POLICY BRIEF

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The Impact of Health Investment on Infant and Under-five Health in South Sudan: Understanding State Effectiveness through Service Delivery

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Summary

This analysis examines the relationship between child health and per capita health spending in South Sudan. The nexus between public health spending and health outcomes lends insights into state effectiveness in service delivery. Net of background variables, we find that a percent increase in per capita health spending increases early age mortality by 31 percent among infants and 24 percent among children under the age of five. The estimates are, however, statistically insignificant, suggesting that there are no health returns to health investment in South Sudan. These results are not surprising and complement the prevailing knowledge that health spending is often ineffective in contexts immersed in poor governance, corruption, aid misalignment, and institutional weakness. Thus, improved governance and enforcement of robust monitoring and accountability measures in social services provision may make public health investment more effective in the country. Lastly, while South Sudan implements the Agreement on the Resolution of Conflict in South Sudan (ARCISS), foreign aid needs a proper realignment to support recovery priorities, with commitment to service delivery as a lead constituent of its fundamental objectives.

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1   Introduction

Healthcare governance in South Sudan is decentralized. The central government offers policy guidance to states and other subnational units. This structure is derived from the idea that health governance decentralization promotes good health (Faguet 2004; Faguet and Sanchez 2007; Crook and Sverrisson 1999). Decentralization builds on institutional strengths and allows increased investment in human capital and basic services through public participation, enabling the disadvantaged sections of the society to become more involved in seeking programs that most address their primary needs (Faguet 2004).

Pre-independence South Sudan adopted two forms of decentralization, devolution and delegation, as a way to restore and manage its fragile health system. Bossert and Beauvais (2002) define devolution in health management as shifting authority from the national ministry of health to state, provincial or municipal governments, whereas delegation refers to granting semi-autonomous agencies new powers. This health system, akin to a reform in a newly independent state, makes for a new context under which decentralization theory of health care governance can be tested.

Secondly, between 2006 and 2011, the South Sudan central government funded subnational health activities irrespective of needs and priorities, implying a system that is more likely to be unresponsive. This allocation of health funds, therefore, cannot meet the expectation of improving health by addressing sector's immediate priorities (Kruk et al 2010). That is, under the decentralization theory, financial transfers from the South Sudanese national government to subnational levels should have strategically responded to the local health conditions during the interim period. But because these allocations have rather been unresponsive to these priorities and needs, this readily invokes a crucial identification problem, allowing for the exploitation of exogenous variation between health outcome and health spending. A series of robustness checks we conducted confirmed the independence between per capita health spending and early age mortality in South Sudan[2].

Finally, in 2005 South Sudan emerged from over two decades of a civil war, which debilitated its systems, particularly health and economic infrastructure. The Comprehensive Peace Agreement (CPA) enabled the formation of the Government of Southern Sudan to respond to a number of recovery and development goals, including health. This was wise because conflict afflicted states experience ineffective governance, with dire consequences on health, as violence and instability often decimate or undermine the institutional capacity necessary for meeting the primary healthcare needs of a country (Haar and Rubenstein 2012; Kruk et al 2010). When peace is finally attained, rebuilding the health systems to provide direly needed services, therefore, becomes a priority that requires substantial health financing (Carrin et al 2007). These sorts of transitions from collapse and violence to the halting of hostilities and nation building make understanding the impact of health sector recovery efforts on health outcomes in a post-conflict setting quite crucial (Cometto et al 2010). How post-conflict governments respond to immediate

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population's basic needs is particularly fundamental for policy, especially in light of designing institutional reforms and innovations capable of promoting good governance (Booth and Gammack 2013). Kruk et al (2010) "argue that early investments in the health system may be a particularly promising development opportunity in countries recently emerging from armed conflict." Indeed, rebuilding a functional, equitable health system that is responsive to the needs and priorities of a post-conflict setting is likely to promote good health, which signifies state effectiveness (Kruk et al 2010).

This policy brief explores state effectiveness through health service delivery in South Sudan. A major subsector, the state of human health in the country is a fundamental indicator of state effectiveness. Similarly, insights into health services could help paint an important picture of the country's state of service delivery as a whole. It assesses the impact of per capita public spending on infant and under-five health in the country. This analysis focuses on infant and under-five health because it is an important measure of human development. This is nationwide analysis that covers the ten states of South Sudan over the interim period (2006-2010). The study is expected to stimulate public policy on health, especially in light of the planned implementation of the ARCISS.

The analysis begins by testing the proposition that decentralization leads to better health returns by focusing on a new context, South Sudan. Secondly, we use a unique identification strategy that examines the exogenous variation between health and per capita health spending. Lastly, the analysis assumes and tests for state-level and residential types heterogeneity in explaining child health-spending relationship. Overall, this research addresses a broad question of public health governance, focusing primarily on health expenditure as a principal indicator of state responsiveness to local development priorities.

Using a combination of health expenditure and nationally representative household survey and census data the study measures child health as infant or child mortality to an individual household i in state k. Health expenditures are extracted from government annual budget and expenditure books, with restriction to 2006-2010 period. This time window is chosen because allocation of funds to subnational governments was unsystematic then, and because health information is only available for this period. Public expenditure is the per capita amount in American Dollars the central government spent on health programs in each state annually during the interim period (2006-2010). The total health expenditure, however, includes a share of aid contribution amounting to 30 percent of the total expenditure. The analysis does not capture direct spending in states by aid organizations.

The remainder of the study proceeds as follows. Section 2 reviews the ongoing debate on the relationship between health and public spending, governance, post-conflict health systems recovery, key health measures, and child health conditions in South Sudan. Section 3 explores South Sudan's health system recovery policies and fiscal commitments. Section 4 briefly discusses our methodology, including data sources, and empirical estimation strategies. Section 5 presents the findings; Section 6 concludes with policy thoughts.

2   Public spending and health

Public spending is critical because it creates incentives that improve health in the population (Pritchett and Filmer 1999; World Bank 2013; Gupta et al 2002; DHS 2005 and 2011). These investments promote good health via several channels (Deaton 2003; World Bank 2013).

There is ample evidence respecting the nexus between health outcomes and public spending under decentralization style of governance in the Eastern African region. For instance, in Ethiopia, infant and child health improved significantly following a substantial investment in public health programs under a newly decentralized health system (DHS 2011). Between 2005 and 2011, Ethiopia saw a reduction of nearly 30 percent in childhood mortality, partly due to an increase in the proportion of rural residents with access to safe, drinking water (DHS 2011; HDA 2013). These positive health changes in Ethiopia are prominently owed to the Health Extension Program (HEP), which funds activities aimed at improving health in the rural areas (Asefa et al 2000). The HEP governance benefits from local participation and ensures meaningful coordination across governments.

Likewise, the Rwandan public health investment has been remarkably praised for its potent results (Logie et al 2008; Basinga et al 2013; Morgan 2010; Gertler and Vermeersch 2013). These health improvements result from the healthcare system that distributes health services to municipalities or districts, with each district supplying all necessary health services to roughly 20,000 people (Logie et al 2008). Rwanda employs a three-track health care system that combines aid coordination with nationwide health insurance scheme and performance-based reward initiative for health facilities and service providers (Logie et al 2008; Morgan 2010). The pay for performance strategy has led to a 20 percent increase in health productivity, contributing significant improvements in child and maternal health (Gertler and Vermeersch 2013).

Dupas (2011) suggests that governments throughout the world are obligated to intervene in healthcare services when necessary. The need for this intervention is even more pronounced in post-conflict settings where health system recovery is key to restoring peace and stability (Kruk et al 2010). First, access to adequate health care is seen as a matter of human rights, often argued with equity in mind. Here, responsive governments focus on providing primary healthcare services, usually at no cost to the beneficiaries (Dupas 2011). The second demand springs from the need to address private market failures (Dupas 2011). Here, the government takes up some service delivery responsibilities if the private markets are not effective to meet the health care needs of the population.

Decentralization in healthcare governance has been used to respond to private market failure. However, a decentralized health system may turn out to be ineffective as well documented in North Sudan (World Bank 2011). This is because the responsiveness of subnational governments to local demands depends on the capacity to raise revenues locally, consistent flows of federal transfers, robust policies guarding against elite capture, and the ability to rationalize public expenditure in accordance with pressing priorities—factors that could be hardly addressed in a low-capacity, post-conflict environment (World Bank 2011). In South Sudan, such institutional caveats are of considerable concern, and may have impeded the government's programs toward improving health systems and outcomes there. If our speculations are correct, then health spending, no matter the level, may not have a significant effect on health outcomes in the country.

3   Context

South Sudan is a constitutional, quasi-federation comprising 10 states. The South Sudanese political system is decentralized so that there is power devolution between national and subnational governments (Transitional Constitution of South Sudan 2011). Prior to independence and during the civil war, over 2 million Sudanese died, many of them South Sudanese, due to direct causes of violence, economic collapse, and health services deprivation (Burr 1998). In 2005, the CPA became a crucial policy tool for system recovery in southern Sudan, as peace meant a revival of development and the rebuilding of livelihoods. One of the primary foci of the CPA was health system recovery.

The Government of Southern Sudan proposed an interim health system recovery policy that covered the 2006-2010 period, committing to equity, accessibility, and efficiency of healthcare service provision at all levels in the region. The policy, which remains in force, advocates for a 4-tier decentralized health system, with the first tier being the federal government which is responsible for stewardship, policy, financing, and resource management; the second tier are the states responsible for leadership, supervision, monitoring and evaluation, sectoral and intersectoral coordination, implementation of service activities, and the management of referrals; the counties are responsible for service delivery, coordination, developing work plans, and assisting with referrals; and the community centers deal with outreach and public participation issues (MoH 2007). For the policy to achieve its primary objectives, such as addressing excess mortality and morbidity and providing incentives for health system recovery, a reasonable financing is required (Gubbins and Walque 2012; Kruk et al 2010).

The health policy stresses access gap in health care services as a leading impediment to development, partly because only 25 percent of the entire population was thought to have had access to healthcare services at the time of peace (MoH 2006). Likewise, the policy sought to meet key MDGs targets, including reducing under-five mortality from 250 per 1000 life births in 2006 to 140 in 2010, maternal mortality from 1700 per 100,000 births to 850, boosting TB case detection from 6 to 51 percent, and improving the overall healthcare access in the region (MoH 2006).

Another critical goal of this policy relates to improving the health infrastructure, namely providing clean water and hygienic facilities. The decision to incorporate infrastructural recovery in this health policy was necessitated by the evidence that 48 percent of deaths in under-five children in Southern Sudan responded to environmental contaminants (MoH 2005). In addition, at the time of peace, rural communities suffered severe health outcomes and had limited access to safe water supplies and sanitation facilities, with safe water and sanitary facilities coverage each estimated around 30 percent against 60 and 50 percent coverage, respectively (MoH 2005). Additional commitment of the nascent government's health recovery policy concerns combating malaria and the HIV/AIDS in the population. The incidence of malaria among children under-five is considered relatively high in the regional context (MoH 2009), and the prevalence of HIV/AIDS is growing, peaking at 3 percent in 2008, and it might have hiked in recent years due to an economically induced international migration between East Africa and South Sudan (MoH 2008).

3.1 GoSS health financing

Despite having an encompassing policy that is aimed at rebuilding a healthcare system in the country, majority of GoSS' health priorities have not been financially supported; for instance, due to lack of strategic investments such as training, there remain a few medical staff across the country. In 2008, for instance, there were fewer than 500 professionally trained medical doctors providing health services to millions of people, and fewer than 10 public hospitals nation-wide, limiting the sector's capacity to provide primary health services (MoH 2011). More specifically, only 4 percent of the government's total annual budget was allocated for health in 2011, contrary to the Abuja Declaration of 15 percent (Brookings 2012; AU 2001; Gubbins and Walque 2012).

As of recent, however, Bol (2015) shows that health spending has gradually increased, though the bulk of this mainly funds salaries. Limited technical capacity and the significant involvement of the development community in the service delivery sector presumably necessitate state under-investment in health in the country (see Table 3 in the appendix for details).

4 Data materials and empirical strategies

4.1 Data materials

Responding to our key research questions requires using repeated observations, whether longitudinal or repeated cross-sections. We focus on the 10 states of the country over the periods for which complete data are available (2006-2010). We take advantage of the more recent South Sudanese health data collected at two different time periods (2008 and 2010) to form necessary panels or repeated cross-sections for this analysis. The 2010 representative household health survey and the 2008 census data provide mortality information. Per capita health spending is our predictor variable and is obtained from government's annual budget and expenditure books and measured as state average spending per person per year (Ministry of Finance, 2006-2010). Per capita health expenditure, reported in American dollars, is the sum of government health related expenditures as a ratio of total population in a particular state at a particular period. Private health expenditure is excluded since the analysis concerns assessing government's commitments toward health.

Supplementary data sources include South Sudan's 2009 baseline household survey, also obtained from the NBS, and the Armed Conflict Location and Event Data (ACLED).

4.2 Theoretical model

Our current cross-sectional data enable us to perform an empirical, state-level clustered analysis. Table 1 gives a detailed summary of our sample characteristics. The empirical strategy tests using mixed effects regression models the proposition that early age mortality is partly dependent upon per capita public spending on health. The second identification strategy concerns mortality's response to public spending according to unique conditions of states, giving emphasis to unobserved heterogeneity. Heterogeneity is to be expected since different settings are likely to vary on a number of scales that are not easily observable, such as politics on development, levels of local revenues, and the nature of disease environment, among others.

Whether the impact of financial transfers to states for health spending on health outcomes varies by urban-rural stratification is also explored due to potential spatial heterogeneity in the effectiveness of spending. For instance, urban areas are more likely to have officials with stronger capacities who exercise more effective decision-making to make the best use of federal funds and avoid wastage (Bossert et al 2003; Bossert and Beauvais 2002). Urban dwellers are also more likely to be politically informed, participate in program planning, and exercise oversight over their authorities either through informal or formal local systems, e.g., civil society initiatives (Kapiriri et al 2003).

The effectiveness of public spending on health outcomes may equally be related to a number of other variables, including demographic and socioeconomic conditions of individual households or communities, health infrastructure such as antenatal care system, maternal health services, income, and educational attainment. Lingering effects of a civil war, and distance to neighboring Sudan as a proxy for spillover mortality due to migration, are also considered. Overall, our analytical procedure accounts for these lurking conditions to obtain causally plausible estimates.

4.3   Empirical model

Since our data are clustered within states, we test all our hypotheses using mixed-effects logistic regression procedure, which jointly estimates fixed effects and random effects for a population. The procedure's primary utility lies in its ability to treat unobserved heterogeneity as random effects that are constituted in an intra-cluster correlation, with observed variables held as invariant (see appendix C for model's details).

5   Results

5.1   Health spending

The Government of South Sudan, with additional fiscal support from aid institutions, earmarks health budgets for salaries, capital, and operating costs. Current health expenditures do not include the nation's ministry of health's spending. On average, South Sudan spent US$3.19 (0.41-17.05) per person on health between 2006 and 2010. The per capita transfer at the national level varied annually between a low $0.78 in 2008 to a relatively high $7.97 in 2006. Although the national government's average transfers to states differ modestly across states, the study finds that there have been significant per capita spending variations due to differences in population sizes, which do not bear on allocating state health funding. For instance, Western Bahr el Ghazal state whose population size is much lower than the rest of the states, averaged $7.79 per person over 5 years, while Jonglei, the most populous state of all, averaged $1.77 per person during the same period.

There are within-state differences in per capita spending. More specifically, Upper Nile state spent $0.57 per person in 2008, down from $5.47 in 2006. By far, Western Bahr el Ghazal state spent more ($17.05) on health than did any other state in 2006. In the 2006 fiscal year, there seems to have been a relatively higher health spending compared to the periods that followed. In

particular, in 2008, this is more apparent as the national government distributed health related funding for salaries only (see Table 2).

5.2   Differential mortality

There are two empirical mortality models considered in this analysis, both focusing on children below the age of five years. The first model concerns infant mortality and the second concerns under-five mortality, with the latter combining deaths for both children younger than a year (infant) and children older but younger than five (under-five) years old. To ensure simplicity, descriptive mortality information is reported as averages just for children under-five. These estimates are further differentiated according to state, residence, and period.

Thus, average mortality for under-five in South Sudan over the 5-year period is 10.3 percent for the entire sample. This translates to 15.40 percent in Central Equatoria state, the highest in the country, to the lowest 6.10 percent in Lakes state. Average under-five mortality is slightly lower for rural children, estimated at 10.68 percent and contrasted with 10.78 percent among urban counterparts. A student's t-test indicates a true difference in early age mortality on the basis of residence. Over the years, under-five mortality has significantly fluctuated. Our estimation shows that the mortality pattern has been rising from 4.2 percent in 2005 to 8.90 percent in 2006, increasing to 11.60 percent again in 2007. In 2008, mortality declined to 6.30 percent and rose again to as high as 21.10 percent in 2010. Within-state cross-sectional differences are striking and in Upper Nile, for example, mortality varied between 3 percent in 2008 and 41.6 percent in 2010. Some states had worse mortality years than others. For example, close to 55 percent of children in Central Equatoria died in 2010.

5.3   Regression results

Our statistical models measure the responsiveness of early age mortality to per capita spending, ceteris paribus. The findings are robust to numerous, appropriate model specifications, including controlling for unique clusters. Prior to conducting regression analyses, we evaluate the prevalence of state-level random heterogeneity using Bartlett's test for equal variances for both infant and under-five mortality. Next, we undertake a two-sample test of equal variances in mortality using residence stratification (urban vs. rural). In both cases, the findings are statistically significant in support of prevailing unobserved heterogeneity across spaces; this warrants incorporating into the model both state and residence-level random effects. The models use a subsample of 25,899 children under the age of five, detailed results provided in the appendix section (appendix B; Table 4).

Model 1 (Table 4) evaluates how infant mortality responds to per capita spending, while controlling for a number of background characteristics, including state and residence levels random effects. The effect of spending on infant mortality is positive but statistically insignificant at all statistical conventional levels (i.e., 90, 95, 99 percent, respectively). However, living in an urban setting significantly influences infant mortality. While being an urban infant seems to reduce mortality by over 60 percent, the interaction between residence and spending indicates that urban infants are actually 2.70 times more likely to die than do rural infants. Model 2 (Table 4) tests the relationship between under-five mortality and per capita spending. We find statistically insignificant link between the two phenomena. The effects of the rest of the variables still hold as with infant mortality.

6   Conclusions

This work has closely looked at how child health has responded to health investment in South Sudan during the interim period. The question of effectiveness of social services endowments has for long spurred policy and academic debates (Bossert & Mitchell 2011; Bossert & Beauvais 2002; Bossert et al. 2003). Evidence, to this effect, suggests that publicly sponsored health systems, especially under decentralization design, deliver desired outcomes when certain governance conditions are satisfied. South Sudan features as an important case to explore in this respect due to its experience with fragility, and as a beneficiary of a huge international reconstruction financing that lasted nearly a decade. Portion of this reconstruction investment was tailored towards health systems recovery and reforms, with the government and partners spending millions of dollars there (Kruk et al 2010).

The analysis shows that health investments in poorly governed settings are often ineffective. More specifically, the statistical models we estimated imply that the decentralized health system in the country is incredibly failing. Corruption, misalignment of foreign aid, and weak governance could be producing ineffective returns to health investment in South Sudan. This understanding is quite instructive for current and future planning in basic services delivery. It could guide the international community and local authorities in developing the ARCISS' implementation matrix that places importance on basic services provision.

We conclude that robust monitoring and accountability measures need to be enforced if positive returns to social services investments in South Sudan are to be attained. During the implementation of the ARCISS, well-defined reporting standards and 'objectively defined project appraisals, along with policies that subordinate low-capacity subnational institutions to reputable donor partners, could minimize wastage in central government's financial transfers to subnational administrations' (Mayai 2015). In the process of transitioning out of recent conflict, decentralization in social service provision in South Sudan needs limiting to identification of local priorities, shared project implementation and accountability, and the monitoring of ongoing projects. The idea is that gradual, yet properly coordinated transitional process, prepares the local institutional structures to acquire the necessary competence that enables them to realize total independence down the road.

Future research that pays special attention to generating necessary data at local levels for more geographically detailed mortality analyses, such as focusing on the role of county grants on early age mortality, is required. Likewise, more recent data are required to better understand the influence of recent economic shocks (2012 oil shutdown) and war on child health. This is important a research contribution because how leaders manage the economy and political disagreements bears on social outcomes, hence state effectiveness. Overall, a comprehensive analysis into the country's service delivery as a whole is crucial. Specifically, there is need to assess the effectiveness of investments, both in education and the security sector. Lessons learned from these analyses could inform service delivery policies at various levels of the government and society.

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Appendices

A. Descriptive statistics

Table 1. Sample characteristics, 2006-2010

Variable	Mean	S.D.	N
Child level variables			
Infant mortality	0.09	0.29	27,354
U5M mortality	0.10	0.30	27,354
Proportion of women literate	0.25	0.66	26,544
Proportion of urban households	0.26	0.44	27,354
Proportion of households with safe drinking water	0.08	0.28	26,714
Proportion of households with a toilet	0.25	1.66	26,429
State level variables			
Maternal mortality ratio (MMR)	2,054.548	190.556	2,741
Proportion of women using contraceptives	0.37	1.28	27,354
Proportion of vaccinated children	2.09	6.57	27,354
Proportion of women with antenatal care	5.39	14.05	27,354
Yearly violent conflict incidents	5.14	7.79	27,354
Distance from Sudan (KMs)	1039.60	429.51	27,354
Population size	918,727.1	356,994	2,741
Per capita spending (US$)	3.19	2.44	27,354

Sources: Mayai (2015).

Table 2: Average per capita spending by state, 2006-2010 (US Dollars)

State	All	Year				
		2006	2007	2008	2009	2010
Upper Nile	2.26	5.47	2.22	0.57	3.02	2.13
Jonglei	1.77	3.95	1.61	0.41	1.78	1.52
Unity	3.64	8.59	3.47	0.94	3.60	3.26
Warrap	2.59	6.16	2.56	0.57	2.37	2.20
Northern B	3.61	8.33	3.49	0.77	2.84	3.04
Western B	7.79	17.05	6.99	1.66	6.19	6.29
Lakes	3.38	8.42	3.47	0.79	3.44	3.05
Western E	3.68	8.62	3.50	0.89	5.74	3.33
Central E	2.05	4.44	1.79	0.50	2.75	1.83
Eastern E	2.51	5.56	2.24	0.61	3.09	2.25

Source: Mayai (2015).

Table 3. Spending proportions by sector, 2006-2014 (in billion SSP)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average
Education	0.076	0.096	0.055	0.062	0.055	0.027	0.047	0.052	0.076	0.058
Health	0.046	0.028	0.022	0.026	0.028	0.027	0.047	0.052	0.076	0.044
Accountability	0.087	0.030	0.125	0.088	0.106	0.138	0.048	0.131	0.034	0.085
Economic Functions	0.021	0.025	0.041	0.027	0.038	0.024	0.022	0.022	0.048	0.031
Natural Resources	0.040	0.045	0.037	0.047	0.037	0.017	0.037	0.033	0.052	0.038
Public Administration	0.062	0.097	0.097	0.091	0.168	0.384	0.146	0.092	0.114	0.143
Rule of Law	0.118	0.106	0.098	0.140	0.132	0.080	0.130	0.149	0.170	0.130
Security	0.405	0.491	0.358	0.373	0.301	0.206	0.401	0.404	0.355	0.361
Humanitarian Affairs	0.029	0.016	0.016	0.010	0.014	0.015	0.015	0.005	0.011	0.014
Infrastructure	0.116	0.066	0.151	0.136	0.120	0.080	0.107	0.059	0.064	0.097

Source: Ministry of Finance; author's estimates.

B. Regression models

Table 4. Infant and under-five mortality multi-level mixed effects models, 2006-2010

Variable	Model	
	Infant	U5M
Logged per capita spending	1.311	1.240
	(0.400)	(0.373)
Per capita spending lag	0.956	0.955
	(0.045)	(0.044)
Urban (urban=1)	0.396***	0.411***
	(0.099)	(0.102)
Urban * per capita spending	2.690***	2.629***
	(0.255)	(0.249)
Education (secondary+=1)	2.590***	2.592***
	(0.224)	(0.223)
Conflict	1.024***	1.024***
	(0.004)	(0.004)
Toilet (access=1)	0.976	0.980
	(0.044)	(0.045)
Logged distance to Sudan	2.784	2.690
	(2.613)	(2.413)
Logged number of boreholes	0.968	0.960*
	(0.021)	(0.021)
Population density	1.083***	1.078***
	(0.017)	(0.170)
Distance * conflict in Sudan	1.000***	1.000***
	(1.19e)	(1.18e)
Year (ref=2006)		
2007	0.986	0.942
	(0.222)	(0.210)
2008	1.969	1.779
	(1.031)	(0.926)
2009	1.131	1.046
	(0.283)	(0.260)
2010	0.310***	0.280***
	(0.092)	(0.082)
N	25,555	25,906

Notes: (*=0.90), (**=0.95), and (***=0.99); in the parentheses are the standard errors; N is the number of observations; U5M is under-five mortality.
Source: Mayai (2015).

C. Empirical model

To test the hypothesis that early age mortality, ceteris paribus, depends on cluster-level per capita

spending using this modeling perspective, we start out by specifying a two-level nested, nonlinear econometrics model, with k clusters (states) as independent and conditional on a state-level set of random effects, a_k.

$$\log it(M_{ik}) = (X_{ik} + S_k)\beta + (T_k)\varpi + (R_{ik})a_k + u_{ik}$$

where $k=1.,….,10$ states, with each k state containing $i=1.,….,n_k$ children. Level one of the model contains children and level two states. Our response variable, M_{ik}, is measured as death to child i under the age of five years in state k and is coded 1 if death or 0 otherwise. M_{ik} represents both infant and under-five mortality. Since this is a mixed-effects model combining both fixed effects and random effects estimates, X_{ik} represents a set of fixed effects covariates while R_{ik} represents a set of random effects covariates whose actual effects (a_k) are not directly estimable. By convention, the R_{ik} are random variables whose mean effects are randomly normally distributed, thus R_{ik} essentially equates to X_{ik}. The program variable, per capita spending on health, is represented by T_j. S_k represents a set of cluster or state level covariates, ß and ϖ represent partial coefficients to be estimated, and u_{ik} is a model random noise associated with child i in state k, which is, by convention, uncorrelated with a_k.

There are practical lessons to draw from this analysis. Chiefly, that public spending is effective on health implies good governance—a sign that the government is responsive to the governed, and effectively performing its functions of health service provision. In addition, improved health outcomes conditioned on state development efforts signify successful system recovery after experiencing fragility. Conversely, poor health outcomes in response to public spending would mean the state is unresponsive and ineffective, a result that challenges its credibility and legitimacy. If public spending increases mortality, then it would mean that it is crowding out aid and humanitarian efforts while being ineffectively utilized to meet the population's health needs. If, however, public spending does indeed influence health but instead operates via local channels, then subjecting heath related financial transfers distribution to such factors might be a necessary policy instrument; it also implies investing in programs that lead to positive results in local dictating factors. For instance, concerns over lack of local capacity should encourage the government to invest in suitable training programs at the local levels. In 2011, for example, there were only 248 doctors in the entire country (MoH 2011). Similarly, if the local revenue does indeed free up some transfers for other significant projects, it would then be appropriate to strengthen local capacities in local revenue generation as a necessary policy strategy.

Finally, issues related to accountability can be dealt with through robust behavioral altering mechanisms, such as administrative policing and appropriation of incentives for effective performance.

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