EconomiX
http://economix.fr

Document de Travail
Working Paper
2014-28

Child Mortality in sub-Saharan Africa: Why Public Health Spending Matters

Carl Grekou
Romain Perez

UMR 7235

Université de Paris Ouest Nanterre La Défense
(bâtiment G)
200, Avenue de la République
92001 NANTERRE CEDEX

Tél et Fax : 33.(0)1.40.97.59.07
Email : nasam.zaroualete@u-paris10.fr

université Paris Ouest Nanterre La Défense

Child Mortality in sub-Saharan Africa: Why Public Health Spending Matters

Carl GREKOU * Romain PEREZ †

Abstract

Since 2000, child mortality has dramatically decreased in Africa. Based on an econometrical analysis over 45 sub-Saharan African countries, this paper analyses the determinants of such evolution, and shows that urbanization, sanitation improvement and GDP growth per capita played a critical role in this overall improvement over 2000-2011. The increase in public health expenditures proved to be also decisive, though the elasticity with mortality rate is much weaker. Reaching the Abuja target of 15% of public health expenditure in total public expenditures would have decreased the under-5 child mortality rate by 9% over 2001-2011. It could further reduce this rate by 14% over 2012-2021, and allow Africa to save 19.8 million of children lives. It would also help the region to achieve the Millennium Development Goal on child mortality (reduce by two thirds under-5 child mortality over 1990-2015) by 2022-23, while it would not be reached before 2027 otherwise, according to our estimates.

JEL Classification: H51, I12, I18, O15.

Keywords: Millennium Development Goals, MDGs, Under-5 mortality rate, sub-Saharan Africa, Public expenditure on health.

*EconomiX - CNRS, Université Paris Ouest-Nanterre La Défense. Email: g.grekou@u-paris10.fr
†OECD, Africa Partnership Forum. Email: Romain.PEREZ@oecd.org

1 Introduction

Reducing child mortality in Africa has been recognized as a major priority by the international community and African governments. Therefore, the reduction by two thirds of under-five (child) mortality (U5MR)[1] between 1990 and 2015 is the fourth goal of the eight United Nations Millennium Development Goals (MDG). The African Union Assembly has consistently reiterated its commitment to this MDG by recommending concrete actions since then, and pledged to allocate at least 15% of government expenditures to health under the 2001 Abuja Declaration. With the introduction of Poverty Reduction Strategy papers (PRSPs) and the heavily Indebted Poor Countries (HIPC) Initiative in 1996 and its enhanced version in 1999, the support to the public health sector has gradually increased in sub-Saharan Africa, reaching 36.6 USD billion (3.06% of GDP) in 2011 versus 8.2 USD billion in 2000 (and 2.15% of GDP).

Progress has been noticeable in terms of health outcomes, with a drop by 39% in U5MR between 1990 and 2011. Though the MDG4 (-66%) appears out of reach for 2015, progress has been continuous and widespread, including every African country but one.[2] Thirteen countries out of forty-nine have reduced their U5MR by more than 50%, while other health and mortality indicators have improved significantly.[3]

However, the causes of this general improvement remain debated leading to an overall uncertainty on the prospect of health conditions and mortality rates in Africa in coming decades. The role of public authorities and international donors in these results is often pointed out not only to account for improvements but also to explain the failure of African countries to reach MDG4. Indeed, the Abuja target has still not been met at the end of 2011, public health expenditures representing only 10.43% of total public expenditures in Sub-Saharan Africa (versus 8.69% in 2000). By contrast, "non-political" factors - such as economic growth, access to water and sanitation, urbanization - are often highlighted as the real determinants to this gradual improvement in child health. According to some studies, the relationship between public health expenditures and health conditions is even

[1]The probability of dying between birth and age five years expressed per 1000 live births.

[2]Swaziland, with a U5MR of 104 at the end of 2011 is 24% above the level reached in 1990, despite a large drop since 2000.

[3]See Table 1 in Section 3.2 for further details.

non-existent or so weak that increasing public expenditures should not be considered as a priority.

The question is to know whether more public resources should be allocated to health systems in order to achieve MDG4 and save children lives in Africa, or whether these rare resources should be allocated to other public priorities, considering that the real determinants of public health and children mortality are not linked to public health expenditures. Beyond this, this analysis is also critical to understand why MDG4 will not be achieved in time; when this goal can be realistically achieved; and which target could be considered beyond 2015, given existing trend in mortality reduction. In a nutshell, should African governments keep the Abuja target as a political priority in the perspective of the MDG4? What implications would have a dramatic increase in health expenditures — and possibly ODA — allocated to health budget in Africa on children lives? Here are some issues tackled by this paper.

Thus, the aim of this paper is to analyze socio-economic determinants of child and neonatal mortality in sub-Saharan Africa over the 2000-2011 period. It considerably differs from other analyses in the extent that it also focus on the implications of the Abuja target on child mortality. Also, in a forecast exercise based on a number of assumptions (on change in public health spending, GDP growth, urbanization, ...), we develop a series of projections of under-5 mortality rate which, given the scenario, allow us to determine the MDG4 achievement year and therefore children lives saved or lost.

The paper is organized as follows. Sections 2 and 3 respectively present the review of literature and the methodological approach. In Section 4, we present the key results. Section 5 is devoted to the importance of public health spending in achieving the Millennium Development Goal on child mortality. Finally, Section 6 concludes.

2 Review of literature

The determinants of health conditions – and child mortality – in Africa remain a controversial topic in academic literature. Some factors are widely recognized as essential, such as

GDP per capita growth, access to water and sanitation and female education. Others are more uncertain. The role of public health expenditures has been questioned, though the most recent literature tends to show a positive correlation between health outcome improvements and expenditures.

2.1 *GDP growth, female education and health conditions are closely related*

Economic growth and general health improvement are generally recognized as closely linked. Growth has several possible direct and indirect effects on health, provided that it benefits to the majority of people: increase in purchasing power and better access to food, water, sanitation and health services; better access to education and birth control means... Additionally, economic growth is generally associated with higher public revenues, and leads to improved public health infrastructure and public health service coverage, stimulating demand for health services (Cutler et al., 2006).

In return, healthier individuals will affect the economy in different ways, as shown by Bloom and Canning (2000; 2003), with more productive workers, less sickness absence or early retirement, more investment in education, and greater expectation of a longer life, which stimulate savings available for investment in the economy. Therefore, Gupta et al. (1999) showed that the population's health status improves as per capita incomes rise, with lower under-five and infant mortality rates. The World health Organization (WHO) estimates that an increase of life expectancy at birth by 10% will boost economic growth rate by 0.35% a year.

In the same vein, female literacy and gender equality are acknowledged as important determinants of health conditions, in particular of children (see Baldacci et al., 2004 and World Bank, 1993). Women tend to play a more important role in family health and sanitation, therefore educating mothers helps improving nutrition and their children's health (Zakir and Wunnava, 1997, Currie and Moretti, 2003). Studies have consistently found a strong relationship between women education and child health, as illustrated by Sastry (1997) in Brazil, where mothers with at least three years of school education were found to have 32% lower mortality risk among their children than mothers with less education. In a study of

several African countries, Madise et al. (1999) came to similar conclusions. Magadi (1997) complemented this stream of work, highlighting that father's education was also significantly associated with child health in the case of Kenyan communities, where mothers do not have much access to education.

2.2 *The role of public health expenditure is more controversial*

The relationship between public health expenditures and health outcomes has been extensively studied. Early studies offered a rather contrasted perspective on this relationship. Some (see Kim and Moody, 1992; Musgrove, 1996; Burnside and Dollar, 1998) find no evidence that total spending on health (public plus private) has any impact on child mortality or that it is not the dominant driver of child mortality outcomes (Filmer and Pritchett, 1997).

Carrin and Politi (1995) studied the influence of poverty reduction and public health expenditure on health status based on a sample of 40 developing countries and covering the period 1985-1990. Their methodology relied on estimating an equation where the dependent variable is health status, captured by life expectancy, infant mortality and under-five mortality. Each of these variables is regressed on public health expenditure to gross national product (GNP) ratio, incidence of total absolute poverty and the GNP per capita. The empirical results indicate that GNP per capita is positive and highly related with health status while the reduction of poverty is directly associated to health. However, public health expenditures are not statistically significant.

This latter result is in line with that of Filmer and Pritchett (1999) which examined the impact of both public spending on health and non-health factors (economic, educational, cultural) in determining child (under-5) and infant mortality. Based on a multivariate regression they concluded to a very weak impact of public spending on health. According to them, change in public health expenditures would explain less than one-seventh of change in under-five mortality, and these results were not statistically significant.

Gupta et al. (1999) also stated that the evidence of the relationship between health expenditures and health outcomes is not robust. Non-robustness as the authors acknowledged may be linked to the fact that the data on public health expenditure and mortality are un-

likely to be comparable across countries. Secondly, non-robustness as suggested by Temple (1999) and Durlauf et al (2005) may be due to the fact that most of these studies suffer the problems common to cross-country regressions, particularly, unobserved heterogeneity that might be correlated with the variable of interest.

Using a model similar to that of Filmer and Pritchett (1997; 1999), Wagstaff and Cleason (2004) show that good policies and institutions (as measured by the World Bank's Country Policy and Institutional Assessment or CPIA index) are important determinants of the impact of government health expenditures on outcomes. In particular, as the quality of policies and institutions improves (as the CPIA index rises), the impact of government health expenditures on maternal mortality, under weight children, under-five and tuberculosis mortality also increases and is statistically significant. However, they conclude that the impact of government expenditures on under-five mortality remains not significantly different from zero. Similarly, Rajkumar and Swaroop (2007) used annual data for 1990, 1997 and 2003 and an ordinary least square regression for 91 developed and developing countries to assess the social outcomes of government spending on health status. Their results indicated that public expenditure on health has a greater negative impact on child mortality in countries with good governance, high quality of bureaucracy and low corruption levels. Public spending on health care alone does not guarantee improved social outcomes, good quality governance tools such as well-functioning budget formulation, execution and monitoring are essential in order to produce a better health position.

More recent literature tends to demonstrate a positive relationship between spending on health and health outcomes. The extension of data collection and coverage, as well as the joint improvement in health outcomes and public health expenditures in recent years, could account for this change in perspective.

Following Gupta et al. (2002), Gupta et al. (2004) reached the conclusions that government spending on health care does improve country's health status. They underlined the necessity of efficient assignment of resources. They also found that health care is also affected positively by per capita income, urbanization, adult literacy, access to water and sanitation, and private spending.

Anyanwu et al. (2007) provided econometric evidence linking African countries' per capita total as well as government health expenditures and per capita income to infant mor-

tality and under-five mortality in Africa between 1999 and 2004. They concluded that total health expenditures, including the public component, are important contributor to health outcomes, while ethnolinguistic fractionalization and HIV prevalence are also affecting significantly these outcomes. They also discussed the implications of these results in the debate over the means to attain the targets envisioned by the Millennium Development Goals.

Novignon et al. (2012) used panel data from 1995 to 2010 covering 44 countries in Sus-Saharan Africa as well as fixed and random effects panel data regression models to show that health care expenditure significantly influences health status through improving life expectancy at birth, reducing death and infant mortality rates. Both public and private health spending were showed correlated to these outcomes, even though the impact of public health expenditures were shown to be stronger. As Anyanwu et al (2007), they stated that increasing health care expenditure is still required to achieve the Millennium Development Goals, while effective public-private partnership in allocating health care expenditures were also needed.

2.3 *Similarly, the importance of urbanization is discussed*

Mortality rate is generally higher among rural households than in their urban counterparts as access to health is typically better, and private cost of health (such as transportation costs) tends to lower in urban areas, as shown by Schulz (1993). Besides, urbanization plays an important role in health conditions as it contributes to an epidemiological transition that affects the pattern of mortality. With urbanization, non-communicable diseases such as depression and heart disease, as well as road traffic deaths, are gradually replacing the traditional causes of disability and premature death in rural areas, such as infectious diseases and malnutrition. This process, of great importance for child mortality, is particularly important in developing regions, where the WHO estimates that non-communicable diseases will account for seven out of every ten deaths by 2020, compared with less than half today.

Despite rapid urbanization in sub-Saharan Africa, few case studies have been conducted on changes in mortality pattern, especially due to the epidemiological transition. Agyei-Mensah and de-Graft (2010) presented evidence to illustrate the nature and speed of this transition in Accra, Ghana. They demonstrated that it transition is polarized across social

class: wealthy communities experience higher risk of chronic diseases, while poor communities experience higher risk of infectious diseases and a double burden of infectious and chronic diseases.

The views on the relationship between urbanization and health remain contrasted. Unplanned rapid urbanization has been identified as a health hazard, as more than a third of the population in sub-Saharan Africa are classified as urban dwellers - this proportion could exceed 50% by 2035. However, Leon (2007) showed in its exhaustive review of literature that there is no clear indication that people, including children, are worse off than people living in non-urban settings. Data available would suggests that in most instances child mortality is lower in urban than in rural areas and that there is no urban penalty in child health in low and middle income countries. Fotso (2007) showed that in sub-Saharan Africa the prevalence of child growth stunting is lower in urban compared with rural areas. Three series of factors are generally said to explain this phenomenon: absolute poverty and malnutrition remain mainly rural phenomena (1), vaccination coverage rates are generally higher in urban populations than in their rural counterparts and (3) dissemination and uptake of effective interventions such as oral rehydration therapy are likely to be more effective in an urban setting. Lastly, most of the growth in urban population observed and projected to occur in coming decades will be in small and medium-sized towns and cities of fewer than 1 million inhabitants.

Despite this bulk literature, on the link between public health spendings and health status - namely child mortality - very few research have sought to tackle this issue under the MDGs scope. Indeed, a considerable number of studies addresses the issue of health status determinant, child mortality being one of the most important indicators. However, to the best of our knowledge, there are no studies attempting to analyze the role of public health spendings as the main channel to reduce child mortality as suggested by the Abuja's target and the MDG4. In this paper, we focus on the role played by changes in public health expenditure in the evolution of child mortality rate. More specifically, after determining the elasticity of child mortality to public health spendings, we tried to assess the effects of the Abuja commitment (a comparative analysis between the observed rate of mortality versus that would be observed if the commitment was respected). We also address the issue of the

year to which the MDG4 could be reached. Obviously, given the mortality rate path, this objective will not be completed in 2015. Finally, we analyze the effects of such delay, namely in terms of lives saved / lost.

3 Data and Methodology

3.1 *Data*

In this paper, we have retained neonatal and under-5 mortality rates (per thousands) as health status indicators. This is in line with existing literature. The under-5 mortality rate is a target fourth goal of the United Nations Millennium Development Goals, while the neonatal mortality rate[4] is often used to measure the quality of health services.

The data used are mainly extracted from the *World Development Indicators* database (World Bank) and cover the period 2000-2011. Our sample consists in 45 sub-Saharan African countries (see Appendix A.2 for more details). The rest of the dataset contains public spending on health (expressed as share of GDP) which is our interest variable and a set of control variables such as GDP per capita (PPP), urbanization rate, water and sanitation improvements, private expenditure on health, and Official Development Assistance (ODA). Table A.3 in Appendix A summarizes and gives further details about the data.

3.2 *Descriptive statistics: health expenditures and health outcomes*

Since 2000, the level of public expenditure on health (as share of GDP) in SSA countries increased from 2.15% to 3.06%. Private expenditure on health also increased even, and as a consequence, total expenditure per capita almost tripled, from US$ 42 to US$ 117.7. In the meantime, life expectancy increased dramatically, while mortality rates declined. The largest decrease is that of the *under-5 mortality rate* which fell from 136.5 (per 1,000) in 2000 to 102.28 in 2011, a 25% decrease, followed by the *infant mortality rate* decrease (-21.7%). *Neonatal mortality rate* followed the same trend, but in lesser extent with a decline of 13.63%.

[4]Neonatal mortality rate is the number of neonates dying before reaching 28 days of age, per 1,000 live births in a given year.

Table 1: Descriptive statistics

	2000	2011	Mean (2000-2011)	Std.dev	Min	Max
Public expenditure on health (%GDP)	2.09	2.88	2.58	0.99	1.13	5.39
Expenditure on health per capita (US$)	41.98	117.72	126.69	80.93	30.67	397.88
Private expenditure on health (%GDP)	2.89	3.53	2.21	0.94	0.65	3.96
Total expenditure on health (%GDP)	4.98	6.42	4.79	1.23	2.01	7.87
Life expectancy (years)	51.34	55.70	68.66	6.49	52.62	74.95
Mortality rate (per 1,000 live births)						
Infant	83.80	65.63	37.80	21.29	12.8	88.30
Neonatal	37.40	32.30	19.9	8.69	7.4	37.60
Under-5	136.45	102.28	46.40	27.355	16.2	113.20
Improved water source (% of population with access)	89	83*	65.64	18.15	19	99*
Improved sanitation (% of population with access)	92	95*	36.58	25.15	15	97*
Urbanization	34.18	38.25	38.45	17.08	7.21	86.14

Note: Values reported correspond to average for all African considered countries.

*= 2010's value

3.3 *Econometrical approach*

The econometrical approach is based on panel data regressions. The basic equation (in logarithm) examines the direct impact of public expenditure on health outcomes, as proxied by *neonatal* and *under-5* mortality rates. We specified the model as follows:

$$Mortality_{it} = \alpha_i + \beta PubExp_{it} + \phi X_{it} + \epsilon_{it} \quad (1)$$

where $Mortality$ is our health outcomes (*neonatal* or *under-5* mortality rates), $PubExp$ are the public expenditure on health, X and ϕ are respectively the vector containing the control variables and estimated coefficients of these control variables. $i = 1, \ldots, N$ $t = 1, \ldots, T$ and are respectively the individual and temporal dimensions of the panel, α_i the country fixed effects and ϵ_{it} the error term.

In line with existing literature, we include the income level (GDP (PPP) per capita). As emphasized by Filmer and Pritchett (1999), the inclusion of income is necessary to control for the impact of income on health which works through a variety of indirect channels (better nutrition, better housing, better sanitation,...). We therefore expect a negative relationship between the mortality rates (neonatal and under-5) and income levels.

We also integrate female literacy rate. Indeed, as stated above, it is often argued that female literacy is an important children health status determinant. One can argue that in Africa, women play an important role in family health and well-being. Furthermore, as stressed by Currie and Moretti (2003), educated mothers are more likely to be aware of nutrition and children health.

We controlled for other sources of health expenditure by including private expenditure on health and net O.D.A (Official Development Assistance) received per capita. As Novignon et al. (2012) observed, private expenditure on health play a considerable role especially in children mortality reduction. We also controlled for two variables affecting directly health status as well: water and sanitation condition improvements. Water and sanitation are proxied respectively by improved water source and improved sanitation facilities (both in percentage of population with access).

Finally, we added urbanization (defined as the percentage of the urban population in the total population). As recently stressed by the World Bank's *Global Monitoring Report (GMR, 2013)*, urbanization helps pulling people out of poverty and advancing progress towards the Millennium Development Goals (MDGs). Given the fact that living in an urban area can somehow[5] facilitate access to health care, we expect a negative relationship between mortality rate and public health expenditure.

As stated above, the econometric approach is based on panel data regressions. We consider three different estimation methods to ensure robustness of our analysis. The two first estimation methods consist respectively in applying fixed-effects (FE) and random effects (RE) estimation techniques to model 1 (i.e. equation 1). These two techniques can handle systemic tendency of individual specific components to be higher in some units than others (individual effects) and possible higher in some time periods than others (time effects). Another advantage of these two techniques is that they adjust for heteroskedasticity.[6] Given that GDP per capita is potentially endogenous, we rely on Instrumental Variable (IV) to

[5]See previous section.

[6]Unlike previous studies, we do not apply Ordinary Least Squares (OLS) on the pooled data since the OLS estimator is likely to generate highly biased coefficients by ignoring both country specific effects and possible endogeneity of the right hand side variables. Even if they still require assumptions to be satisfied (such as strict exogeneity), the fixed-effects and random effects estimators are therefore preferable to the pooled OLS estimator.

deal with this possible endogeneity issue. Instrumental variable methods allow consistent estimation when the explanatory variables are correlated with the error terms of a regression relationship.[7] IV regression consist in instrumenting an explanatory variable (that supposed to be endogenous) by another variable (the instrument), correlated with the "endogenous" variable but not with the error term. In our study, we have instrumented GDP per capita using its lagged value (second lag).

4 Key results: estimating the main economic determinants of child mortality reduction in sub-Saharan Africa

4.1 *Urbanization, GDP growth and improvement in sanitation accounted for most of the improvement in child mortality in Africa*

According to our results (see Table 2), the main determinant to child mortality over 2000-2011 was urbanization. The estimated elasticity varies between -0.33 and -0.72 and is statistically significant for all models (see Tables 2 and 3). Similarly, GDP per capita change is another critical and statistically reliable determinant to account for under-5 child mortality variation over this period of time. Our estimates range from -0.23 to -0.36: a 1% increase in the income level (GDP per capita), leads to a reduction of under-5 mortality rate between 0.23% and 0.36%.

Improvement in sanitation facilities (% population with access) is also an important determinant for under-5 mortality rate. The estimated impact varies between -0.19 and -0.24 and is statistically significant at 10% confidence level.[8] Female enrollment in secondary is also negatively linked with under-5 mortality rate but this relationship does not appear statistically significant. Finally, we found that net O.D.A (Official Development Assistance) received per capita negatively impact the under-5 mortality rate but marginally only (a 1% increase in O.D.A. would lead to a reduction of U5MR around 0.04%).

[7]Such correlation may occur when the dependent variable causes at least one of the covariates ("reverse" causation), when there are relevant explanatory variables that are omitted from the model, or when the covariates are subject to measurement error.

[8]We do not mention the FE-IV estimate since it is not statistically significant.

4.2 *The role of public expenditure increases was less determinant, but statistically significant*

From the three estimations (FE, RE and FE-IV), public expenditure on health is found to be negatively correlated with under-5 mortality rate and statistically significant. The correlation is however small. The elasticity coefficient varies between -0.06 for the FE-IV estimation and -0.10 for the RE estimation, which mean that a 1% increase in public health expenditure leads to a reduction between 0.06% and 0.10% of the under-5 mortality rate.

Our results also show a negative but not statistically significant relationship between private expenditure and under-5 mortality rate. Indeed, private expenditure appears to be significant at lower confidence level than the conventional ones.[9]

Table 2: Under-5 mortality rates and public expenditure on health

Dependent variable	Under-5 mortality rate		
GDP per capita	-0.23***	-0.28***	-0.36***
	(-4.45)	(-5.99)	(-4.81)
Public expenditure	-0.08***	-0.10***	-0.06**
	(-3.56)	(-4.47)	(-2.54)
Private expenditure	-0.04	-0.03	-0.04
	(-1.38)	(-1.05)	(-1.10)
Urban	-0.72***	-0.33***	-0.53**
	(-4.33)	(-2.88)	(-2.44)
Sanitation	-0.24**	-0.19**	-0.13
	(-2.60)	(-2.51)	(-1.04)
Female secondary	-0.09	-0.18	-0.16
	(-0.65)	(-1.39)	(-1.00)
O.D.A	-0.04***	-0.05***	-0.04**
	(-2.86)	(-3.57)	(-2.53)
Constant	10.16***	9.51***	10.39***
	(16.80)	(17.54)	(15.35)
R-squared	0.63	0.62	0.61
Estimation method	FE	RE	FE - IV
	Within	GLS	TSLS

Note: ***, ** and * respectively denote significance at 1%, 5% and 10%. t-statistics are reported in parentheses.

[9]Significant at 20%.

4.3 *The analysis is similar for neonatal mortality rates*

Neonatal mortality rates, which dropped less significantly than U5MR, appear to have similar determinants, as shown in Table 3. Estimated elasticities are however smaller, due to the magnitude of neonatal mortality change. Once again, urbanization, GDP per capita and sanitation appear to be the main factors to mortality rate reduction. The effects of public expenditures is more marginal, but still significant.

Table 3: Neonatal mortality rates and public expenditure on health

Dependent variable	Neonatal mortality rate		
GDP per capita	-0.13***	-0.16***	-0.17***
	(-5.09)	(-6.37)	(-4.68)
Public expenditure	-0.03***	-0.04***	-0.02*
	(-2.86)	(-3.59)	(-1.76)
Private expenditure	-0.05***	-0.04***	-0.05***
	(-3.16)	(-2.71)	(-2.86)
Urban	-0.37***	-0.23***	-0.29***
	(-4.44)	(-3.33)	(-2.76)
Sanitation	-0.14***	-0.12***	-0.11*
	(-3.02)	(-3.04)	(-1.83)
Female secondary	-0.06	-0.10*	-0.13*
	(-0.94)	(-1.66)	(-1.64)
O.D.A	-0.01	-0.01	-0.00
	(-0.92)	(-1.22)	(-0.55)
Constant	6.52***	6.35***	6.65***
	(21.30)	(21.69)	(20.20)
R-squared	0.64	0.64	0.63
Estimation method	FE	RE	FE - IV
	Within	GLS	TSLS

Note: ***, ** and * respectively denote significance at 1%, 5% and 10%. t-statistics are reported in parentheses.

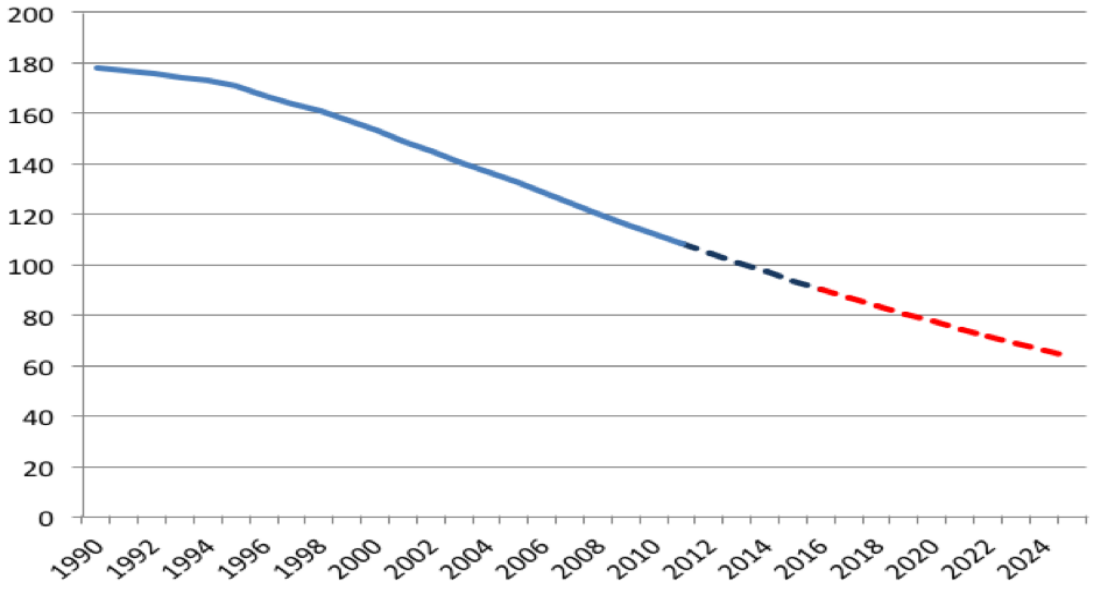
To sum up, the income level (GDP per capita), improvements in sanitation access, urbanization, O.D.A and public expenditure on health are important determinants in reducing the neonatal and under-5 mortality rate. Moreover, our results suggest that increasing public expenditures does help bringing down children mortality rate, though the correlation coefficient is weaker than for structural determinants such as income level.

5 Achieving MDG4 in Africa: the importance of public health expenditures

As it can be seen in Figure 1, under-5 mortality rate in SSA fell from 178 (per thousands) to 108.3 between 1990 and 2011. This decrease represents a decline of 39.1% in two decades, which is significant but far from the target set for the MDG4 (reducing child mortality by two third between 1990 and 2015). As a result, it is clear that SSA countries will not reach the MDG4 by 2015. We have estimated that the under-5 mortality rate should be around 93.5 (per thousands) by then. This is far from the target of 60 per thousands (*i.e.* the 1990 rate's third).

From this perspective, an interesting issue is to know when SSA countries would reach the "MDG 4". Based on projections, we estimated that the MDG4 could be reached in 2027, if everything remains unchanged. This result should be interpreted cautiously since there is a certain level of uncertainty on key assumptions, including on GDP growth in Africa over this period.

Figure 1: Under-5 mortality rate in SSA (observed and forecasted)



Source: Authors

What if Abuja's commitment was respected?

In 2001, African countries committed to devote 15% of their budget to health expenditure, under the Abuja Declaration. However, this commitment has not been generally respected: from 2000 to 2011, the share of government expenditure devoted to health expenditure in total public expenditure increased from 8.7 to 10.4% (see Table 4).

Table 4: Public expenditure on health in SSA countries

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
% Gov. expenditure	8.69	8.73	9.12	9.65	10.27	10.70	10.58	10.66	10.30	10.17	10.06	10.43
% GDP	2.15	2.26	2.34	2.50	2.64	2.70	2.69	2.74	2.76	2.98	2.93	3.06

Source: World Bank (WDI)

In the previous section, we found that the impact of public expenditure on health is relatively weak, with elasticities varying between -0.06 and -0.10. However, given the gap between the Abuja target and the effective level of public health expenditure, the increase in expenditures could be important for child health if African governments were to meet their commitment. This is all the more true given that capital spending in public expenditures have long-term effects that cumulate over time.

Based on the econometric work presented in section 3, and a simple projection exercise (described in Appendix C.3), we have analyzed the implications of such increase in public health expenditures. In terms of under-5 child mortality rate, reaching the Abuja target would have implied an average drop of 9% per year from 2001 to 2011, allowing Africa to save a total of 16.3 million of children lives over this period of time, as shown in Table 5 (exhaustive results are presented in Appendix C.2). On average, public health expenditures should have been increased by 52%, which explains the magnitude of the impact on U5MR.

Reaching the Abuja target could have much stronger effect as time goes by, while proving easier to reach. As a result of the increasing trend in public expenditure, the gap between this target and the effective level of expenditure narrows, so that the annual cost of reaching the Abuja target would represent 1.2% of GDP beyond 2012 (vs. an average of 1.3% over 2001-2011). As health systems benefit from the accumulation of capital, the effects of the

long term increase in public spending are magnified, so that child mortality rate would be on average 14% lower over 2012-2021, representing a total of 19.8 million of lives saved over this period.

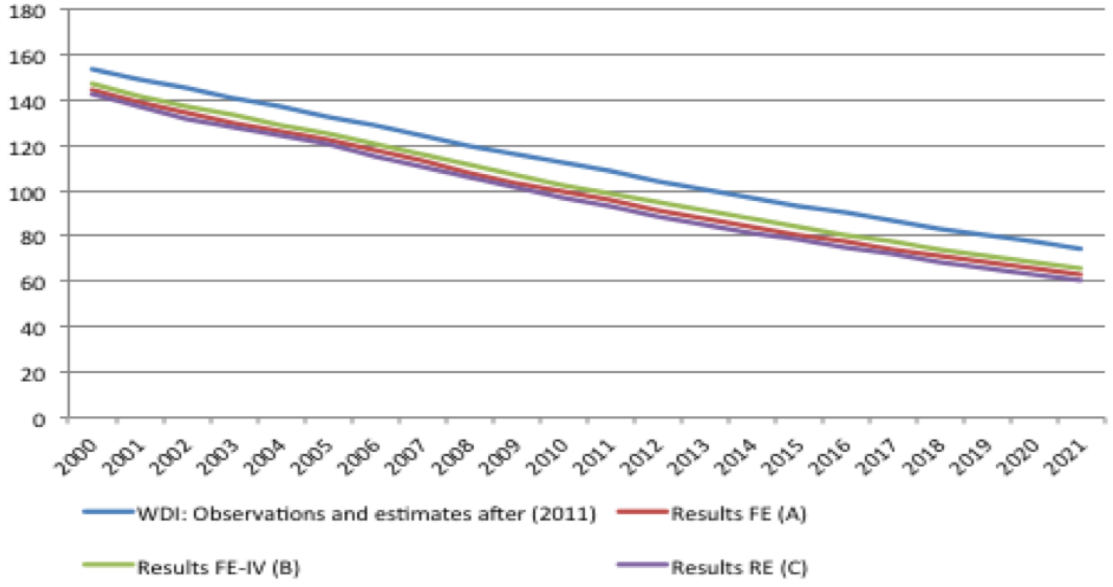
Table 5: Increasing public health spending to 15% of total public spending - health and financial implications

	U5MR WDI: observations and estimates (after 2011)	U5MR Results (Abuja target)	Difference in U5MR	Children lives saved	Increase in public health spending
2000	153.39	144.49	-6%	979,355	73%
2011	108.34	95.52	-12%	1,828,477	44%
2016	90.19	77.48	-14%	1,997,792	37%
2021	74.36	62.82	-16%	1,972,071	27%

*Source:*Authors' calculations

According to our estimate, increasing health public expenditure to 15% of the total public expenditure would allow African economies to reach the MDG4 by 2022-2023 instead of 2027, but would clearly not suffice to meet the 2015 deadline.

Figure 2: Under-5 mortality rate: observed and Abuja engagement



Sources: WDI and Authors' calculations.

These results raise several questions related to the importance and priorities of health policies in Africa. On the one hand, we see that committing more public resources would

have a dramatic impact on health, allowing Africa to save almost two million children per year in the coming decade and significantly contributing to the achievement of the MDG4. On the other hand, the financial burden of the Abuja target should not be underestimated, and it remains challenging to identify how these additional resources could be mobilized given that other development priorities (education, infrastructures, ...) also require more public spending. In this perspective, the improvement in the efficiency of public spending could play a critical role in the reduction of child mortality.

In the same vein, the role of capital public health spending should be pointed out. As a result of their lasting effect, their increase has dramatic effects on child mortality and proves much more important than recurrent public spending. Of note, the WHO (2010) estimates that at least 50% of medical equipment in developing countries is either partly usable or totally unusable.

6 Conclusion

Our study confirms the importance of structural factors – such as urbanization and long-term growth – in the evolution of child mortality in Africa over the period 2000-2011. This shed some lights on the challenge to reach MDG4 in Africa by 2015. However, it also points out the statistical significance of the relationship between public health expenditure and under-5 child mortality rate, in line with the most recent literature on this topic. This relationship is of critical importance for African development, despite the weakness of the correlation coefficient between U5MR and public expenditure. Indeed, the MDG4 target, which aims at reducing child mortality by two-third, could be achieved in 2022 if African governments were to respect the commitment made in 2001 and increase the share of their health public expenditure to 15%, while the target would not be met before 2027 otherwise.

On the field this increase in public expenditure would dramatically change the pattern of child mortality, allowing Africa to save almost 20 million of children lives between 2012 and 2021. The cost of reaching the Abuja target would amount annually to 1.2% of African GDP, which obviously shows the limitations of this commitment. However, the human and social effects of such increase appear to be of such magnitude that it could deserve further

attention.

Another avenue that was not explored in this paper concerns the improvement in the efficiency of public health expenditures. Undoubtedly, this qualitative improvement could also play a major role in helping African countries in their efforts to cut child mortality and achieve Millennium Development Goals.

References

African Summit on HIV/AIDS, tuberculosis and other related infectious diseases. Abuja Declaration on HIV/AIDS, Tuberculosis and Other Related Infectious Diseases, 24–27 April 2001. Organisation of African Unity, 2001 (OAU/SPS/ ABUJA/3).

Agyei-Mensah S., de-Graft A. (2010), "Epidemiological transition and the double burden of disease in Accra, Ghana", *Journal of Urban Health*. 2010 Sep.

Anand S., Ravallion R. (1993), "Human development in poor countries: on the role of private incomes and public services", *Journal of Economic Perspectives*, Vol. 7, pp. 133-50.

Anyanwu J.C., Erhijakpor A.E. (2007), "Health Expenditures and Health Outcomes in Africa", African development bank.

Baldacci .E, Guin-Siu M.T., de Mello L. (2003), "More on the effectiveness of public spending on health care and education: a covariance structure model", *Journal of International Development*, Vol. 15, pp.709-725.

Baldacci E., Clements B., Gupta S., Cui Q. (2004), "Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs", IMF Working Paper, no. wp/04/217, Washington DC.

Bloom D., Canning D. (2000), "The health and wealth of nations", *Science 2000*, 287, 1207- 1209.

Bloom D., Canning D. (2003), "The Health and Poverty of Nations: From Theory to Practice", *Journal of Human Development*, Vol. 4, No. 1, pp. 47–71.

Burnside C., Dollar D. (1998), "Aid, the Incentive Regime, and Poverty Reduction", The World Bank, Washington D.C. Macroeconomics and Growth Group.

Carrin G., Politi C. (1995), "Exploring the Health Impact of Economic Growth, Poverty Reduction and Public Health Expenditure", *Tidjschrift voor Economie en Management*, (40)3-4, pp. 227-246.

Craigwell R., Bynoe D., Shane L. (2012),"The effectiveness of government expenditure on education and health care in the Caribbean", *International Journal of Development Issues*, Vol. 11 Iss: 1 pp. 4 – 18.

Currie J., Moretti E. (2003), "Mother's Education and the International Transmission of Human Capital: Evidence from College Openings", *Quarterly Journal of economics*, 118(4).

Cutler D., Deaton A., Lleras-Muney A. (2006), "The Determinants of Mortality", *Journal of Economic Perspectives*, January.

De Mello L., Pisu M. (2009), "The effectiveness of education and health spending among Brazilian municipalities", OECD Economics Department Working Papers, No. 712.

Dumitrescu E. I., Hurlin C. (2012), "Testing for Granger non-causality in heterogeneous panels", *Economic Modelling*, 29(4), 1450-1460.

Durlauf S.P., Temple J. (2005), Growth Econometrics chapter 8 in Aghion p and Durlant S.N (Eds) *Handbook of Economic Growth*, Vol 1A, North-Holland: Amsterdam, 555-677.

Elmendorf E., Kandola K., Gnanaraj C., Peters D. (1999), "Health Expenditures, Services, and Outcomes in Africa: basic data and cross-national comparisons 1990-1996", World Bank Publications 434.

Filmer D., Pritchett L. (1997), "Child Mortality and Public Spending on Health: How Much Does Money Matter?", World Bank Policy Research Working Paper No. 1864 (Washington: World Bank).

Filmer D., Pritchett L. (1999), "The impact of public spending on health: does money matter?", *Social Science Medecine*, Vol. 49, pp. 1309-1323.

Fotso J.C. (2007), "Urban-rural differentials in child malnutrition: trends and socioeconomic correlates in sub-Saharan Africa". Health Place 2007;13:205-23.

Gupta S., Verhoeven M., Tiongson E. (1999), "Does Higher Government Spending Buy Better Results in Education and Health Care?", IMF, Washington D.C, Working paper 99/21.

Gupta S., Clements B., Inchauste G. (2004), "Helping Countries Develop: The Role of Fiscal Policy", International Monetary Fund, Washington, DC.

Gupta S., Verhoeven M., Tiongson E. (2002), "The effectiveness of government spending on education and health care in developing and transition economies", *European Journal of Political Economy*, Vol. 18 No. 4, pp. 717-37.

Harpham T., Reed H., Montgomery M., Satterthwaite D., Moser C., Cohen B. (2004), "Mortality and morbidity: is city life good for your health?" In: MontgomeryMR, StrenR, CohenB, Reed HE, editors. Cities Transformed: Demographic Change and its Implications in the Developing World. London: Earthscan; 2004. p. 259-99.

Kim K., Moody P.M. (1992), "More Resources, Better Health? A Cross-National Perspective," *Social Science and Medicine*, Vol. 34, pp. 837–42.

Leon D. (2007), "Cities, urbanization and health", *Oxford Journals, Medicine International Journal of Epidemiology*, Volume 37, Issue 1, Pp. 4-8.

Madise N., Matthews Z., Margetts B. (1999), "Heterogeneity of Child Nutritional Status between Households: A Comparison of Six Sub-Saharan African Countries.", *Population Studies*, 53(3): 331-43.

Magadi M.A. (1997), "Status of women and infant/child health in Kenya with particular reference to the high mortality zone in Nyaza Province", UAPS Study Report.

Musgrove P. (1996), "Public and Private Roles in Health," Technical Report 339, World Bank Washington, D.C.

Novignon J., Mussa R., Chiwaula L. (2012), "Health and vulnerability to poverty in Ghana: evidence from the Ghana Living Standards Survey Round", *Health Economics Review* 2012, 2:11.

Rajkumar A.S., Swaroop V. (2007), "Public spending and outcomes: does governance matter?", *Journal of Development Economics*, Vol. 86, pp. 96-111.

Sastry N. (1997), "Family-level Clustering of Childhood Mortality Risk in Northeast Brazil", *Population Studies* 51: 245-261.

Schultz T.P. (1993), "Mortality Decline in the Low-Income World: Causes and Consequences," Economic Growth Center Discussion Paper No. 681 (New Haven: Yale University).

Temple J.R. (1999), "The New growth Evidence", *Journal of Economic Literature*, March, 37 (1), 112-156.

Wagstaff A., Cleason M. (2004), "The Millennium Development Goals for Health: Rising to the challenge", Washington, D.C. World Bank.

WHO (2003), Increasing Investments in Health Outcomes for the Poor, Geneva.

WHO (2010), Health systems financing, the path to universal coverage, Geneva.

World Bank. (1993), World Development Report 1993: Investing in Health. Oxford University Press: New York, NY.

Zakir M., Wunnava P. V. (1999), "Factors Affecting Infant Mortality Rates: Evidence from Cross-sectional Data", *Applied Economics Letters*, 6, 271-273.

Appendix

A. Data appendix

A.1. Sub-Saharan Africa statistics

Table A.1: Sub-Saharan Africa' statistics

	1995	2000	2005	2010-2011
Public expenditure on health (% GDP)	2.03	2.09	2.69	2.88
Water access	57.65	61.39	65.30	69.07*
Sanitation access	28.33	30.12	32.34	33.43*
Expenditure on health (per capita) (USD)	44.33	41.98	76.37	117.72
Private expenditure on health (% GDP)	2.78	2.89	3.17	3.53
Total expenditure on health (% GDP)	4.76	4.98	5.86	6.42
Life expectancy (years)	51.05	51.34	53.33	55.70
Infant mortality rate	90.81	83.80	74.53	65.63
Neonatal mortality rate	39.39	37.40	34.79	32.30
Under 5 y mortality rate	149.89	136.45	119.37	102.28
Population (above 65y)	3.15	3.17	3.22	3.28
Population (15 - 64 y)	52.52	53.46	54.47	55.52
Fertility rate	5.70	5.30	4.96	4.62
Urbanisation rate	32.29	34.18	36.18	38.25
Population (0 - 14 years old)	44.32	43.35	42.31	41.20
Population growth rate	2.34	2.53	2.32	2.28
ODA per capita (USD)	74.37	41.88	63.79	104.98
GDP per capita (USD)	1840.37	2307.70	3128.33	4011.10

	Average	Std.Error	Min.	Max.
Public expenditure on health	2.58	0.99	1.13	5.39
water	84.92	11.23	54	99.0
Sanitation	80.48	15.18	50	97.0
Expenditure on health (per capita)	126.69	80.93	30.67	397.88
Private expenditure on health	2.21	0.94	0.65	3.96
Total expenditure on health	4.79	1.23	2.01	7.87
Life expectancy	68.66	6.49	52.62	74.95
Infant mortality rate	37.80	21.29	12.8	88.30
Neonatal mortality rate	19.9	8.69	7.4	37.60
Under 5 y mortality rate	46.40	27.355	16.2	113.20
Population (above 65y)	2.99	0.82	2.0	5.48
Fertility rate	63.22	12.21	42.79	77.73
Urbanisation	38.65	45.47	0.77	191.16
ODA	5597	3598	1556	16897

Source: WDI and authors' calculations

A.2. Sample

Table A.2: Studied sub-Saharan countries

Angola	Cote d'Ivoire	Madagascar	Seychelles
Benin	Equatorial Guinea	Malawi	Sierra Leone
Botswana	Eritrea	Mali	South Africa
Burkina Faso	Ethiopia	Mauritania	Sudan
Burundi	Gabon	Mauritius	Swaziland
Cameroon	Gambia, The	Mozambique	Tanzania
Cape Verde	Ghana	Namibia	Togo
Central African Republic	Guinea	Niger	Uganda
Chad	Guinea-Bissau	Nigeria	Zambia
Comoros	Kenya	Rwanda	
Congo, Dem. Rep.	Lesotho	Sao Tome and Principe	
Congo, Rep.	Liberia	Senegal	

Source: WDI and authors' calculations

A.3. Variables and sources

Table A.3: Variables and sources

Variable	Source
Health	
Health expenditure, public (%GDP)	WDI
Health expenditure per capita (current US$)	WDI
Health expenditure, private (% of GDP)	WDI
Health expenditure, total (% of GDP)	WDI
Mortality rate, infant (per 1,000 live births)	WDI
Mortality rate, neonatal (per 1,000 live births)	WDI
Mortality rate, under-5 (per 1,000 live births)	WDI
Fertility rate, total (births per woman)	WDI
Others	
GDP per capita (PPP) US$	WDI
Net official development assistance received per capita	WDI
Improved sanitation facilities (% population with access)	WDI
Improved water source (% population with access)	WDI
Urban population (% of total)	WDI
GDP (forecasted values)	WEO
Population (aged 0-4 years)	WPP

WDI: World Development Indicators (World Bank)
WEO: World Economic Outlook (International Monetary Fund)
WPP: World Population Prospect (United Nations)

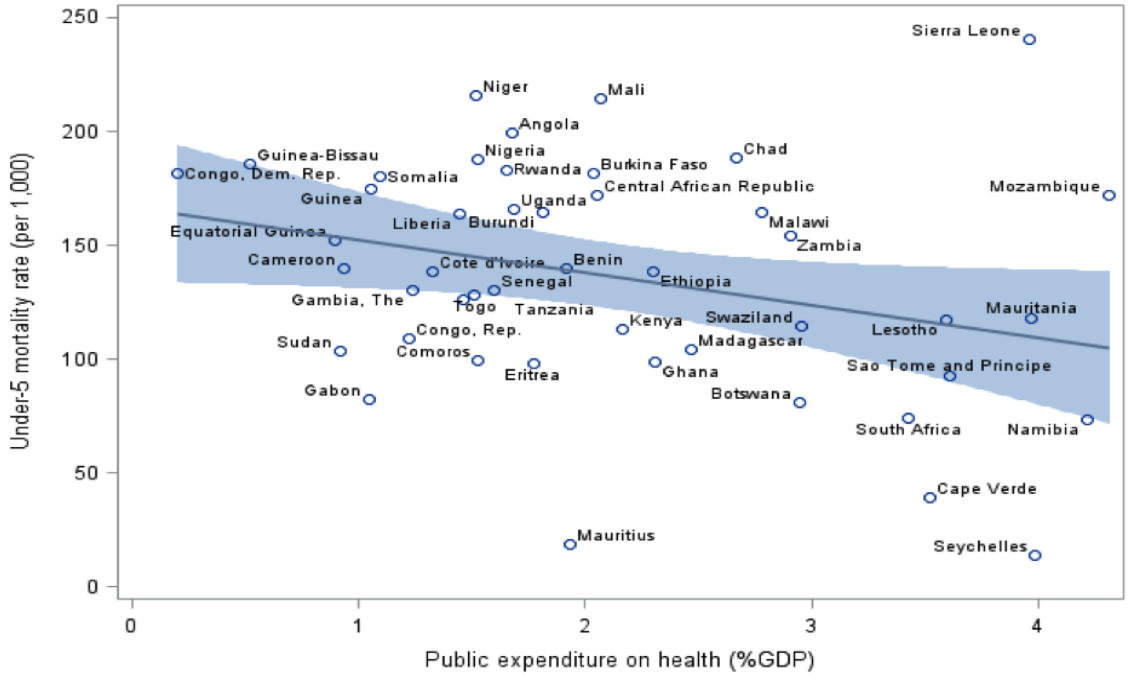
B. Graphics: Public expenditure and mortality rates in SSA

For illustrative purposes, we presented in Figures B.1 and B.2, the level of our health outcomes and the level of the public expenditure on health. The scatter plot representations allow us to observe the dispersion around the trend.

B.1. Public expenditure and Under-5 mortality rate in SSA

With respect to the under-5 mortality rate, as Figure B.1 (a and b) shows, we can observe the diversity of the situations. The decreasing trend reflects the fact that, overall, an increase in the public expenditure could lead to a decrease in the under-5 mortality rate. Only a few countries present "low" levels of under-5 mortality rate (Seychelles, Mauritius, Cape Verde...).

Figure B.1.a: Public expenditure on health and under-5 mortality rates in SSA (2000)

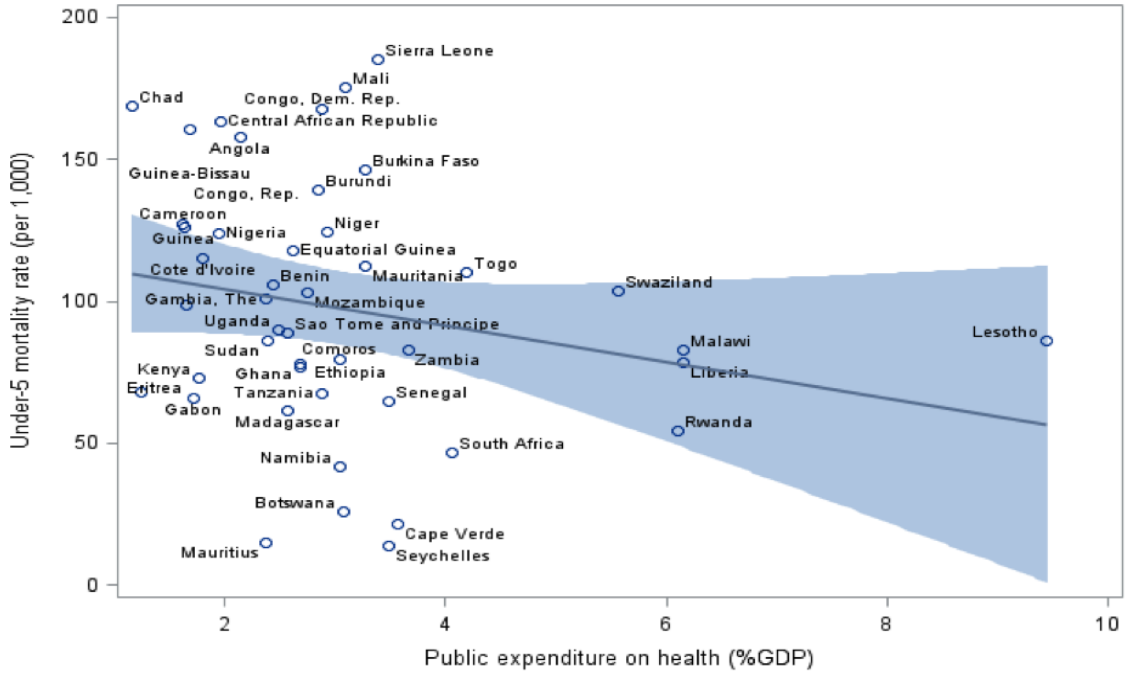


Sources: Authors

In 2000, some countries such as Sierra Leone and Mozambique present not only high level of public expenditure but also high level of under-5 mortality rates. Looking at Figure X1.b (*i.e.* in 2011), a noticeable fact is the cluster of countries spending between 2% and

4% of their GDP as public expenditure on health. In other words, nearly all SSA countries increased the share of their GDP allocated to health expenditure. To look deeper into these figures, we will take Sierra Leone, Lesotho and Rwanda examples.

Figure B.1.b: Public expenditure on health and under-5 mortality rates in SSA (2011)



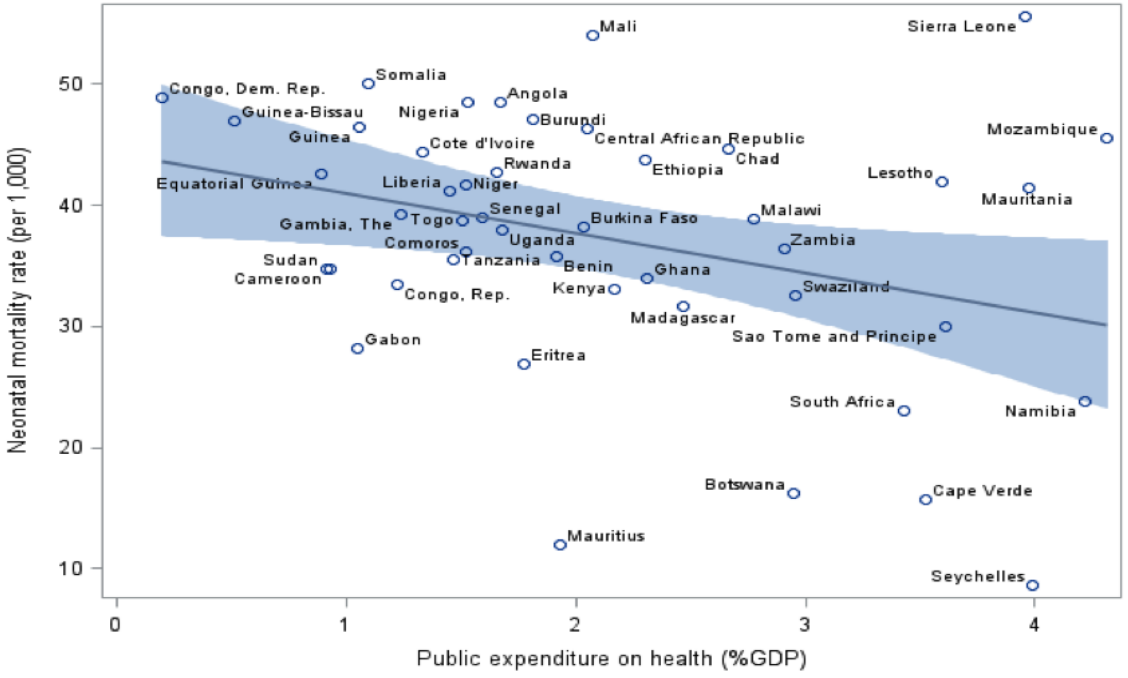
Sources: Authors

In 2000, Lesotho, Rwanda and Sierra Leone spent respectively 3.95%, 1.65% and 3.59% of their GDP as health expenditure. Their under-5 mortality rates were respectively 117.3, 183 and 240.6. In 2011, health public expenditure for Lesotho, Rwanda and Sierra Leone respectively corresponds to 9.45%, 6.10%, 3.39% of their GDP and the under-5 mortality were respectively 86, 54.1 and 185.3. The striking fact is the considerable drop (-70.4%) of the under-5 mortality rate in Rwanda. In a lesser extent, we also note the reduction in under-5 mortality in Lesotho. In general, all countries increased their public expenditure on health and have, despite the heterogeneity, and all but one recorded a decrease in the under-5 mortality rates.

B.2. Public expenditure and neonatal mortality rate in SSA

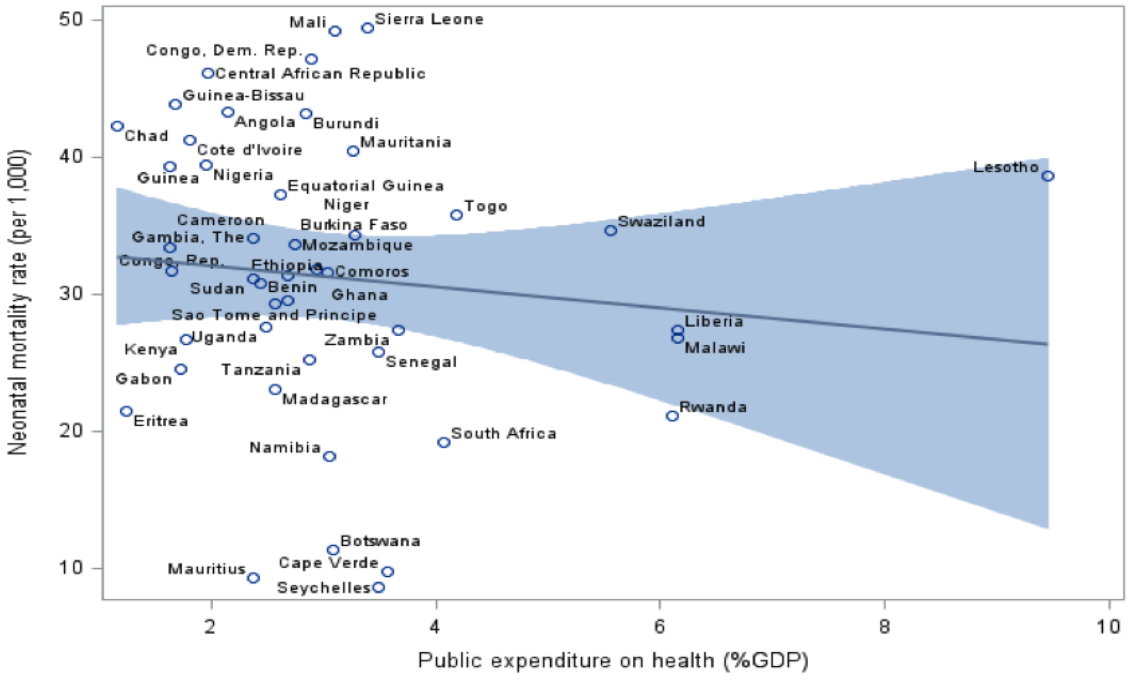
Let us turn now to the neonatal mortality rate. As shown in Figures B.2 (a and b), the trends are similar as for under-5 mortality rate. We note an increase in public expenditure on health and a decline in the neonatal mortality rates. However, some countries namely Sierra Leone and Mali, Congo Dem. Rep., despite a level of public expenditure above 4% of GDP, recorded very high rate of neonatal mortality. We note again the good performance of Rwanda in reducing mortality rates.

Figure B.2.a: Public expenditure on health and neonatal mortality rates in SSA (2000)



Sources: Authors

Figure B.2.b: Public expenditure on health and neonatal mortality rates in SSA (2011)



Sources: Authors

In general, SSA countries increase their public expenditure on health but these latters remain very low.

C. Key results

C.1. Causality tests

Results displayed in Table C.1 are those obtained from the test proposed by Dumitrescu and Hurlin (2012). For brevity, we do not present the details. Note however that under the null of Homogenous Non Causality (HNC), there is no causal relationship for all the cross-units of the panel. Under the alternative, there is a causal relationship for at least for one cross-unit.

Table C.1: Causality tests between public health spending and the mortality rate indexes

	Public spending to Under-5 mortality rate			Public spending to neonatal mortality rate		
	K=1	K=2	K=3	K=1	K=2	K=3
W_{HNC}	11.41	3.64	6.55	18.48	5.86	8.92
Z_{HNC}	54.08*	12.12*	31.96*	90.86*	28.41*	53.36*
$\tilde{Z}_{HNC}$	40.00*	3.12*	4.96*	67.66*	8.66*	9.18*

Note: "Public spending to X" indicates that we test the null hypothesis of Homogenous Non Causality (HNC) from Public spending to X. "*" indicates rejection of the null at the 5% significance level.

C.2. Abuja target and under-5 mortality rate

Table C.2: The effects of increasing public health spending to 15% of total public spending (Abuja target) on U5MR

	WDI: U5MR observations and estimates (after 2011)	U5MR after Abuja - FE **(A)**	U5MR after Abuja - FE-IV **(B)**	U5MR after Abuja - RE **(C)**	Difference in U5MR **(A)**	Difference in U5MR **(B)**	Difference in U5MR **(C)**	Children lives saved **(A)**	Children lives saved **(B)**	Children lives saved **(C)**
2000	153.39	144.49	146.71	142.26	-0.06	-0.04	-0.07	979,355	734,516	1,224,194
2001	149.19	138.53	141.62	136.63	-0.07	-0.05	-0.08	1,203,361	854,680	1,418,311
2002	144.99	134.01	137.16	132.02	-0.08	-0.05	-0.09	1,270,470	906,379	1,501,279
2003	140.92	129.96	133.09	127.96	-0.08	-0.06	-0.09	1,299,019	928,579	1,536,696
2004	136.89	126.19	129.24	124.23	-0.08	-0.06	-0.09	1,299,191	929,071	1,537,231
2005	132.81	122.17	125.19	120.21	-0.08	-0.06	-0.09	1,321,308	946,547	1,564,883
2006	128.63	117.47	120.59	115.38	-0.09	-0.06	-0.10	1,420,237	1,023,095	1,687,015
2007	124.28	112.90	116.05	110.74	-0.09	-0.07	-0.11	1,484,338	1,073,183	1,766,304
2008	120.07	107.97	111.27	105.63	-0.10	-0.07	-0.12	1,615,580	1,175,156	1,927,813
2009	116.09	103.51	106.90	101.06	-0.11	-0.08	-0.13	1,717,351	1,254,620	2,052,793
2010	112.23	99.24	102.70	96.68	-0.12	-0.08	-0.14	1,814,090	1,330,417	2,171,341
2011	108.34	95.52	98.93	92.99	-0.12	-0.09	-0.14	1,828,477	1,342,687	2,189,397
2012	104.47	91.40	94.84	88.81	-0.13	-0.09	-0.15	1,901,438	1,400,583	2,278,744
2013	100.77	87.73	91.14	85.13	-0.13	-0.10	-0.16	1,936,799	1,429,353	2,322,175
2014	97.15	84.18	87.56	81.59	-0.13	-0.10	-0.16	1,964,881	1,452,566	2,356,693
2015	93.63	80.76	84.10	78.20	-0.14	-0.10	-0.16	1,986,031	1,470,470	2,382,736
2016	90.19	77.48	80.76	74.93	-0.14	-0.10	-0.17	1,997,792	1,481,240	2,397,379
2017	86.84	74.31	77.54	71.80	-0.14	-0.11	-0.17	2,003,418	1,487,281	2,404,546
2018	83.58	71.26	74.43	68.80	-0.15	-0.11	-0.18	2,003,295	1,488,879	2,404,716
2019	80.42	68.34	71.43	65.91	-0.15	-0.11	-0.18	1,997,803	1,486,318	2,398,364
2020	77.34	65.52	68.54	63.15	-0.15	-0.11	-0.18	1,987,321	1,479,882	2,385,957
2021	74.36	62.82	65.76	60.50	-0.16	-0.12	-0.19	1,972,071	1,469,739	2,367,775

Source: WDI and authors' calculations

C.3. Estimating the implications of Abuja's commitment

Let us consider the following equation:

$$Pub.Exp_{it} = \alpha Capital_{it} + \beta Recurrent_{it} \qquad (C.1)$$

Equation C.1 decomposes the public expenditure on health ($Pub.Exp$) into $Capital$ expenditure (investment) and $Recurrent$ expenditure (wages, contraceptives, drugs and vaccines). α and β are respectively the share of public expenditure allocated to $Capital$ and $Recurrent$ expenditure.

To evaluate the effects of Abuja commitment, we proceeded as follows:

$$Mort.rate'_{i1} = Mort.rate_{i1} + (1 - \epsilon_{m/G} \times \dot{G}_1) \qquad (C.2)$$

where $Mort.rate'_{it}$ is the under-5 mortality rate obtained in period 1 if the Abuja's commitment was respected; $Mort.rate_{it}$ is the observed mortality rate and $\epsilon_{m/G}$ the estimated elasticity of under-5 mortality rate to public expenditure (see section 3). $\dot{G}_1$ is the variation of public expenditure to reach the Abuja's target. Equation C.2 therefore allows us to approximate the mortality rate in period 1 if Abuja's commitment was respected.

We proceeded in a similar manner to obtain the under-5 mortality rate in period 2. The main difference here is that we subtracted the effect of recurrent expenditure on health. Indeed, we assume that only capital expenditure have a persistent effect on the mortality rate. The share of recurrent expenditure on health is given by in equation C.3.[10]

$$Mort.rate'_{i2} = Mort.rate_{i1} \times [1 + g - \epsilon_{m/G} \times \dot{G}_2 + \beta(\epsilon_{m/G} \times \dot{G}_1)] \qquad (C.3)$$

where $g = \frac{Mort.rate_2 - Mort.rate_1}{Mort.rate_1}$ is the observed decline rate in under-5 mortality rate and $\dot{G}_2$ the variation of public expenditure between period 1 and 2 to reach the Abuja's commitment. Equation C.3 can be rewritten as follows:

$$Mort.rate'_{i2} = Mort.rate_{i1} \times [1 + g + \epsilon_{m/G}\ (\beta\dot{G}_1 - \dot{G}_2)] \qquad (C.4)$$

[10] We surveyed the literature and set β to 18% (see Elmendorf et al.,1999).

We proceeded in a similar manner for the following period, continuing to subtract the impact of recurrent expenditure of the previous period.