Does Access to Basic Services Matter for Child Health? Evidence From Togo

Djahini-Afwoubo Dossè Mawussi
Abstract

This paper aims to analyze the effect of access to basic services on child health in Togo. We use the structural equation model (SEM) to take account of the possible interdependencies between child health and basic service capabilities, and settle endogeneity issues. The results indicate that access to basic services improves children’s health by reducing the probability of occurrence of illness (malaria and diarrhoea). These results suggest that government should improve access to basic services to help reduce child morbidity and mortality related to diarrhoea and malaria. This could be done through public financing of basic services targeting disadvantaged groups, particularly rural populations.

This paper is the product of the Vice-Presidency for Economic Governance and Knowledge Management. It is part of a larger effort by the African Development Bank to promote knowledge and learning, share ideas, provide open access to its research, and make a contribution to development policy. The papers featured in the Working Paper Series (WPS) are those considered to have a bearing on the mission of AfDB, its strategic objectives of Inclusive and Green Growth, and its High-5 priority areas—to Power Africa, Feed Africa, Industrialize Africa, Integrate Africa and Improve Living Conditions of Africans. The authors may be contacted at workingpaper@afdb.org.

Does Access to Basic Services Matter for Child Health?

Evidence From Togo¹

DJAHINI-AFAWOUBO Dossè Mawussi

JEL Classification: I12

Keywords: Child, Health; Sanitation, Water, Basic services

¹ DJAHINI-AFAWOUBO Dossè Mawussi, Department of Economics / FASEG / University of Lomé (TOGO) Email: dossedjahini@gmail.com
1. Introduction

Good health is important for the sustainable development of economies. The Millennium Development Goals (MDGs) have stressed the importance of health with three of its goals related to health outcomes: reduce child mortality under 5 years (MDG 4), improve maternal health, and fight against HIV/AIDS, malaria and other diseases (MDG 6). Due to its importance, this is reflected in the Sustainable Development Goals (SDGs): ensure healthy lives and promote well-being for all at all ages (SDG 3). Despite the importance of health to development, health outcomes particularly in children in sub-Saharan Africa are very poor. Evidence suggests that many nations in sub-Saharan Africa have failed to achieve MDG 4. Child mortality under 5 years in sub-Saharan Africa is more than three times higher compare to Latin America and Caribbean, and more than ten times higher compare to North America (see Figure 1).

Among the causes of child mortality under 5 years, diarrhoea has emerged as one of the important causal factors. According to the World Health Organization (WHO), poor sanitation as well as poor water quality are the leading causes of diarrhoea-related child deaths (see Günther et al., 2011). This suggests that improving water quality as well as ensuring good sanitation will significantly reduce child mortality under 5 years in many countries, but this remains a major challenge for developing countries especially in sub-Saharan Africa, which has some of the poorest sanitation facilities in the world. According to the World Development Indicators (WDI, 2016), whereas 99.98% of North America’s population is estimated to have access to improved sanitation facilities, only 29.74% of the population in sub-Saharan Africa had access to adequate sanitation facilities in 2015. Similar problems exist in the water sector. While about 98% of the population in North America have access to quality water, only about 55% of the population in sub-Saharan Africa have access to quality water supply (see Figures 2 and 3). Obviously in sub-Saharan Africa, these factors present a great motivation to investigate the link between basic facilities and child health.

The objective of this study is to investigate the link between basic services and child health using survey data from Togo. Specifically, we examine the effect of access to basic services on child health as well as the interdependencies between the two. In this paper, access to basic services refers to access to improved water and sanitation, and access to improved housing. Togo is a small emerging economy on the west coast of Africa with a total population of 6.8 million people. The economy is estimated to grow annually at 5.1%. Major
contributing sectors are the agriculture and service sectors with respective contributions of about 45% and 34%. Though some structural transformation is taking place in the country, the social indicators are not very good. About 55.1% of the population lives in poverty in 2015 according to INSEED-Togo (2016). The review of the overall results of INSEED-Togo (2007, 2012 and 2016) revealed that poverty marginally decreased by 3 points in the 5 years between 2006 (61.7%) and 2011 (58.7%) and 3.6 points in the 5 years between 2011 and 2015 (55.1%). However, it should be noted that poverty has increased significantly (6.3 percentage points) in the capital and its urban periphery (Grand Lomé), from 28.5% in 2011 to 34.8% in 2015.

The health and nutritional status of the people is very poor. For more than two decades, the country has only succeeded in reducing mother and child mortality marginally. Child mortality rate per 1000 in 2010 was 92, compared to the average of 66.5 in developing countries, and 6.9 in developed countries. Infant mortality per 1000, on the other hand, was 68.3 compared to 78.6 in developing countries, and 5.8 in developed countries. According to Togo DSH-III, during the period 2009 to 2013, of 1000 live births, 49 died before their first birthday, and of 1000 surviving children on the first birthday, 42 died before their fifth birthday. Overall, of 1000 live births, 88 do not reach their fifth birthday. This rate is 4.6 times higher than in Middle East and North Africa (19.66) and 31.7 points higher than the average in sub-Saharan Africa (56.3). Major causes of the high morbidity and mortality in the country include delivery complications, early childhood diseases, endemic diseases, and nutritional deficiencies. Malaria remains a major killer in the country. The statistics show that, in 2005, about 57.58% of under-fives slept under treated nets. This rate decreased to 32.3% in 2008. Much of the disease-related under-five mortality is caused by poor sanitation and unsafe drinking water. The statistics indicate that access to these basic facilities are low in the country. In 2008, access to safe water was 60% compared to averages of 64.5% in Africa, 80% in developing countries, and 100% in developed countries. In the same year, access to sanitation was 12% compared to 41% in Africa, 53.6% in developing countries, and 99.5% in developed countries (data source: AfDB and ADF, 2011). According to INSEED-Togo, 2016, only 23% of households have access to improved sanitation facilities. With the recent trends in the country, Togo has not achieved six of the eight MDGs. Progress has only been made in terms of universal primary education and the control of HIV/AIDS, malaria and other diseases. This makes the topic investigated in this study more relevant. But, to our knowledge,
few studies focus on this issue in Togo. One of the contributions of this paper is to fill this gap.

Several studies (for example Esrey et al., 1991; Fewtrell et al., 2005; Günther and Günther, 2010; Günther et al., 2011; Rania et al., 2012; Bampoky, 2013; Ezeh et al., 2014; Britta and Rodriguez-Lesmes 2015) have investigated the associations between child health and access to water and sanitation. But these studies failed to account for potential interdependencies between child health and access to safe sanitation and safe water. By ignoring such possible interdependencies, they may suffer from endogeneity issues. Batana (2010) and Di Tommaso (2007) dealt with these issues. Di Tommaso (2007) has used a structural equation model to measure child capabilities in India while Batana (2010) analyzed the effect of aid on well-being in ten selected sub-Saharan African countries. But their studies have not focused on child health. Britta and Rodriguez-Lesmes (2015) also dealt with endogeneity issues by using instrumental variables. However, an important weakness of instrumental variable method is the validity of instruments.

Unlike previous studies, we assume that child health and the ability to access basic services are latent. They are not directly observable but manifest themselves in many observable indicators. A structural equation model (SEM) is used to take account of the possible interdependencies between latent variables (child health and basic service capabilities in our case) and, in doing so, settles the endogeneity issues. Moreover, the SEM allows including some exogenous variables susceptible to directly impact the latent variables. The results indicate that access to basic services (safe water, sanitation and improved housing) improves children’s health by reducing the probability of occurrence of illness (malaria and diarrhoea).

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 presents the theoretical framework and econometric model. Section 4 presents the results of the study. Finally, Section 5 concludes with policy recommendations.
The effects of water and sanitation on child health have been studied in many developing nations across the world. Esrey et al. (1991) reviewed a total of 144 studies to examine the impact of improved water supply and sanitation facilities on ascariasis (roundworm infection), diarrhoea, dracunculiasis (Guinea-worm disease), hookworm infection, schistosomiasis (bilharziasis), and trachoma. They found a 17% reduction in diarrhoea induced by improved water supply and a 22% reduction induced by improved sanitation infrastructure. Fewtrell et al. (2005) developed a comprehensive search strategy designed to identify all peer-reviewed articles, in any language, that presented water, sanitation, or hygiene interventions. They examined only those articles with specific measurement of diarrhoea morbidity as a health outcome in non-outbreak conditions. They show a reduction in illness of 25% for water and 32% for sanitation infrastructure. The results are, however, insignificant for water interventions if only diarrhoea is considered as the dependent variable. Their review includes works by Iijima et al. (2001) and Quick et al. (2002) respectively on Kenya and Zambia. Iijima et al. (2001) focused on approximately 1,500 households in Kenya and found that the incidence of severe diarrhoea among people drinking sterilized water was significantly lower than in people taking raw water. Quick et al. (2002) found that diarrhoeal disease risk for individuals in intervention households was 48% lower than for controls.

Waddington et al. (2009) also reviewed 71 studies. They reported no significant impact on diarrhoea morbidity for water supply and a 37% relative reduction in diarrhoea incidence for sanitation infrastructure (but with low precision due to the small number of relevant studies). More recently, Günther and Günther (2010) combined 172 Demography and Health Survey (DHS) data sets from 70 countries to estimate the effect of water and sanitation on child mortality and morbidity. Their results show a robust association between access to water and sanitation technologies and both child morbidity and child mortality. The point estimates imply, depending on the technology level and the sub-region chosen, that water and sanitation infrastructure lowers the odds of children suffering from diarrhoea by 7% to 17%, and reduces the mortality risk for children under the age of 5 years by 5% to 20%. The effects seem largest for modern sanitation technologies and least significant for basic water supply. The authors also find evidence for the Mills-Reincke Multiplier for both water and sanitation access as well as positive health externalities for sanitation investments. The overall magnitude of the estimated effects appears smaller than coefficients reported in meta-studies.
based on randomized field trials, suggesting limits to the scalability and sustainability of the health benefits associated with water and sanitation interventions.

Günther et al. (2011) merged data sets of 171 surveys in 70 low- and middle-income countries over the period 1986 to 2007 and used logistic models to estimate the effect of water and sanitation access on infant and child mortality, diarrhoea, and stunting. Even though the estimated effect of improved water and sanitation is smaller than estimations done by other studies, they still found a positive impact in the reduction of mortality, as well as a lower risk of diarrhoea and stunting. However, the authors also found that the positive results of clean water are more subtle and affect only children between 1 and 12 months.

Several other studies have investigated the effect of water and sanitation on child health, for example Gasana et al. (2002); Checkley et al. (2004); Fay et al. (2005); Ravallion (2007); Bampoky (2013); Ezeh et al. (2014); Britta and Rodriguez-Lesmes (2015); Rah et al. (2015); K’Akumu (2016). Gasana et al. (2002) studied the frequency and intensity of water contamination at the source, during transportation, and at home to determine the causes of contamination and its impact on the health of children aged 0 to 5 years. The methods used were construction of the infrastructure for three sources of potable water, administration of a questionnaire about socioeconomic status and sanitation behaviour, anthropometric measurement of children, and analysis of water and faeces. They found that contamination, first thought to be only a function of rainfall, turned out to be a very complex phenomenon. Water in homes was contaminated due to the use of unclean utensils to transport and store water. The latrines presented a double-edged problem. The extremely high population density reduced the surface area of land per family, which resulted in a severe nutritional deficit affecting mainly young children, rendering them more susceptible to diarrhoea.

Checkley et al. (2004) aimed to assess the effects of water and sanitation on childhood health in a birth cohort of Peruvian children. To do so, they followed up children once a day for diarrhoea and once a month for anthropometry, and obtained data for household water and sanitation at baseline. They find that at 24 months of age, children with the worst conditions for water source, water storage, and sanitation were 10 cm shorter and had 54% more diarrhoeal episodes than did those with the best conditions. Children from households with small storage containers had 28% more diarrhoeal episodes than did children from households with large containers. Lack of adequate sewage disposal explained a height deficit of 9 cm at 24 months of age. Better water sources alone did not accomplish full health benefits. In 24-
month-old children from households with a water connection, those in households without adequate sewage disposal and with small storage containers were 18 cm shorter than children in households with sewage and with large storage containers. They conclude that nutritional status is a useful endpoint for water and sanitation interventions and underscores the need to improve sanitation in developing countries. Improved and more reliable water sources should discourage water storage with the risk of becoming contaminated, decrease diarrhoeal incidence, and improve linear growth in children.

Fay et al. (2005) provides an empirical analysis of the determinants of three child-health outcomes related to the Millennium Development Goals: the infant mortality rate, the child mortality rate, and the prevalence of malnutrition. Using data from Demographic and Health Surveys, their findings suggest that, apart from traditional variables (income, assets, education, and direct health interventions), better access to basic infrastructure services has an important role to play in improving child-health outcomes. Using an alternative estimator and augmenting their data set to include female schooling, Ravallion (2007) finds little sign that better infrastructure lowers either child mortality or stunting. He argues that the infrastructure impacts found by Fay et al. stem from a combination of functional-form mis-specification, latent country effects, and omitted quintile-specific schooling effects.

Bampoky (2013) found modern sanitation facilities do have a large effect on reducing mortality in urban areas in Senegal. Ezeh et al. (2014) used pooled 2003, 2008, and 2013 Nigeria Demographic and Health Survey data to examine the impact of water and sanitation on deaths of children aged 0-28 days, 1-11 months, and 12-59 months using Cox regression analysis. They found that over a 10-year period, the odds of neonatal, post-neonatal and child deaths significantly reduced by 31%, 41%, and 47% respectively. The risk of mortality from both unimproved water and sanitation was significantly higher by 38% for post-neonatal mortality and 24% for child mortality. Britta and Rodriguez-Lesmes (2015) examined the effects of sanitation coverage and usage on child height for age in a semi-urban setting in Northern India. They found that sanitation coverage plays a significant and positive role in height growth during the first years of life.

Rah et al. (2015) determined the association between household access to water, sanitation and personal hygiene practices with stunting among children aged 0-23 months in rural India. They included in their analysis a total of 10,364, 34,639 and 1282 under-2-year-olds who participated in the 2005-2006 National Family Health Survey (NFHS-3), the 2011
Hunger and Malnutrition Survey (HUNGaMA) and the 2012 Comprehensive Nutrition Survey in Maharashtra (CNSM), respectively. Using logistic regression models, they find that the prevalence of stunting ranged from 25% to 50% across the three studies. Compared with open defecation, household access to toilet facility was associated with a 16-39% reduction of odds on stunting among children aged 0-23 months, after adjusting for all potential confounders. Household access to improved water supply or piped water was not in itself associated with stunting. The caregiver’s self-reported practices of washing hands with soap before meals or after defecation were inversely associated with child stunting. However, the inverse association between reported personal hygiene practices and stunting was stronger among households with access to toilet facility or piped water. K’Akumu (2016) analyzes the mortality rate data from consecutive decennial population censuses conducted in the country from 1979. He finds that water sources and type of sanitation are significant determinants of child mortality, as in any other developing country. He recommends to combat water- (and sanitation-) based child mortality by enforcing public health regulations, and making public investment in water and water treatment at point of use.

Few are the studies that have investigated the link between basic services and child health in Togo. One of the contributions of this paper is to fill this gap. Ended, most of the existing studies on Togo in the field of well-being and poverty assessment, have been limited to the analysis of inequalities in multidimensional poverty (see Agbodji et al., 2013; Djahini-Afawoubo, 2015 and Noglo, 2016). Only studies by Agbodji and Djoké (2009), Abalo (2009), Abalo et al. (2014), Agbodji (2010) put emphasis on child poverty and child health. Agbodji and Djoké (2009) analyze the factors contributing to the state of child poverty in four West African Economic and Monetary Union countries including Togo. Using the multidimensional approach, their findings show that access to vitamin A, quality of iodized salt consumed, breastfeeding, immunization against poliomyelitis, diphtheria, measles and yellow fever on the one hand, and diseases such as diarrhoea, cough, fever, and breathing difficulties on the other hand are the main factors explaining child poverty. Using data from the Demographic and Health Survey (EDST-II), Abalo (2009) first constructed a composite index that characterized non-monetary assets. He then identified the determinants of child malnutrition by correlating both the non-monetary wealth and the socio-demographic characteristics of households. He found that among the characteristics specific to the child, age and sex are the main explanatory factors of child health status. Parental education has a positive impact on the improvement of the child’s nutritional status, in particular in rural
areas. Moreover, the household’s wealth level has a positive impact on child health and nutritional status in both rural and urban areas. Agbodji (2010) provides an analysis of the impact of maternal prenatal visits on birth weight of newborns in Togo. Using the national MICS-3 survey of 2006 he first shows that the number of maternal prenatal visits has a statistically significant impact on the weight of the newborn. Second, he shows that the other determining factors in newborn weight are mother’s age, newborn gender and household environment. Finally he shows that mother’s age and education level as well as non-monetary wealth assets influence the likelihood of prenatal visits. Abalo et al. (2014) focused on the determinants of childhood nutrition and health in Togo. Their findings show that, even if child inequalities seem moderate, they remain a stark reality in Togo. They observed strong pure inequalities, generally attributable to natural variations, as well as significant regional disparities, both for pure and social health inequalities. But their study did not put emphasis on the link between basic services and child health. Furthermore, previous studies which investigate this link failed to account for potential interdependencies between child health and access to safe sanitation and safe water. By ignoring such possible interdependencies, these studies may suffer from endogeneity issues. Batana (2010) and Di Tommaso (2007) dealt with these issues. Di Tommaso (2007) used a structural equation model to measure child capabilities in India while Batana (2010) analyzed the effect of aid on well-being in ten selected sub-Saharan African countries. But their studies have not focused on child health.

Britta and Rodriguez-Lesmes (2015) also dealt with endogeneity issues by using instrumental variables. But an important weakness of the instrumental variable method is the validity of the instruments.

Unlike previous studies, we assume that child health and the ability to access basic services are latent. They are not directly observable but manifest themselves in many observable indicators. We use a structural equation model (SEM) to take account of the possible interdependencies between child health and basic services capabilities in our case) and, in doing so, settles the endogeneity issues. Moreover, the SEM allows the inclusion of some exogenous variables susceptible to directly impact the latent variables.
3. Theoretical Framework and Econometric Model

3.1. Theoretical Framework

We can distinguish four main approaches to measure welfare including the utilitarianism or the monetary approach, the basic needs approach, the primary social goods approach by Rawls (1971), and the capability approach. This paper is based on the capability framework (Sen, 1981). Unlike other approaches, the capability framework highlighted in the definition of poverty the relationship between resources and their owners. Sen highlights the complexity of relationships between individuals with goods, between individuals and others (social relationships), and of individuals with their environment (institutions, norms, customs, etc.). This triple-level relation puts the individual at the centre, both in terms of development and in terms of the study of poverty. In this approach, capabilities refer to the real choices that a person has to lead the life he/she wants to lead and hence constitute a broader and ‘richer’ concept than his/her actual lifestyle. While functioning focuses on achievements – what the person manages to do or to be, that is, his/her states of doing and being (being sheltered, being educated) – capabilities refer to what he/she can choose to do or to achieve, that is, the ability to achieve – being able to be sheltered or educated (Sen, 1987).

Sen (1987) formalizes the capability approach as follow. Denoted by $z_i$, the commodity vector possessed by any individual $i$. These commodities in turn have certain characteristics $c(z_i)$ that the individual makes use of to achieve certain ‘beings’ and ‘doings’, denoted by $b_i = f_i(c_i(z_i))$ where $f$ characterizes the utilization of the commodities. Thus, the capability set is the set of all possible $b_i$s that a person can achieve using any one of the possible $f_i$s that he/she can choose from.

The conversion function determines the transformation of the commodities into functioning. Thus, the resources are no longer seen as ends in themselves, but they are still important. While the possession of these resources does not guarantee the owner to reach the desired level of well-being, their absence significantly reduces his/her opportunity to expand overall capability. Several factors present in the conversion function may force the individual to not realize what he expects in life. These are: (i) the heterogeneity of people (physical, mental, or sexual characteristics); (ii) the diversity of the environment (climate parameters, the endemic nature of infectious diseases, pollution); (iii) the disparities in the social environment (nature of social relations, public services); (iv) the relativity of perspectives
(personal status in society, social life, response to certain standards); and (v) distribution within the family (allocation rules in a family).

Individual characteristics involve different ways to convert resources into functioning across individuals. Thus, two people, from the same resource, may not transform its characteristics into a similar capability. Social environment is also a factor in the conversion process. A society whose standards discriminate against a particular group also forces the transformation. Suppose a man and a woman each have the same income. However, in this society, women cannot freely dispose of their money to buy what they want. They must refer to their husbands first. Referring to the monetary approach the man and woman have the same level of welfare as they have the same resources. Yet the social norms binding for women reduce their capabilities.

The capability approach also attaches importance to the issue of choice – the choice of the ‘utilization’ function and the choice of function to be accomplished among all possible functions. Thus, from the same resource, e.g. a bicycle, an individual will be able to choose between several ‘utilization’ functions (e.g. to move, to play sports or even exchange it against another good). Similarly, the individual does not value all the possible functions. He produces preferences by choosing to value one such function and not another.

The capability approach thus measures welfare by what a person is actually able to accomplish with the resources he owns, taking into account his personal characteristics and external circumstances. One can notice that many elements are unobservable in the capability framework: the particular characteristics \( c(z_t) \) that enable any person to convert commodities into functionings, the conversion function \( f \) which is particular to each individual, the set of possible conversion functions that any individual can choose from and thus the capability set itself. The only input that is observed, and only partially, is the vector of commodities possessed by the individual apart from his/her actual achievements (Krishnakumar and Ballon, 2008). The capability approach is appealing because of two characteristics: it assumes that (i) the capability set or the freedom to choose is not directly observable but manifests itself in many observable indicators; and (ii) any single indicator can only be a partial measure of the underlying concept. In the next section, we present a methodology that suits the capability framework.
3.2. Econometric Model

3.2.1. The Structural Equation Model

To achieve our goals, a structural equation model (SEM) is used. This methodological approach is relevant since it takes account of the possible interdependencies between latent variables (child health and basic service capabilities in our case) and, in doing so, settles the endogeneity issues. Moreover, it allows including some exogenous variables susceptible to directly impact the latent variables. Di Tommaso (2007), Krishnakumar and Ballon (2008) and Batana (2010) have also used this model.

In our model we specify capabilities \( y_i^* \) as latent (unobservable) variables. They are the key endogenous variables of our model. Achievements \( y_i \) are measurable and are linked to the underlying capabilities through a set of measurement equations. In the model, we consider two capabilities: health and basic services (access to water and sanitation, access to housing). The main variables of our model are listed in Table 1.

We assume that health and basic services have a reciprocal influence on one another. Figure 4 presents the interrelationships between the variables of the model, namely the two latent variables, the observed endogenous variables representing the functioning, and the exogenous variables from structural equations. The observed variables are enclosed in boxes and the unobserved or latent variables are circled. Straight single-headed arrows represent causal relations between the variables connected by arrows in the direction shown by the arrow. Two straight single-headed arrows connecting two variables signify feedback relation or simultaneous influence.

Following Krishnakumar and Ballon (2008) and Batana (2010), our framework is formalized by the following two sets of equations. The first set of equations represents the latent variable model or the structural model (1) and the second set of equations (2) forms the measurement model. The model is specified as follows:

\[
\Gamma y_i^* + BX_i + \varepsilon_i = 0, \quad (1)
\]
\[
y_i = h(y_i^*) + \zeta_i, \quad (2)
\]
where \( i \) denotes the individual, \( y_i^\ast \) is a \((m \times 1)\) vector of capability dimensions, \( y_i \) is a \((P \times 1)\) vector of indicators, and \( X_i(q \times 1) \) is a vector of exogenous variables.

As the vector of indicators \( y_i \) may include different types of indicators continuous and ordered categorical, depending on the empirical context, we specify a nonlinear relationship for the measurement part. If all the observed indicators in \( y_i \) are continuous, then the relationship (2) can be written as follows:

\[
y_i = \Lambda y_i^\ast + \xi_i
\] (3)

However, in the presence of qualitative indicators, as in our case, the nature of the function \( h(.) \) depends on the type of indicator (dichotomous or categorical). For simplicity let us just consider a single element, say the \( j \)th one, of the \( y_i \) vector and denote it \( y_{ij} \) as \((j \) denotes the indicator). Let the corresponding latent variable be \( y_i^\ast \). In this case, one introduces a corresponding continuous latent response variable \( y_{ij}^\circ \) such that:

\[
y_{ij}^\circ = \lambda_j y_i^\ast + \xi_j \] (4)

Then, this latent response variable \( y_{ij}^\circ \) is linked to the observed indicator \( y_{ij} \) as follows for a dichotomous indicator:

\[
y_{ij} = \begin{cases} 1 & \text{if } y_{ij} \geq 0 \\ 0 & \text{if } y_{ij} \leq 0 \end{cases}
\] (5)

The stochastic assumptions of the model are as follows:

\[
E(\varepsilon_i) = 0, E(\xi_i) = 0, \\
V(\varepsilon_i) = E(\varepsilon_i \varepsilon_i^\prime) = \phi \\
V(\xi_i) = E(\xi_i \xi_i^\prime) = \psi
\] (6)

\( \xi \) uncorrelated with \( \varepsilon_i \), \( \Gamma \) non-singular.

Table 2 gives a definition of all the notations used in our model. Factor loadings \( (\lambda_j) \) give the magnitude of the expected change in the observed indicator or outcome for one unit change in the latent variable or capability. These coefficients are the regression coefficients for the effects of capabilities on outcomes. The simultaneous nature of capabilities is
emphasized by the $\Gamma$ coefficient matrix. The effects of exogenous causes in structural equations are given by the coefficient matrix $B$.

Using the stochastic assumptions, in particular, the variance covariance matrices of the error terms, one can obtain the theoretical expressions of the variance matrix of $y_i$, $\epsilon_i$, $\xi_i$ in terms of $\Gamma, B, \Lambda, \psi$ and $\Phi$ say:

$$\Sigma = \sum(\theta)$$

Where $\theta$ is a vector that contains all the distinct elements of the unknown parameter vectors and matrices of the model, that is, $\tau, \Lambda, A, B, \Gamma, \Phi, \Psi$. $\Sigma$ is the population covariance/correlation matrix of the observed variables $y_i, X_i$. $\sum(\theta)$ is the covariance/correlation matrix written as a function of $\theta$. In order to estimate the parameters of the model, we must be sure that the model is identified (exactly identified or over-identified).

Among the tests for identification, the $t$-rule is widely applied due to its simplicity (Krishnakumar and Ballon, 2008). However, this rule is a necessary but not a sufficient condition of identification. The rule compares the number of non-redundant elements in the covariance/correlation matrix of the (latent) response variables with the number of unknown free parameters in $\theta$ denoted as $t$. If the former is greater than or equal to the latter, the model is identified (over-identified or exactly identified, respectively). The difference between these two groups of elements gives the degrees of freedom for the calculation of the $\chi^2$ statistic of model fit. The $t$-rule for identification is given by:

$$t \leq \left(\frac{1}{2}\right)(p+q)(p+q+1) \text{ where } p \text{, and } q \text{ are defined in Table 2.}$$

Like Krishnakumar and Ballon (2008) we apply a two-stage procedure to test for identification. In the first step, we treat the model as a confirmatory factor analysis, that is, we only focus on the measurement equations and we test for identification applying, for example, the $t$-rule. In a second step, we examine the latent variable part and we treat it as if it were a structural equation model in observed variables. Then, we test for identification using typical identification rules for observed structural equations models, that is, rank and order conditions. If both steps show that the respective parameters are identified then the whole model is identified.
After verifying the identification conditions, we can proceed to the estimation of the unknown parameters by minimizing the distance between the theoretical expression of the moments and their empirical counterparts. In doing so, some constraints must be introduced to provide a scale for the latent variables. Typically, the scale is given by either setting the variances of the latent variables to be one or giving them a scale in the same units as one of their indicators by constraining one factor loading to be equal to one. In this case, the scale means that on average a one-unit shift of the latent capability leads to a one-unit shift in the corresponding observed outcome (Krishnakumar and Ballon, 2008).

Assuming a multivariate normal distribution of $y_i^*$ conditional on $X_i$, (so that the first and second order moments suffice), Muthén (1984) proposes a three-stage procedure (see Krishnakumar and Ballon, 2008) using weighted least squares for minimizing the following fitting function:

$$
F_{\text{WLS}} = \left[ \bar{\rho} - \sigma(\theta) \right] G^{-1} \left[ \bar{\rho} - \sigma(\theta) \right],
$$

where $\bar{\rho}$ is a $\left( \frac{1}{2} \right) (p+q)(p+q+1) \times 1$ vector containing sample estimates of the non-redundant two by two correlations between the elements of $y_i^*$. $\rho(\theta)$ is the corresponding vector for the theoretical covariance matrix. $G$ is the optimal weighting matrix given by a consistent estimator of the asymptotic covariance matrix of $\bar{\rho}$ of order $m \times m$, where $m = p + q$.

Once the parameters of the model are estimated, the latent variable scores, in other words, the capabilities $y_i^*$ of each individual $i$ can be obtained (for both health and basic services). The maximum posterior likelihood method (see Krishnakumar and Nagar, 2008) is used to compute the estimates of $y_i^*$.

### 3.2.2. Data Description

Our data are from 2011 Questionnaire Unifié des Indicateurs de Base du Bien-Être (QUIBB) survey (INSEED-Togo, 2012). This survey aims to provide the necessary elements for the assessment of poverty: socio-demographic information (household composition, education, etc.), housing characteristics, ownership of durable goods, and access to basic infrastructure. It covered 5532 households (29,781 individuals including 15,260 women) and is nationally
representative of the Togolese population. For our analysis, we return only children aged from 0 to 5 years. Except the age and the size of household, all our variables are dichotomous (0, 1). Classification of water source and sanitation is based on the WHO/UNICEF guidelines (see Table 3).

Table 4 provides summary statistics of main variables by gender and by area of residence. It highlights significant disparities between rural and urban areas in terms of access to improved drinking water and sanitation in particular, and basic services in general. By cons, gender-based inequalities are slight.

4. Results and Discussions

This section presents and analyzes the estimation results for our generalized latent variable model specified by Figure 4. The model is estimated according to the procedure discussed earlier and heteroscedasticity-consistent standard deviations are calculated for the coefficient estimators. The results are computed using the fifth version of Mplus (Muthén and Muthén, 2007).

Before we start interpreting the results, a word should be said about the quality of fit of the model. This analysis is based on the values of TLI (Tucker-Lewis Index), CFI (Comparative Fit Adjustment) and the root mean square error of approximation (RMSEA) reported in Table 5. According to Hu and Bentler (1999) a value greater than 0.90 for both TLI and CFI is needed to ensure that poorly specified models are not accepted. Hence, a value of CFI and TLI greater than or equal to 0.95 is recognized as a good criterion. For the RMSA, Hu and Bentler (1999) consider a threshold of 0.06 whereas Steiger (2007) considers a threshold of 0.07. A value of RMSA <=0.06 or 0.07 is considered as the indication of good fit of the model. In our case, TLI, CFI and RMSA are respectively 0.949, 0.952 and 0.033 and indicate a good quality of fit.

Table 5 also reports the results of the structural model. Both the normal coefficients and the standardized coefficients are reported as only the latter can be compared in size for variables expressed in different units. Basic services capability has a positive effect on health capability but the latter do not have any effect on the former. Thus, the simultaneous nature of the two capabilities is not confirmed. This result is not surprising. It can be explained by the static nature of our model. Indeed, children’s health was used to measure the health capability.
In this case, only a dynamic model can bring out the influence of children’s health on their future ability to access basic services.

The positive effect of the basic services capability on the health capability means that access to basic services (access to safe water, access to sanitation and access to decent housing in our case) improves children’s health by reducing occurrence of illness (malaria and diarrhoea). This result is consistent with Günther et al. (2011) and Ezeh et al. (2014). Günther et al. (2011) found that access to improved sanitation is associated with lower mortality, a lower risk of child diarrhoea, and a lower risk of mild or severe stunting. Access to improved water is associated with a lower risk of diarrhoea and a lower risk of mild or severe stunting. Ezeh et al. (2014) have also found a higher risk of neonatal, post-neonatal and child deaths from both unimproved water and sanitation in Nigeria. Among the exogenous variables for the basic services dimension, only the area of residence has a significant influence. Urban environments favour basic service capability. This result is consistent with Krishnakumar and Ballon (2008) who have found that, in the case of Bolivian children, urban environments favour knowledge capability. It can be explained by the fact that the offers of basic service facilities are greater in urban areas than in rural areas. Turning to the exogenous factors in the health dimension, we observe that the area of residence, whether a child’s father is alive or not, and the size of the household are the exogenous factors that have a significant influence.

Table 6 reports the estimation results for our measurement model. Standardized factor loadings for the basic service measurement equation are all significant and show the right sign. A unit change in the basic services capability will result in an increase of the probability of having improved places of sewage and waste disposal by 0.73 standardized units; to have an improved drinking water source by 0.67 standardized units; and the probability to have improved toilet facilities, improved wall, improved roof, and improved floor by respectively 0.89, 0.92, 0.82, and 0.93 standardized units. Factor loadings of occurrence of malaria and diarrhoea are negative and significant. They indicate a decrease of respectively 0.997 and 0.977 standardized units in the probability of occurrence of malaria and diarrhoea resulting from a standardized unit variation of the capability level.
5. Conclusion

Many nations particularly in sub-Saharan Africa failed to achieve MDG 4 related to the reduction child mortality under 5 years. Diarrhoea is one of the most important causes of under-5s’ deaths. WHO attributed the majority of diarrhoea deaths to unimproved water supply or unimproved sanitation. Improving water supply and sanitation could thus potentially go a long way towards reducing child mortality under 5 years in many countries. Despite continued national and international efforts, access to improved water and sanitation remains limited in sub-Saharan Africa compared to other regions of the world. The health consequences of lacking access to water and sanitation are severe, and particularly important for child development. In Togo, the child mortality rate under 5 years is 31.7 points higher than the average in sub-Saharan Africa. A question that may arise therefore is whether access to basic services matters for child health. The aim of this paper has been to analyze the effect of access to basic services on child health in Togo. Unlike previous studies, a structural equation model is used. This methodological approach is relevant since it takes account of the possible interdependencies between latent variables (child health and basic service capabilities in our case) and, in doing so, settles the endogeneity issues. Moreover, it allows including some exogenous variables susceptible to directly impact the latent variables. The results indicate that access to basic services (access to safe water, access to sanitation and access to improved housing) improves children’s health by reducing the probability of occurrence of illness (malaria and diarrhoea). These results imply that to reduce morbidity and mortality related to diarrhoea and malaria and improve child health, government should improve access to basic services. This could be done through public financing of basic services targeting disadvantaged groups including rural populations.
References


Tables

Table 1: List of main variables and indicators

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Observed indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic services</td>
<td>Dwelling conditions: wall materials, floor materials, roof materials, overcrowding</td>
</tr>
<tr>
<td></td>
<td>Access to improved water: water source and the time to reach the nearest source of drinking water</td>
</tr>
<tr>
<td></td>
<td>Access to sanitation: place of sewage, place of waste disposal</td>
</tr>
<tr>
<td>Health</td>
<td>Occurrence of malaria</td>
</tr>
<tr>
<td></td>
<td>Occurrence of diarrhoea</td>
</tr>
<tr>
<td></td>
<td>Time to reach the nearest health facility</td>
</tr>
</tbody>
</table>

Exogenous causes
Father’s survival
Residence area: rural/urban
Gender
Household size
Age of child
Mother’s survival

Source: author

Table 2: List of notations in the econometric model

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimension</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Variables</strong></td>
</tr>
<tr>
<td>$y^*$</td>
<td>$m \times 1$</td>
<td>Vector of latent/unobserved endogenous capabilities</td>
</tr>
<tr>
<td>$y$</td>
<td>$p \times 1$</td>
<td>Vector of observed indicators/functions</td>
</tr>
<tr>
<td>$\tilde{y}$</td>
<td>$p \times 1$</td>
<td>Vector of latent response variables</td>
</tr>
<tr>
<td>$W$</td>
<td>$s \times 1$</td>
<td>Vector of exogenous factors in the measurement equation</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Coefficients</strong></td>
</tr>
<tr>
<td>$\tau$</td>
<td>$(C - C \times 1)$</td>
<td>Threshold vector</td>
</tr>
<tr>
<td>$\Lambda$</td>
<td>$p \times m$</td>
<td>Matrix of measurement slopes or loadings, relating to $y^*$</td>
</tr>
<tr>
<td>$D$</td>
<td>$p \times s$</td>
<td>Coefficient matrix of exogenous factors</td>
</tr>
<tr>
<td>$\Gamma$</td>
<td>$m \times m$</td>
<td>Coefficient matrix for latent endogenous capabilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Covariance matrices</strong></td>
</tr>
<tr>
<td>$\Phi$</td>
<td>$p \times p$</td>
<td>Covariance matrix for the residuals in the measurement equations</td>
</tr>
<tr>
<td>$\Psi$</td>
<td>$m \times m$</td>
<td>Covariance matrix for the residuals in the latent variable equations</td>
</tr>
</tbody>
</table>

Source: author
Table 3: Classification of water sources and sanitation based on WHO/UNICEF guidelines

<table>
<thead>
<tr>
<th>Variables</th>
<th>Improved</th>
<th>Unimproved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water source</td>
<td>Piped water connection to household, public taps or standpipes, boreholes or tube wells, protected dug well, protected spring, rainwater collection</td>
<td>Unprotected dug well, unprotected spring, cart with small tank or drum, surface water, bottled water</td>
</tr>
<tr>
<td>Toilet</td>
<td>Pour-flush system, piped sewer system, septic tank, ventilated improved pit latrine (VIP), pit latrine with slab</td>
<td>Pit latrine without slab, bucket, hanging toilet or latrine, no facilities, bush or field, shared or public facility</td>
</tr>
</tbody>
</table>

*Source:* Ezeh et al. (2014), p. 9259
<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of observations</th>
<th>Urban area (%)</th>
<th>Rural area (%)</th>
<th>Female (%)</th>
<th>Male (%)</th>
<th>National (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic services capability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water and sanitation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to improved source of drinking water</td>
<td>5,729</td>
<td>61</td>
<td>33.32</td>
<td>44.37</td>
<td>43.5</td>
<td>43.93</td>
</tr>
<tr>
<td>Time to reach the nearest source of drinking water</td>
<td>5677</td>
<td>92.72</td>
<td>84.04</td>
<td>86.75</td>
<td>87.92</td>
<td>87.33</td>
</tr>
<tr>
<td>Access to improved toilet facilities</td>
<td>5729</td>
<td>55.85</td>
<td>18.77</td>
<td>32.38</td>
<td>33.6</td>
<td>32.99</td>
</tr>
<tr>
<td>Access to improved place of sewage</td>
<td>5729</td>
<td>6.46</td>
<td>1.53</td>
<td>3.52</td>
<td>3.32</td>
<td>3.42</td>
</tr>
<tr>
<td>Housing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to improved place of waste disposal</td>
<td>5729</td>
<td>31.5</td>
<td>13.19</td>
<td>20.18</td>
<td>20.98</td>
<td>20.58</td>
</tr>
<tr>
<td>Access to improved wall materials</td>
<td>5722</td>
<td>50.84</td>
<td>18.87</td>
<td>30.55</td>
<td>31.70</td>
<td>31.13</td>
</tr>
<tr>
<td>Access to improved floor materials</td>
<td>5721</td>
<td>88.15</td>
<td>79</td>
<td>82.55</td>
<td>82.23</td>
<td>82.54</td>
</tr>
<tr>
<td>Access to improved roof materials</td>
<td>5725</td>
<td>84.33</td>
<td>70.33</td>
<td>75.25</td>
<td>75.77</td>
<td>75.51</td>
</tr>
<tr>
<td>Health capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to reach the nearest health facilities</td>
<td>5704</td>
<td>44.53</td>
<td>32</td>
<td>37.17</td>
<td>36.42</td>
<td>36.8</td>
</tr>
<tr>
<td>Occurrence of diarrhoea</td>
<td>5729</td>
<td>98.45</td>
<td>97.99</td>
<td>97.84</td>
<td>98.50</td>
<td>98.17</td>
</tr>
<tr>
<td>Occurrence of malaria</td>
<td>5729</td>
<td>16.84</td>
<td>17.38</td>
<td>17.04</td>
<td>17.31</td>
<td>17.18</td>
</tr>
</tbody>
</table>

Source: author
Table 5: Structural model results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Basic services capability</th>
<th></th>
<th></th>
<th>Health capability</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standardized coefficient</td>
<td>Significance</td>
<td>Coefficient</td>
<td>Standardized coefficient</td>
<td>Significance</td>
</tr>
<tr>
<td>$y_1$</td>
<td>Basic service capability</td>
<td>-</td>
<td>-</td>
<td>0.598</td>
<td>0.008</td>
<td>***</td>
</tr>
<tr>
<td>$y_2$</td>
<td>Health capability</td>
<td>0.000</td>
<td>-0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_1$</td>
<td>Area</td>
<td>0.901</td>
<td>0.689</td>
<td>-0.144</td>
<td>-0.001</td>
<td>***</td>
</tr>
<tr>
<td>$x_2$</td>
<td>Age of child</td>
<td>-0.001</td>
<td>-0.002</td>
<td>0.005</td>
<td>0.000</td>
<td>**</td>
</tr>
<tr>
<td>$x_3$</td>
<td>Gender of household head</td>
<td>-0.032</td>
<td>-0.019</td>
<td>-0.008</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>$x_4$</td>
<td>Father is alive</td>
<td>-0.150</td>
<td>-0.738</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>$x_5$</td>
<td>Mother is alive</td>
<td>-0.084</td>
<td>-0.468</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_6$</td>
<td>Size of household</td>
<td>-0.058</td>
<td>-0.485</td>
<td></td>
<td></td>
<td>***</td>
</tr>
</tbody>
</table>

CFI=0.952
TLI=0.949
RMSA=0.033

***,**,* denote significance at 1%, 5%, and 10% levels respectively

Source: author’s estimates
Table 6: Basic services measurement equation results (part A) and health measurement equation results (part B)

<table>
<thead>
<tr>
<th>Variables</th>
<th>$y_1$</th>
<th>$y_2$</th>
<th>$y_3$</th>
<th>$y_4$</th>
<th>$y_5$</th>
<th>$y_6$</th>
<th>$y_7$</th>
<th>$y_8$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste disposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$y_1^*$ Basic services</th>
<th>Standardized coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y_2^*$ Time to health centre</td>
<td>Standardized coefficient</td>
</tr>
<tr>
<td>$y_3^*$ Malaria</td>
<td>Standardized coefficient</td>
</tr>
<tr>
<td>$y_4^*$ Diarrhoea</td>
<td>Standardized coefficient</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$y_2^*$ Health</th>
<th>Standardized coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$</td>
<td>0.94</td>
</tr>
</tbody>
</table>

***, **, * denote significance at 1%, 5% and 10% levels respectively

Source: author’s estimates
Figures

Figure 1: Access to improved sanitation by sub-regions of the world

Source: WDI, 2016.

Figure 2: Access to improved water by sub-regions of the world

Source: WDI, 2016
Figure 3: Under-5-years mortality rate (per 1000 live birth)

![Graph showing under-5-years mortality rate](image)

*Source:* WDI, 2016

Figure 4: Structure of the general theoretical framework

![Diagram of theoretical framework](image)

*Source:* author