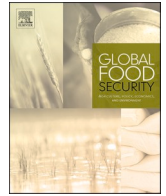




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Africa: The livestock revolution urbanizes

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ABSTRACT

Population growth, rising income and urbanization have fueled a significant increase in demand for animal products in developing countries since the early 1970s. The phenomenon, dubbed as the Livestock Revolution, is anticipated to slow down in the coming decades, except in Africa where the Revolution is expected to continue and urbanize. This paper examines the urbanization of the Livestock Revolution in Africa. It estimates that in 2050 almost 70% of total meat and milk consumption will likely come from cities, with urban dwellers demanding, compared to today, 28 and 47 additional million metric tons of meat and milk, respectively. The consequent transformations of the livestock value chain serving urban and peri-urban areas may pose unprecedented public health and environmental challenges to policy-makers.

1. Introduction

The population of Africa is projected to almost double reaching about 2.5 billion people in 2050. More than 80% of that increase should occur in cities, with about 1.5 billion Africans living in urban areas by 2050. Economic growth is also expected to keep its pace, supporting major increases in consumer purchasing power. Sustained population growth, coupled with changes in consumption patterns due to rising real per capita income and urbanization, underpins what [Delgado et al. in 1999](#) dubbed the Livestock Revolution. The term, *Livestock Revolution*, was coined to describe the significant increase in demand for animal-sourced foods (ASFs) that started in developing countries at the beginning of the 1970s and continued in the new millennium (see [Fig. 5](#)). The term also captures the associated implications on livestock production systems, environment and public health.

A wealth of literature exists on the determinants of the demand of ASFs. On the one hand, as purchasing power increases, consumer food preferences shift towards higher quality and more diversified diets, in which ASFs are a key component. ([Colen et al., 2018](#); [Skoufias et al., 2011](#)). On the other hand, urban residents not only have different lifestyles than rural dwellers – for example they are more sedentary, members of a two-income family and usually employed in either the industry or the service sector – but also have access to wider food options and infrastructure that facilitates transporting and storing perishable food products, such as milk and meat ([Cockx et al., 2018](#); [Hawkes, 2008](#); [Regmi and Dyck, 2001](#)). Many studies have therefore found a positive correlation between urbanization and per capita consumption of animal

products ([Delisle et al., 2012](#); [Rae, 1998](#); [Worku et al., 2017](#)), though opposite evidence also exists ([Abdulai and Aubert, 2004](#); [Cockx et al., 2018](#)).

The significant growth in ASF consumption in developing countries between 1973 and 2013 – a six- and four-fold increase in meat and milk consumption, respectively – brought on a parallel increase in production, with developing countries accounting in 2013 for 63% and 53% of the total world's meat and milk production, respectively, versus 31% and 22% forty years earlier ([FAO, 2018b](#)). A larger herd and higher animal productivity contributed to increased livestock production, which was also characterized by land-use conversion from forests to pastures for large ruminants, particularly in Latin America, and the emergence of mid and large-scale poultry, pig and dairy producers around urban and peri-urban areas, which moved afield only as urbanization intensified ([FAO, 2013](#); [Steinfeld et al., 2006](#); [Steinfeld, H., 2019](#); [Thornton, 2010](#)). As a consequence, the effects of livestock production on the environment, such as through greenhouse gas emissions, and public health, such as through zoonotic diseases that jump from animals to humans, have become increasingly pronounced ([FAO, 2013](#); [Jones et al., 2008](#); [Steinfeld et al., 2006](#)).

In the coming three decades the *Livestock Revolution* is anticipated to slow down, as developing countries should experience slower growth rate of population, urbanization and GDP per capita than in the past forty years. The exception will likely be Africa, where the *Livestock Revolution* might continue unfolding but with a peculiar feature with respect to the past: it is expected to be urban. With the number of people living in urban areas skyrocketing, even a small rise in per capita

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consumption would translate in a very large increase in aggregate demand of ASFs, which may pull livestock production system closer to urban areas, as historical evidences from Asia and Latin America suggest (Steinfeld et al., 2006). An urbanized *Livestock Revolution* will likely have profound and unprecedented effects on the development trajectory of the livestock sector, with major consequences on the environment and public health.

This paper examines the urbanization of the *Livestock Revolution* in Africa and discusses its implications on livestock production systems and value chains. It relies upon FAO's long-term demand and supply projections of ASFs (FAO, 2018a) in Africa under a "business-as-usual" (BAU) scenario, which assumes no structural change with respect to the past, on the World Bank Global Consumption Database (2007), which provides information on per capita expenditure of livestock products by rural and urban areas, and on the United Nations (UN) World Urbanization Prospects (UNDESA, Population Division, 2018) that provide long-term projections on rural and urban population by region and country.

Section 2 presents long-term trends in ASF consumption in Africa, with a focus on the aggregate rather than per capita demand as the former, more than the latter, will likely prompt changes of interest in livestock production systems and value chains. Section 3 estimates meat and milk consumption in urban and rural areas in 2050; to our knowledge neither projections nor forecasts are available on consumption of livestock products by urban and rural areas in the future. Section 4 discusses the likely transformations of the livestock production systems and value chains in response to the urbanized *Livestock Revolution* and the associated environmental and public health consequences. Section 5 draws conclusions.

2. The Livestock revolution continues

Between 1973 and 2013 total consumption of meat and milk in developing countries increased by 161 and 281 million metric tons, respectively. In the developed world, consumption of meat and milk grew by 33 and 57 million metric tons, respectively. Over the same period, per capita consumption of meat tripled in developing countries, reaching 34 kg/year in 2013, while milk consumption more than doubled from 29 to 63 kg/year. Percentage increases in per capita consumption in the developed world have been instead contained, both due to the already high protein intake and an increased preference toward diets with reduced consumption of ASFs (Annex I).

In the last four decades, the *Livestock Revolution* did not occur uniformly across the developing world (Delgado et al., 2001; Pica-Ciamarra and Otte, 2011): China and Brazil accounted for about 59% of the total increase in meat consumption, while India, China, Pakistan and Brazil contributed 67% to the total increase in milk consumption. Though the population size of these countries largely explains this trend, increases in per capita consumption were also overwhelming. For example, in 1973, China's per capita consumption of milk was 2 kg/year and reached 32 kg/year in 2013.

Africa contributed little to the *Livestock Revolution* between 1973 and 2013. Although the proportion of developing countries' population living in Africa increased from 14% to 19%, Africa contributed only 9% and 11% to the total increase in meat and milk consumption in the developing world. On the continent, meat and milk consumption grew by 14 and 32 million metric tons, respectively. In 1973, per capita meat consumption in Sub-Saharan Africa (SSA) and Northern Africa was 13.7 and 12.6 kg/year, respectively; it grew to 16.2 kg/year and 27.8 kg/year in 2013. Similarly, between 1973 and 2013 per capita milk consumption increased from 28 to 30 kg/year in SSA and from 44 to 92 kg/year in Northern Africa (Annex I).

FAO's long-term consumption projections (2018a) suggest that in the next decades total and per capita consumption of ASFs in developing countries, with the exclusion of Africa, will likely grow at a substantially lower annual rate than in the previous 40 years (Annex I). After all, in

developing countries (excluding Africa), total and urban population are projected to grow by 0.6% and 1.4% per year, less than half of the annual growth rates for the 1973–2013 period. GDP per capita, which more than tripled in the first period, should about double by 2050.

Conversely, the drivers of the *Livestock Revolution* are expected to continue exercising their influence in Africa. Between 2013 and 2050, the African population is projected to grow by 2.2% per year vis-à-vis an annual growth rate of 2.7% over the 1973–2013 period. In 2050, close to 60% of the population will likely be urban vis-à-vis 40% in 2013 and 24% in 1973 (UNDESA, Population Division, 2018). These trends are expected to be more pronounced in SSA, where urban population should almost quadruple in the next three decades, reaching 1.2 billion in 2050. Finally, GDP per capita in Africa is expected to double by 2050, while it grew by 36% over the 1973–2013 period.

A veritable *Livestock Revolution* is therefore expected to unfold in Africa in the next decades. In particular, in SSA, aggregate meat and milk consumption are projected to growth at 3.4% and 2.9% per year (vis-à-vis 1% in the other developing regions), with both absolute and relative increases in per capita consumption higher in the coming decades compared with the past 40 years (Annex I).

What matters the most, however, is that the coming *Livestock Revolution* in Africa differs from any past development trajectory. Fig. 1 displays indexed series for urbanization, GDP per capita and aggregate meat consumption in Africa and Eastern Asia, which is the region that experienced the largest changes in meat consumption over the past decades (Pica-Ciamarra and Otte, 2011). Three main features emerge from the comparison of the trends in these regions.

First, the growth rate in meat consumption in Africa for the 2013–2050 period is expected to be similar to that experienced by Eastern Asia during the peak of the Revolution, as the slopes of the two lines representing aggregate meat consumption do not differ significantly. In Africa, the aggregate increase in meat demand for the 2013–2050 period (+38 million metric tons) should be 2.7 times higher than the increase in the previous decades (+14 million metric tons). Today, African livestock production is unable to satisfy local demand, with about one third of all countries in the continent importing more than 20 percent of their total meat supply. The projected increase in aggregate meat demand, therefore, will likely exacerbate pressures on livestock production systems and may increase the African dependence on imports.

Second, Africa will have to respond to this production challenge while facing a massive urbanization process. The growth rate in urban population, already higher in Africa than in Eastern Asia over the period 1973–2013, is projected to remain significantly higher also in the coming decades, as shown in Fig. 1. In Eastern Asia, the urban population increased by 666 million between 1973 and 2013; in Africa, it is estimated to increase by more than 1 billion between 2013 and 2050.

Last but not least, Africa will likely have less resources available on a per capita basis than Eastern Asia to manage a sustainable transformation of the Livestock Sector (Annex VI). In 1973, GDP per capita in Eastern Asia was 1.8 times higher than in Africa and, since then, has grown and is projected to grow at a much faster rate. African decision-makers, therefore, may face unprecedented challenges in managing the coming *Livestock Revolution* on the continent.

3. Africa: the Livestock revolution urbanizes

The projected massive increase in ASF consumption in Africa calls for a better understanding of the contribution of urbanization to the *Livestock Revolution* for informed policy decisions. The way livestock production systems and value chains adjust in response to a growing demand for ASFs, in fact, depends not only on the total quantity but also on the location where the demand occurs. To our knowledge, neither forecasts nor projections exist on the future consumption of ASFs in urban versus rural areas in Africa. This section provides estimates of the future demand for livestock products in African urban areas.

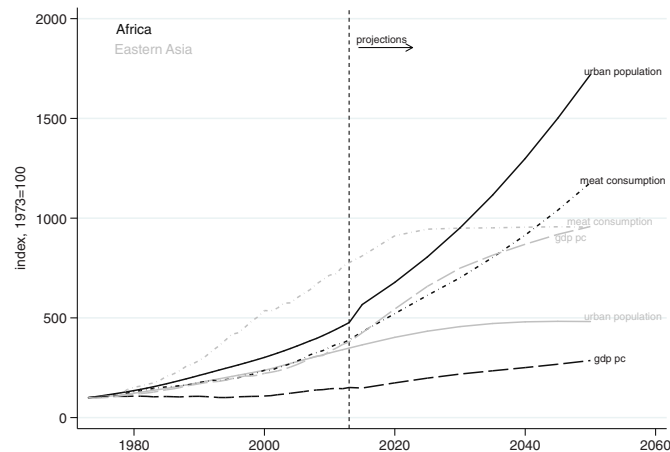


Fig. 1. Urban population, GDP per capita and total meat consumption in Africa and Eastern Asia, 1973–2050.

Note: consumption refers to the “total amount of the commodity available as human food during the reference period. Data include the commodity in question, as well as any commodity derived therefrom as a result of further processing” (FAOSTAT – Definition and standards).

Source: authors’ calculation based on [UNDESA \(2018\)](#), [FAO \(2018a\)](#) and [FAO \(2018b\)](#).

3.1. Data

To estimate the projected quantity of livestock products consumed in urban versus rural areas, we use three sets of data: the FAO long-term consumption projections (2018a), the World Bank Global Consumption Database (2007) and the UN World Urbanization Prospects (2018).

[FAO \(2018a\)](#) provides 5-year interval estimates for the aggregate consumption of beef and veal, pork, small ruminant meat, poultry meat and milk by country for the 2015–2050 period. FAO projections are based on two economic models: (i) the FAO Global Agriculture Perspectives System Model ([Kavallari et al., 2016](#)), a partial equilibrium model that, starting from FAOSTAT food balance sheets for 2012, projects supply, demand and prices for agricultural commodities (crops, processed good, and livestock products) by adjusting simultaneously variables such as crop yields, land requirements and animal herd size by livestock production system, and balancing the global market up to the year 2050; and (ii) the Environmental Impact and Sustainability Applied General Equilibrium Model ([Mensbrugge, 2010](#)), a general equilibrium model that simulates the interactions between the different economies, including their agricultural sector, and the global environment as affected by greenhouse gas emissions or global mean temperature. [FAO \(2018a\)](#) produced projections for three scenarios (“towards sustainability”, “business-as-usual” and the “stratified societies”). Here, we use the projections from the “business-as-usual” scenario, which assumes no major structural break with respect to past trends of food preferences and food waste at consumer level. As the FAO database does not contain country-level data for Burundi, the Democratic Republic of the Congo, Eritrea, Libya, Somalia, and Sudan, we imputed projected values using the average per capita consumption of neighboring countries with comparable level of development (GDP per capita projections are also

sourced from [FAO \(2018a\)](#)).

The World Bank Global Consumption Database (2007) draws on 77 national household consumption or expenditure surveys conducted between 2000 and 2011 in Africa, Asia, Europe, and Central and Latin America. It presents summary statistics on consumer spending patterns, expressed in 2010 values, for a variety of food and non-food items at national level and by rural and urban areas. As the relation between urban and rural per capita consumption depends on the level of development of the survey year, we generate estimates for the survey year by multiplying the database values by the ratio of the household final consumption expenditure per capita in the survey year to the corresponding value in 2010. To allow for cross-country comparison, we convert local currencies into international dollars adjusted for purchasing power parity (2011 PPP).

The UN World Urbanization Prospects are the official UN estimates and projections of rural and urban population by country and region ([UNDESA, 2018](#)). Projections are based on the most recent available population censuses. The dataset does not use its own definition of urban, but follows the definitions used by the different countries. For example, in Ethiopia localities with more than 2000 inhabitants are considered urban, while in Burkina Faso all administrative centers of provinces (total of 45) plus 4 medium-sized towns are considered as urban areas ([UNDESA, 2018](#)).

3.2. Methods

To estimate the consumption of livestock products originating from urban dwellers, we first use the World Bank Global Consumption Database (2007) to calculate the rural to urban expenditure ratio of selected ASFs. We then use the estimated expenditure ratio to split the

FAO country-level projections of ASF consumption into rural and urban consumption. In particular, under the hypothesis that the ratio between total rural and urban consumption in country j is primarily explained by the level of development (GDP per capita) and the share of population living in urban areas (urban share), we use equation (1) to estimate the relation between per capita rural expenditure ($X_{-pc}^{i,rural}$) and per capita urban expenditure ($X_{-pc}^{i,urban}$) for each livestock commodity (i : beef and veal, pork, small ruminant meat, poultry meat and milk). We control for regional fixed effects by grouping the countries in 12 regions (Central, Eastern, Western, South-Eastern and Southern Asia; Northern and Sub-Saharan Africa; Northern, Eastern and Southern Europe; Caribbean and Central America; South America). In all cases, the Breusch-Pagan test (Breusch and Pagan, 1979) detects heteroskedasticity, i.e. the variance of the error term is not constant across observations causing inefficiency of the estimates. We use ordinary least squares and the Huber-White robust sandwich estimator for all equations to correct for heteroskedasticity (Huber, 1967; White, 1980).

$$X_{-pc}^{i,rural} = f(X_{-pc}^{i,urban}, GDP \text{ per capita}, \text{urban share}, \text{regional dummies}) \tag{1}$$

The functional form is specific for each livestock commodity, with the selection of both the explanatory variables and the interaction terms guided by the Akaike’s information criterion (Akaike, 1973), Bayesian information criterion (Schwarz, 1978), the statistical significance of the parameter and the variance inflation factor (VIF) (Verbeek, 2008).

Based on the predictions of the fitted models, we estimate the marginal effects (i.e. margins of derivative of response - $ME_{GDP,U}^i$) and the elasticity of urban expenditure on ASFs ($E_{GDP,U}^i$) at different level of GDP per capita and share of urban population (U) as follows:

$$ME_{GDP,U}^i = \partial X_{-pc}^{i,rural} / \partial X_{-pc}^{i,urban} \tag{2}$$

$$E_{GDP,U}^i = \partial X_{-pc}^{i,rural} / \partial X_{-pc}^{i,urban} * X_{-pc}^{i,urban} / X_{-pc}^{i,rural} \tag{3}$$

The combination of equations (2) and (3) allows estimating the rural to urban expenditure ratio ($R_{GDP,U}^i$), as:

$$R_{GDP,U}^i = ME_{GDP,U}^i / E_{GDP,U}^i = X_{-pc}^{i,rural} / X_{-pc}^{i,urban} \tag{4}$$

The expenditure ratio (equation (4)) depends on the country’s economic development, proxied by GDP per capita and urbanization. A

ratio equal to 1 implies equal per capita expenditure for product i in rural and urban areas. A ratio greater than 1 implies a lower per capita expenditure in urban areas. We use the estimated ratios to calculate the urban consumption of beef and veal, pork, small ruminant meat, poultry meat and milk for each African country j as follows:

$$C_{urban,j}^i = C_j^{i*} \left(1 + R_{GDP,U}^i * P_{rural,j} / P_{urban,j} \right)^{-1} \tag{5}$$

where C_j^i is the FAO projected aggregate consumption of product i in country j ; $P_{rural,j}$ and $P_{urban,j}$ are the population living in rural and urban areas in country j , respectively.

3.3. Regression results

Table 1 reports the results of regressions for each livestock commodity as well as the specification of equation (1), i.e. the selected explanatory variables. Note that the share of population living in urban areas was excluded as a stand-alone regressor or as an interaction variable in two out of the five estimated equations as its inclusion did not significantly increase the explanatory power of the model and caused high values for VIF, i.e. urban population share was highly correlated with at least one of the other predictors in the model. Regional fixed effects were found significant only for pork and poultry meat.

Based on the predictions of the fitted models, we calculated the rural to urban expenditure ratio for different animal products (equation (4)). Results are similar for all products, but for small ruminant meat (Fig. 2).

At low levels of GDP per capita, per capita expenditure in rural areas for beef and veal, poultry meat, and milk is about half of that in urban areas. As per capita GDP increases, the per capita expenditure in rural and urban areas converges, though it always remains higher for urban dwellers. This pattern is similar for per capita expenditure on pork, though at high level of GDP and/or urban share people in rural areas may spend more on pork than their urban counterparts. In particular, the rural/urban expenditure ratio is higher than 1 when GDP per capita is higher than 3600 USD and the urban population is at least 88%, or when the urban population is more than 28% and GDP per capita is at least 11,500 USD. For per capita expenditure on small ruminant meat, the rural/urban expenditure ratio decreases as GDP per capita goes up and increases with urbanization. In particular, with a GDP per capita lower than 5300 USD, rural households spend more on small ruminant meat than urban dwellers, regardless of the urbanization level.

Table 1
Estimation results of per capita rural expenditure for selected animal products.

	beef and veal	pork	small ruminant meat	poultry meat	milk
urban expenditure	0.597*** (0.11)	1.467*** (0.20)	1.193*** (0.18)	0.234*** (0.07)	0.508*** (0.09)
urban exp*GDP per capita	0.028*** (0.01)		-0.067*** (0.01)	0.015* (0.01)	0.021** (0.01)
urban share*urban expenditure	-0.393 (0.23)				
GDP per capita*urban share		0.647* (0.27)	0.419* (0.17)		
D(Southern Europe) = 0*urban exp		-0.489* (0.20)			
D(Northern Europe) = 0*urban exp		-0.371*** (0.05)			
D(South America) = 0*urban exp				0.347*** (0.07)	
Observations	76	65	69	77	76
Adjusted R-squared	0.920	0.967	0.856	0.920	0.894

Standard errors in parentheses.
*p < 0.05, **p < 0.01, ***p < 0.001.

Note: Urban and rural expenditure are per capita values in current international \$ (2011 PPP) from the World Bank Global Consumption Database. GDP per capita, expressed in 1000\$ (2011 PPP), is from the World Bank’s World Development Indicators database; urban population share data are from UNDESA Population Division, World Urbanization Prospects: The 2018 Revision, table 21. D(region name) are dummy variable for the regions.

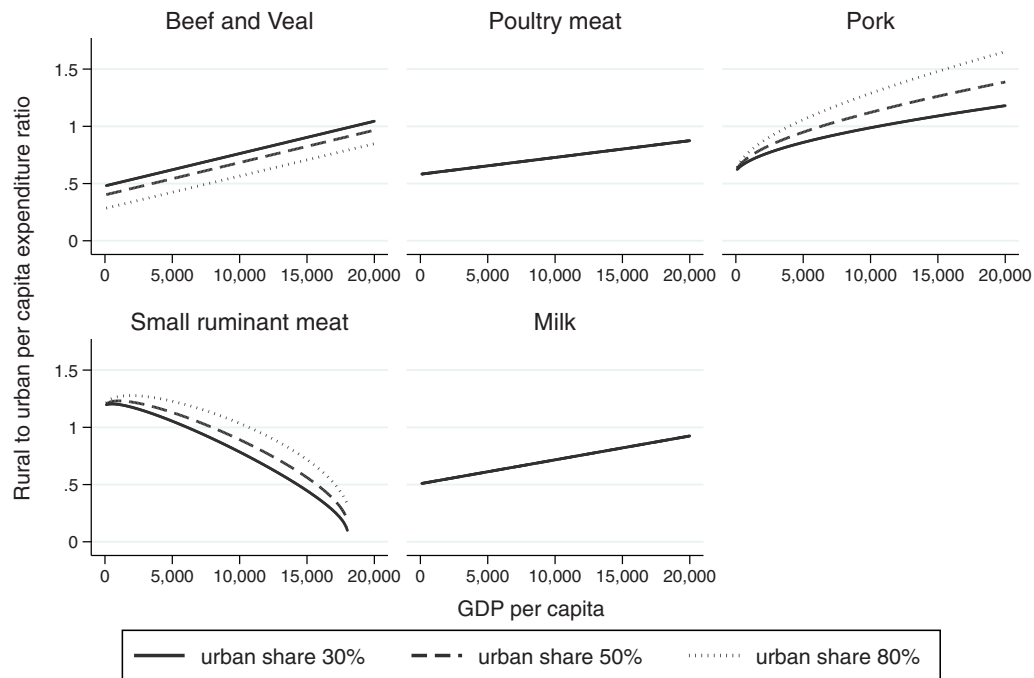


Fig. 2. Ratio of rural to urban per capita expenditure for selected livestock products. Source: authors' calculation.

Note: different values of the ratio for same level of GDP per capita correspond to the ratio at different level of urban shares for given level of GDP per capita. The three urban share thresholds used in the graph are the 2015 urban share in low-, middle- and high-income countries.

Conversely, with a GDP per capita higher than 10,200 USD, people in urban areas spend more than those in rural areas on small ruminant meat, even at low level of urbanization.

Different trends of the rural to urban expenditure ratio for small ruminant meat can be explained by the fact that rural households largely hold small ruminants as a source of financial security; demand for small ruminant meat is highly seasonal, with peaks around religious ceremonies and other celebrations; and consumption of small ruminant meat is highly responsive to price dynamics (CNFA, 2016; Abdulrahman 2017). Accordingly, as GDP per capita goes up, less rural households are expected to hold small ruminants, with a consequent reduction in self-consumption and increase in market demand. During demand peaks, prices will be higher and better-off urban dwellers will be likely to purchase more meat than their rural counterparts. That said, estimates of the rural to urban expenditure ratio for small ruminant meat should be taken with caution also noting that for GDP per capita higher than 18,000 USD and high level of urbanization, the ratio is highly unstable; we therefore truncated the results in Fig. 2. The weakness of the results may be due to the data underlying the model, as no clear relation between expenditure, GDP per capita and urbanization emerges (Annex II). The high seasonality of demand for small ruminant meat and the fact that some of the household surveys of the Global Consumption Database collected consumption data over a short period of time may partly explain this anomaly.

3.4. Urban and rural consumption in 2050

The 2050 consumption of beef and veal, pork, small ruminant meat, poultry meat and milk projected by FAO (2018a) for each African country was divided by rural and urban areas using equation (4). Results suggest that the *Livestock Revolution* in Africa should urbanize, with the demand for livestock products mainly originating from urban dwellers

in the coming decades.

3.4.1. Consumption of meat in urban areas

In 2050, the aggregate consumption of meat originating from urban dwellers might more than triple with respect to today and should represent 69% of the total, though Africa will likely be only 59% urban. For all types of meat, the percentage increase in consumption is projected to be 3 times higher in urban than in rural areas. On the other side, increase in per capita consumption is expected to be more accentuated in rural areas (+30% or 3.9 kg/person between 2015 and 2050) than in urban areas (+11% or 2.7 kg/person between 2015 and 2050); thus, the consumption gap between rural and urban areas is expected to shrink. Nevertheless, in 2050 urban dwellers should still consume significantly more meat on a per capita base (27 kg/person/year *vis-à-vis* 17 kg/person/year in rural areas) (Table 2), with the only exception for small ruminant meat (Table 6 in Annex III).

The gap between urban areas of Northern Africa and SSA is projected to widen. In fact, although aggregate urban meat consumption should more than double in Northern Africa and almost quadruple in SSA (Fig. 3), population growth will likely offset this difference: in 2050 urban dwellers in SSA are expected to consume 25 kg/person/year of meat (3 kg more than in 2015), *vis-à-vis* 38 kg/person/year in Northern Africa (up from 31 kg/person/year in 2015).

3.4.2. Consumption of milk in urban areas

Between 2015 and 2050 in Africa, urban consumption of milk is projected to grow by 2.6 times to account for 68% of the total milk consumption in the continent. This trend is largely explained by the growing urban population, as per capita consumption is expected to marginally decrease in cities (Table 2). Conversely, over the same period, per capita milk consumption in rural areas should slightly increase (+2%), resulting in a shrunk urban-rural gap, though per capita

Table 2
Per capita consumption of meat and milk in urban and rural area, 2015–2050.

Region	Meat consumption (kg/person/year)				Milk consumption (kg/person/year)			
	rural		urban		rural		urban	
	2015	2050	2015	2050	2015	2050	2015	2050
Africa	13.1	17.1	24.2	26.9	33.1	33.8	57.9	49.9
Northern Africa	20.8	28.4	30.8	37.6	72.8	77.5	123.3	120.3
Sub-Saharan Africa	11.7	15.4	22.2	25.0	25.7	27.5	37.5	36.9

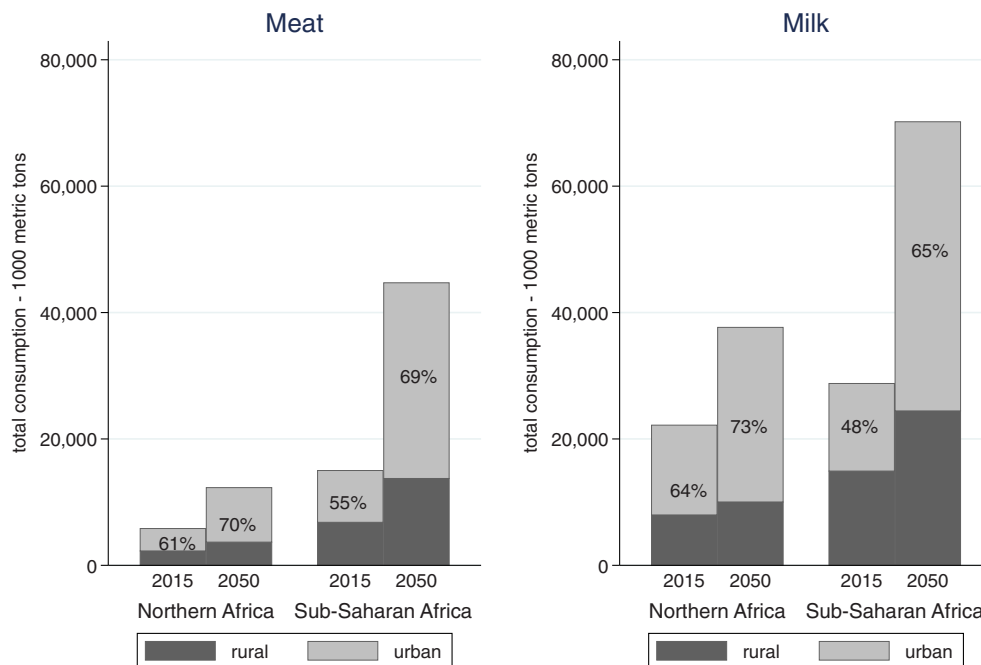


Fig. 3. Urban and rural consumption of meat and milk in Africa, 2015–2050. Note: percentage values are the share of urban consumption. Source: authors’ calculation

values should remain significantly lower in rural areas (34 versus 50 kg/person/year).

The increase in the aggregate urban consumption should mainly be led by SSA, where consumption might more than triple. Nevertheless, in per capita terms, the gap between SSA and Northern Africa is expected to remain significantly high, with people in Northern Africa consuming 3 times more milk on a per capita basis in 2050.

3.5. Sensitivity analysis

The results presented above have to be interpreted considering their potential limitations.

The hypothesis underpinning equation (5) is that the urban to rural expenditure ratio is equal to the ratio of the quantities consumed. This would be true if there were no price differences between urban and rural areas, which is not always the case (Cockx et al., 2018; Deaton and Dupriez, 2011; Gaddis, 2016). Because of high transportation cost and limited market integration, rural prices are often lower for unprocessed and locally produced food, and higher for processed and imported food

products (e.g. Gibson (2009) for Vietnam and Nakamura et al. (2019) for Nigeria). Deaton and Dupriez (2011) found that differences in food prices between urban and rural areas decrease as economic development progresses because both transaction cost and self-production in rural areas reduce. In particular, they found that in India and Brazil urban food prices were about 10% and 3% higher than rural food prices respectively.

Furthermore, the statistics available in the Global Consumption Database of the World Bank – used to estimate the rural to urban ASF expenditure ratio— include consumption of home-produced food as well as food received as gift: these are valued at farm-gate prices that are lower than retail prices. As self-consumption is higher in rural areas and, based on literature on spatial price differences mentioned above, prices in urban areas are likely higher for domestically produced livestock products, i.e. the model results for urban consumption of ASFs may suffer from overestimation.

However, Africa imports a non-negligible quantity of its domestic supply of meat and milk. For example, import values are significantly higher if compared with the share of the domestic supply imported in

India and Brazil when the study of [Deaton and Dupriez \(2011\)](#) was carried out ([Table 7](#) in Annex IV). Accordingly, given the importance of imported food, the pace of urbanization and the economic growth, we can expect a mild and decreasing spatial price difference over time.

Unfortunately, disaggregated price data for urban and rural areas are not readily available. Thus, to test the sensitivity of our results to price differences between rural and urban areas, we rerun the model under two alternative scenarios, i.e. with urban prices 3% and 10% higher than rural prices. Results hardly change: in 2050 the share of ASF consumption in urban areas would reduce by less than one and by between one and two percentage points if urban prices were higher by 3% and 10% than rural ones, respectively ([Table 8](#) in Annex IV).

4. Discussion

The projected increase in ASF consumption in Africa should come mainly from urban centers: in 2050, urban dwellers are expected to contribute about 69% and 68% of the total consumption of meat and milk, respectively. We estimated that in 2015 about 56% and 55% of all meat and milk consumption originates in urban areas. Market transactions for ASFs should be even more skewed towards urban areas, because self-consumption is largely a rural phenomenon. Nationally representative survey data for Kenya, Ethiopia, Nigeria, Uganda and Burkina Faso suggest that, on average, urban households purchase at least 77% of the milk and 82% of the meat they consume. On the other side, households in rural areas purchase less than half of the milk they consume (with the exception of Nigeria) and between 47% and 88% of the meat consumed (Annex V). Therefore, if the average share of ASF self-consumption is excluded from the model results, the urban market for meat and milk would represent 74% and 82% of total market for ASFs, respectively.

The remarkable increase in demand for ASFs, coupled with a shift in its geography, is expected to trigger major transformations in African livestock production systems and value chains. Historical evidence suggests a process of production intensification should occur, with increased levels of productivity all along the livestock value chain ([Thornton, 2010](#); [OECD-FAO, 2009](#)). Indeed, in 2015 the African Union launched the 2015–2035 Livestock Development Strategy for Africa whose aim is to transform “the prevailing subsistence livestock production systems ... into vibrant market-oriented systems” through concerted policies and investments in breeding, feeding, water systems, animal health and marketing ([African Union, 2015](#)). However, based on FAO “business-as-usual” projections, net trade (i.e. domestic production net of demand for food and other uses) is projected to increase yearly by 3.9% for meat, despite a large expansion of production. Though, projections for milk production and demand should move Africa from a position of net importer in 2013 to net exporter in 2050. In all cases, the anticipated process of livestock production intensification, while varied by country and region, will be intertwined with the process of urbanization. In particular, when cities and towns grow and infrastructure in rural areas is limited, production of perishable food, including livestock, tend to be located close to consumption ([Chamberlin and Jaybe, 2013](#); [Migose et al., 2018](#); [Steinfeld et al., 2006](#)). Based on The World Bank logistic performance index, which measures the efficiency and quality of a country’s logistics services, SSA scores last among the six world regions in five out of the six dimensions of the index. If one looks at the *quality of trade and transport related infrastructure*, 15 out of the bottom 20 countries are in Africa ([World Bank, 2019](#)).

Currently, only in 33% of all African districts households and farms need less than 1 h to reach the closest urban center; it takes more than 6 h for households in 20% of all districts to reach a town or city ([Weiss et al., 2018](#)). While being closer to markets reduces transaction costs for producers, land and labor are expected to be scarce and hence expensive production factors in urban and peri-urban areas. Thus, livestock operators in these locations will have incentives to intensify production and maximize their profit per unit of animal or labor ([Duncan et al., 2013](#);

[Oosting et al., 2014](#)).

As a response to the massive increase in the demand for ASFs in urban areas in the coming years, we expect therefore a growing number of market-oriented livestock operators, from small to medium -scale livestock farms, to emerge in and around cities and towns in the medium term. In the longer term – with growing availability of infrastructure and increased pressure on farmlands due to urban expansion – production may move afield ([Seto and Ramankutty, 2016](#)). Available evidence, though scattered, indicates that already today there is a significant number of livestock keepers in African urban and peri-urban areas, including subsistence and commercially-oriented producers ([Amadou et al., 2012](#); [Graefe et al., 2008](#); [Muhammad, 2008](#)). Furthermore, a large share of urban dwellers keep poultry, and ownership of small ruminants and dairy cattle is also common ([Grace et al., 2015](#)).

Data from nationally representative surveys for 12 SSA countries indicate that between 2% (Sierra Leone) and 49% (Niger) of all urban households keep cattle; between 15% (Malawi) and 71% (Senegal) small ruminants; and between 33% (Rwanda) and 84% (Mozambique) poultry ([FAO, 2020](#)). As a consequence, the density of livestock in urban areas is high. Census data for Kenya and Uganda, which allow accurate small area estimations, confirm that already today livestock density in urban and peri-urban areas is as high as that in rural areas, as shown in [Fig. 4](#) ([Kenya National Bureau of Statistics, 2009](#); [Uganda Bureau of Statistics, 2010](#)).

The urbanizing livestock revolution, therefore, will likely lead to an increased concentration of livestock and people in and around urban areas in the coming decades, which represents an emerging and worrisome environmental and public health challenge for the African continent. In particular, land-use change and increased animal density in urban areas might support novel and more frequent contacts between humans, domesticated animals and wildlife, thereby creating veritable hotspots for the emergence of zoonotic diseases (ZDs) ([Hassell et al., 2017](#); [Neiderud, 2015](#)). An outbreak of a ZD originating in wild and/or domestic animals that jumps to humans might not only significantly impact livestock production, but also result in a high human death toll with broader disruptive impact on society. Eventually, it could trigger social unrest and destabilize governments by eroding public trust and confidence. If a ZD spreads rapidly across countries, it can also result in worldwide pandemics ([Berry et al., 2018](#); [Ayano Ogawa, 2019](#)), as the recent Covid-19 pandemic is demonstrating. And because of both the increased risk of animal diseases as well as stiffer competition to access productive resources in urban and peri-urban areas, farmers could be tempted to imprudently use antibiotics not only to treat sick animals but also as a growth promoter and/or for prophylaxis. This, in turn, might contribute to antimicrobial resistance in humans which is an increasing threat to global health ([Robinson et al., 2017](#)).

In addition, the animal herds that are required to meet the sharp increase in demand will likely generate profound environmental impacts ([Steinfeld et al., 2006](#)). Livestock production systems in proximity to urban centers may pollute available water sources and, in water scarce areas, also generate social tensions. The same could happen with livestock production systems that require large land areas in the proximity of urban and peri-urban centers, which also contribute to raising land price.

It is worth noting that the growing demand for ASFs in urban areas also presents a major business opportunity for the livestock sector to develop sustainably and contribute to poverty reduction and food security ([Cole et al., 2008](#)). [Lee-Smith \(2010\)](#) even argues that the nutritional benefits of urban livestock-keeping outweighs any health risks, as the latter can be effectively managed if appropriate policies are in place.

The correlations between urbanization, livestock production systems and their ultimate impact on African society, including on public health, the environment and people’s livelihoods, are complex, heterogeneous and shaped by a multitude of anthropogenic and agro-ecological factors. In the coming decades, because of the urbanizing Livestock Revolution, they will become increasingly complex and difficult to manage.

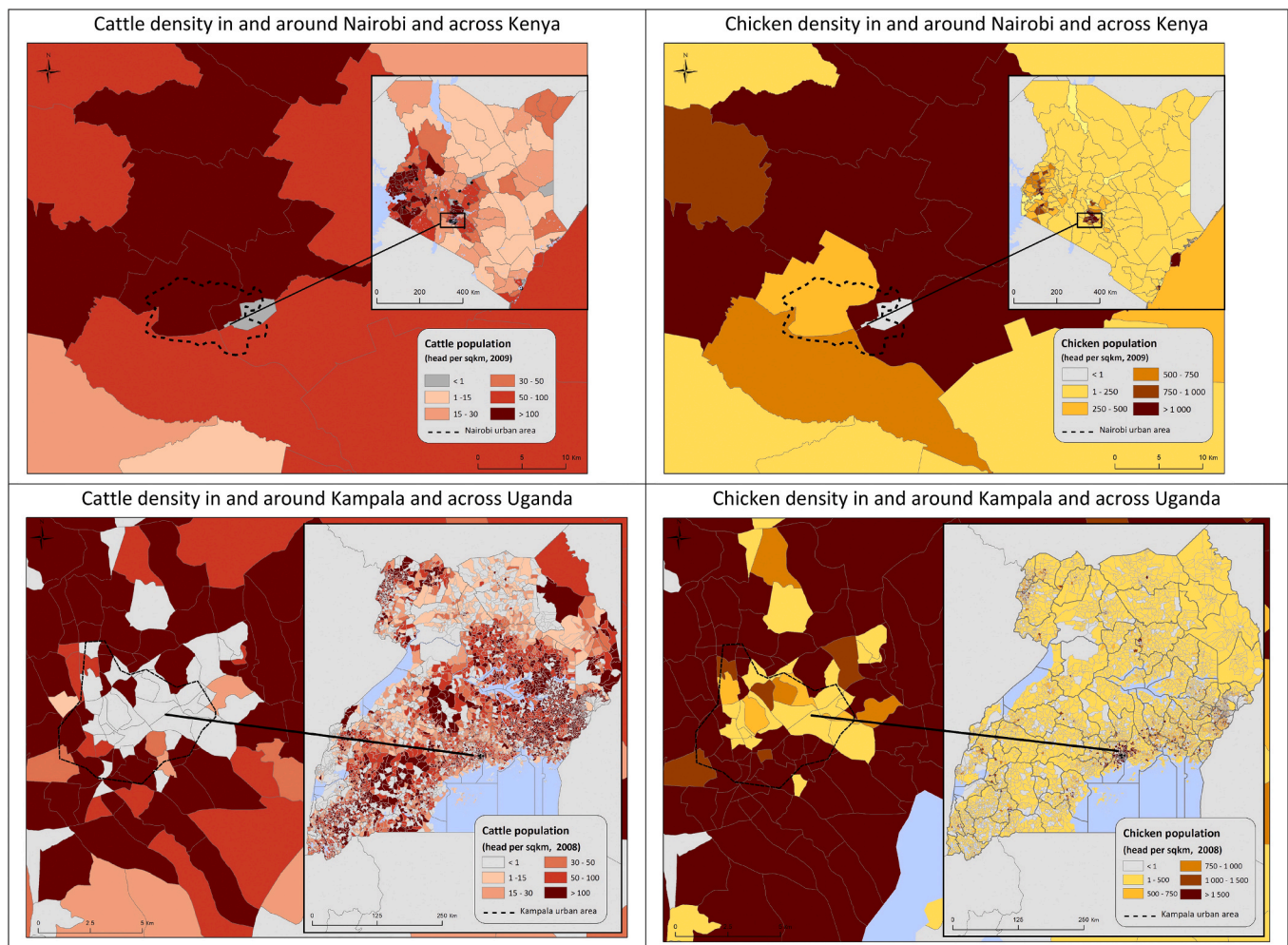


Fig. 4. Livestock density in urban and rural areas of Kenya and Uganda.

Source: authors' calculation based on (Uganda Bureau of Statistics, 2010; Bright et al., 2009; Global Human Settlement Layer (GHSL), 2008) for Uganda and (Kenya National Bureau of Statistics, 2009; Bright et al., 2010; Global Human Settlement Layer (GHSL), 2009) for Kenya.

However, urban and peri-urban livestock systems are not among the top priorities in the Africa policy agenda, at national, regional and continental level. For example, the 2015–2035 Livestock Development Strategy for Africa (African Union, 2015) considers the urbanization of the Livestock Revolution largely, if not only, as a business opportunity and does not recommend any specific policy and investment focus on urban and peri-urban livestock systems. It is of paramount importance that the urbanization of the Livestock Revolution enters the Africa policy agenda, as the sustainability of livestock production systems in the coming decades will depend, to a significant extent, on the development trajectory of livestock production systems in urban and peri-urban areas.

5. Conclusion

For the first time in history, in 2034, more African people are expected to live in cities than in rural areas. In 2050, the African population should reach 2.5 billion people, of which 1.5 billion people will likely live in urban areas. As urbanization keeps advancing, economies expanding and the middle class growing (African Development Bank, 2011), the demand for livestock products is projected to grow substantially if continuation of historical trends of food preferences is assumed and economic growth observed in the early 2000s will keep its pace till 2030 and then get closer to historical long-term rates. Along the years, the bulk of ASF consumption should gradually shift from rural to urban

areas and the massive increase and changes in location of ASF consumption are expected to radically transform the livestock value chains.

Although there is uncertainty about how it might evolve, historical evidences from Asia and Latin America suggest that the perishable character of animal products and limited infrastructure will likely induce production to initially locate close to demand. Accordingly, an increase in the number of mid- and large-scale operators in peri-urban areas is to be expected. There will likely be major transformations of livestock production systems in rural areas too and projections picture SSA unable to meet consumers' demand if current yield trends continue; thus, the food import bill for many African countries is also projected to increase.

In any case, the likely extraordinary concentration of people and livestock in urban and peri-urban areas will pose critical environmental and public health challenges. In particular, land-use change and novel and more frequent interactions between humans, livestock and wildlife will likely create veritable hotspots for the emergence of zoonotic diseases, while high density of animals in urban areas may easily pollute soil, water and air, further exacerbating the negative impact of livestock on public health.

Africa is heterogenous, and so will be the future development of its regions, countries and the multitude of livestock production systems and value chains. However, the urbanization of the *Livestock Revolution* and its impact on society will be soon become a recurrent theme. Up to date,

policy makers have shown little attention to the unfolding of the *Livestock Revolution* in urban areas. A change of pace is necessary. This should include three core elements. First, the generation of more robust evidences of the coming transformations of livestock sector in and around African urban areas, from any discipline. Second, the adoption of a One Health approach for decision-makers - including not only the Ministries in charge of livestock but also urban planners and city governors - to better appreciate the role of livestock in the urban context and its multiple connections, including trade-offs, with desirable societal outcomes, such as livelihoods, environmental sustainability and public health. Third, the engagement of private sector stakeholders in the design of any policy and public investments targeting the livestock sector. Livestock is a private business and urban areas represent the more lucrative market for livestock entrepreneurs: it is only through engaging private sector in a constructive dialogue that policies can be formulated to create that enabling environment that ensures sustainability from an economic, environmental and public health dimension.

The findings of this paper shed light on the importance of generating a novel policy narrative on livestock sector development in the African continent, which not only includes rural areas but also urban and peri-urban livestock farming and value chain. It is crucial to produce

evidence and knowledge to allow an efficient allocation of scarce resources for livestock sector development, which considers the coming changing location of production and consumption of livestock products in the African continent.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

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Annex I

The Livestock Revolution in numbers

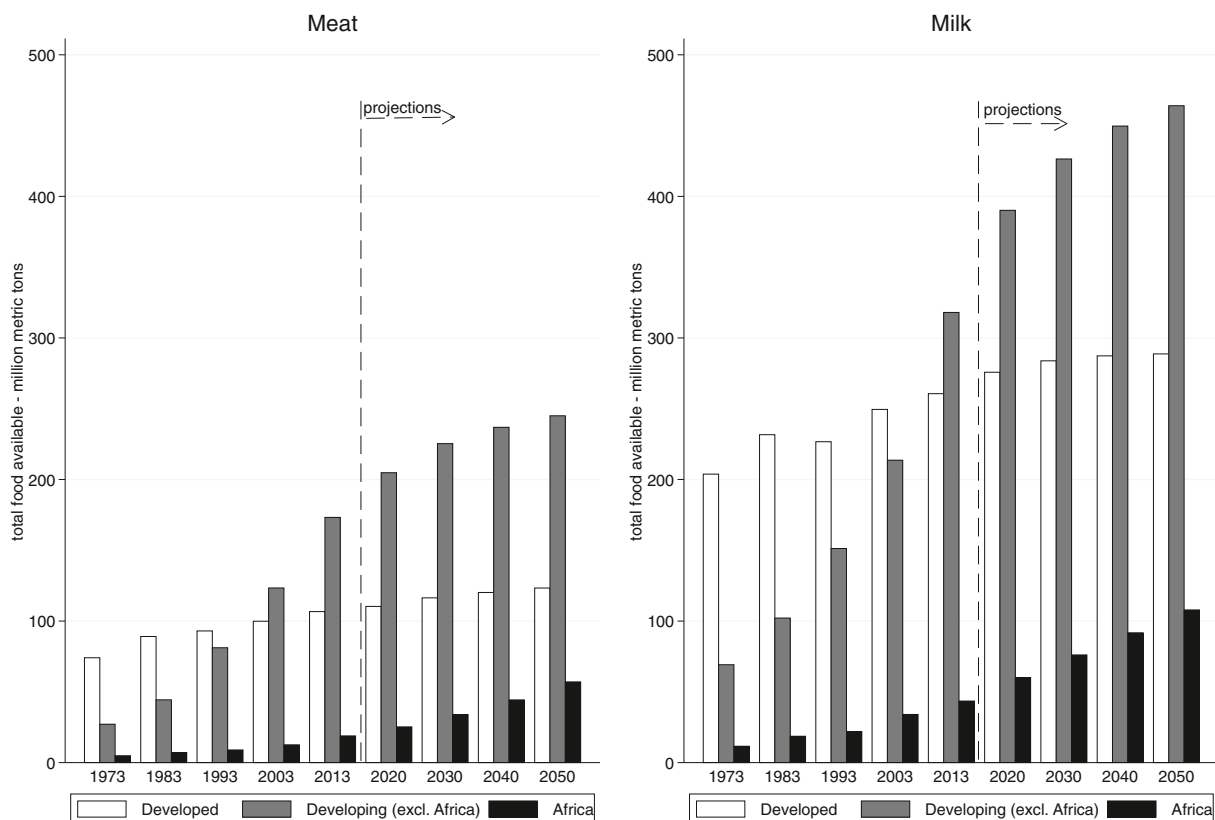


Fig. 5. Aggregate consumption of meat and milk, 1973–2050.

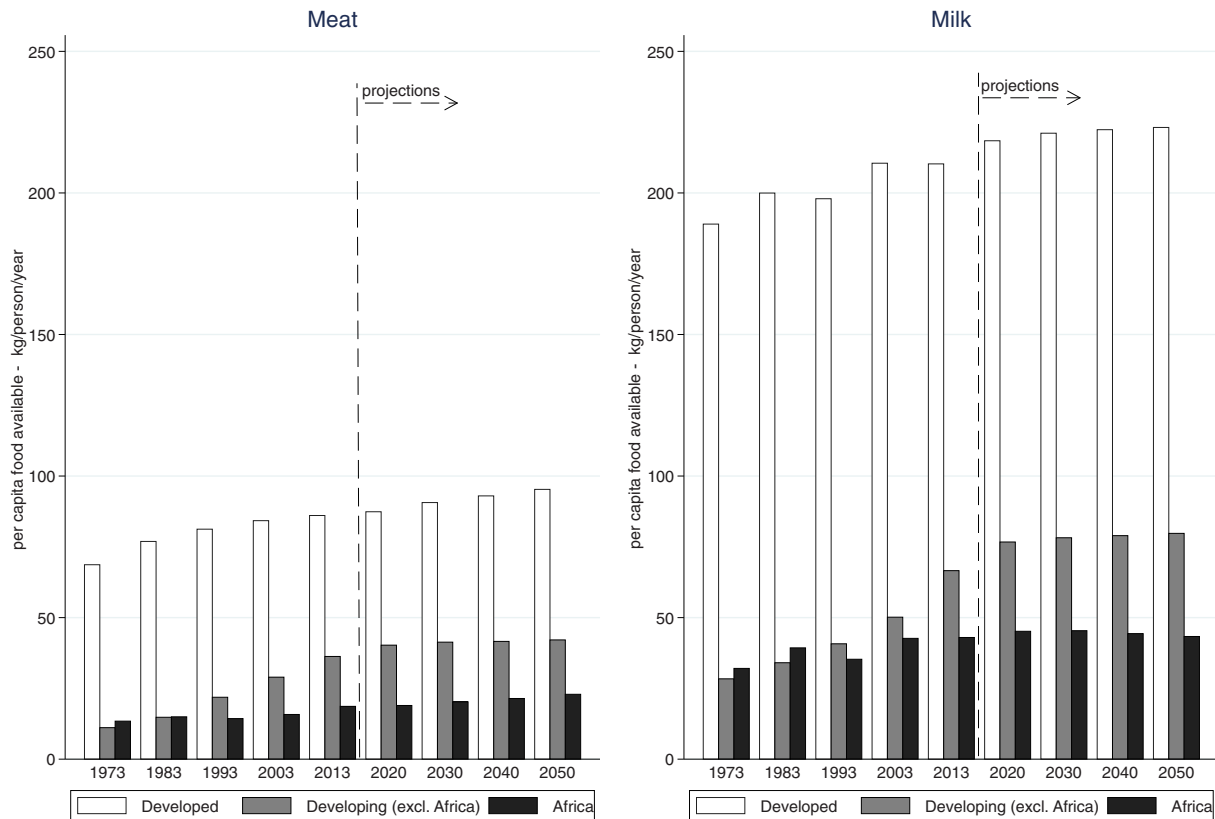


Fig. 6. Per capita consumption of meat and milk, 1973–2050.

Source: historical data are from FAOSTAT (FAO, 2018b); projection are the results of the “business-as-usual” scenario in FAO (2018a). Note: consumption refers to the “total amount of the commodity available as human food during the reference period. Data include the commodity in question, as well as any commodity derived therefrom as a result of further processing. [...] For example, food from milk relates to the amounts of milk as such, as well as the fresh milk equivalent of dairy products”, excluding butter. (FAOSTAT – Definition and standards)

Table 3

Yearly growth rate and absolute increase of aggregate and per capita consumption of meat, 1973–2050.

Region	Yearly growth rate				Absolute increase			
	aggregate consumption		per capita consumption		aggregate consumption		per capita consumption	
	(%)		(%)		(1000 metric tons)		(kg/person)	
	1973–2013	2013–2050	1973–2013	2013–2050	1973–2013	2013–2050	1973–2013	2013–2050
Developed	0.9	0.4	0.6	0.3	32612	16634	17.4	9.2
Developing	4.6	1.2	2.7	0.2	160913	106881	21.9	2.7
Developing (excl. Africa)	4.7	0.9	3.0	0.4	146901	68733	25.4	5.3
Africa	3.5	3.0	0.8	0.6	14015	38147	5.2	4.3
Northern Africa	4.2	2.0	2.0	0.6	4695	6452	15.2	6.4
Sub-Saharan Africa	3.2	3.4	0.4	0.7	9320	31696	2.5	4.8

Source: author’s elaboration on FAOSTAT and FAO (2018a).

Table 4
Yearly growth rate and absolute increase of aggregate and per capita consumption of milk, 1973–2050.

Region	Yearly growth rate				Absolute increase			
	aggregate consumption		per capita consumption		aggregate consumption		per capita consumption	
	(%)		(%)		(1000 metric tons)		(kg/person)	
	1973–2013	2013–2050	1973–2013	2013–2050	1973–2013	2013–2050	1973–2013	2013–2050
Developed	0.6	0.3	0.3	0.2	56846	28102	21.3	12.9
Developing	3.8	3.2	1.9	0.2	281422	208632	33.8	6.1
Developing (excl. Africa)	3.9	1.0	2.2	0.5	249508	144256	38.5	12.8
Africa	3.4	2.5	0.7	0.0	31913	64376	10.9	0.4
<i>Northern Africa</i>	4.0	1.8	1.9	0.3	15392	18270	48.5	12.5
<i>Sub-Saharan Africa</i>	2.9	2.9	0.2	0.2	16522	46106	2.0	2.9

Source: author's elaboration on FAOSTAT and [FAO \(2018a\)](#).

Annex II

Summary statistics on small ruminant meat expenditure

Table 5
Average urban and rural expenditure on small ruminant meat by GDP per capita and urban share quintiles in the 77 countries of the Global Consumption Database.

quantiles of GDP per capita	average			Rural to Urban ratio
	GDP per capita	Rural per capita expenditure	Urban per capita expenditure	
	2011 PPP (current international \$)	2011 PPP (current international \$)	2011 PPP (current international \$)	
1	1224	6	10	0.78
2	2717	15	18	0.7
3	5137	9.1	12	1
4	8504	17	16	1.3
5	14624	11	21	1.2

quantiles of urban share	average			Rural to Urban ratio
	GDP per capita	Rural per capita expenditure	Urban per capita expenditure	
	2011 PPP (current international \$)	2011 PPP (current international \$)	2011 PPP (current international \$)	
1	2755	6.9	10	1.1
2	2814	11	14	0.66
3	5887	5.6	7.7	0.91
4	8383	15	15	1.3
5	12215	20	31	1.1

Source: author's elaboration on Global Consumption Database ([World Bank, 2007](#))

Annex III

Consumption of ASFs in urban and rural areas, 2015–2050

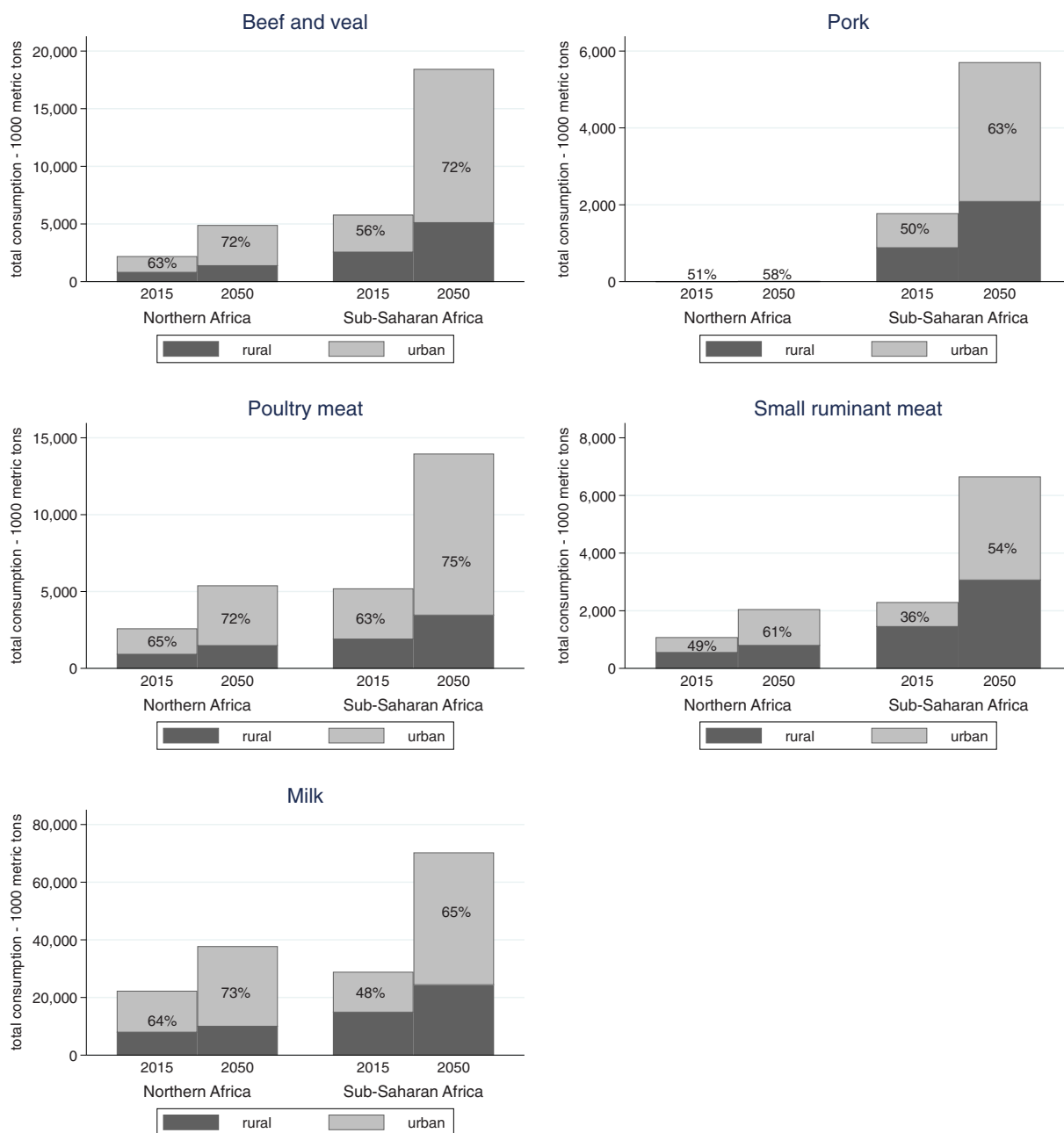


Fig. 7. Urban and rural consumption of selected livestock products, 2015–2050. Note: percentage values are the share of urban consumption. Source: authors' calculation based on FAO (2018a).

Table 6 Per capita consumption of selected ASFs in urban and rural areas, 2015–2050.

	Beef and Veal (kg/person/year)		Pork (kg/person/year)		Poultry meat (kg/person/year)		Small ruminant meat (kg/person/year)		Milk (kg/person/year)	
	rural	urban	rural	urban	rural	urban	rural	urban	rural	urban
Africa										
2015	4.9	9.4	1.3	1.8	4.1	10.2	2.9	2.8	33.1	57.9
2050	6.4	11.4	2.1	2.5	4.9	9.8	3.8	3.3	33.8	49.9
Northern Africa										
2015	7.4	11.9	0.0	0.0	8.4	14.4	5.0	4.5	72.8	123.3
2050	10.7	15.2	0.0	0.0	11.5	17.0	6.2	5.4	77.5	120.3
Sub-Saharan Africa										
2015	4.4	8.7	1.5	2.4	3.3	8.9	2.5	2.3	25.7	37.5
2050	5.8	10.7	2.3	2.9	3.9	8.4	3.4	2.9	27.5	36.9

Annex IV

Sensitivity analysis

Table 7

Share of domestic supply imported for meat and milk in Africa, Brazil and India.

Area	year	Meat (%)	Milk (%)
Africa	2013	12.04	16.61
Northern Africa	2013	8.10	19.95
Sub-Saharan Africa	2013	13.80	13.83
Brazil	2003	0.45	1.89
India	2005	0.01	0.01

Source: author's elaboration on [FAO data \(2018c\)](#)

Table 8

Sensitivity of the share of urban consumption of ASFs to spatial price differences in 2050.

Product	Area		
	Africa	Northern Africa	Sub-Saharan Africa
Beef and veal			
equal price	72.1%	71.5%	72.2%
urban price 3% higher	71.5%	70.9%	71.7%
urban price 10% higher	70.2%	69.6%	70.4%
Poultry meat			
equal price	74.4%	72.5%	75.2%
urban price 3% higher	73.9%	71.9%	74.6%
urban price 10% higher	72.7%	70.6%	73.4%
Pork			
equal price	63.4%	58.2%	63.4%
urban price 3% higher	62.7%	57.5%	62.7%
urban price 10% higher	61.2%	56.0%	61.3%
Small ruminant meat			
equal price	55.5%	61.0%	53.8%
urban price 3% higher	54.9%	60.4%	53.2%
urban price 10% higher	53.4%	58.9%	51.7%
Meat			
equal price	69.5%	70.2%	69.3%
urban price 3% higher	68.9%	69.6%	68.7%
urban price 10% higher	67.6%	68.3%	67.4%
Milk			
equal price	68.1%	73.4%	65.2%
urban price 3% higher	67.5%	72.8%	64.6%
urban price 10% higher	66.1%	71.6%	63.2%

Annex V

Share of consumption of milk and meat purchased in rural and urban areas

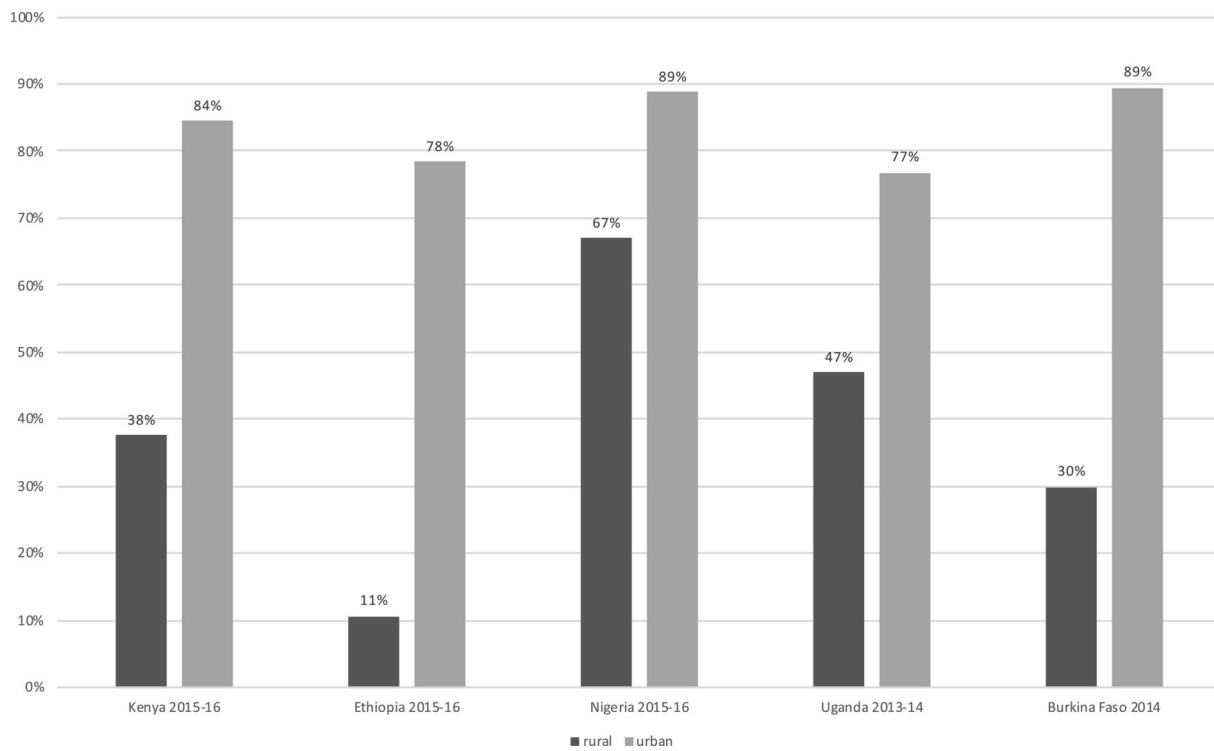


Fig. 8. Share of consumption of milk purchased in 5 African countries by urban and rural areas. Notes: the shares are derived from the average weekly per capita consumption. Years on the y-axis refer to the survey year.

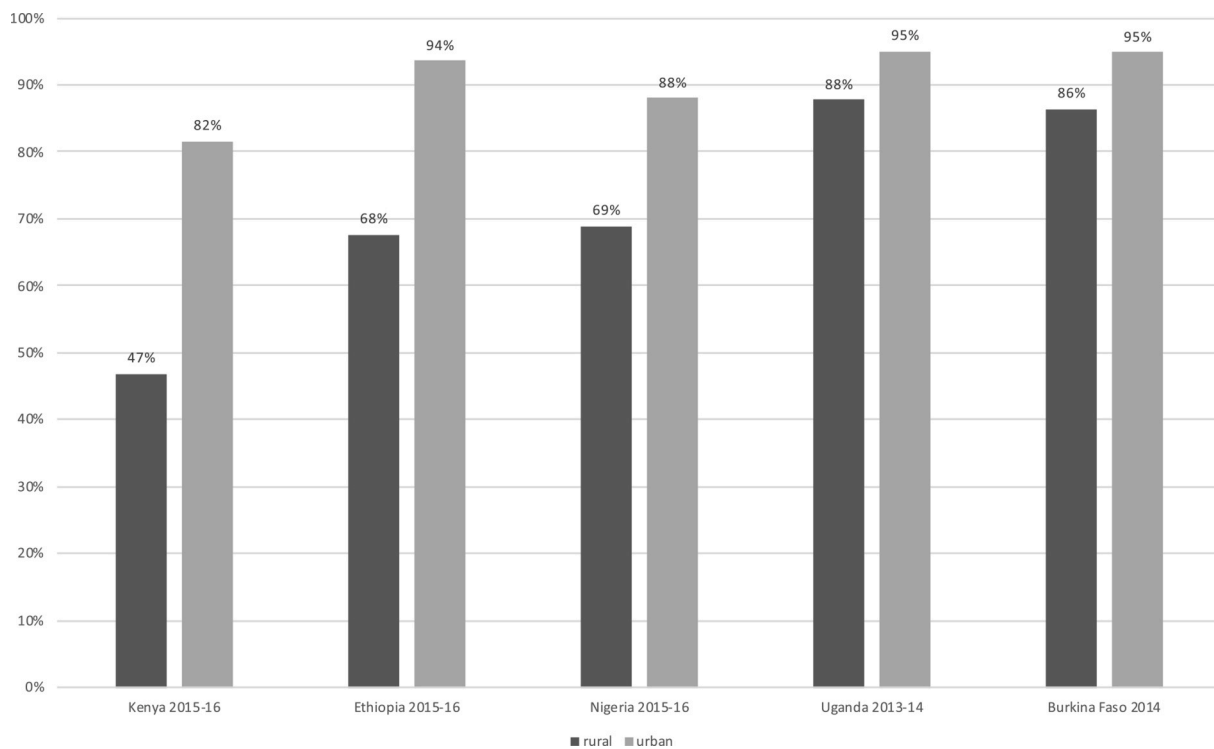


Fig. 9. Share of consumption of meat purchased in 5 African countries by urban and rural areas. Notes: the shares are derived from the average weekly per capita consumption. Years on the y-axis refer to the survey year. In Kenya and Burkina Faso, meat includes beef, poultry and other meat. In Ethiopia and Nigeria, meat includes beef, poultry, goat and mutton. In Uganda, meat includes beef, poultry, pork and other meat.

Annex VI

GDP per capita and urban population in African and Asian regions

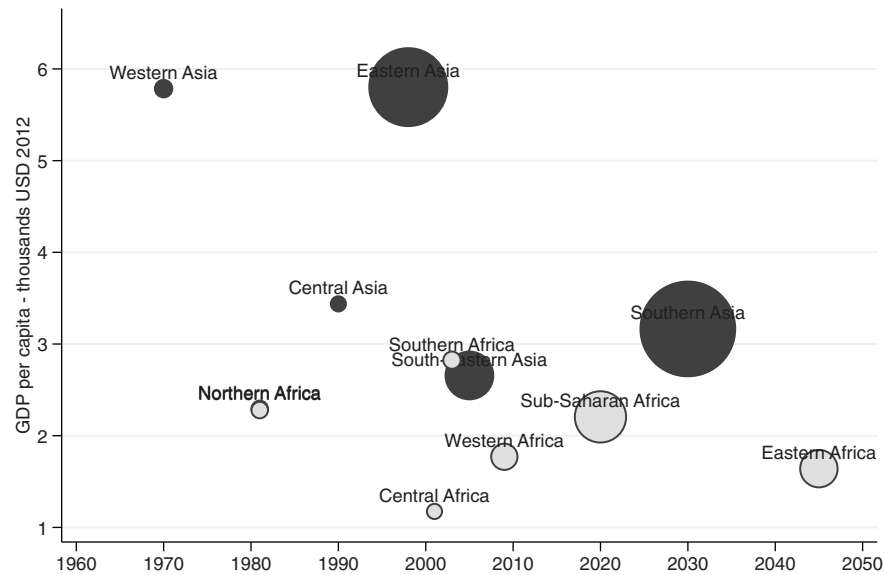


Fig. 10. GDP per capita and urban population in Africa and Asia when regions were 40% urbanized. Note: the graph shows the average per capita income of African and Asian regions in the year the region reached 40% of urbanization. The area of the circles is proportional to the total number of people living in urban areas. In 2004, 40% of Asian population (i.e. 1.5 billion people) was living in urban areas and GDP per capita stood at 4124 USD (constant 2012 prices). Almost 10 years later, in 2013, Africa was 40% urbanized with 450 million people living in urban area and a GDP per capita of only 2134 USD (constant 2012 prices).

Annex VII

Regional classification

Table 9
Regional classification.

Developed vs. Developing	Sub-region	country
Developing	Northern Africa	Algeria
Developing	Northern Africa	Egypt
Developing	Northern Africa	Libya
Developing	Northern Africa	Morocco
Developing	Northern Africa	Sudan
Developing	Northern Africa	Tunisia
Developing	Sub-Saharan Africa	Angola
Developing	Sub-Saharan Africa	Benin
Developing	Sub-Saharan Africa	Botswana
Developing	Sub-Saharan Africa	Burkina Faso
Developing	Sub-Saharan Africa	Burundi
Developing	Sub-Saharan Africa	Cameroon
Developing	Sub-Saharan Africa	Central African Republic
Developing	Sub-Saharan Africa	Chad
Developing	Sub-Saharan Africa	Congo
Developing	Sub-Saharan Africa	Côte d'Ivoire
Developing	Sub-Saharan Africa	Democratic Republic of the Congo
Developing	Sub-Saharan Africa	Eritrea
Developing	Sub-Saharan Africa	Eswatini
Developing	Sub-Saharan Africa	Ethiopia
Developing	Sub-Saharan Africa	Gabon
Developing	Sub-Saharan Africa	Gambia
Developing	Sub-Saharan Africa	Ghana
Developing	Sub-Saharan Africa	Guinea
Developing	Sub-Saharan Africa	Kenya
Developing	Sub-Saharan Africa	Lesotho
Developing	Sub-Saharan Africa	Liberia
Developing	Sub-Saharan Africa	Madagascar
Developing	Sub-Saharan Africa	Malawi
Developing	Sub-Saharan Africa	Mali
Developing	Sub-Saharan Africa	Mauritania
Developing	Sub-Saharan Africa	Mauritius
Developing	Sub-Saharan Africa	Mozambique
Developing	Sub-Saharan Africa	Namibia
Developing	Sub-Saharan Africa	Niger
Developing	Sub-Saharan Africa	Nigeria
Developing	Sub-Saharan Africa	Rwanda
Developing	Sub-Saharan Africa	Senegal
Developing	Sub-Saharan Africa	Sierra Leone
Developing	Sub-Saharan Africa	Somalia
Developing	Sub-Saharan Africa	South Africa
Developing	Sub-Saharan Africa	Togo
Developing	Sub-Saharan Africa	Uganda
Developing	Sub-Saharan Africa	United Republic of Tanzania
Developing	Sub-Saharan Africa	Zambia
Developing	Sub-Saharan Africa	Zimbabwe
Developing	Central America and the Caribbean	Costa Rica
Developing	Central America and the Caribbean	Cuba
Developing	Central America and the Caribbean	Dominican Republic
Developing	Central America and the Caribbean	El Salvador
Developing	Central America and the Caribbean	Guatemala
Developing	Central America and the Caribbean	Guyana

Developed vs. Developing	Sub-region	country
Developing	Central Asia	Kazakhstan
Developing	Central Asia	Kyrgyzstan
Developing	Central Asia	Tajikistan
Developing	Central Asia	Turkmenistan
Developing	Central Asia	Uzbekistan
Developing	Eastern Asia	China
Developing	Eastern Asia	China, Hong Kong SAR
Developing	Eastern Asia	Democratic People's Republic of Korea
Developing	Eastern Asia	Mongolia
Developing	Eastern Asia	Republic of Korea
Developing	South-eastern Asia	Cambodia
Developing	South-eastern Asia	Indonesia
Developing	South-eastern Asia	Lao People's Democratic Republic
Developing	South-eastern Asia	Malaysia
Developing	South-eastern Asia	Myanmar
Developing	South-eastern Asia	Philippines
Developing	South-eastern Asia	Thailand
Developing	South-eastern Asia	Viet Nam
Developing	Southern Asia	Afghanistan
Developing	Southern Asia	Bangladesh
Developing	Southern Asia	India
Developing	Southern Asia	Iran (Islamic Republic of)
Developing	Southern Asia	Nepal
Developing	Southern Asia	Pakistan
Developing	Southern Asia	Sri Lanka
Developing	Western Asia	Armenia
Developing	Western Asia	Azerbaijan
Developing	Western Asia	Georgia
Developing	Western Asia	Iraq
Developing	Western Asia	Jordan
Developing	Western Asia	Lebanon
Developing	Western Asia	Saudi Arabia
Developing	Western Asia	Turkey
Developing	Western Asia	Yemen
Developed	Northern America	Canada
Developed	Northern America	United States of America
Developed	Eastern Asia	Japan
Developed	Western Asia	Israel
Developed	Eastern Europe	Bulgaria
Developed	Eastern Europe	Hungary
Developed	Eastern Europe	Poland
Developed	Eastern Europe	Romania
Developed	Northern Europe	Denmark
Developed	Northern Europe	Finland
Developed	Northern Europe	Ireland
Developed	Northern Europe	Norway
Developed	Northern Europe	Sweden
Developed	Northern Europe	United Kingdom
Developed	Southern Europe	Albania
Developed	Southern Europe	Greece
Developed	Southern Europe	Italy
Developed	Southern Europe	Portugal

Developing	Central America and the Caribbean	Haiti
Developing	Central America and the Caribbean	Honduras
Developing	Central America and the Caribbean	Jamaica
Developing	Central America and the Caribbean	Mexico
Developing	Central America and the Caribbean	Nicaragua
Developing	Central America and the Caribbean	Panama
Developing	Central America and the Caribbean	Suriname
Developing	Central America and the Caribbean	Trinidad and Tobago
Developing	South America	Argentina
Developing	South America	Bolivia (Plurinational State of)
Developing	South America	Brazil
Developing	South America	Chile
Developing	South America	Colombia
Developing	South America	Ecuador
Developing	South America	Paraguay
Developing	South America	Peru
Developing	South America	Uruguay
Developing	South America	Venezuela (Bolivarian Republic of)

Developed	Southern Europe	Spain
Developed	Western Europe	Austria
Developed	Western Europe	Belgium
Developed	Western Europe	France
Developed	Western Europe	Germany
Developed	Western Europe	Netherlands
Developed	Australia and New Zealand	Australia
Developed	Australia and New Zealand	New Zealand

Table 10
African countries not included in the analysis.

region	country	2012 population (thousands)	share of African population
Western	Cabo Verde	514	0.05%
Southern	Comoros	724	0.07%
Central	Equatorial Guinea	1039	0.09%
Eastern	Djibouti	881	0.08%
Western	Guinea-Bissau	1638	0.15%
Central	Sao Tome and Principe	183	0.02%
Southern	Seychelles	92	0.01%
Northern	Western Sahara	496	0.04%
	<i>tot</i>	<i>5567</i>	<i>0.50%</i>
	<i>African population</i>	<i>1,104,216</i>	

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