to classify countries as “developed”. The remaining countries (with “medium development” and “low development”) are categorised as “developing”.

This paper is organised as follows: in the next section, we highlight the interlinkages between urbanisation and different aspects of food security, taking into account the human development context. In Section 3, we provide a summary of data and methods used for the analysis. The empirical work, presented in Section 4, consists of descriptive analysis and regression modelling of a macro-level dataset with indicators of food security, urbanisation and drivers of human development. Conclusions are drawn throughout the paper, with the last section providing a summary of the results, a discussion regarding study limitations and implications for policy.

2. Urbanisation and Food Insecurity in Different Developmental Contexts

The goal of this section is to provide a discussion of the interrelationships between urbanisation and each aspect of food security, i.e. food availability, food access, food utilisation and food stability, which encompasses factors related to the dependence on imports and exposure to economic and environmental shocks (FAO, IFAD, & WFP, 2014). The issues related to the availability of food and food access will be discussed first, followed by food utilisation and the problem of sustainability.

2.1 Urbanisation and Food Availability

Urbanisation constitutes a challenge to food availability in terms of evolving consumption patterns and food production and supply processes. Rapid urban growth and an increasing number of megacities imply that more food will have to be available to people who live in an environment that has traditionally been perceived as inappropriate for agriculture. Almost all urban dwellers are net buyers of food, which is also, more surprisingly, the case for small-scale farmers; land-poor households are often the poorest of the poor because they do not produce enough to feed their families and are unable to sustain their livelihoods (FAO, 2011). The rural–urban migration trends, which are the key contributor to urbanisation (van Veenhuizen, 2006), result in changing lifestyles including evolving nutritional habits and food supply strategies. However, continuing urban sprawl often makes it difficult to set clear boundaries between urban and rural areas. At the same time, land—including in urban peripheries and adjacent rural zones—is becoming more expensive and farmers often sell land for non-agricultural uses, which leads to further urban expansion. As cities continue to grow, water—a key resource for agricultural production—is becoming scarcer and often wasted because of excessive domestic and industrial use, thereby endangering food supplies.

In order to gain a better understanding of the developmental differentials in the urbanisation-food availability nexus, graphical illustration of the historical trends is presented in Figure 1. As can be observed from the graph, in the last 50 years the proportion of urban population in the least developed countries (LDCs) almost tripled. At the same time, the OECD member states, which were already highly urbanised in the 1960s, continued to experience urban expansion. Even though urban growth was faster in the LDCs, the increase in their agricultural yield (measured as cereal yield in kilograms per hectare) amounted to only 72%, while in the OECD group it exceeded 147%. In developing countries, cereal intake constitutes 56% of total calories, which translates into 173 kg of cereal consumption per person per year (FAO, 2003b), while in developed countries, the proportion of cereals consumed is smaller. However, the developed nations also consume cereals in an indirect way through the consumption of livestock (Koohafkan, Stewart, & FAO, 2008).

2.2 Urbanisation and Food Access

When it comes to the physical access to food, better infrastructure means that urbanisation is likely to have a positive impact on food security. In highly developed countries, in general, physical food access is not a concern. Individuals who are unable to access grocery shops may have the possibility of home delivery. This facilitates food access for

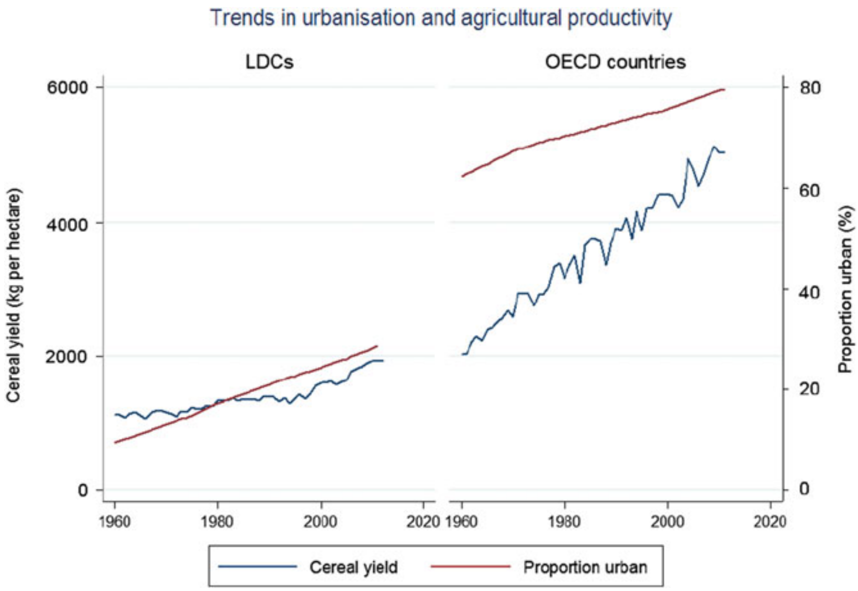

Figure 1. Trends in urbanisation and agricultural productivity—OECD countries and LDCs (1960–2010). *Source*: World Development Indicators (WDI), The World Bank.

the sick and disabled. In developing countries, on the other hand, access to food due to inadequate infrastructure can be a major problem. In many African countries, farming is predominantly subsistence based (FAO, 2012; Sarpong, 2006), for a variety of reasons including the absence of tenure rights, inadequate infrastructure and lack of finance for commercial agriculture. Urbanisation is generally likely to contribute to overall economic development and improve physical access to a variety of foods.

In addition to physical food access, financial access plays an important role in ensuring food security. In this respect, residents of urban and peri-urban areas tend to be more disadvantaged than their rural counterparts because most often they have to purchase their food, which makes them dependent on food markets and thus more vulnerable to potential price spikes. Research has shown that urban dwellers are likely to buy more than 90% of their food (Ruel & Garrett, 2003) and therefore food prices are a major determinant of whether foodstuffs can be acquired. Residents of metropolitan areas such as Cairo, Lima or Maputo purchase between 92% and 98% of their food (Ruel & Garrett, 2003). For comparison, in rural Peru 58% of food is purchased, while in rural Mozambique the equivalent proportion is 29% (Ruel & Garrett, 2003). Although urban agriculture can supplement the diet of urban residents, in many cases such an option is not available to the poorest urban communities. Often, the urban poor engage in informal exchange of services and commodities in return for food, which is likely to be of low quality

2.3 Urbanisation and Food Utilisation

Urban growth can have an important impact on food utilisation. Because urban residents as largely net buyers of food are particularly vulnerable to volatile food prices, they are often forced to reduce other expenditure in order to meet their basic food requirements. In the context of developing countries, poor urban dwellers are thus at risk of consuming insufficient and low-quality food, including street food, which may be unhygienic, exposing them to health risks (Matuschke, 2009). The informal food sector can contribute to food insecurity because of the low quality of the food sold and lack of hygiene during food preparation and sale (Mensah, Yeboah-Manu, Owusu-Darko, & Ablordey, 2002). As a result, similar to amongst the rural poor, many city dwellers incur infections, and are at risk of life-threatening diseases. Recognising the importance of sanitation for food security outcomes, FAO included the percentage of population with access to sanitation facilities as an official indicator of food security.

A crucial aspect of food consumption in both developing and developed countries pertains to the quality of food, which is linked to the food supply system. Amongst the consequences of rapid urbanisation, there has been a shift in production patterns of food. It has been shown that urbanisation is highly correlated with access to processed foodstuffs, which have higher sugar levels (Popkin & Nielsen, 2003). In addition to sugar and artificial sweeteners, processed food tends to contain artificial colouring agents, hydrogenated fats, preservatives and chemical pesticides. In the contemporary world, processed food is often the most accessible type of food, both in terms of physical proximity as well as price. The urban poor also tend to consume high-energy processed food due to its affordability and accessibility. Although the obesity epidemic was traditionally considered to be a health concern of developed countries, today the overall burden of obesity and chronic diseases is greater in developing countries (Malik, Willett, & Hu, 2013).

2.4 Urbanisation and Food Stability

Finally, stability of food supplies can constitute a serious concern for urban residents. Whereas in developed countries cities are likely to be well organised and thus disaster preparedness is generally high, in the developing world the urban poor are at risk of food insecurity caused by extreme weather events, natural hazards and disasters (International Federation of Red Cross and Red Crescent Societies [IFRCRCS], 2010). Temporary difficulties with access to food can be the results of disastrous events including war, or may be linked to other unforeseen occurrences. The case of Burkina Faso is a pertinent example of the challenges related to food stability. Over the last decade, Burkina Faso has suffered from major food shortages, which have affected household food security and hampered the country's socio-economic development. Most recently, in 2012, the Sahel food and nutrition crisis contributed to the urbanisation of poverty in the region in at least two ways. First, large urban populations' access to food was reduced due to food shortages and high food prices. Second, the crisis triggered population movements because many households—mainly in rural areas—were unable to sustain their livelihoods and so migrated to cities in search of alternative income. Because of the economic and environmental vulnerability of the region, out-migration has become an important adaptation strategy amongst farmer communities, thus further contributing to a largely uncontrolled urban sprawl.

Because of the increasing urbanisation of poverty and reliance of urban dwellers on purchased food, many food insecurity risks, in particular financial access to food and food availability, are expected to continue to be greater in urban areas than in rural communities. This could be especially the case if food commodity markets are not adequately regulated, potentially leading to even more price volatility as exemplified by the food crisis in 2007–2008 (FAO, 2013). The risk of increasing food insecurity in urban areas will continue to be especially high in slums and informal settlements where, in many cases, socio-economic development is already lower than in rural areas (United Nations Children's Fund [UNICEF], 2010). However, the urban–rural differentials as well as intra-urban disparities are likely to become less stark as a country progresses in terms of its human development level. Consequently, some aspects of food insecurity can be expected to be greater in urban than rural areas, but lessening so that countries become more developed.

3. Data and Methods

3.1 The Dataset

The dataset comprises macro-level statistics including information about 174 countries. It was compiled for the 1990–2010 time period with five distinct time points (1990, 1995, 2000, 2005 and 2010), thus constituting a short panel. The complete list of variables and their definitions and sources is provided in Table 1. The choice of the outcome variable follows from the discussion regarding specific food insecurity risks at the country level. While more detailed description of the food insecurity risk indicator will be presented in the next sub-section, two aspects underlying the choice of the variable should be highlighted: first, the need to incorporate distinct features of the multidimensional nature of food security, such as food utilisation and food stability; and second, the availability and reliability of the aggregate data. In order to satisfy these two requirements, the official FAO indicators were consulted and only complete datasets and raw data have been taken into account. After the creation of the FIRI, as explained in the methods sub-section below, the ordinal outcome variable was created with three categories measuring the levels of food insecurity risk.

The main explanatory variables of interest include the rate of urban growth as well as indicators measuring development, both as binary/categorical variables and by means of specific developmental drivers. The indicator of urbanisation is drawn from the 2011 United Nations World Urbanization Prospects database. The level of development is based on the UNDP's HDI. In order to align with the timeframe of other indicators, an average of HDI scores between 1990 and 2000 was calculated and countries reclassified into two and four developmental categories based on the new score. The HDI ranking and indicators have been extensively used and referred to in the existing literature to analyse country-level phenomena pertaining to developmental issues (Anand & Sen, 2000; Kelley, 1991; Kuhn, 2012; Neumayer, 2001, 2012). Individual developmental drivers used in the present study include mean years of schooling, life expectancy at birth and GNI per capita.

In addition to developmental factors, selected confounding variables have been included in the modelling. These comprise the measures of geographical habitat, such as percentage of agricultural land, population size and aggregate number of disasters at the country level. Finally, based on empirical evidence of the impact of globalisation on food security (McMichael, 2001; Misselhorn et al., 2012), indicators of globalisation have also been incorporated in the analysis. According to the OECD's definition, globalisation refers to "an increasing internationalisation of markets for goods and services, the means of

Table 1. Key variables and data sources

Variable	Description and source
Food security	
Food insecurity risk	Food insecurity risk based on FIRI. Ordinal variable with three categories: 1—low risk, 2—medium risk and 3—high risk.
Urbanisation	
Rate of urban growth	Average exponential rate of growth of the urban population over a given period. It is calculated as $\ln(UP_t/UP_0)/n$, where *n* is the length of the period and UP is the urban population. It is expressed as a percentage. United Nations Urbanization Prospects, 2011 Revision.
Development	
Level of development	Level of development based on HDI values (mean value between 1990 and 2010). Both binary variable (developed vs. developing) and categorical variables are used (very high development, high development, medium development and low development).
Population stock	
TFR	Total fertility rate represents the number of children who would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. World Development Indicators, The World Bank.
Globalisation/economic openness	
Trade	Trade (% of GDP). Trade is the sum of exports and imports of goods and services measured as a share of the gross domestic product. World Development Indicators, The World Bank.
Foreign direct investment	Foreign direct investment is the net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital and short-term capital as shown in the balance of payments. Net inflows (new investment inflows less disinvestment) are reported as a percentage of GDP. World Development Indicators, The World Bank.
Geographical habitat	
Agricultural land	Agricultural land (km^2). Agricultural land refers to the share of land area which is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. World Development Indicators, The World Bank.
Water availability	Water productivity, total (constant USD2000 GDP per cubic meter of total freshwater withdrawal). Water productivity is calculated as GDP in constant prices divided by annual total water withdrawal. World Development Indicators, The World Bank.
Carbon dioxide emissions	CO_2 emissions (metric tons per capita). Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid and gas fuels and gas flaring. World Development Indicators, The World Bank.

(*Continued*)

Table 1. *Continued*

Variable	Description and source
Number of disasters	Disaster is defined as a situation or event that overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering. The International Disaster Database (EM-DAT).

Note: The selected data comprise variables for the following time points: 1990, 1995, 2000, 2005 and 2010. When no data were available for the specific time point, the closest available data were used.

production, financial systems, competition, corporations, technology and industries" (OECD, 2012). Interpreted as such, globalisation encompasses economic expansion, trade and cross-countries investments, as well as transportation links and the institutions representing global governance. The specific indicators included in the analysis are variables that measure the volume of international trade and investments (OECD, 2005, 2010).

3.2 Methodology

This research uses quantitative methods, including descriptive statistics and regression analysis. As mentioned previously, the outcome variable is based on the index of food insecurity risks, which includes indicators of food availability, stability and utilisation. When choosing specific variables, two main selection criteria were applied. First, attention was paid to selecting only indicators that do not have many (more than 5%) missing values. Second, indicators that constitute compound indices were excluded and only individual indicators taken into consideration. The index of food insecurity was constructed using principal component analysis (PCA), and for ease of interpretation it is named the FIRI. All the variables included in the PCA are official food security indicators developed and used by the FAO (see Table 2). Given the fact that the dataset has five time points, separate scores were calculated for each time period. Cronbach's alpha was used to assess the score validity, as recommended by Bland and Altman (1997, 2002). The values of Cronbach's alpha for specific times varied between 6.8 for 1990 and 0.8 for 2010. The index scores were then grouped into three distinct categories based on the tertile distribution of the data. The three categories are: low, medium and high levels of food insecurity risk, and thus lend themselves to an ordinal measurement scale. A ranking of countries based on the most recent 2010 score is provided in Table A1.

The choice of modelling technique and model selection are often complex issues requiring analytical decisions based on, amongst others, the type of the data available, model fit, and the specific model assumptions. Initially, ordinal logistic models were considered, including the option recently made available by STATA 13 for panel datasets. This option, while appealing, is limited to fitting random effects models only, which requires that the idiosyncratic error term be uncorrelated with explanatory variables at any time point. In addition, the basic requirement of the ordinal logistics models is to satisfy the parallel lines, or proportional odds, assumption. Because this assumption is not met, following Williams (2009, 2010), the final choice of the modelling strategy was of heterogeneous choice models. The main advantage of these models, as compared to the

Table 2. Indicators used for the construction of the Food Insecurity Risk Index (FIRI)

Indicator	Definition	Food security component
Per capita value of food production	The total value of annual food production, as estimated by FAO and published by FAOSTAT in international dollars (I $) divided by the total population. It provides a cross-country comparable measure of the relative economic size of the food production sector in the country.	Availability
Average protein supply	National average protein supply (expressed in grams per capita per day).	Availability/ utilisation
Percentage of population with access to sanitation facilities	Access to improved sanitation facilities refers to the percentage of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained.	Utilisation
Value of food imports over total merchandise exports	Value of food (excluding fish) imports over total merchandise exports.	Stability

Note: All indicators and their definitions are based on the official FAO indicators of food security. They can be accessed at: http://www.fao.org/economic/ess/ess-fs/fs-data/en (date of access: 22 September 2014).

more widely used ordinal logistic models, is that they allow for differences in residual variance. By fitting two simultaneous equations, one for the outcome (choice), and the other for the residual variance determinants, heterogeneous choice models increase the validity of cross-group comparisons. In the case of the present research, the three categories of the outcome variable comprise the food insecurity risks (high, medium and low), while the explanatory variables are predominantly continuous. For each model, Brant test (Brant, 1990) has been performed and the variables that were identified as violating the parallel odds assumption were specifically included in the variance equation. All statistical analyses were conducted using STATA 13 (SE).

4. Results

The modelling applied in this paper follows the standard stepwise routine. The results reported in Table 3 refer to the high risk of food insecurity. Model 1 tests the first hypothesis, which states that countries' rapid urbanisation has a negative effect on food security. The results of the unadjusted Model 1 confirm this assumption and specifically demonstrate that a one-unit increase in the rate of urban growth increases the odds of being in the high food insecurity risk category by more than 2.1 times. The model accounts for the potential heteroskedasticity of the explanatory variable (as confirmed by the Brant test)

Table 3. Food insecurity risks, urban growth and human development

Food insecurity risk (high)	Model 1	Model 2	Model 3	Model 4
Variable	OR (CI)	OR (CI)	OR (CI)	OR (CI)
Urban growth	2.14 (1.76; 2.61)***	1.84 (1.46; 2.32)***	1.43 (1.10; 1.88)***	1.33 (1.03; 1.71)**
Development level		0.11 (0.03; 0.33)***		
Baseline: less developed		1.00		
Urban growth* development level		0.59 (0.42; 0.82)***		
Development dummy 4 (LHD)			11.38 (3.86; 33.55)***	
Development dummy 2 (HHD)			0.39 (0.15; 1.05)*	
Development dummy 1 (VHHD)			0.19 (0.07; 0.53)***	
Urban growth* development dummy 4 (LHD)			0.74 (0.55; 0.99)***	
Urban growth* development dummy 2 (HHD)			0.71 (0.52; 0.97)**	
Urban growth* development dummy 1 (VHHD)			0.73 (0.56; 0.94)**	
Mean education				0.95 (0.86; 1.05)
Urban growth* mean education				0.97 (0.94; 1.00)**
Life expectancy				0.92 (0.97; 0.98)**
Agricultural land				0.67 (0.50; 0.89)***
Baseline: low proportion				1.00
Trade				0.998 (0.99; 1.00)
FDI				1.02 (1.00; 1.04)*
Disasters				1.003 (1.00; 1.01)**
TFR				1.22 (1.05; 1.42)**
Water production				0.999 (1.00; 1.00)

Table 3. *Continued*

Food insecurity risk (high)	Model 1	Model 2	Model 3	Model 4
Ln(σ)	γ	γ	γ	γ
Urban growth	0.01 (−0.07; 0.09)		0.01 (−0.08; 0.11)	
Development dummy 1 (VHD)			−1.57 (−2.09; −1.06)***	
Development dummy 2 (HD)			−0.50 (−0.89; −0.10)**	
Development dummy 4 (LD)			−1.56 (−1.78; −1.35)***	
Ln(σ)	γ	γ	γ	γ
Agricultural land (high proportion)				−0.08 (−0.44; 0.28)
Mean education				−0.14 (−0.21; −0.06)***
FDI				−0.02 (−0.05; 0.01)
Cut point 1	0.72 (0.23; 1.21)***	−1.58 (−2.63; −0.53)***	−1.18 (−2.13; −0.24)**	−5.93 (−10.93; −0.93)**
Cut point 2	2.73 (2.12; 3.33)***	1.49 (0.66; 2.31)***	1.98 (1.03; 2.93)***	−4.48 (−8.69; −0.28)**
Pseudo R^2	0.182	0.348	0.521	0.574
Log likelihood	−781	−622	−457	−335
N	869	869	869	717

Note: $*p \leq 0.1$, $**p \leq 0.05$, $***p \leq 0.01$. CI denotes 95% confidence intervals. Cut points are the thresholds of the underlying latent variable (FIRI) used to differentiate between different categories of food insecurity risks.

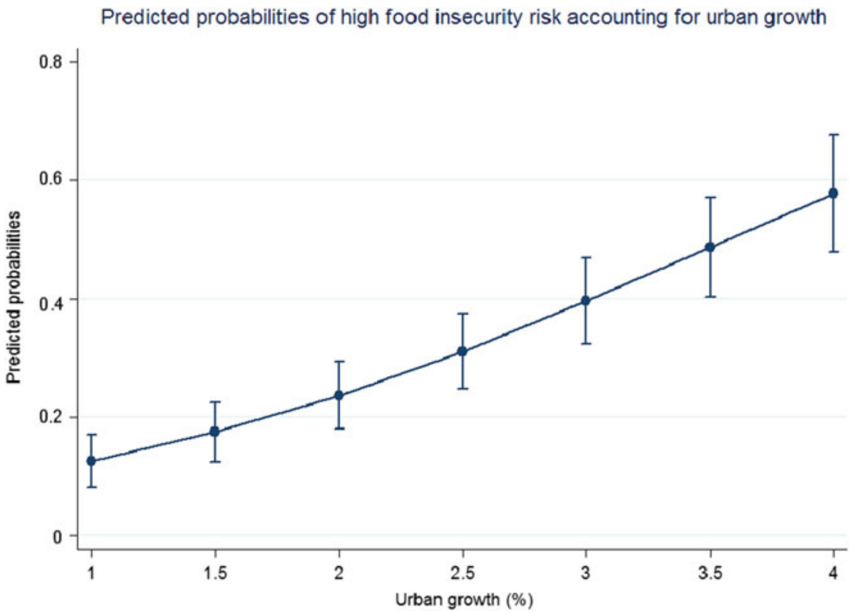

Figure 2. Predicted probabilities of high food insecurity risk accounting for urban growth.

by including the variance of urban growth. When considering the sign of ln(σ), it can be deduced that, as urban growth increases, so does the residual variability. When analysing the predicted probabilities of being in the high-risk outcome group (see Figure 2), it can be noted that this probability increases from 0.13 for those countries with an urban growth rate of 1% to 0.58 for countries with a rate of urban growth of 4%. On the other hand, the probability of being in the category of low food insecurity risk decreases with more rapid urban growth. For example, a country with a rate of urban growth of 4% has only 0.1% probability of being in the low-risk food insecurity grouping.

Model 2 adds an interaction term of urban growth and development (a binary variable). The interaction is statistically significant ($p < 0.01$) and confirms that, as urban growth increases, so do the odds of being in the high-risk food insecurity category. As can be best observed graphically (see Figure 3), belonging to the more developed countries group has a strong attenuating effect on the negative impact of urban growth. While less developed countries with a 4% rate of urban growth have a 66% probability of being in the high food insecurity risk group, for more developed countries this probability drops to 17%. These are expected results as they reflect the combined impact of the rapid pace of urbanisation at the macro level and countries' human development level. In many developing countries that experience relatively rapid rates of urban growth, macro-level urbanisation processes resulting from poor planning and management of human settlements and physical environment are likely to be strongly associated with greater food insecurity risks.

In addition, Model 3 tests the hypothesised modifying effect of the development level on the association between urban growth and food insecurity risk. This model incorporates three dummy variables measuring different levels of human development, i.e. very high, high and low. As can be noted, countries with the lowest levels of human development are

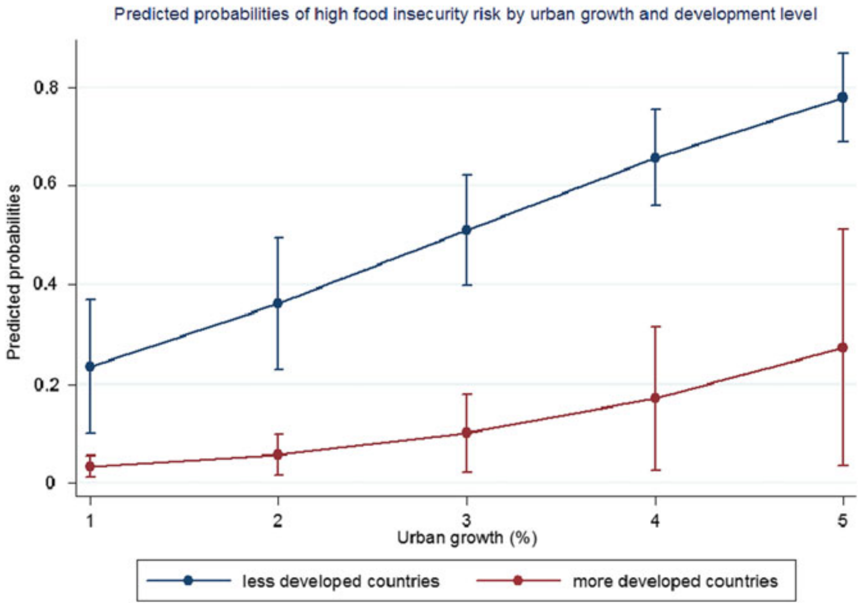

Figure 3. Predicted probabilities of high food insecurity risk by urban growth and development level.

at greatest risk of high food insecurity. Figure 4 illustrates the predicted probabilities of high food security risk by categorising countries into those with low levels of human development vs. other categories. As can be seen, while the LDCs are significantly more likely to suffer from food insecurity risks, the impact of these risks is affected by the rate of

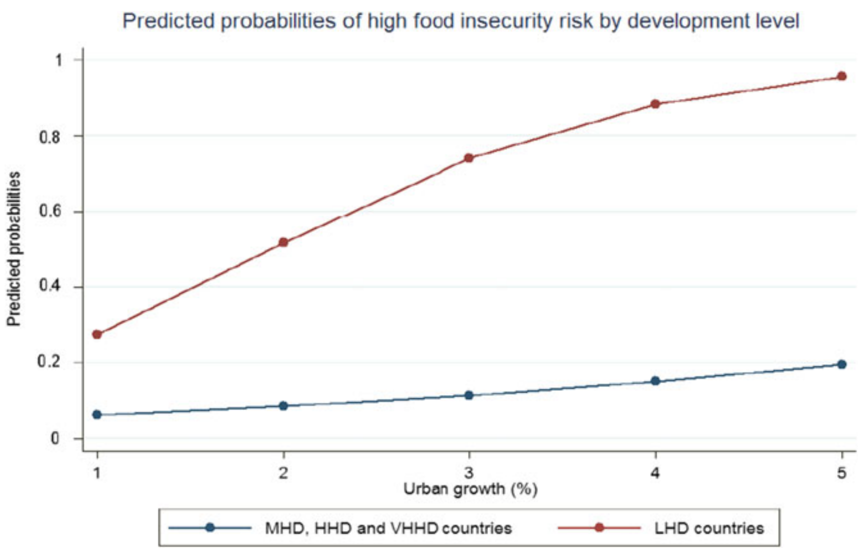

Figure 4. Predicted probabilities of high food insecurity risk accounting for urban growth and level of human development (LHD countries vs. medium, HHD and VHHD countries).

urban growth. For example, for countries with low levels of human development and a rate of urban growth of 1%, the probability of having high food insecurity risk is 27%. At the same time, for the same group of countries with a higher rate of urban growth of 4%, the estimated probability of having high food insecurity risk increases to 89%. Given the likely impact of regional effects, we also examine the associations between food insecurity risks, urban growth and world regions (see Table A2). As can be seen in Figure A1, African countries experiencing rapid urbanisation have the highest probability of food insecurity risks.

Finally, Model 4 tests the direct effects of individual development drivers (i.e. education, income and health) as well as the hypothesised mitigating effects of these factors on the association between urban growth and food security. We found a significant negative association between life expectancy and food insecurity risks (OR = 0.92, $p < 0.0.1$). In addition, *ceteris paribus*, education has a significant modifying impact on the relationship between urban growth and food security (for the interaction effect see Figure 5). As expected, there is a positive association between the total fertility rate and high food insecurity risk, thus confirming Malthusian concerns. It should be noted, however, that the significance of this variable depends on other indicators included in the model. The effect of agricultural land is also significant. Thus, controlling for other factors included in the model, the odds of high food insecurity risk for countries with a high proportion of agricultural land are 0.67 times the odds for countries with a low proportion of agricultural land. Regarding the impact of globalisation variables, trade is not statistically significant as a confounding factor. On the other hand, there is a positive association between foreign direct investment (FDI) and food insecurity risk (OR = 1.02,

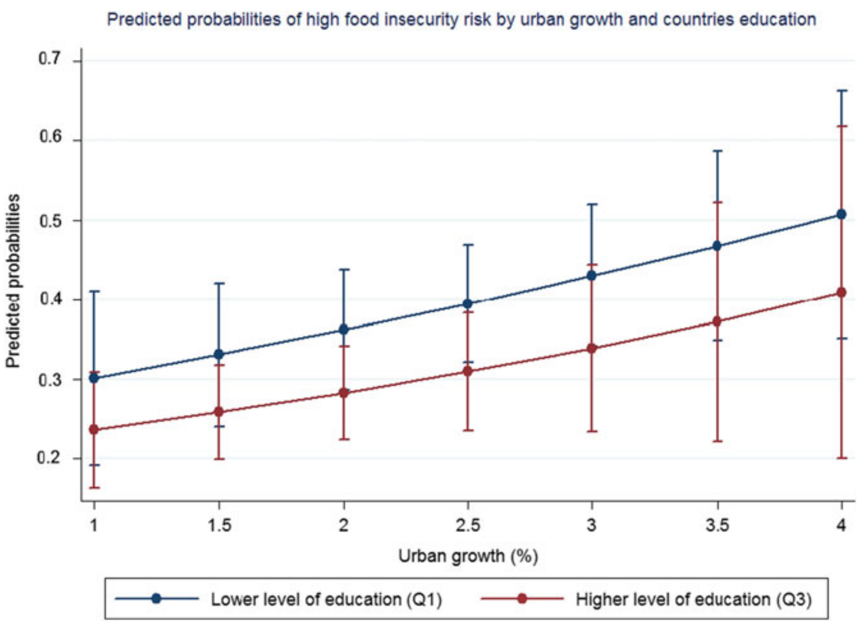

Figure 5. Predicted probabilities of high food insecurity risk by urban growth and countries' education. *Note*: Results based on Model 5. Q1 refers to 1st quartile, while Q3 refers to 3rd quartile.

$p < 0.1$). Lastly, the model controls for the impact of disastrous events on the risk of food insecurity. With regard to the variance equation, it should be noted that the residual variability in food insecurity risk declines with values of mean education and FDI. In addition, there was less residual variability in countries with a high proportion of agricultural land (as compared to countries with a low proportion of agricultural land).

5. Conclusions

Drawing from the population and development literature, this paper aimed at assessing the impact of urbanisation on food insecurity risks, accounting for different human development contexts. Based on the results of the quantitative analysis, several conclusions can be drawn. First, macro-level urban growth has a significant effect in raising a country's food insecurity risk. The strength of this association varies depending on a country's level of development. Despite the fact that it is difficult to make direct comparisons with existing results because of limited quantitative evidence, a large body of literature exists on the negative impacts of urban growth, including with regard to its effects on water and food security (FAO, 2011; Matuschke, 2009; Montgomery, 2004, 2008; Neuwirth, 2006; Ruel & Garrett, 2003; Ruel, Garrett, Hawkes, & Cohen, 2010; Satterthwaite, 2003; Satterthwaite & Mitlin, 2013). Concerning the confounding factors, previous economic research reports the potential negative impact of FDI (Kentor & Boswell, 2003) and natural disasters (IFRCRCS, 2010) on food security. The results of the present study are thus in line with those reported by Kentor (2001), who also found that dependence on foreign capital may impede economic development, while trade openness was positively associated with economic development. Another body of research has shown that FDI can have mixed effects on food security as it can both boost rural development and have negative impacts on local communities because of increased risk of monoculture production and lower income for some farmer households (GTZ, 2010).

While our research findings advance the current understanding of the phenomena discussed, certain limitations need to be stressed. First, this research does not claim causal relationships but focuses solely on investigating the underlying associations. Traditionally, research is prone to different types of fallacies, including individualistic and ecological fallacies. In the context of the present study, inferences should not be made beyond the macro-level phenomena. The analysis does not account for specific urbanisation processes or drivers of urbanisation. Additional analyses should be carried out when attempting to disentangle the impact of urbanisation at regional and household levels. Another limitation is related to the problem of endogeneity. It has been acknowledged that "most non-experimental developmental studies of context are subject to a host of possible endogeneity biases" (Duncan, Magnuson, & Ludwig, 2004, p. 2). Yet, it is often impossible to conduct natural experiments or quasi-experiments, especially when it comes to cross-country comparisons. Furthermore, the limitation of the food security indicator should be acknowledged. Food security is a multidimensional concept and thus difficult to measure. The indicator used in this study focused on food security risks only and did not consider food security outcomes, including measures related to body weight.

Finally, it should be stressed that the future outlook in relation to associations between urbanisation and food security is mixed. The global convergence patterns in fertility and urbanisation, and also in economic and human development, provide arguments for an optimistic outlook in terms of sustainable urban development and the fight against hunger and under-nutrition. Of particular relevance is the increased policy focus on the need for green growth and sustainable cities. In this respect, the proposed sustainable development goals (SDGs) constitute a move in the right direction as they provide more comprehensive targets and indicators for ensuring food security and combating hunger. For example, SDG targets 2a and 2c, which focus on regulating commodity markets, limiting price volatility and investments in rural infrastructure (UN, 2014a), are highly relevant in the context of interactions between urbanisation and food security, as evidenced in this study. Given the increasing urbanisation of poverty (Battersby, 2013), the introduction of disaggregated indicators measuring progress in food security in urban, peri-urban and rural areas is necessary. Because of the often negative impacts of rapid urban growth on food security, it is critical to prioritise sustainable urbanisation strategies, in particular in countries with the lowest levels of human development.

Disclosure Statement

No potential conflict of interest was reported by the author.

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Appendix

Table A1. Food Insecurity Risk Index (FIRI) – 2010 ranking

Low risk		Medium risk		High risk	
1	New Zealand	59	Bosnia and Herzegovina	117	Palestine
2	Denmark	60	Armenia	118	Vanuatu
3	Ireland	61	Barbados	119	Gabon
4	Australia	62	Cuba	120	Swaziland
5	United States of America	63	Uzbekistan	121	Nicaragua
6	Netherlands	64	Kyrgyzstan	122	Mauritania
7	Iceland	65	Latvia	123	**Botswana**
8	Canada	66	Belize	124	**Indonesia**
9	Argentina	67	Algeria	125	Cameroon
10	Uruguay	68	Saudi Arabia	126	Sudan
11	**Israel**	69	Slovakia	127	Pakistan
12	**Spain**	70	Guyana	128	Malawi
13	Greece	71	China	129	Bangladesh
14	France	72	Maldives	130	Senegal
15	Lithuania	73	The former Yugoslav Republic of Macedonia	131	**Bolivia (Plurinational State of)**
16	Italy	74	Azerbaijan	132	**Cambodia**
17	Portugal	75	Paraguay	133	**Nigeria**
18	Austria	76	Libya	134	Burkina Faso
19	Luxembourg	77	Jordan	135	Mali
20	Finland	78	Bahamas	136	Namibia
21	Belgium	79	Brunei Darussalam	137	Rwanda
22	Kazakhstan	80	Venezuela (Bolivarian Republic of)	138	Niger
23	Germany	81	Cuba	139	Angola
24	Turkey	82	Mauritius	140	Yemen
25	Sweden	83	South Africa	141	India
26	Hungary	84	Samoa	142	Solomon Islands
27	Norway	85	Thailand	143	Nepal
28	Slovenia	86	Morocco	144	Cote d'Ivoire
29	**Malta**	87	Republic of Moldova	145	Lesotho
30	**Poland**	88	Ecuador	146	Kenya
31	United Kingdom	89	Seychelles	147	Ghana
32	Belarus	90	Montenegro	148	Zambia
33	Kuwait	91	Fiji	149	Zmbabwe
34	Romania	92	Georgia	150	Central African Republic
35	Chile	93	Antigua and Barbuda	151	Gambia
36	Switzerland	94	**Kiribati**	152	Benin
37	**Brazil**	95	**Viet Nam**	153	Chad
38	**Turkmenistan**	96	Jamaica	154	Uganda
39	Czech Republic	97	Colombia	155	Guinea
40	Ukraine	98	El Salvador	156	Burundi
41	Estonia	99	Myanmar	157	Ethiopia
42	Albania	100	Peru	158	Timor Leste
43	Iran (Islamic Republic of)	101	**Saint Lucia**	159	Togo
44	Tunisia	102	**T rinidad and T obago**	160	United Republic of Tanzania

(*Continued*)

Table A1. *Continued*

Low risk		Medium risk		High risk	
45	United Arab Emirates	103	Papua New Guinea	161	Madagascar
46	Egypt	104	Saint Vincent and the Grenadines	162	Afghanistan
47	Costa Rica	105	Saint Kitts	163	Guinea-Bissau
48	Malaysia	106	Honduras	164	Cape Verde
49	Republic of Korea	107	Mongolia	165	**Congo (Brazaville)**
50	**Croatia**	108	Panama	166	**Sao Tome and Principe**
51	**Mexico**	109	Guatemala	167	Democratic Republic of the Congo
52	**Serbia**	110	Dominican Republic	168	Sierra Leone
53	Bulgaria	111	**Suriname**	169	Mozambique
54	Japan	112	**Sri Lanka**	170	Haiti
55	Syrian Arab Republic	113	Tajikistan	171	Liberia
56	Lebanon	114	**Grenada**	172	Djibouti
57	Russian Federation	115	**Philippines**	173	Comoros
58	Dominica	116	Lao People's Democratic Republic	174	Eritrea

Note: Highest ranking denotes highest food insecurity risk. Index scores based on author's calculations using FAO data. Bold font indicates equal ranking.

Table A2. Food insecurity risks, urban growth and world regions

Food insecurity risk (high)	β	SE	z	p-value	CI	
Variable						
Urban growth	−0.53	0.22	−2.42	0.02	−0.96	−0.10
World region						
Africa	3.37	0.48	7.04	0.00	2.43	4.31
Asia	1.99	0.32	6.31	0.00	1.37	2.60
Americas	1.66	0.32	5.13	0.00	1.03	2.30
Oceania	0.81	0.63	1.28	0.20	−0.43	2.05
Interactions world region urban growth						
Africa	1.11	0.25	4.46	0.00	0.62	1.60
Asia	0.88	0.23	3.84	0.00	0.43	1.33
Americas	0.89	0.24	3.68	0.00	0.42	1.37
Oceania	1.49	0.32	4.68	0.00	0.86	2.11
Cut point 1	1.54	0.22			1.12	1.97
Cut point 2	4.12	0.26			3.62	4.62
Pseudo R^2	0.348					
Log likelihood	−622.65					
N	869					

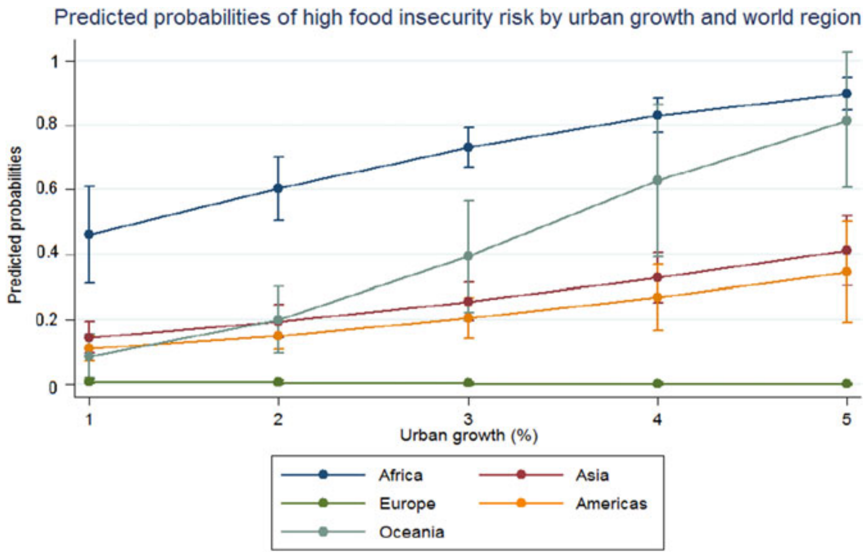

Figure A1. Predicted probabilities of high food insecurity risk by urban growth and world region.