Spatial Disparities in Child Growth Faltering in the Democratic Republic of Congo

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Abstract: This paper investigates the extent to which the differences in the growth faltering of children among provinces in the Democratic Republic of Congo (DRC) are due to differences in the marginal returns associated with household mobile endowments or differences in the household endowments themselves. The DRC faces severe resource constraints for investments in human capital improvements and poverty alleviation, resulting in significant trade-offs between targeting nutrition and poverty alleviation programs to poor provinces and programs directly targeting poor households or malnourished children. The analysis reveals that spatial differences in the returns to household mobile characteristics provide the primary explanation of the differences in child height-for-age z-scores in the DRC. Thus, in comparison to policies targeted to people, "place-based" policies that invest in communication networks, improve public infrastructure and access and/or quality of basic services, and develop institutions that will enhance local governance and build social capital, in provinces with high chronic malnutrition rates are likely to deliver impactful immediate and long-term development results in the DRC.

Keywords: FCV African Country, Geographic Inequities, Malnutrition.

1. INTRODUCTION

The Democratic Republic of Congo (DRC), one of the largest countries in Sub-Saharan Africa, is estimated to have the third largest number of poor in the world after India and Nigeria. The country is characterized by a high prevalence of child chronic malnutrition (stunting), limited access to basic services, low overall human capital, and significant spatial disparities in monetary and nonmonetary welfare and in the provision and access of basic services [1, 2].

Growth faltering, the rapid decline in height- and weight-for-age of children in the first two years of life is associated with impaired cognitive development, lower school attendance rates, reduced human capital attainment, and a higher risk of chronic disease and health problems in adulthood [3-5]. Inequities in access to services early in the life of a child also contribute to the intergenerational transmission of poverty. It is in response to the prevalence of growth faltering among children in developing countries that several global health policy and information campaigns emphasize the first 1,000 days window [6].

For[1] DRC, the value of the World Bank's Human Capital Index, a measure of the amount of human capital that a child born today can expect to attain by age 18, is 0.37. This implies that a child born in the DRC today will be 37 percent as productive when she grows up as she could be if she enjoyed a complete education and full health. This is lower than the average for the Sub-Saharan Africa region, and slightly lower than the average for low-income countries.[2]

In the context of limited budgetary resources for poverty alleviation and investments in human capital, a key policy concern is whether resources should be targeted towards poor regions or poor people. There is a general lack of consensus on how to deal with differences in the standard of living between regions (leading and lagging regions) and within regions (urban vs. rural areas within a given region) [7]. The lack of consensus on these two policy strategies can be attributed to two contrasting perspectives about the determinants of spatial differences in the monetary and nonmonetary dimensions of welfare: endowments vs. geography. The "endowments" hypothesis posits that

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[1]Recent World Bank estimates suggest that the per capita income penalty a country incurs for not having eliminated stunting when today's workers were children is around 7 percent of gross domestic product (GDP), on average. In Sub-Saharan Africa and South Asia, these figures rise to about 9-10 percent of GDP per capita [8].

[2]Specifically, the HCI conveys the productivity of the next generation of workers compared to a benchmark of complete education and full health. It is made up of five indicators: the probability of survival to age five, a child's expected years of schooling, harmonized test scores as a measure of quality of learning, adult survival rate (fraction of 15-year-old children that will survive to age 60), and the proportion of children who are not stunted. Globally, 56 percent of all children born today will grow up to be, at best, half as productive as they could be.

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chronic malnutrition is prevalent in a given area because of the concentration of individuals with personal attributes (such as low parental education) and household endowments (such as lack of productive or income-generating assets) that limit investment in child nutrition and human capital. According to this view, children in households with identical endowments will have the same nutritional prospects, independently of where they live. Differentials in access to basic services or income-earning opportunities between regions will drive migration, which will, holding all else equal, reduce any potential nutritional advantage associated with living in a region where income-earning opportunities are better and basic services are relatively more accessible. The policy focus that emerges from this perspective centers on enhancing a household's human capital endowments or characteristics (such as education and health) and improving their ability to make a better living.[3]

The "geography" hypothesis suggests that the primary cause of chronic malnutrition in different areas is low returns to household endowments and investments in child health and nutrition in different geographic locations. In areas with access to local public goods, such as infrastructure and other basic services (electricity, water, and sanitation), productivity levels and the returns to investments in human capital tend to be higher, thereby reducing the likelihood that a child gets sick or has diarrhea and thus increasing the potential benefits derived from the same investments in human capital. According to this view, if there are two children with identical attributes and identical household endowments, the one living in an area with lower access to public goods and basic services is more likely to be malnourished. Policies that emerge from this perspective focus on allocating resources in backward or lagging regions by improving public infrastructure and access to basic services, investing in communication networks, and developing institutions that will enhance local governance and build social capital.

In reality, of course, both of these hypotheses play a role in the observed spatial differences in the various dimensions of welfare. Ex ante, the human capital theory of migration would predict that the concentration of poorly endowed households in certain areas is the primary explanation for the differences in welfare across regions, since migration is expected to equalize returns to a given set of observable characteristics across regions within a country. However, in the DRC as in many other countries, the role of migration in equalizing returns may be limited by several factors such as the monetary and psychological costs of migration (the means of transportation, the disruption of social ties and cultural values), and the uncertainty of its benefits (the low probability of getting a high paying job or the risk of unemployment).[4]

In such a context, the relative contribution of differences in household mobile endowments across space to differences in the returns to these endowments across space in explaining differences in welfare across space becomes of paramount concern in the design of policies. This article sheds light on the question of whether policies aiming to improve child malnutrition in the DRC should be "place-based" and thus target resources to the geographic areas where child chronic malnutrition is higher, or "people-based" targeting malnourished children. Specifically, the following two main questions are addressed: (i) How does child chronic malnutrition vary among the 26 provinces of the DRC? (ii) Are these mean differences in chronic malnutrition mainly due to differences in returns to mobile endowments or differences in household mobile endowments in a given province, such as the level of education and family composition?

In our analysis, we distinguish between mobile endowments (embodied in individuals through, for example, their level of education or in households by the age and gender composition of household members) and immobile endowments and/or geographic characteristics. In our framework, investments in physical infrastructure serve as policy instruments that can increase returns to household endowments in areas with lower returns, allowing households to move to places where they can obtain the highest returns for their mobile endowments.

[3]Conditional cash transfer programs targeted at the household level -such as *PKH* (*Program Keluarga Harapan*) in Indonesia, *Oportunidades* in Mexico, *Bolsa Familia* in Brazil, and *Familias en Acción* in Colombia, among others - are good examples of this policy focus.

[4]Another critical factor is the presence of agglomeration economies, brought to prominence by new theories in economic geography [9]. "Agglomeration economies" summarize all the external economies of scale that arise from economic interactions between producers located next to each other in selected areas or regions of a country. These include the benefits of localization (being near other producers of the same commodity or service) and urbanization (being close to other producers of a wide range of commodities and services). In the presence of agglomeration economies, the size of the market grows in the destination region as labor migrates in response to an initial wage differential. As a result, through a variety of mechanisms related to scale economies, the real wage in the destination region increases rather than decreases [10].

The paper is structured as follows. Section 2 presents the data used and the methodological framework that guides the empirical analysis. Section 3 presents and interprets the results of the study, while Section 4 concludes with some of the policy implications.

2. DATA AND METHODS

Data

The analysis is based on the cross-sectional Multiple Indicators Cluster Survey (MICS) for DRC. For logistical reasons related to implementation, this survey was conducted in December 2017 (in Kinshasa) and between February - July 2018 in the remaining provinces. MICS is an international household survey program that collects information about the health, nutrition, education, and early development of children and their families in developing countries. Based on several questionnaires-including a household questionnaire, an individual women's questionnaire, a separate men's questionnaire, and a children's questionnaire-the 2017-2018 MICS for DRC gathered information on the socio-economic and demographic characteristics of households (such as household size and composition, gender of the household head, access to water, sanitation, and electricity, possession of assets, housing characteristics, etc.), children's health and nutrition (including vaccination, nutrition, and access to healthcare), as well as reproductive health, education, and employment among women and men. More specifically, the survey covers 21,477 children less than 60 months of age,[5] and is designed to be representative at the national level, and by province, as well as for urban and rural areas within each of the 26 provinces of DRC [11].[6]

Child growth retardation (or faltering) is measured by the height-for-age Z score (HAZ), which is defined as the difference between a child's height and the median height of a healthy reference population (based on the 2006 WHO child growth reference population) divided by the standard deviation of the height in the reference population. A child is considered stunted if their height-for-age Z-score (HAZ) is more than two standard deviations (SD) below the median height of a healthy reference population (that is, HAZ <-2SD).[7] The focus on the continuous measure of HAZ rather than the binary variable of whether a child is stunted or not, provides the opportunity to take into account the fact that linear growth retardation occurs both among children classified as stunted as well as children who do not have a HAZ <-2SD; [12, 13]. This is particularly important for DRC, where essentially all children across the HAZ spectrum manifest a height deficit relative to their potential under optimal growth conditions.

The socioeconomic differences in the patterns of growth faltering serve as preliminary indicators of the geographic areas or groups of children in need of targeted interventions. Figure **1** below presents evidence on the growth faltering prevalent among children in the DRC by location (rural/urban), child gender, household wealth status, and the education level of the mother. There are apparent differences in the level and speed at which growth retardation takes place between urban and rural areas, boys and girls, and households at the top and bottom of the wealth distribution (based on the wealth index provided by the MICS). In contrast to the pattern prevailing in SSA countries (see Fig. 3.3f in [14]), there are no significant differences in the level and speed of child growth retardation depending on the level of education of the child's mother.

In consideration of the prevalence of stunting in the policy arena, Figure **2** below presents the geographic distribution of the stunting rate (rather than the mean growth faltering or mean HAZ scores) among children less than 60 months of age. The differences in stunting rates among provinces are compounded by differences in the prevalence of stunting between urban and rural areas within provinces, a topic also investigated below.

The set of *portable* or *mobile* household endowments (denoted below by X) included in the analysis consists of variables that characterize the mother of the child, the head of the household, and the demographic composition of the household.

The specification intentionally excludes from the model the proximity to and/or use of basic services such as health facilities, electricity, quality of water and sanitation facilities, the ownership of assets by the household typically summarized by a wealth or asset index, and information about the type and quality of

[5]The response reported by the MICS is 99.9%

[6]The DRC MICS 2017-18 is representative of both urban areas, including provinces, towns, and cities, and rural areas. The following link provides access to the full DRC MICS report, which includes descriptive statistics such as distributions by gender, place of residence, and age: [Congo, Democratic Republic of the, 2017-18 MICS SFR_French.pdf].

[7]A child is classified as severely stunted if HAZ<-3.

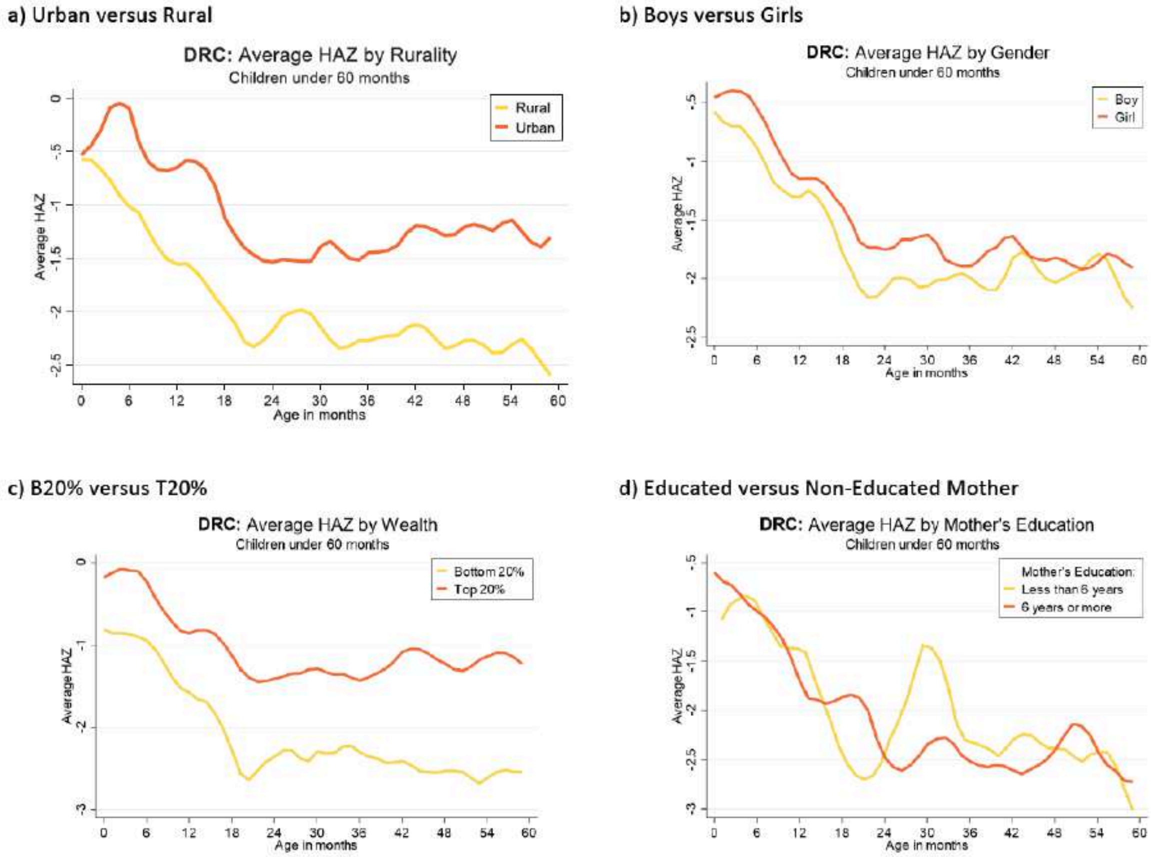

Figure 1: Growth faltering in the DRC by socio-economic characteristics (children 0–59 months).

Source: World Bank staff estimates based on the DRC MICS 2017-18.

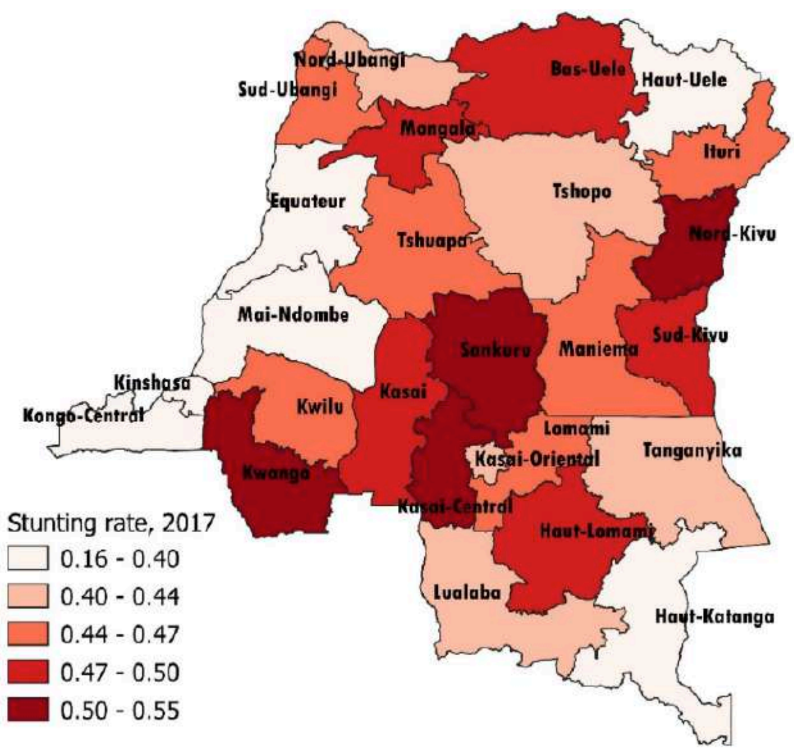

Figure 2: The geographic (provincial) distribution of stunting (children less than 5 years old).

Source: World Bank staff estimates based on the DRC MICS 2017-18.

materials of the household residence, such as floor, walls, and roof. The influence of these basic services, asset ownership, and other unobserved or purposely omitted variables on child growth faltering is assumed to be captured by the estimated coefficients of the household's portable characteristics. Thus, access to a paved road may impact child HAZ indirectly by facilitating access to employment opportunities for household members of different ages, genders, and education levels. As the formula for omitted variable bias suggests, the estimated coefficients of the portable household characteristics can be considered as inclusive of the direct effect of the omitted variables (such as basic services, infrastructure, local institutions and other household variables possibly correlated with the location of the household) on child height and the correlation of these omitted variables with the included portable household characteristics.

METHODS

The various determinants of child faltering (HAZ) are classified into two broad groups: (i) a set of "covariates" that summarize the portable or non-geographic attributes of the household, such as age, level of education, demographic composition, denoted by the vector X; and (ii) and a set of structural parameters that summarize the marginal effects or "returns" of these household attributes, denoted by the constant term α and the parameter vector β.[8] Using more formal notation, and assuming for simplicity, only two mobile characteristics or endowments for a given household, for example, the level of education of the household head, denoted by X_1 , and the number of children in the household, denoted by X_2 , the determinants of child HAZ, in any given province p, may be summarized by the equation

$$HAZ^p(i) = \alpha^p + \beta_1^p(Z_1^p, Z_2^p; \theta)X_1^p + \beta_2^p(Z_1^p, Z_2^p; \theta)X_2^p + \varepsilon^p(i) \quad (1)$$

where $\varepsilon^p(i)$ is a random disturbance term with the usual properties summarizing the influence of all other factors on child HAZ. The returns to any given mobile characteristic X^p may be considered as the realized values of the underlying functions $\beta_1^p(\ )$ and $\beta_2^p(\ )$ summarizing the relationship between the returns to any given mobile endowment and location-specific variables such as access to paved roads Z_1^p and health facilities Z_2^p,

$$\beta_j^p = \beta_j^p(Z_1^p, Z_2^p; \theta) \quad (2)$$

where j=1,2 and θ summarizes the role of institutional factors that are common across locations. Thus, the coefficients β or the "returns" to characteristics summarize the influence of a variety of factors on child HAZ in different provinces. Basic infrastructure, ease of access to markets, and other basic services are among the most important of these factors. In addition, returns to characteristics are also affected by the role of institutions, social customs, and other cultural factors that are typically too difficult to quantify. The direct effect of the location-specific variables on HAZ could be incorporated into the model by adding the terms $\gamma_1^p Z_1^p$ and $\gamma_1^p Z_2^p$ in equation (1) above.

3. RESULTS

Actual vs. Simulated Child Growth Faltering

To determine the main factors that contribute to spatial differences in child HAZ we investigate the correlation between the average (actual) HAZ score of children and two simulated HAZ score profiles: (i) a returns (or geographic) profile; based on the simulated HAZ score holding constant household endowments or characteristics at the province level (and allowing coefficients or returns to differ across rural and urban areas of provinces); and (ii) an endowments (or characteristics) profile, based on the simulated HAZ score while holding constant "returns" at the national level (and allowing mean endowments to differ across urban and rural areas within provinces). This is a variant of the method initially employed for Bangladesh, extending the traditional Oaxaca decomposition to explain the gap in the means of an outcome variable between only two groups [15].

The actual profile of the mean HAZ across the 26 urban and 25 rural areas of DRC is derived by first estimating a separate regression using ordinary least squares (OLS) on the sample of children in each of the 51 different areas, 26 urban and 25 rural areas of provinces.

$$HAZ_U^p(i) = \alpha_U^p + \beta_U^p X_U^p(i) + \varepsilon_U^p(i) \text{ where } p = 1, \dots, 26 \quad (3)$$

$$HAZ_R^p(i) = \alpha_R^p + \beta_R^p X_R^p(i) + \varepsilon_R^p(i) \text{ where } p = 1, \dots, 25$$

Given that regression lines always cross the sample mean values of the dependent and independent

[8]Equation (1) may be considered as a reduced form equation derived from the "health production function" framework, which treats social, economic, and environmental factors as inputs of a production system [16].

variables in the sample, the estimated coefficients of equation (3) can be used to derive the mean value or actual profile of HAZ in the 26 urban and 25 rural areas of provinces (at the sample mean value of the independent variables).[9]

The *geographic* profile of mean HAZ may be derived based on the estimated province-specific urban and rural coefficients and the mean household characteristics at the national level, as in the expression (4) below:

$$\widehat{HAZ}_U^p = \widehat{\alpha_U^p} + \widehat{\beta_U^p}\, X^N \text{ where } p = 1, \ldots, 26 \quad (4)$$

$$\widehat{HAZ}_R^p = \widehat{\alpha_R^p} + \widehat{\beta_R^p} X^N \text{ where } p = 1, \ldots, 25$$

where $\widehat{HAZ}_J^p$ denotes the mean predicted HAZ score in province p, $\widehat{\alpha_J^p}$, and $\widehat{\beta_J^p}$ are the estimated coefficients for urban ($j = U$), and rural ($j = R$) areas in province p, and X^N denotes the mean (using population weights) characteristics of households at the national level.

The *endowments profile* of mean HAZ is derived as the mean simulated welfare ratio for each district by "holding returns constant" as the national average and allowing characteristics to vary by urban and rural areas within provinces, i.e.,

$$\widehat{HAZ}_U^p = \widehat{\alpha^N} + \widehat{\beta^N}\, \overline{X_U^p} \text{ where } p = 1, \ldots, 26 \quad (5)$$

$$\widehat{HAZ}_R^p = \widehat{\alpha^N} + \widehat{\beta^N}\, \overline{X_R^p} \text{ where } p = 1, \ldots, 25$$

where $\overline{X_J^p}$ represents the mean characteristics of households in urban ($j = U$), and rural ($j = R$) areas in province p, and the parameters are calculated as population-weighted means:

$$\alpha^N \equiv \textstyle\sum_{p=1}^{26} \widehat{\alpha_U^p}\, s_U^p + \sum_{p=1}^{25} \widehat{\alpha_R^p}\, s_R^p \quad (6)$$

$$\beta^N \equiv \textstyle\sum_{p=1}^{26} \widehat{\beta_U^p}\, s_U^p + \sum_{p=1}^{25} \widehat{\beta_R^p}\, s_R^p$$

where s_U^p denotes the share in the total population in the country in urban areas of province p, and s_R^p is the share in the total population in rural areas of province p.

Table **2** below presents the actual profile of the mean HAZ scores in the 26 urban and 25 rural areas of DRC, along with the simulated returns and endowments profiles of mean HAZ. The correlation between the actual HAZ profile and the simulated "returns" profile of HAZ is 0.533 in urban areas and 0.691 in rural areas. In contrast, the correlation between the actual HAZ profile and the simulated endowments profile of HAZ is 0.333 in urban areas and 0.2182 in rural areas. [10] Thus, the simulated returns or geographic profile exhibit a significantly stronger correlation with the actual welfare profile compared to the endowments profile in both urban and rural areas. This implies that the *differences in the returns* to household mobile endowments are the main correlates of spatial disparities in children's growth faltering in the DRC.

Determinants of Child Growth Faltering within and between Geographic Areas

To explore further differences in mean child HAZ in urban and rural areas within and between any two provinces we also employ the Oaxaca method.[11] The Oaxaca decomposition allows us to estimate the relative contributions of differences in household characteristics and returns to these characteristics in accounting for differences in child HAZ. Given any two geographic areas or groups A and B, we assume that the linear regression can summarize HAZ in each area/group:

$$HAZ^A = \beta^A X^A + \varepsilon^A \quad (7)$$

$$HAZ^B = \beta^B X^B + \varepsilon^B$$

Based on the specification above, and given that estimated regression lines always cross through the mean values of the sample, the mean difference in the HAZ of children between provinces A and B may then be expressed as:

[9] Likely, estimates of specific coefficients of interest, such as education, obtained by OLS are subject to self-selection bias (due to selective migration, for example). However, the presence of a selection bias does not necessarily imply that its size is sufficiently large to reverse or invalidate the general inferences drawn from an analysis without correcting for such bias. An ingenious method for correcting for selection bias in the estimation of the returns to education for each of the 51 states in the US is proposed in [17]. The US is characterized by a high mobility of labor across states, so one would expect that estimates of the state-level returns to education by OLS are seriously biased. It is found that there is indeed an upward bias in the OLS estimates, but this bias is slight (estimates of the rate of return to education fall by 10% after correcting for selection). Interestingly, even after correcting for selection bias in the state-level estimates in the US (where mobility is high), he finds that the rate of return to education continues to be quite different across states.

[10] We also compared and confirmed that the variance of the returns or endowment profiles explains a larger fraction of the total variance of the actual welfare profile.

[11] Earlier applications of the Oaxaca decomposition to explain inequalities in health among poor and nonpoor households include [18-19]. To our knowledge, this is the first application of the Oaxaca decomposition to explaining spatial disparities in child growth faltering.

Table 1: List of Portable Household Endowments

Set of portable household endowments	Variables
Household characteristics	Household size and composition including dependency ratio (ratio of members less than 16 years and above 64 years to the number of 16-64 years old adults), and home ownership
Household head's characteristics	Age, years of education, religion, language spoken, ethnicity
Mother's characteristics	Years of education, age, source of information from the media, number of births given, and current pregnancy status
Child characteristics	Gender, age in months, birth order, and whether the child is a twin

Notes: Descriptive statistics by province of the variables used to summarize the portable endowments of households are provided in the Annex of the paper.

Table 2: Profiles of mean Height-for-age Z scores (HAZ) for Urban and Rural areas within Provinces

Province	Urban			Rural		
	Actual	Returns	Endowments	Actual	Returns	Endowments
Kinshasa	-0.55	-0.95	-1.34			
Kongo Central	-1.20	-0.83	-1.51	-1.54	-1.03	-1.60
Kwango	-1.60	-1.65	-1.45	-2.20	-2.15	-1.51
Kwilu	-1.55	-0.54	-1.58	-1.71	-2.09	-1.55
Maindombe	-1.59	-1.57	-1.48	-1.53	-1.57	-1.49
Equateur	-1.30	-1.37	-1.53	-1.35	-1.18	-1.51
Sud Ubangi	-1.12	-1.00	-1.46	-1.83	-1.45	-1.59
Nord Ubangi	-1.47	-1.54	-1.54	-1.50	-1.20	-1.67
Mongala	-1.47	-1.29	-1.44	-1.82	-1.68	-1.57
Tshuapa	-1.41	-1.43	-1.52	-1.67	-1.58	-1.58
Tshopo	-1.24	-1.52	-1.52	-1.82	-1.66	-1.61
Bas Uele	-1.95	-2.25	-1.51	-1.94	-1.60	-1.61
Haut Uele	-0.81	-1.63	-1.50	-1.53	-1.05	-1.69
Ituri	-0.86	-0.36	-1.54	-2.06	-2.10	-1.67
Nord Kivu	-1.18	-1.53	-1.40	-2.32	-1.98	-1.61
Sud Kivu	-1.47	-1.09	-1.44	-2.30	-2.44	-1.67
Maniema	-1.41	-2.06	-1.57	-1.66	-1.99	-1.55
Haut Katanga	-1.26	-1.20	-1.53	-1.78	-1.41	-1.59
Lualaba	-1.16	-1.17	-1.55	-1.85	-2.21	-1.56
Haut Lomami	-1.35	-1.61	-1.59	-1.95	-2.20	-1.63
Tanganyika	-1.59	-1.73	-1.67	-1.31	-1.46	-1.60
Lomami	-1.09	-1.04	-1.50	-1.83	-1.66	-1.60
Kasai Oriental	-1.16	-1.53	-1.48	-1.92	-1.26	-1.68
Sankuru	-1.95	-1.78	-1.48	-1.78	-1.25	-1.65
Kasai Central	-1.18	-1.04	-1.52	-2.07	-2.17	-1.61
Kasai	-1.65	-1.41	-1.58	-1.76	-1.38	-1.63

Source: Authors' estimates based on the DRC MICS 2017-18.

$$E(HAZ^A) - E(HAZ^B) = \beta^A E(X^A) - \beta^B E(X^B) \quad (8)$$

where $E(\ \ )$ is the expected value (or sample mean) of the respective variables, and including the assumption that $E(\varepsilon_j) = 0$, where $j = A, B$

After adding and subtracting the term $\beta^B E(X^A)$, the difference in equation (8) above may be expressed as

$$E(HAZ^A) - E(HAZ^B) = \left(E(X^A) - E(X^B)\right)\beta^B + (\beta^A - \beta^B)E(X^A) \quad (9)$$

Alternatively, if one were to add and subtract the term $\beta^A E(X^B)$, the difference in (8) could be expressed as:

$$E(HAZ^A) - E(HAZ^B) = \left(E(X^A) - E(X^B)\right)\beta^A + (\beta^A - \beta^B)E(X^B) \quad (10)$$

Both expressions (9) and (10) imply that the differential in the mean HAZ between provinces A and B can be decomposed into two components: one that consists of the differences in mean characteristics or endowments, summarized by the term $\left(E(X^A) - E(X^B)\right)$ and another due to the differences in the coefficients or returns to characteristics between the different groups, summarized by the term $(\beta^A - \beta^B)$. The decompositions given by expressions (9) and (10) are equally valid. The only difference between them lies in how the differences in characteristics and coefficients are weighted. In expression (9), the differences in the traits are weighted by the returns of the attributes in province B. In contrast, the differences in the returns are weighted by the average characteristics of households in province A. In contrast, in expression (10), the differences in the traits are weighted by the returns of the attributes in province A. In comparison, the differences in the returns are weighted by the average characteristics of households in province B.

Various papers have extended the method by proposing alternative weights for the differences in characteristics and returns [20 - 22]. A weighted average of the coefficients and a weighted average of the characteristics are used, based on a pooled model over the groups compared, such as provinces or urban vs. rural areas within the country, or urban vs. rural within each province [23].[12]

The use and interpretation of the decomposition method discussed above involve several caveats. For a start, these decompositions are simple descriptive tools that provide a helpful way of summarizing the role of endowments and returns in explaining existing HAZ differentials. For this reason, we refrain from attributing causality to either endowments or returns in the differences in child HAZ between or within regions. Our specification intentionally excludes infrastructure and access to basic services. The influence of infrastructure, as well as other omitted variables, is captured by default by the estimated coefficients of the household's portable characteristics. As the formula for omitted variable bias suggests, the estimated coefficients of the household characteristics may be considered as inclusive of the direct effect of the omitted variables (such as infrastructure, local institutions, and other household variables possibly correlated with the location of the household) on child HAZ and the correlation of the omitted variables with the included household characteristics. The decomposition formula in equations (6) of (7) hold only at the mean of the pair of groups compared. The findings obtained from the decompositions at the mean may or may not hold at other deciles of the distribution of HAZ.[13] Lastly, the decomposition results may be biased because of the presence of selection bias. To the extent there is free internal migration within and between different provinces, the current place of residence may not be exogenous.

Dividing both sides of equations (9) or (10) above by the difference in HAZ between group A and B (denoted by ΔHAZ) allows one to determine the fraction of the differential that can be attributed the difference in endowments (ΔX) between the two groups and the fraction of the differential that can be attributed to differences in the returns between the two groups $\Delta\beta$, i.e.,[14]

$$\Delta HAZ = \Delta X + \Delta\beta, \text{ or } 1 = \left(\frac{\Delta X}{\Delta HAZ}\right) + \left(\frac{\Delta\beta}{\Delta HAZ}\right) \quad (11)$$

Differences Across Urban Areas of Provinces

Taking advantage of the fact that the MICS survey is representative for urban and rural areas separately within each province, it is also possible to examine the difference between metropolitan areas of each province (*p*= 2,…, 26) and Kinshasa (*p*= 1)

$$HAZ_U^p = \alpha_U^p + \beta_U^p X_U^p + \varepsilon_U^p \quad (12)$$

$$HAZ_U^1 = \alpha_U^1 + \beta_U^1 X_U^1 + \varepsilon_U^1$$

Access to basic services is likely higher in the urban areas of provinces compared to rural areas within the

[12]Specifically, the differences reported are based on the following expression $E(HAZ^A) - E(HAZ^B) = \left(E(X^A) - E(X^B)\right)[\boldsymbol{W}\beta^A + (\boldsymbol{I} - \boldsymbol{W})\beta^B] + [(\boldsymbol{I} - \boldsymbol{W})E(X^A) + \boldsymbol{W}\,E(X^B)]\,(\beta^A - \beta^B)$ where $\boldsymbol{W}$ is a matrix of relative weights given to the coefficients of province A and $\boldsymbol{I}$ is the identity matrix.

[13]For an analysis of the differences in HAZ at different points of the distribution of HAZ, besides the mean (or median), the Recentered Influence Function regression method (RIF) may also be used [24].

[14]It should be noted that occasionally, either the ratio ($\Delta X/\Delta HAZ$) or the ratio ($\Delta\beta/\Delta HAZ$) can be greater than 1 (in absolute value). Given that the sum of the two terms has to equal to 1 (or 100%) then the fraction of the differential attributed to the other term will have to be of opposite sign.

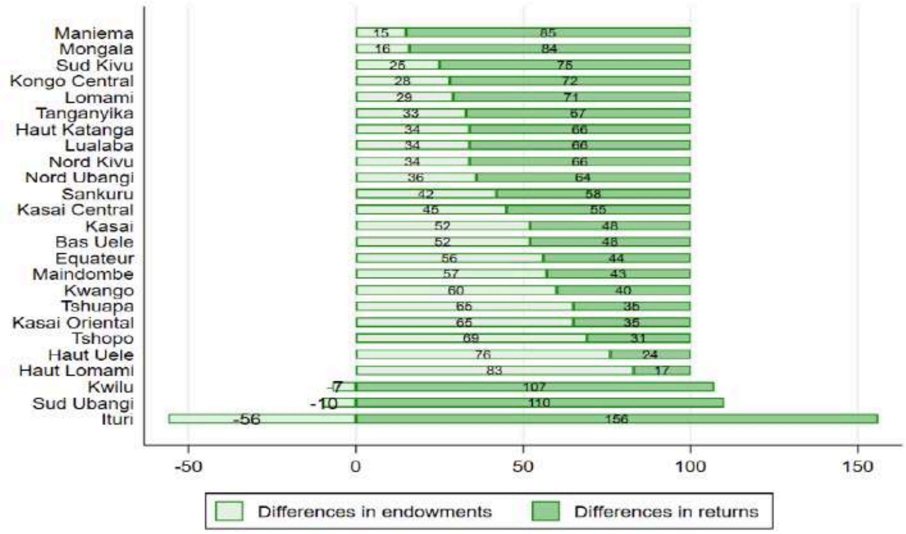

Figure 3: Decompositions of HAZ differences between Urban areas in the provinces of the DRC (vs Kinshasa)

Source: Authors' estimates based on the DRC MICS 2017-18

same province. A comparison of the urban regions within provinces that are more similar to Kinshasa on the surface helps determine whether the role of differences in returns remains dominant when comparing the differences in mean HAZ at the province level with Kinshasa. Figure **3** reveals that in 15 out of 25 provinces, differences between mean HAZ in urban areas in these provinces and mean HAZ in Kinshasa are explained primarily by differences in returns (i.e., the fraction of the differential attributed to differences in returns is 50% or more). The 10 provinces where differences in portable household characteristics play a relatively more important role than differences in returns are: Haut Lomami, Haut Uele, Tshopo, Kasai Oriental, Tshuapa, Kwango, Maindombe, Equateur, Bas Uele, and Kasai.

Differences Across Rural Areas of Provinces

A similar comparison is carried out between rural areas of each province (*p* = 3,…, 26) and rural Kongo Central (*p* =2) by estimating the model.

$$HAZ_R^p = \alpha_R^p + \beta_R^p X_R^p + \varepsilon_R^p \quad (13)$$

$$HAZ_R^2 = \alpha_R^2 + \beta_R^2 X_R^2 + \varepsilon_R^2$$

Figure **4** presents the decomposition estimates for the 12 provinces, highlighting significant differences in mean child HAZ scores between rural areas and the overall mean HAZ score in rural Kongo Central.[15] The latter is used as the comparison group instead of Kinshasa, because Kinshasa is an exclusively urban province. As before, in the majority of these provinces (9 out of 12 provinces), differences in mean HAZ scores can be attributed mainly (50% or more) to differences in the returns. The three provinces where differences in endowments provide the primary explanation for the differential in HAZ scores are Lomami, Kasai, and Sud Ubangi.

The province of Sud Ubangi, in particular, appears to have very low household endowments of portable characteristics in both urban and rural areas. In the comparison of the gaps in HAZ between urban regions in Sud Ubangi with Kinshasa (Figure **3**) or between rural areas of Sud Ubangi and rural Kongo Central (Figure **4**), differences in endowments appear to play a dominant role.

Differences between Urban and Rural Areas within Provinces

The last comparison concerns the differential between urban and rural areas within each of the 25 provinces (excluding Kinshasa, which is exclusively an urban province). Thus, the model estimated for each province *p* where *p*=2,…,26, is

$$HAZ_U^p = \alpha_U^p + \beta_U^p X_U^p + \varepsilon_U^p \quad (14)$$

$$HAZ_R^p = \alpha_R^p + \beta_R^p X_R^p + \varepsilon_R^p$$

Figure **5** reports the decomposition results for the 16 provinces in which there were significant differences in the gap in child HAZ scores between urban and rural

[15]eChild HAZ scores did not differ significantly in the rural areas of the remaining provinces.

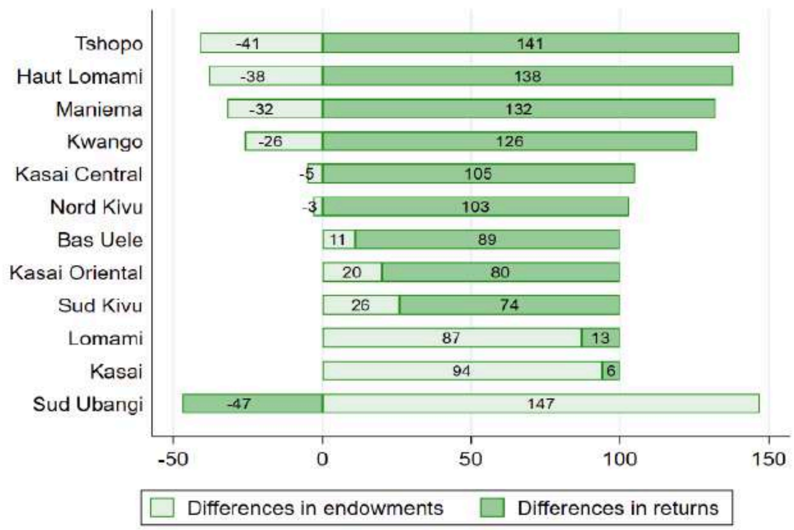

Figure 4: Decompositions of HAZ differences between Rural areas in the provinces of the DRC (vs Rural Kongo Central).

Source: Authors' estimates based on the DRC MICS 2017-18.

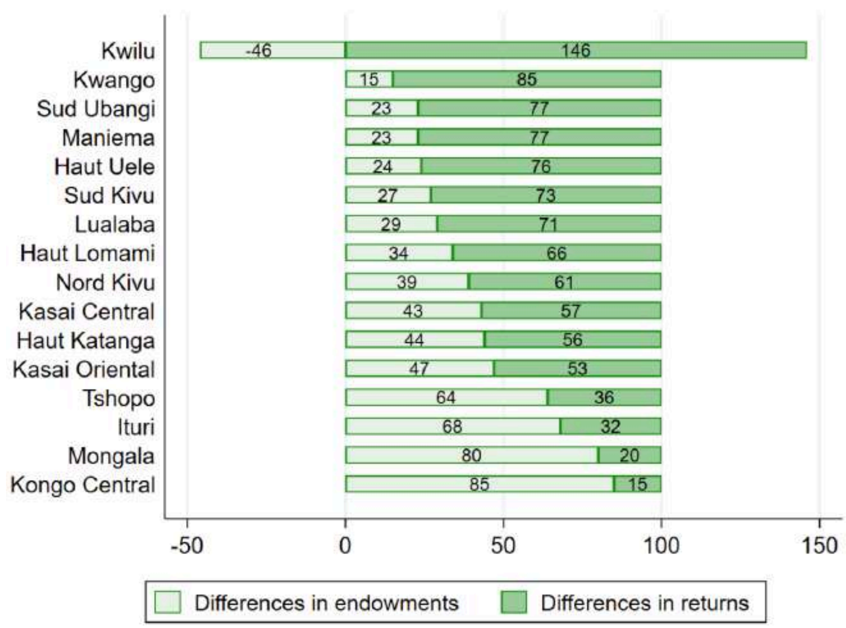

Figure 5: Decompositions of HAZ differences between urban and rural areas within each province of the DRC.

Source: Authors' estimates based on the DRC MICS 2017-18.

areas. Again, consistent with the earlier findings, in the majority of these provinces (12 out of 16 provinces), differences in mean HAZ scores can be attributed mainly (50% or more) to differences in the returns. The four provinces where differences in endowments provide the primary explanation for the differential in HAZ scores between urban and rural areas are Kongo Central, Mongala, Ituri, and Tshopo.

Limitations of the Study

Given the poverty and scarcity of statistical data in the DRC, the study uses the available cross-sectional data. For instance, having access to panel data would have made it possible to use more sophisticated models that could account for other effects, including additional direct effects of geographic factors.

4. CONCLUSIONS AND POLICY CONSIDERATIONS

Overall, the analysis reveals that spatial differences in the returns to household mobile characteristics provide the primary explanation for the differences in child growth faltering or HAZ scores in the DRC. Both the comparison of actual versus simulated child growth faltering as well as the Oaxaca decomposition of HAZ suggest that it is the returns and not endowments that drive the differences in provincial HAZ rates. Thus, in contrast to policies targeting people, “place-based” policies that invest in communication networks, improve public infrastructure and access and/or quality of basic services, and develop institutions that will enhance local governance and build social capital, in provinces with high chronic malnutrition rates are likely to deliver impactful, immediate, and long-term development results in the DRC.

Migration models would predict a movement of people until the marginal returns across geographic areas are equalized and the incentives to migrate vanish. How can the persistence of these differences in returns be explained? There are at least three possible complementary explanations.

In principle, unconstrained and costless migration should facilitate the equalization of returns, as the existence of higher returns in a particular area draws labor from lower return areas until returns are equalized. In a Harris-Todaro model, where migration decisions are based on expected net benefits, not just wage differentials, the low predicted probability of finding a good job in the city, given lower rural education levels, would decrease the incentives for rural to urban migration, thereby allowing returns to differ. Other factors such as high migration costs, insufficient land rights, and social segmentation may also be creating barriers to migration. Second, the analysis presented in this study does not control for the quality of some of the portable characteristics analyzed-for instance, education. Suppose the quality of education in lagging areas is lower than in leading regions. In that case, the returns to education with respect to child growth faltering will be lower in the former than in the latter. The lower returns of lower quality education on child HAZ are likely to be reinforced by the extent to which labor markets recognize lower quality education and assign lower wages and more limited employment opportunities. Another possibility is that positive agglomeration effects are elevating returns in large metropolitan areas. As described in the New Economic Geography literature, agglomeration economies are characterized by increasing economies of scale. With better infrastructure, a high degree of market specialization, greater competition, information exchange, and more efficient matching in the labor market, the environment is conducive to lowering costs and producing higher returns [9]. Thus, one could expect metropolitan areas of leading regions to have both high returns from increasing economies of scale and a higher concentration of individuals with valuable human capital assets (both observable education and unobservable ability and motivation) as talented workers are attracted to the higher rates of return and a wider range of employment opportunities.

ACKNOWLEDGEMENTS

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ANNEX

In Table **A1**, each portable endowment in the sample is regressed against a binary variable identifying rural areas and 25 binary variables, one for each province in DRC (with the province of Kinshasa as the reference province included in the constant term). Invariably, the mean values of the household portable endowments are significantly lower in the provinces other than Kinshasa. This, on the surface, points in favor of the endowments hypothesis that argues that the primary determinant of welfare (measured either as the prevalence of malnutrition or poverty) across provinces is the concentration of people with lower endowments in certain areas.

Tables **A2**, **A3**, and **A4** below summarize the spatial differences in the deprivations in basic services and other living conditions experienced by the populations in different provinces and in urban and rural areas within provinces.

Table A.1: Differences in Mean HAZ and household portable endowments across provinces (relative to Kinshasa)

Province	HAZ	age	Girl	Twin	hhsize	nchlt5	dep_ratio	nom_edu	mom_age	m_media	om_births	pregnant	age_hoh	ed_hoh	language	nobantou	notOWN
Kongo Central	-0.915***	-2.150**	-0.047	0.013	-0.527***	-0.122**	0.328***	-3.936***	-0.739*	-0.484***	0.394***	-0.052	-3.309***	-4.244***	0.031	-0.012	-0.367***
Kwango	-1.345***	-0.520	0.009	0.004	-0.832***	0.186***	0.312***	-2.557***	-0.964**	-0.462***	0.096	0.033	-4.306***	-2.503***	-0.765***	-0.012	-0.541***
Kwilu	-1.031***	-1.470	-0.013	0.016	-0.568***	-0.033	0.594***	-2.853***	-0.715*	-0.741***	0.701***	0.006	-5.141***	-2.390***	-0.779***	-0.010	-0.595***
Maindombe	-0.997***	-0.921	-0.022	-0.005	-0.771***	-0.085*	0.401***	-2.745***	-0.683	-0.720***	0.533***	-0.017	-5.280***	-2.480***	-0.535***	-0.005	-0.431***
Equateur	-0.816***	-1.381	0.014	0.009	-0.532***	0.017	0.477***	-3.644***	-0.862**	-0.662***	0.860***	0.056	-6.812***	-2.653***	-0.616***	0.007	-0.357***
Sud Ubangi	-1.250***	-2.966***	-0.044	-0.003	-0.616***	0.007	0.644***	-5.540***	-2.184***	-0.560***	0.877***	0.047	10.423***	-4.198***	-0.607***	0.746***	-0.305***
Nord Ubangi	-1.080***	-2.187**	-0.027	-0.005	-0.450***	0.048	0.570***	-6.315***	-1.849***	-0.574***	0.729***	0.002	-8.726***	-4.913***	-0.927***	0.861***	-0.497***
Mongala	-1.087***	-1.939*	-0.025	-0.004	-0.713***	0.045	0.537***	-4.960***	-1.558***	-0.644***	0.553***	-0.003	-8.518***	-3.604***	-0.140***	0.106***	-0.370***
Tshuapa	-0.995***	-1.935*	-0.024	-0.008	-0.594***	0.011	0.530***	-4.755***	-0.789*	-0.656***	0.627***	0.076*	-7.561***	-3.579***	-0.744***	0.082***	-0.284***
Tshopo	-1.101***	-1.591*	-0.005	0.023**	0.234*	0.275***	0.431***	-4.539***	-2.001***	-0.611***	0.702***	0.020	-5.280***	-3.333***	-0.047**	-0.002	-0.330***
Bas Uele	-1.302***	-2.005*	0.013	0.006	-0.924***	-0.032	0.474***	-5.429***	-1.744***	-0.636***	0.413***	0.068*	-8.686***	-4.645***	-0.099***	0.122***	-0.410***
Haut Uele	-0.915***	-1.913*	-0.018	0.015	-1.010***	-0.041	0.513***	-5.392***	-2.039***	-0.580***	0.436***	0.130***	-7.856***	-4.903***	-0.365***	0.411***	-0.424***
Ituri	-1.078***	-0.962	0.048	-0.008	-0.358***	0.050	0.548***	-4.869***	-2.042***	-0.604***	0.590***	0.015	-7.168***	-4.385***	-0.729***	0.831***	-0.441***
Nord Kivu	-1.498***	-2.190**	-0.021	-0.002	0.086	0.171***	0.552***	-3.839***	-1.596***	-0.467***	0.857***	-0.023	-7.431***	-4.185***	-0.513***	-0.004	-0.405***
Sud Kivu	-1.473***	-1.274	-0.012	-0.014	-0.196	0.298***	0.916***	-3.611***	-2.082***	-0.583***	1.064***	0.053	-8.761***	-3.305***	-0.653***	-0.004	-0.459***
Maniema	-1.328***	-0.807	-0.011	0.005	-0.448***	0.240***	0.348***	-4.523***	-2.499***	-0.760***	0.653***	0.107***	-9.366***	-2.863***	-0.050**	-0.001	-0.434***
Haut Katanga	-0.793***	-1.179	-0.012	0.002	0.075	0.209***	0.550***	-3.064***	-0.814**	-0.171***	1.394***	0.200***	-5.424***	-1.809***	-0.294***	-0.012	-0.006
Lualaba	-0.972***	-1.596	-0.001	-0.001	-0.037	0.106**	0.455***	-4.369***	-1.257***	-0.420***	0.791***	0.069*	-6.570***	-3.109***	-0.435***	-0.005	-0.303***
Haut Lomami	-1.401***	-2.284**	-0.014	0.003	0.316***	0.261***	0.480***	-5.102***	-0.826**	-0.656***	1.558***	0.038	-3.673***	-3.447***	-0.820***	-0.011	-0.437***
Tanganyika	-0.947***	-1.056	-0.012	0.014	-0.746***	0.040	0.305***	-4.489***	-2.598***	-0.635***	0.440***	0.003	-7.768***	-3.395***	-0.531***	-0.002	-0.393***
Lomami	-1.219***	-1.260	-0.036	-0.007	-0.316**	0.226***	0.633***	-4.770***	-1.047***	-0.695***	1.192***	0.144***	-6.967***	-3.608***	-0.339***	-0.012	-0.431***
Kasai Oriental	-0.887***	-1.383	0.011	0.005	-0.317***	0.183***	0.761***	-4.084***	-1.189***	-0.523***	1.669***	0.057	-6.683***	-3.114***	0.030	-0.009	-0.124***
Sankuru	-1.136***	-1.955**	-0.030	0.017*	-0.256**	0.180***	0.646***	-4.211***	-0.974**	-0.698***	0.913***	0.021	-6.202***	-3.447***	-0.879***	-0.012	-0.475***
Kasai Central	-1.297***	-2.801***	-0.021	0.009	-0.125	0.085*	0.564***	-4.607***	-1.626***	-0.678***	1.285***	0.072*	-6.299***	-3.172***	-0.166***	-0.010	-0.376***
Kasai	-1.319***	-1.056	-0.016	-0.012	-0.227*	0.097**	0.554***	-5.051***	-1.055***	-0.733***	1.304***	0.049	-5.732***	-3.780***	-0.513***	-0.003	-0.432***
Kinshasa	-0.509***	29.642***	0.516***	0.029***	6.640***	1.913***	1.239***	10.542***	30.770***	0.794***	3.275***	0.123***	44.609***	11.412***	0.955***	0.012	0.675***
*** p<.01, ** p<.05, * p<.1																	

Table A2: Share of the Population by Province Experiencing Deprivations in Basic Services and other Living Conditions

	Fraction of the population deprived of						
Province	**child Schooling**	**Electricity**	**sanitation**	**water**	**housing material**	**cooking fuel**	**assets**
Kinshasa	0.097	0.135	0.791	0.037	0.086	0.732	0.186
Kongo Central	0.221	0.630	0.940	0.563	0.573	0.954	0.431
Kwango	0.284	0.907	0.989	0.918	0.970	0.987	0.855
Kwilu	0.230	0.972	1.000	0.885	0.961	0.978	0.836
Maindombe	0.200	0.999	0.997	0.784	0.942	0.995	0.707
Equateur	0.220	0.970	0.764	0.775	0.906	0.993	0.759
Sud Ubangi	0.310	0.968	0.720	0.873	0.978	0.999	0.671
Nord Ubangi	0.253	0.952	0.813	0.920	0.980	0.999	0.726
Mongala	0.297	0.985	0.653	0.986	0.994	0.991	0.813
Tshuapa	0.382	0.972	0.925	0.937	0.967	0.998	0.802
Tshopo	0.198	0.756	0.778	0.660	0.854	0.972	0.503
Bas Uele	0.119	0.962	0.825	0.858	0.958	0.993	0.461
Haut Uele	0.229	0.878	0.853	0.683	0.921	0.875	0.435
Ituri	0.337	0.852	0.644	0.495	0.924	0.996	0.552
Nord Kivu	0.268	0.556	0.861	0.647	0.724	0.992	0.527
Sud Kivu	0.228	0.616	0.873	0.413	0.642	0.997	0.563
Maniema	0.246	0.974	0.980	0.959	0.994	0.996	0.669
Haut Katanga	0.274	0.601	0.771	0.445	0.592	0.987	0.389
Lualaba	0.384	0.634	0.910	0.719	0.710	0.984	0.441
Haut Lomami	0.249	0.895	0.780	0.756	0.925	0.999	0.525
Tanganyika	0.301	0.867	0.940	0.557	0.916	0.993	0.607
Lomami	0.255	0.923	0.971	0.892	0.984	0.997	0.554
Kasai Oriental	0.238	0.932	0.872	0.617	0.841	0.998	0.650
Sankuru	0.130	0.937	0.941	0.719	0.936	0.994	0.650
Kasai Central	0.275	0.978	0.960	0.950	0.965	0.992	0.810
Kasai	0.449	0.992	0.979	0.927	0.965	0.994	0.849

Table A3: Share of the Urban Population by Province Experiencing Deprivations in Basic Services and other Living Conditions

	Fraction of the population deprived of					
Urban areas of:	**child Schooling**	**Electricity**	**sanitation**	**water**	**housing material**	**cooking fuel**
Kinshasa	0.097	0.135	0.037	0.086	0.732	0.186
Kongo Central	0.134	0.241	0.161	0.219	0.897	0.231
Kwango	0.213	0.779	0.382	0.860	0.995	0.562
Kwilu	0.086	0.842	0.506	0.727	0.874	0.582
Maindombe	0.121	1.000	0.750	0.914	0.997	0.560
Equateur	0.188	0.966	0.465	0.745	0.992	0.536
Sud Ubangi	0.199	0.898	0.663	0.927	1.000	0.392
Nord Ubangi	0.120	0.845	0.688	0.931	1.000	0.370

Mongala	0.130	0.909	0.827	0.946	1.000	0.617
Tshuapa	0.159	0.898	0.740	0.852	0.997	0.398
Tshopo	0.170	0.504	0.255	0.640	0.929	0.228
Bas Uele	0.102	0.939	0.771	0.932	0.991	0.314
Haut Uele	0.207	0.835	0.601	0.880	0.889	0.329
Ituri	0.213	0.688	0.595	0.825	0.992	0.434
Nord Kivu	0.250	0.257	0.200	0.326	0.978	0.197
Sud Kivu	0.180	0.480	0.348	0.435	1.000	0.394
Maniema	0.113	0.941	0.698	0.958	0.997	0.608
Haut Katanga	0.197	0.394	0.231	0.338	0.979	0.217
Lualaba	0.284	0.378	0.514	0.441	0.975	0.211
Haut Lomami	0.198	0.734	0.523	0.814	1.000	0.308
Tanganyika	0.201	0.694	0.221	0.772	1.000	0.503
Lomami	0.201	0.886	0.863	0.967	1.000	0.405
Kasai Oriental	0.160	0.853	0.256	0.621	0.994	0.489
Sankuru	0.081	0.947	0.378	0.839	0.999	0.485
Kasai Central	0.094	0.927	0.869	0.691	0.885	0.366
Kasai	0.358	0.982	0.763	0.913	0.985	0.650

Table A4: Share of the Rural Population by Province Experiencing Deprivations in Basic Services and other Living Conditions

	Fraction of the population deprived of						
Rural areas of	**child Schooling**	**Electricity**	**Sanitation**	**Water**	**Housing material**	**Cooking fuel**	**Assets**
Kongo Central	0.287	0.922	0.963	0.865	0.840	0.997	0.581
Kwango	0.287	0.912	0.992	0.939	0.974	0.986	0.866
Kwilu	0.252	0.992	1.000	0.943	0.998	0.994	0.876
Maindombe	0.217	0.999	1.000	0.791	0.948	0.994	0.739
Equateur	0.236	0.972	0.751	0.937	0.990	0.994	0.875
Sud Ubangi	0.342	0.989	0.736	0.934	0.993	0.999	0.751
Nord Ubangi	0.294	0.984	0.868	0.991	0.995	0.999	0.835
Mongala	0.310	0.990	0.644	0.998	0.997	0.991	0.828
Tshuapa	0.438	0.991	0.926	0.986	0.996	0.999	0.904
Tshopo	0.216	0.916	0.838	0.918	0.991	1.000	0.678
Bas Uele	0.139	0.988	0.926	0.958	0.986	0.995	0.628
Haut Uele	0.271	0.958	0.846	0.834	0.996	0.848	0.633
Ituri	0.389	0.920	0.644	0.453	0.965	0.998	0.602
Nord Kivu	0.277	0.722	0.982	0.895	0.945	1.000	0.711
Sud Kivu	0.282	0.767	0.985	0.486	0.873	0.994	0.752
Maniema	0.263	0.978	0.985	0.993	0.999	0.996	0.678
Haut Katanga	0.396	0.924	0.721	0.779	0.988	0.998	0.658
Lualaba	0.493	0.908	0.990	0.941	1.000	0.995	0.688
Haut Lomami	0.279	0.988	0.799	0.891	0.989	0.998	0.652
Tanganyika	0.350	0.953	0.927	0.724	0.987	0.990	0.658

Lomami	0.307	0.959	0.955	0.920	1.000	0.995	0.698
Kasai Oriental	0.292	0.987	0.877	0.868	0.994	1.000	0.763
Sankuru	0.162	0.931	0.929	0.945	1.000	0.990	0.758
Kasai Central	0.289	0.982	0.964	0.956	0.986	1.000	0.844
Kasai	0.451	0.992	0.979	0.931	0.967	0.994	0.853

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