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Determinants of Health in Developing Countries: Cross-Country Evidence

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【Abstract】There is a growing consensus that stronger health systems are crucial to achieving a further reduction in child mortality. On the other hand, socioeconomic status has also long been considered to be a crucial factor to affect people's health status. Nevertheless, there exists no consistent empirical evidence on whether or not and how health systems and socioeconomic factors affect health outcomes. This paper applies system Generalised Method of Moments (system GMM) to estimate the determinants of under-five mortality for cross-country panel data from 141 developing countries. Empirical results show that GDP per capita and the access to improved sanitation have statistically significant and favourable effects in reducing child mortality. In contrast, health system factors, which are measured by government health spending, the coverage of immunisation and skilled birth attendants, and the number of physicians per 1,000 people, do not lead to mortality reduction.

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1. Introduction

Every year 8.8 million of under-five children die and half a million women lose their lives from causes related to pregnancy and childbirth. Saving lives of children and mothers has become a global agenda since the establishment of Millennium Development Goals (MDGs) in 2000. The UN Millennium Declaration was adopted in 2000 by 189 countries, exemplifying a commitment to a new global partnership to reduce extreme poverty by the year 2015. Amongst the eight MDGs, two goals directly aim to improve maternal and child health. MDG 4 targets to reduce the under-five mortality rate by two thirds between 1990 and 2015, whilst MDG 5 aims to reduce maternal mortality ratio by three quarters between 1990 and 2015 (MDG 5-A) and to achieve universal access to reproductive health by 2015 (MDG 5-B) as shown in Table 1.

<Table 1>

Regarding the progress of MDG 4 and 5, under-five mortality rate in developing countries declined by 28% from 100 deaths in 1990 to 72 deaths per 1,000 live births in 2008 (Figure 1). It is encouraging that the progress has been accelerated after the year 2000, i.e. the average annual rate of reduction increased to 2.3% during 2000-2008, compared to 1.4% in the 1990s (UN, 2010). The total number of under-five deaths per annum decreased from 12.5 million in 1990 to 8.8 million in 2008, in which a half of the deaths occurred in

Sub-Saharan Africa. Although under-five mortality rate in Sub-Saharan Africa dropped by 22% from 183 deaths per 1,000 live births to 144 deaths per 1,000 live births during 1990-2008, the pace of progress is not sufficient to meet the target by 2015. Looking at individual countries, there are several countries in Sub-Saharan Africa such as Eritrea, Malawi, Mozambique and Rwanda that performed well in reducing child mortality, but most of the countries still suffer unacceptably high levels of child deaths[1]. Figure 2 shows the causes of under-five mortality rate worldwide. It shows that pneumonia (14%), diarrhoea (14%) and malaria (8%) constitute main causes. 41% of child deaths occur in the neonatal period (the first four weeks after the birth), and the progress in reducing newborn deaths is slower than deaths among children aged one month to five years (WHO and UNICEF, 2010).

<Figures 1-2>

Prospect to achieve MDG 5 is more pessimistic than MDG 4. Global maternal mortality ratio dropped by just 6% from 480 per 100,000 live births in 1990 to 450 deaths per 100,000 live births in 2005 (Figure 3). To achieve the MDG 5-A, 40% of reduction per annum is necessary. Geographically, among 536,000 deaths which took place in 2005, more than 99% occurred in developing countries. About a half of the maternal deaths (265,000)

[1] All of 34 countries with under-five mortality rates exceeding 100 per 1,000 live births in 2008 are from Sub-Saharan Africa except for Afghanistan.

occurred in sub-Saharan Africa and another third (187,000) in South Asia (WHO, 2008, UN, 2009)[2].

<Figure 3>

A maternal death is defined by "the death of a woman during pregnancy or within 42 days of termination of pregnancy, from any cause related to or aggravated by the pregnancy or its management, regardless of the site or duration of pregnancy" (WHO and UNICEF, 2010). According to UNICEF, 2009, the causes of maternal deaths can be divided into *direct causes*, *indirect causes* and *underlying causes*. *Direct causes* comprise of obstetric complications (post-partum haemorrhage, infections, eclampsia and prolonged or obstructed labour) and complications of abortion. These direct causes can be preventable if women have access to skilled health personnel, key drugs and equipment. *Indirect causes* include maternal anaemia, iodine deficiency during pregnancy, HIV/AIDS and Malaria. Latest estimate show that haemorrhage (35%) and hypertension (18%) are dominant among direct and indirect causes of maternal deaths (Figure 4). *Underlying causes* include a lack of knowledge and education, inadequate maternal and newborn practices and care seeking, insufficient access to nutritious food and essential micronutrients, poor environmental

[2] A recent analysis, using a new database for 181 countries constructed from registration data, censuses, surveys, and verbal autopsy studies for 1980-2008, estimate that there were 342,900 maternal deaths worldwide in 2008, down from 526300 in 1980. According to their study, maternal mortality ratio declined from 422 in 1980 to 320 in 1990, and to 251 per 100,000 live births in 2008 (Hogan et al., 2010).

health facilities and inadequate basic health care services and limited access to maternity services (UNICEF, 2009). Poverty, social exclusion and gender discrimination are also important underlying causes. In particular, access to quality health care services is of particular significance to women's health.

<Figure 4>

Figure 5 presents the indicators of access to health services for pregnant women in developing countries for the period 2000-2007. Delivery-care coverage with skilled attendants at birth and contraceptive prevalence in developing countries are 61% and 60% respectively. The proportion of women who receive four or more antenatal visits is lower in South Asia (34%) and Sub-Saharan Arica (42%), where the most of maternal deaths occur.

<Figure 5>

There is now a global consensus that health systems strengthening (HSS) is crucial to improving health status of children and mothers in the developing world. On the other hand, socioeconomic status (SES) such as political, economic, social, technological and environmental factors, which is often called "social determinants of health (SDH)", has also long been considered to be critical in affecting health outcomes worldwide. Figure 6 depicts a conceptual framework for SES and HSS as determining factors of maternal, newborn and child survival.

<Figure 6>

Both theoretical and empirical analysis on the linkages of HSS and SES with health outcomes assists policymakers in designing effective public policies for improvement of maternal and child health. This paper therefore provides a theoretical framework to analyse causes of health outcomes by reviewing past studies, and uses it as a basis to perform regression analysis using cross-country panel data. Since there is scarce evidence on the role of health system and socioeconomic factors in explaining variations of child health outcomes across countries, the analysis throughout the paper will be a merit to providing important policy implications towards the progress of the health-related MDGs.

2. Literature review

In this section, I review the literature on HSS and SDH in the context of maternal and child health in developing countries.

Health System Strengthening (HSS)

Although there is increasing evidence on the efficacy of specific interventions for priority health problems including maternal and child health[3], progress towards the health-related MDGs remains sluggish in many developing countries. This fact implies that a primary bottleneck to the MDGs targets are fragile and fragmented health systems and therefore strong and effective health systems are considered a prerequisite to achieving the health-related MDGs (Jesper et al., 2010, Travis et al., 2004, Reich and Takemi, 2009).

One of the most frequently cited frameworks of health systems was developed by the World Health Organization (WHO)'s *World Health Report 2000*, in which health systems are defined as "all the activities whose primary purpose is to promote, restore or maintain health" (WHO, 2000). This framework is based on four key functions: stewardship, resource creation, service provision, and financing (Figure 7). Health system outcomes are defined as "good health, responsiveness to the expectations of the population, and fairness of financial contribution". Following this framework, WHO ranked health systems in 189 countries according to their performance.

<Figure 7>

In 2007 WHO provided a revised framework on health systems in its publication *Everybody's Business: strengthening health systems to improve health outcomes*, which

[3] On the other hand, there are very few evaluation studies which scrutinise the effectiveness of large-scale programmes which comprise packages of interventions (Lancet, 2010, Victora et al., 2010, Bryce et al., 2010, Victora et al., 2009).

include six building blocks; service delivery; human resources; information; medical product; financing; and governance (Figure 8). In this framework, HSS is defined as "improving these six health system building blocks and managing their interactions in ways that achieve more equitable and sustained improvements across health services and health outcomes" (WHO, 2007). This approach is useful to describe health system constraints and identify where, why, and in what way further investments are needed (Shakarishvili 2009).

<Figure 8>

Social Determinants of Health (SDH)

Socioeconomic factors have also long been considered as important determinants of health outcomes, which are now widely known as "social determinants of health" (SDH) (Mammot and Wilkinson, 2006). Thomas and Frankenberg 2002, reviewing both experimental and observational studies, conclude that there is abundant evidence at both the microeconomic and macroeconomic levels showing that a variety of health indicators are positively associated with different dimensions of economic prosperity and the causal pathways linking health and economic outcomes run in both directions (For review papers see: WB, 1993, CMH, 2001, Jack and Lewis, 2009, UNESCAP, 2007, Deaton, 2006, CSDH, 2008, Lopez, 2007, Caldwell, 1986, Ranis and Stewart, 2005, Deaton, 2003, Strauss and Duncan, 1998, Currie, 2009). In 2008 WHO's Commission on the Social Determinants of

Health (CSDH) published a comprehensive report on SDH which contains a plenty of evidence for SDH to affect health outcomes and health inequality (CSDH, 2008). Figure 9 presents the framework developed by CSDH, which illustrates both routes from SES to health and vice versa.

<Figure 9>

Empirical evidence on the determinants of health

There is a large volume of empirical literature to scrutinise the linkages of health system and socioeconomic factors with health outcomes. First, as to the link between income and health, early economics literature documented the importance of health as human capital in boosting economic growth. Bloom and Canning, 2003, Bloom et al., 2004, Gyimah-Brempong and Wilson, 2004, Sala-i-Martin, 1997, among others, have clarified that health capital has a positive impact on aggregate economic output. According to their analysis, about one-fourth of economic growth was attributable to health capital accumulation, and health condition equivalent to one additional year of life expectancy is correlated with higher economic growth of up to 4% per year. Thereafter, human capital became identified as an ultimate goal of countries instead of just a driver for economic growth especially since the publication of *Human Development Report* by the United Nations Development Programme (UNDP) in 1990 (Schultz, 1999, Anand and Ravallion, 1993, Ravallion and

Chen, 1997, Squire, 1993). A conceptual framework underpinning this idea clearly comes from a series of works by Novel laureate Amartya Sen (Sen, 1999, Sen, 1987, Sen, 1985, Sen, 1977a, Sen, 1977b). Nowadays there are numerous empirical studies that analyse factors contributing to better health outcomes using cross-country data.

As reviewed above, stronger health systems are expected to contribute to better population health. However, a theoretical linkage between health systems, which is often proxied by government health expenditures, and health outcomes is complex for the following reasons. First, if there is a functioning private health care market, an increase in government health expenditure may "crowd out" private health spending, i.e. a household diverts its resources towards other uses once the government increases their spending on health. Second, public resources may be used ineffectively. For instance, it is often observed in developing countries that doctors or nurses don't show up to work at health facilities, equipment lies idle due to a lack of necessary parts, or drugs provided by a central government are not distributed to patients in need (Lewis, 2006). Third, even if public spending applied appropriately, they may yield little benefit to people's health if complementary services such as water, sanitation, transportation and communication infrastructure are not there or lacking.

Empirical results from cross-country studies on the linkage between health spending and health outcomes have so far built a relatively "fair" consensus that aggregate government health spending has less impact on average health status than it is expected for, whilst socioeconomic characteristics explain almost all of the variations in infant and child mortality rates across countries (Filmer et al., 2000). Early studies, especially during 1980-1990s, examined cross-sectional data for a specific year or pooled cross-sectional data using the ordinary least squares (OLS) or two-step least squares (2SLS). They confirmed that the impact of government health investment on child health outcomes is either small or statistically insignificant (Kim and Moody, 1992, Carrin and Politi, 1995, Musgrove, 1996, Filmer and Pritchett, 1999). For instance, Filmer and Pritchett, 1999, which is one of the most influential studies, investigated the association between government health expenditure as a share of GDP and under-five mortality rate across around 100 countries. They found that government health spending explains just one-seventh of one percent of variations in infant and under-5 mortality across countries, whilst GDP per capita, income distribution, female schooling, ethno-linguistic fragmentation, and religious and regional dummy variables explain almost 95% of the variations. In contrast, several early studies also confirm a statistically significant impact of government public spending on the reduction in infant or child mortality albeit for a relatively small sample size ranging from 10 to 35 countries (Anand and Ravallion, 1993, Bidani and Ravallion, 1997, Hojman, 1996, Gupta et al., 2002b). For example, Bidani and Ravallion, 1997 confirmed that public spending has a significant and positive effect on the health status of the poor (but not on aggregate health status of the poor and the non-poor taken together). Recent studies, using the Generalised Method of Moments (GMM) estimation technique with instrumental variables for cross-sectional country data, confirmed the statistically significant effects of government health spending on child mortality (Bokhari et al., 2007, Gottret and Schieber, 2006).

One of the reasons why the effect of government health expenditure is not straightforward is attributable to a weak institutional capacity in the public sector to realise efficient transformation from inputs to health outcomes. Filmer et al., 2000 and Lewis, 2006 argue that fragile institutional capacity in developing countries, including a lack of incentive mechanism in the public sector for utilising limited resources, critically hampers effective health service provision. Fayissa and Gutema, 2005 find an unexpected negative impact of health expenditures (including both public and private) on health outcomes for 31 Sub-Saharan African countries using a two-way random effect model. This result made them speculate that inefficient health service provision caused a negative relationship between government health spending and health outcomes. One of the examples that clearly show the inefficiency of health systems in developing countries is a high rate of absenteeism and a lack of motivation among public health workers. Chaudhury et al., 2006 showed that absenteeism rates of health staff ranged from 25% to 40% in Bangladesh, Ecuador, India, Indonesia, Peru, and Uganda. Das and Hammer, 2007 found that doctors in the public health facilities exert less effort than private doctors. Recent studies confirmed the importance of institutional capacity and incentive mechanism. For instance, Meessen et al., 2007 found that the change of contract structure from fixed payment to performance-based payment increased health staff productivity in Rwanda.

There is also a growing volume of cross-country studies on the impact of governance on population health. Virtuous effects of good governance on health indicators are verified by several studies (Gupta et al., 2002b, Gupta et al., 1999)[4]. Wagstaff and Claeson, 2004 confirms that public expenditure contributes to the reduction in child mortality rate in countries with good governance indicators measured by the World Bank's Country Policy and Institutional Assessment (CPIA). Baldacci et al., 2008 conclude that government health spending is effective only in an environment with good governance. Rajkumar and Swaroop, 2008 obtain similar results using the degree of corruption and bureaucratic quality as governance indicators. However, Lewis, 2006 confirmed no significant effects of governance indicators measured by government effectiveness or corruption indices produced by Kaufmann et al., 2004.

Some other studies analyse the effects of a composition of government health spending. Filmer et al., 1997 found that the share of total national health spending on "local" health services is unrelated to under-five mortality. In contrast, Mehrotra and Delamonica, 2002 confirmed that the share of public spending on primary health care devoted to the poorest quintile of the population is associated with lower under-five mortality. However, McGuire, 2006 found the public health care spending on "basic", "local", or "primary" health services

[4] Regarding the social spending for economic development, Mauro, 1998, Gupta et al., 2002a, Rodrik et al., 2004, Hausmann et al., 2005 confirm the importance of governance in fostering economic growth.

are not effective in reducing child mortality. They state that this result may be caused by the fact that health interventions which are most effective in reducing under-five mortality are inexpensive and therefore they do not show up in aggregate data.

The role of human resource, which is also an important component of health systems, in improving health status has also been analysed empirically. A number of cross-sectional studies showed that density of human resources for health is positively associated with better population health (Anand et al., 2008, Anand and Barnighausen, 2007, Anand and Barnighausen, 2004, Aakvik and Holmås, 2006, Speybroeck et al., 2006, Flegg, 1982, Robinson and Wharrad, 2000). In particular, physicians density per capita plays the most significant role in explaining country variations in infant, under-five, and maternal mortality (Farahani et al., 2009).

3. Model

Based on the literature review in the previous section, an aggregate health production function (Grossman, 1972, Fayissa and Gutema, 2005) is specified as,

[1] $h = F(SES, HS)$

where h denotes average health status of children at the national level measured by under-five mortality rate, $SES = (ses_1, ses_2, \dots, ses_r)$ is a vector of socioeconomic factors, $HS = (hs_1, hs_2, \dots, hs_s)$ is a vector of health system components, and r and s are the number of variables in each category. In the following analysis, *SES* vector includes variables of income, sanitation, gender, population, inequality and governance indicator, while *HS* vector comprises of variables representing health financing, health service delivery and human resources for health at the national levels.

Pooled cross-sectional specification

As to the empirical model, I first apply a pooled-cross sectional OLS regression model as a basic specification.

[2] $ln\, U5MR_{it} = \alpha + \beta SES_{it} + \gamma HS_{it} + \tau_t + \varepsilon_{it}$

where $ln\, U5MR_{it}$ is a natural log of the under-five mortality rate, $SES_{it} = (ses_{1it}, ses_{2it}, \dots, ses_{rit})$ is a vector of socioeconomic status variables, and $HS_{it} = (hs_{1it}, hs_{2it}, \dots, hs_{sit})$ is a vector of health system variables for a country $i = 1,2, \dots, N$ and for the period $t = 1,2, \dots, T$. τ_t is a vector of period dummies capturing time trends, and ε_{it} is an error term. For each variable, the annual data are averaged over five-year periods to reduce annual fluctuations and measurement errors. I specify the log-log functional form for several variables of the *SES* and *HS* vectors to smooth the data as well as to calculate elasticities of these variables on under-five mortality. The log-log specification also accommodates the fact that health gains from an increase in health spending is larger in countries where the initial mortality is higher (Deaton, 2006).

Fixed effects panel data specification

The OLS estimates are biased if explanatory variables of interest in the equation [2] are correlated with the unobserved error components of child mortality. To control for the unobserved country-specific heterogeneities, country-fixed effects are included in the estimation model. The fixed effects model is specified as:

[3] $\ln U5MR_{it} = \alpha + \beta SES_{it} + \gamma HS_{it} + \varphi_i + \tau_t + \varepsilon_{it}$

where φ_i a vector of time-invariant country fixed effects which reflect unobserved country factors that may affect under-five mortality.

System GMM specification

Even after controlling for time-invariant country fixed effects, the residual may contain time-varying factors that may be correlated with explanatory variables and it would cause biased estimates on the coefficients of interest. In addition, the presence of measurement errors in variables of the *SES* and *HS* vectors would also bias the estimated coefficients. To deal with this endogeneity bias stemming from omitted variables or measurement errors, I use a system of moment equations using the GMM, i.e. system GMM, developed by Blundell and Bond, 1998 which is specified as follows:

[4] $\ln U5MR_{it} = \alpha + \delta \ln U5MR_{it-1} + \beta SES_{it} + \gamma HS_{it} + \varphi_i + \tau_t + \varepsilon_{it}$

[5] $\Delta \ln U5MR_{it} = \delta(\Delta \ln U5MR_{it-1}) + \beta(\Delta SES_{it}) + \gamma(\Delta HS_{it}) + \Delta\tau_t + \Delta\varepsilon_{it}$

Note that SES_{it} vector includes both endogenous and exogenous variables, and variables in HS_{it} vector are basically endogenous. I differentiate a set of endogenous variables included in SES_{it} by adding a subscript* as SES_{it}^{*}. In the system GMM estimation, lagged differences of potential endogenous variables, i.e. $(\ln U5MR_{it} - \ln U5MR_{it-1})$, $(SES_{it}^{*} - SES_{it-1}^{*})$, $(HS_{it} - HS_{it-1})$, are used as instruments in the level equation [4], and lagged levels of the endogenous variables, i.e. $\ln U5MR_{it-2}$, SES_{it-1}^{*} and HS_{it-1} are used as instruments in the first differenced equation [5]. In the following analysis, lagged under-five mortality rate as well as variables reflecting income, population, health financing, health service delivery and human resources for health are treated as endogenous variables. Then, sanitation, gender and governance variables, which are not strictly exogenous, are assumed to be "predetermined variables" (Bond, 2002). Lastly, period dummies are treated as "strictly exogenous variables". Following Blundell and Bond, 2000 and Mishra and Newhouse, 2009, I use system GMM rather than first-differenced GMM (Arellano and Bond, 1991) which use only equation [5] because system GMM improves the accuracy of estimates by setting the additional moment conditions in the level equations when the dependent variable is persistent like child mortality. The following assumptions are made under the system GMM estimators (Blundell and Bond, 2000).

[6] $E(\varphi_i) = E(\varepsilon_{it}) = E(\varphi_i \varepsilon_{it}) = 0$

[7] $E(\varepsilon_{it}\varepsilon_{is}) = 0, \quad t \neq s$

[8] $E(U5MR_{i1}\varepsilon_{it}) = 0, \quad t = 2, \dots, T$

[9] $E(SES_{i1}^{*}\varepsilon_{it}) = 0,\ \ t = 2, \dots, T$

[10] $E(HS_{i1}\varepsilon_{it}) = 0,\ \ t = 2, \dots, T$

[11] $E(\Delta U5MR_{i2}\varphi_i) = 0$

[12] $E(\Delta SES_{i2}^{*}\varphi_i) = 0$

[13] $E(\Delta HS_{i2}\varphi_i) = 0$

Equations [8]-[13] denote the initial conditions under the system GMM model. Conditions [8]-[10] assume that the initial levels of endogenous variables, i.e. $U5MR_{i1}$, SES_{i1}^{*}, HS_{i1}, are uncorrelated with all future unobserved shocks in under-five mortality. Similarly, conditions [11]-[13] postulate that initial changes of endogenous variables, i.e. $\Delta U5MR_{i2}$, ΔSES_{i2}^{*}, ΔHS_{i2}, are uncorrelated with the unobserved country fixed effects[5]. Importantly, the system GMM estimator has much smaller finite sample bias and is much more accurate in estimating autoregressive parameters using panel data with a large number of cross-section units (large *N*) and a small number of time periods (small *T*). For the estimation using system GMM, I used "xtabond2" command in Stata (Roodman, 2009). One caveat of system GMM is that including excessive number of instruments, relative to the number of observations, may yield finite-sample bias in the estimates. Furthermore, too many instruments dilute the power of Hansen's J test for over identification and the test may falsely reject the null hypothesis that the instruments are valid (Roodman, 2008). I check the robustness of the model in changing the number of instruments by using different time lags.

[5] Similar assumptions are made for the predetermined variables.

All of the estimations are performed by the two-step GMM, but standard errors of the two-step GMM estimators are known to be downward biased. I therefore use Windmeijer's finite-sample correction for the two-step covariance matrix (Windmeijer, 2005).

4. Data

I compile panel data for 141 developing countries during the period of 1990-2008[6]. Most of health systems and socioeconomic variables are from the World Development Indicators 2009, WHO Statistical Information System[7] and World Bank's Worldwide Governance Indicators Project[8].

Dependent variable

Under-five mortality rate: The number of newborn children out of 1,000 who die before reaching the age of five. Source: World Development Indicators

Independent variables

Income: Gross Domestic Product (GDP) per capita based on purchasing power parity (PPP). Data are in constant 2005 international US dollar. Source: World Development Indicators

[6] Name of each country in the dataset are listed in Table A.1.1.
[7] http://www.who.int/whosis/en/
[8] http://info.worldbank.org/governance/wgi/index.asp

Sanitation: Improved sanitation facilities expressed as a percentage of population with access. Source: World Development Indicators

Gender equality: Share of female students in primary schools. Source: World Development Indicators

Population: Population (in thousand). Source: World Development Indicators

Inequality: Gini coefficient. Source: World Development Indicators

Governance: Mean values of six governance indicators produced by Kaufmann et al., 2009: (1) Voices and Accountability; (2) Political Stability and Absence of Violence; (3) Government Effectiveness; (4) Regulatory Quality; (5) Rule of Law; and (6) Control of Corruption[9]. Source: World Bank's Governance Indicator Project

Health financing: Government health expenditures as a share of total government expenditures. Source: WHO Statistical Information System

Health service delivery: Coverage of DPT (diphtheria, pertussis, and tetanus) as a percentage of children ages 12-23 months and utilisation of skilled attendants at birth delivery. Source: World Development Indicators

Human resources for health: Physicians per 1,000 people. Source: World Development Indicators

In addition, period dummies for the year 1995-1999, 2000-2004, and 2005-2008 (with a reference to the period 1990-1994), are included as independent variables. World regions are categorized into East Asia and Pacific (EAP), Europe and Central Asia (ECA),

[9] Definition of each governance indicator is shown in Table A.2.

Latin America and Caribbean (LAC), Middle East and North Africa (MENA), South Asia (SA) and Sub-Saharan Africa (SSA).

Descriptive statistics are summarised in Table 2. The mean value of child mortality (per 1,000 live births) is 82, ranging from 6.7 to 303.5. The average share of government health expenditures in total government spending is 9.68% ranging from 0.98% to 28.75%. Level of health service delivery also varies a lot across countries, i.e. the coverage of DPT and skilled birth attendance ranges from 15.8% to 99.0% and from 5.6% to 100% respectively. Figures A.1-A.12 are created using locally weighted smoothed scatter plots (LOWESS) in Stata to depict the relationship between *SES* and *HS* variables and under-five mortality rates.

<Table 2>

<Figures A.1-A.12>

5. Results

I report the estimated results from OLS, fixed effects, and system GMM models on the effects of socioeconomic status and health system variables in reducing child mortality rate in developing countries.

Results from the OLS estimation

Table 3 presents the results from OLS regressions. The estimated coefficients on GDP per capita and improved sanitation are negative and statistically significant at the less than 1% significance level throughout Model 1 to Model 8. The share of female students is also significantly related to lower child mortality except for Model 5. All of the health system variables except government health expenditure have effects in reducing child mortality at the less than 1% significance level.

<Table 3>

Results from the fixed effects estimation

Table 4 presents the fixed effects regression results. F-statistics show that time-invariant country fixed effects (=φ_i) are different across countries and therefore the fixed effects specification is preferred to OLS. The effects of DPT coverage, physician density, and an interaction term of health spending and governance turn to be insignificant.

<Table 4>

Results from the System GMM estimation

Estimated coefficients from the system GMM are reported in Table 5.[10] Identification is based on lags of independent variables. One and more period lagged levels (up to two or three lags depending on the length of time periods in each model specification) of the endogenous variables and predetermined variables are used as instruments in the difference equations, while the current and one period lagged differences are used in the level equations. Specification tests are satisfactory as Hansen's J for over-identifying restrictions passes. In addition, tests for serial correlation cannot reject the null hypothesis that there are autoregressive correlations for both the one- and two-periods.

<Table 5>

The system GMM results suggest that estimated coefficients on lagged under-five mortality are close to one (ranging from 0.893 to 0.989) at the 1% significance level, implying that child mortality is persistent over time. Of the socioeconomic variables, GDP per capita has a significant and favourable effect in reducing child mortality although it becomes insignificant when governance (Model 3) or health spending variable (Model 4) is included in the estimation. The access to improved sanitation also contributes to the reduction in child mortality except for Model 2 and 7. With regards to the health system

[10] Results are obtained from two-step estimator. However, one-step estimator yields the similar results.

variables, the health service delivery, which is represented by the coverage of DPT and skilled birth attendants, does not affect a significant impact on the mortality reduction. Furthermore, the coverage of skilled birth attendants exhibits an effect in increasing child mortality on the contrary to the expectation. Turning to the variables on health financing and human resources, neither government health expenditures nor physician density are statistically significant.

In summary, the empirical results from system GMM demonstrate that the effects of health system factors, which are shown to be significant in OLS and fixed effects models, become insignificant. It implies that residuals in the equations contain unobserved time-varying country specific factors such as the access to community health facilities, people's hygiene practices and epidemic situation, and these factors are correlated with health system variables in the equations. Therefore, the estimated coefficients ($=\gamma$) on health system factors in both the OLS and fixed effects models are probably overestimated.

Finally, I checked the robustness of a different lag structure of endogenous and predetermined variables, and confirmed that the estimated results are robust to using only one period or two periods of lags as instruments. Table 6 presents the estimated coefficients on the effects for lagged independent variables from both *SES* and *HS*. It is confirmed that the overall results are not different from Table 5.

<Table 6>

6. Conclusions

This paper scrutinised the impact of socioeconomic factors and health system components on child health outcomes by applying estimation methods which treat with the endogenous nature of those variables. I used system GMM to estimate the determinants of under-five mortality rate with a cross-country panel dataset from 141 developing countries. The empirical results show that GDP per capita and access to improved sanitation have statistically significant and favourable effects in reducing child mortality. On the other hand, health system factors, which are measured by government health spending, immunisation coverage, and physician density, do not affect any significant impact on the mortality reduction. These results suggest that estimation models which do not properly treat with the endogenous nature of determinants of health would lead to biased results.

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Tables and Figures

Table 1. Maternal and child health related MDGs

MDG 4 Reduce child mortality	
Targets	Indicators
4-A: Reduce by two thirds, between 1990 and 2015, the under-five mortality rate	4.1: Under-five mortality rate 4.2: Infant mortality rate 4.3: Proportion of 1-year-old children immunized against measles
MDG 5 Improve maternal health	
Targets	Indicators
5-A: Reduce by three quarters, between 1990 and 2015, maternal mortality ratio	5.1: Maternal mortality ratio 5.2: Proportion of births attended by skilled health personnel
5-B: Achieve, by 2015, universal access to reproductive health	5.3: Contraceptive prevalence rate 5.4: Adolescent birth rate 5.5: Antenatal care coverage (at least one visit and at least four visits) 5.6: Unmet need for family planning

Table 2. Descriptive statistics

Variable	Obs.	Mean	S.D.	Min	Max
Health outcome variable					
Under-five mortality rate, per 1,000 live births	563	82.0	64.7	6.7	303.5
Socioeconomic status (SES)					
GDP per capita (PPP, constant 2000 international US$)	518	4241	3606	252	18830
Improved sanitation facilities (% of population with access)	480	55.9	29.4	3.0	100
Share of female students in primary schools (%)	508	91.8	12.0	29.2	126.2
Population (thousand)	562	35,449	136,572	16	1,314,672
Gini coefficient	280	43.2	9.5	21.8	74.3
Governance*	415	3.534	0.643	1.649	5.187
Health systems (HS)					
Government health expenditures per total government expenditures (%)	419	9.68	4.21	0.98	28.75
DPT (diphtheria, pertussis and tetanus) coverage (%)	552	78.5	19.0	15.8	99.0
Skilled birth attendance (%)	387	70.6	27.7	5.6	100.0
Physician density (physicians per 1,000 people)	431	1.114	1.267	0.000	5.900

*Mean value of six governance indicators produced by Kaufmann et al, 2009

Table 3. Results of the OLS estimations
(Dependent variable: Under-five mortality rate)

Variables	Model 1		Model 2		Model 3		Model 4	
Socioeconomic factors								
Log GDP per capita	-0.370		-0.451		-0.310		-0.381	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Improved sanitation	-0.012		-0.009		-0.014		-0.013	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Share of female students	-0.008		-0.013		-0.007		-0.008	
	(0.000)	***	(0.000)	***	(0.015)	**	(0.002)	***
Log population	0.006		0.016		-0.011		0.003	
	(0.572)		(0.362)		(0.351)		(0.768)	
Gini coefficient			0.009					
			(0.002)	***				
Governance					-0.197			
					(0.000)	***		
Health system factors								
Log health spending							-0.044	
							(0.381)	
Log DPT coverage								
Log MCV coverage								
Log physician density								
Log health spending*Governance								
Year dummy 1995	-0.046		-0.059					
	(0.423)		(0.374)					
Year dummy 2000	-0.125		-0.099		-0.090		-0.076	
	(0.028)	**	(0.130)		(0.085)	*	(0.152)	
Year dummy 2005	-0.225		-0.387		-0.196		-0.169	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.002)	***
Constant	8.491		8.858		8.790		8.718	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
F-statistics: p-value	0.000	***	0.000	***	0.000	***	0.000	***
Adjusted R-squared	0.784		0.817		0.793		0.784	
#Observations	418		230		334		336	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 3. (continued) Results of the OLS estimations
(Dependent variable: Under-five mortality rate)

Variables	Model 5		Model 6		Model 7		Model 8	
Socioeconomic factors								
Log GDP per capita	-0.371		-0.380		-0.307		-0.352	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Improved sanitation	-0.010		-0.010		-0.010		-0.013	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Share of female students	-0.004		-0.007		-0.011		-0.007	
	(0.126)		(0.010)	**	(0.000)	***	(0.008)	***
Log population	0.004		-0.010		0.011		-0.008	
	(0.667)		(0.408)		(0.387)		(0.537)	
Gini coefficient								
Governance								
Health system factors								
Log health spending								
DPT coverage	-0.007							
	(0.000)	***						
Skilled Birth Attendance			-0.005					
			(0.004)	***				
Log physician density					-0.082			
					(0.009)	***		
Log health spending*Governance							-0.031	
							(0.008)	***
Year dummy 1995	-0.026		-0.044		-0.024			
	(0.650)		(0.542)		(0.701)			
Year dummy 2000	-0.091		-0.110		-0.101		-0.085	
	(0.104)		(0.115)		(0.102)		(0.107)	
Year dummy 2005	-0.165		-0.200		-0.289		-0.179	
	(0.005)	***	(0.008)	***	(0.002)	***	(0.001)	***
Constant	8.530		8.764		7.974		8.653	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
F-statistics: p-value	0.000	***	0.000	***	0.000	***	0.000	***
Adjusted R-squared	0.794		0.798		0.753		0.793	
#Observations	417		312		288		334	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 4. Results of the fixed effects estimations
(Dependent variable: Under-five mortality rate)

Variables	Model 1		Model 2		Model 3		Model 4	
Socioeconomic factors								
Log GDP per capita	-0.210		-0.238		-0.217		-0.176	
	(0.001)	***	(0.007)	***	(0.005)	***	(0.020)	**
Improved sanitation	-0.011		-0.014		-0.008		-0.010	
	(0.000)	***	(0.000)	***	(0.003)	***	(0.000)	***
Share of female students	0.001		0.004		0.003		0.002	
	(0.680)		(0.120)		(0.248)		(0.347)	
Log population	0.512		0.179		0.299		0.393	
	(0.000)	***	(0.345)		(0.109)		(0.034)	**
Gini coefficient			-0.003					
			(0.172)					
Governance					0.133			
					(0.006)	***		
Health system factors								
Log health spending							-0.057	
							(0.109)	
DPT coverage								
Skilled Birth Attendance								
Log physician density								
Log health spending*Governance								
Year dummy 1995	-0.132		-0.103					
	(0.000)	***	(0.000)	***				
Year dummy 2000	-0.280		-0.237		-0.138		-0.148	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Year dummy 2005	-0.460		-0.414		-0.312		-0.327	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Constant	1.969		4.924		2.994		2.587	
	(0.147)		(0.014)	**	(0.113)		(0.168)	
F-statistics: p-value	0.000	***	0.000	***	0.000	***	0.000	***
#Observations	418		230		334		336	
#Group	125		93		125		125	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 4. (continued) Results of the fixed effects estimations
(Dependent variable: Under-five mortality rate)

Variables	Model 5		Model 6		Model 7		Model 8	
Socioeconomic factors								
Log GDP per capita	-0.200		-0.201		-0.230		-0.159	
	(0.001)	***	(0.025)	**	(0.002)	***	(0.037)	**
Improved sanitation	-0.011		-0.011		-0.012		-0.010	
	(0.000)	***	(0.001)	***	(0.001)	***	(0.001)	***
Share of female students	0.001		0.000		-0.001		0.002	
	(0.729)		(0.947)		(0.552)		(0.346)	
Log population	0.542		0.653		0.377		0.390	
	(0.000)	***	(0.002)	***	(0.035)	**	(0.039)	**
Gini coefficient								
Governance								
Health system factors								
Log health spending								
DPT coverage	0.000							
	(0.851)							
Skilled Birth Attendance			-0.003					
			(0.027)	**				
Log physician density					0.012			
					(0.722)			
Log health spending*Governance							-0.005	
							(0.589)	
Year dummy 1995	-0.136		-0.164		-0.122			
	(0.000)	***	(0.000)	***	(0.000)	***		
Year dummy 2000	-0.286		-0.305		-0.245		-0.152	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Year dummy 2005	-0.469		-0.483		-0.448		-0.336	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Constant	1.641		0.813		3.486		2.379	
	(0.242)		(0.716)		(0.042)	**	(0.213)	
F-statistics: p-value	0.000	***	0.000	***	0.000	***	0.000	***
#Observations	417		312		288		334	
#Group	125		125		114		125	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 5. Results of the system GMM estimations
(Dependent variable: Under-five mortality rate)

Variables	Model 1		Model 2		Model 3		Model 4	
Socioeconomic factors								
Lagged log under-five mortality rate	0.893		0.913		0.942		0.938	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Log GDP per capita	-0.090		-0.103		-0.080		-0.072	
	(0.023)	**	(0.020)	**	(0.132)		(0.157)	
Improved sanitation	-0.003		-0.002		-0.003		-0.003	
	(0.029)	**	(0.237)		(0.024)	**	(0.024)	**
Share of female students	0.001		0.000		0.002		0.002	
	(0.364)		(0.940)		(0.223)		(0.308)	
Log population	-0.017		-0.043		-0.017		-0.019	
	(0.117)		(0.014)	**	(0.194)		(0.038)	**
Gini coefficient			0.000					
			(0.649)					
Governance					0.023			
					(0.541)			
Health system factors								
Log health spending							0.030	
							(0.290)	
DPT coverage								
Skilled Birth Attendance								
Log physician density								
Log health spending*Governance								
Year dummy 1995	0.000		-0.007					
	(0.984)		(0.672)					
Year dummy 2000	-0.023		-0.033		-0.021		-0.018	
	(0.246)		(0.117)		(0.050)	*	(0.072)	*
Year dummy 2005	-0.068		-0.077		-0.059		-0.060	
	(0.019)	**	(0.088)	*	(0.002)	***	(0.004)	***
Constant	1.255		1.564		0.801		0.831	
	(0.033)	**	(0.080)	*	(0.137)		(0.233)	
AR1 test: p-value	0.51		0.298		0.647		0.557	
AR2 test: p-value	0.214		0.703					
Hansen test: p-value	0.356		0.489		0.276		0.338	
#Instruments	65		66		55		57	
#Observations	416		230		334		336	
#Groups	125		93		125		125	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 5. (continued) Results of the system GMM estimations
(Dependent variable: Under-five mortality rate)

Variables	Model 5		Model 6		Model 7		Model 8	
Socioeconomic factors								
Lagged log under-five mortality rate	0.905		0.989		0.935		0.946	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Log GDP per capita	-0.071		-0.064		-0.091		-0.080	
	(0.000)	***	(0.050)	*	(0.056)	*	(0.082)	*
Improved sanitation	-0.003		-0.002		-0.002		-0.003	
	(0.012)	**	(0.043)	**	(0.220)		(0.019)	**
Share of female students	0.002		0.000		0.000		0.002	
	(0.188)		(0.952)		(0.797)		(0.171)	
Log population	-0.023		-0.020		-0.023		-0.014	
	(0.005)	***	(0.041)	**	(0.063)	*	(0.126)	
Gini coefficient								
Governance								
Health system factors								
Log health spending								
DPT coverage	-0.002							
	(0.171)							
Skilled Birth Attendance			0.002					
			(0.096)	*				
Log physician density					0.004			
					(0.862)			
Log health spending*Governance							0.010	
							(0.190)	
Year dummy 1995	0.005		0.010		0.009			
	(0.743)		(0.616)		(0.527)			
Year dummy 2000	-0.019		-0.009		-0.012		-0.018	
	(0.255)		(0.715)		(0.444)		(0.063)	*
Year dummy 2005	-0.058		-0.042		-0.060		-0.059	
	(0.019)	**	(0.168)		(0.054)	*	(0.001)	***
Constant	1.162		0.552		1.126		0.768	
	(0.028)	**	(0.297)		(0.153)		(0.178)	
AR1 test: p-value	0.467		0.232		0.13		0.577	
AR2 test: p-value	0.21		0.261		0.959			
Hansen test: p-value	0.692		0.668		0.454		0.423	
#Instruments	78		70		78		57	
#Observations	415		312		286		334	
#Groups	125		125		113		125	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 6. Results of the system GMM estimations using lagged independent variables (Dependent variable: Under-five mortality rate)

Variables	Model 1		Model 2		Model 3		Model 4	
Lagged log under-five mortality rate	0.893		0.980		1.069		1.038	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Log GDP per capita	-0.090		-0.049		0.026		-0.003	
	(0.023)	**	(0.365)		(0.644)		(0.955)	
Improved sanitation	-0.003		-0.001		-0.001		-0.001	
	(0.029)	**	(0.433)		(0.398)		(0.548)	
Share of female students	0.001		0.000		0.001		-0.002	
	(0.364)		(0.837)		(0.701)		(0.350)	
Log population	-0.017		-0.036		-0.038		-0.024	
	(0.117)		(0.016)	**	(0.008)	***	(0.035)	**
Lagged Gini coefficient			-0.001					
			(0.506)					
Lagged Governance					-0.006			
					(0.879)			
Health system factors								
Lagged Log health spending							0.076	
							(0.269)	
Lagged DPT coverage								
Lagged Skilled Birth Attendance								
Lagged Log physician density								
Lagged Log health spending*Governance								
Year dummy 1995	0.000		0.020					
	(0.984)		(0.212)					
Year dummy 2000	-0.023		-0.024		0.000		0.027	
	(0.246)		(0.321)		(0.000)	***	(0.017)	**
Year dummy 2005	-0.068		-0.058		-0.031		0.000	
	(0.019)	**	(0.039)	**	(0.025)	**	(0.000)	***
Constant	1.255		0.750		-0.281		-0.051	
	(0.033)	**	(0.335)		(0.668)		(0.943)	
AR1 test: p-value	0.51		0.247		.			***
AR2 test: p-value	0.214		0.251					
Hansen test: p-value	0.356		0.061	*	0.509		0.499	
#Instruments	65		66		55		57	
#Observations	416		263		225		230	
#Groups	125		96		122		122	

P-value in parentheses
Significance: * p<0.1; ** p<0.05; *** p<0.01

Table 6. (continued) Results of the system GMM estimations using lagged independent variables (Dependent variable: Under-five mortality rate)

Variables	Model 5		Model 6		Model 7		Model 8	
Lagged log under-five mortality rate	0.918		0.915		0.872		1.076	
	(0.000)	***	(0.000)	***	(0.000)	***	(0.000)	***
Log GDP per capita	-0.051		-0.107		-0.111		0.014	
	(0.000)	***	(0.157)		(0.001)	***	(0.790)	
Improved sanitation	-0.003		-0.003		-0.002		-0.001	
	(0.081)	*	(0.003)	***	(0.286)		(0.676)	
Share of female students	0.001		-0.002		0.001		-0.001	
	(0.598)		(0.478)		(0.554)		(0.684)	
Log population	-0.020		-0.030		-0.018		-0.035	
	(0.041)	**	(0.046)	**	(0.079)	*	(0.024)	**
Gini coefficient								
Governance								
Health system factors								
Log health spending								
DPT coverage	-0.002							
	(0.120)							
Skilled Birth Attendance			0.002					
			(0.061)	*				
Log physician density					-0.018			
					(0.489)			
Log health spending*Governance							0.008	
							(0.420)	
Year dummy 1995	0.027		-0.019		-0.008			
	(0.099)		(0.558)		(0.510)			
Year dummy 2000	0.013		-0.037		-0.025		0.000	
	(0.547)		(0.208)		(0.149)		(0.000)	***
Year dummy 2005	-0.023		-0.075		-0.072		-0.024	
	(0.385)		(0.030)	**	(0.001)	***	(0.079)	*
Constant	0.966		1.521		1.490		-0.204	
	(0.063)	*	(0.157)		(0.001)	***	(0.767)	
AR1 test: p-value	0.366		0.208		0.883			***
AR2 test: p-value	0.345		0.195		0.288			
Hansen test: p-value	0.666		0.769		0.454		0.579	
#Instruments	78		70		78		57	
#Observations	406		268		343		225	
#Groups	125		117		113		122	

P-value in parentheses

Significance: * p<0.1; ** p<0.05; *** p<0.01

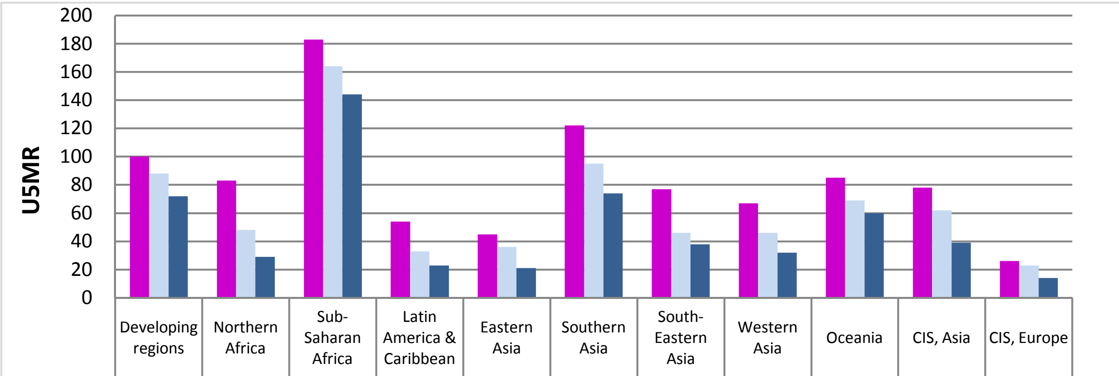
Table A.1. Countries in the sample

East Asia and Pacific (EAP): 22 countries	**Latin America and Caribbean (LAC): 29 countries**	**Middle East and North Africa (MENA): 13 countries**	**Sub-Saharan Africa (SSA): 46 countries**
Cambodia	Argentina	Algeria	Angola
China	Belize	Djibouti	Benin
Fiji	Bolivia	Egypt	Botswana
Indonesia	Brazil	Iran	Burkina Faso
Kiribati	Chile	Iraq	Burundi
Korea, Dem. Rep.	Colombia	Jordan	Cameroon
Lao PDR	Costa Rica	Lebanon	Cape Verde
Malaysia	Cuba	Libya	Central African Republic
Marshall Islands	Dominica	Morocco	Chad
Micronesia	Dominican Republic	Syria	Comoros
Mongolia	Ecuador	Tunisia	Congo, Dem. Rep.
Myanmar	El Salvador	West Bank and Gaza	Congo, Rep.
Palau	Grenada	Yemen	Cote d'Ivoire
Papua New Guinea	Guatemala	**South Asia (SA): 8 countries**	Eritrea
Philippines	Guyana	Afghanistan	Ethiopia
Samoa	Haiti	Bangladesh	Gabon
Solomon Islands	Honduras	Bhutan	Gambia
Thailand	Jamaica	India	Ghana
Timor-Leste	Mexico	Maldives	Guinea
Tonga	Nicaragua	Nepal	Guinea-Bissau
Vanuatu	Panama	Pakistan	Kenya
Vietnam	Paraguay	Sri Lanka	Lesotho
Europe and Central Asia (ECA): 23 countries	Peru		Liberia
Albania	St. Kitts and Nevis		Madagascar
Armenia	St. Lucia		Malawi
Azerbaijan	Vincent and the Grenadines		Mali
Belarus	Suriname		Mauritania
Bosnia and Herzegovina	Uruguay		Mauritius
Bulgaria	Venezuela		Mozambique
Georgia			Namibia
Kazakhstan			Niger
Kyrgyz Republic			Nigeria
Latvia			Rwanda
Lithuania			Sao Tome and Principe
Macedonia			Senegal
Moldova			Seychelles
Montenegro			Sierra Leone
Poland			Somalia
Romania			South Africa
Russian Federation			Sudan
Serbia			Swaziland
Tajikistan			Tanzania
Turkey			Togo
Turkmenistan			Uganda
Ukraine			Zambia
Uzbekistan			Zimbabwe

Table A.2. Description of governance indicators

Indicator	Description
1. Voice and Accountability	– capturing perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.
2. Political Stability and Absence of Violence	– capturing perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.
3. Government Effectiveness	– capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
4. Regulatory Quality	– capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
5. Rule of Law	– capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.
6. Control of Corruption	– capturing perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

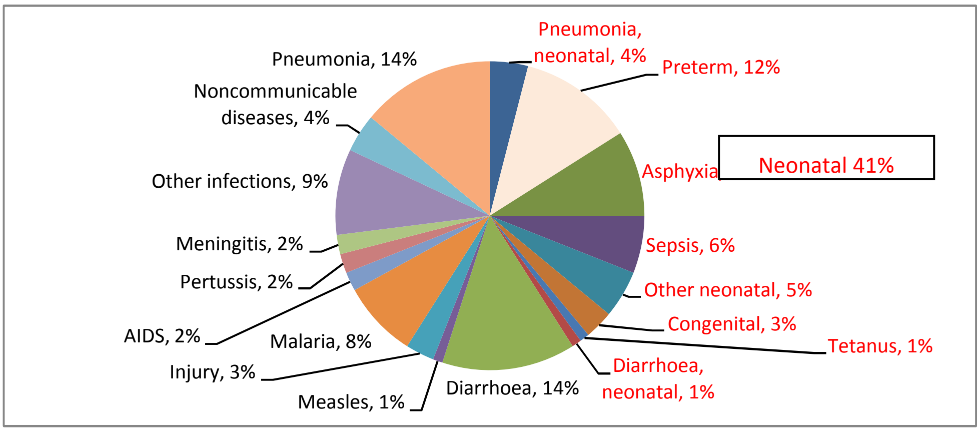
Figure 1. Under-five mortality rate in the developing regions



	Developing regions	Northern Africa	Sub-Saharan Africa	Latin America & Caribbean	Eastern Asia	Southern Asia	South-Eastern Asia	Western Asia	Oceania	CIS, Asia	CIS, Europe
1990	100	83	183	54	45	122	77	67	85	78	26
2000	88	48	164	33	36	95	46	46	69	62	23
2007	72	29	144	23	21	74	38	32	60	39	14

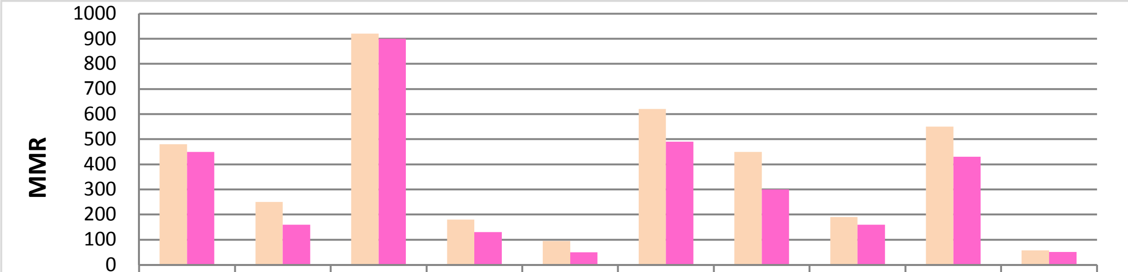
Source: UN, 2009 and UN, 2010

Figure 2. Causes of child deaths



Source: WHO and UNICEF, 2010

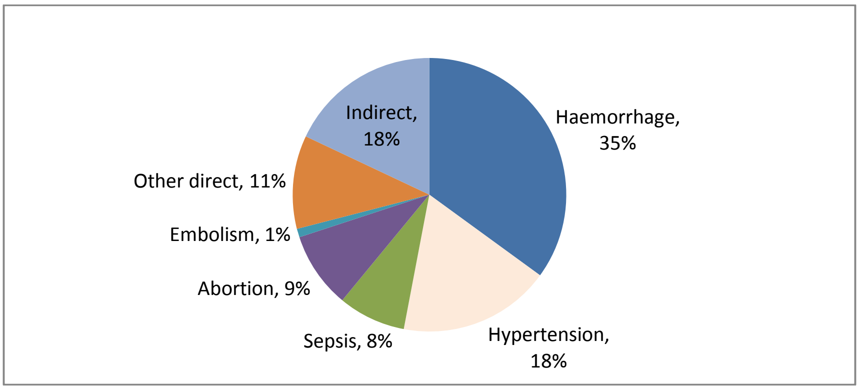
Figure 3. Maternal mortality ratio in the developing regions



	Developing regions	Northern Africa	Sub-Saharan Africa	Latin America & Caribbean	Eastern Asia	Southern Asia	South-Eastern Asia	Western Asia	Oceania	CIS
1990	480	250	920	180	95	620	450	190	550	58
2005	450	160	900	130	50	490	300	160	430	51

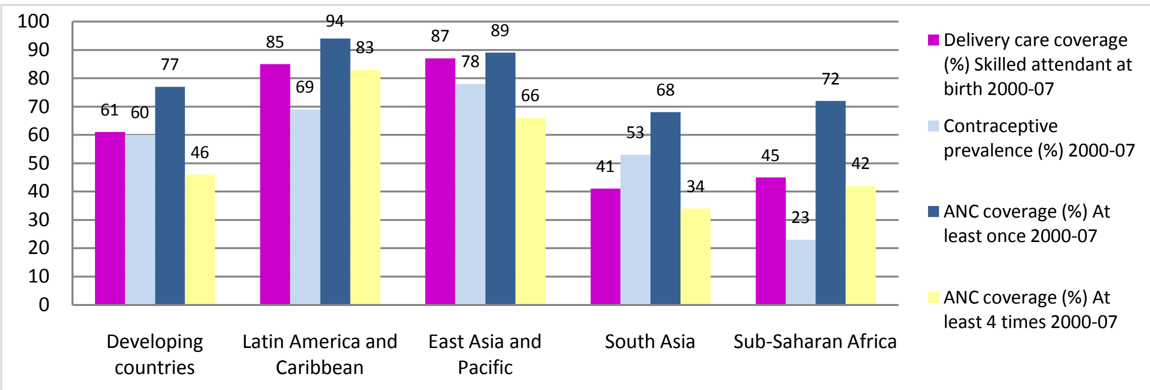
Source: UN, 2009

Figure 4. Direct and indirect causes of maternal deaths



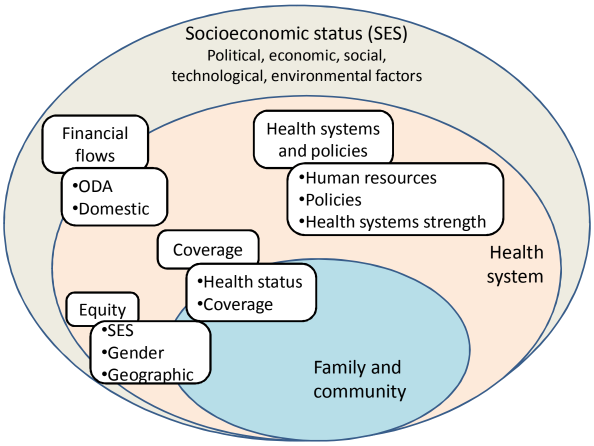
Source: WHO and UNICEF, 2010

Figure 5. Access to health services for pregnant women in developing countries



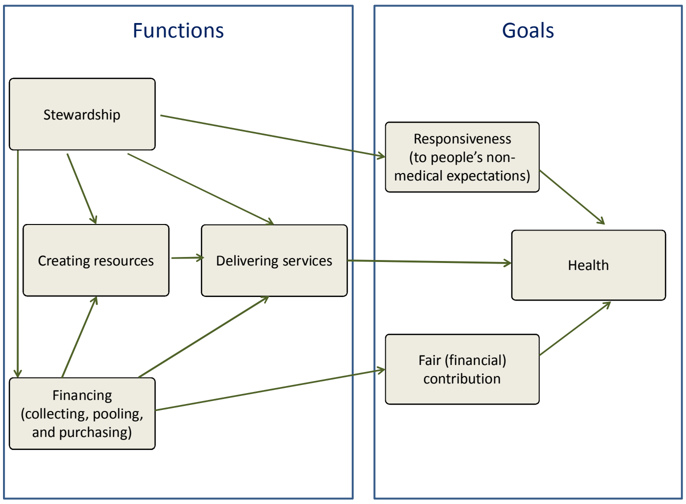
Source: UNICEF, 2009

Figure 6. Conceptual framework of maternal, newborn and child survival



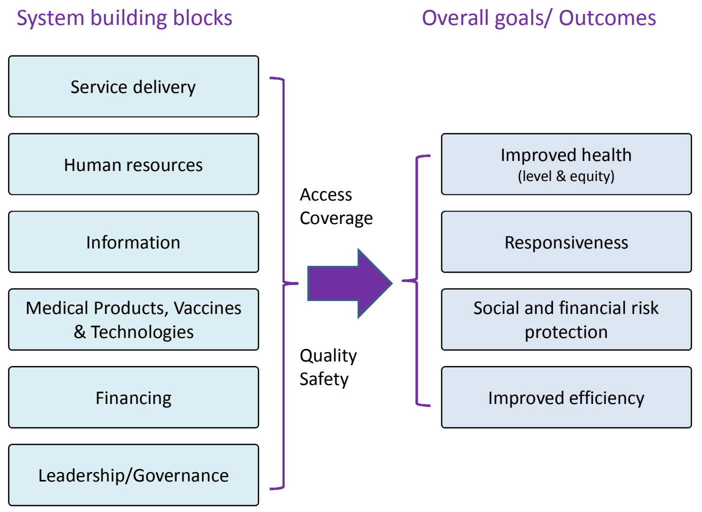
Source: WHO and UNICEF, 2010

Figure 7. Framework of health systems in "World Health Report 2000"



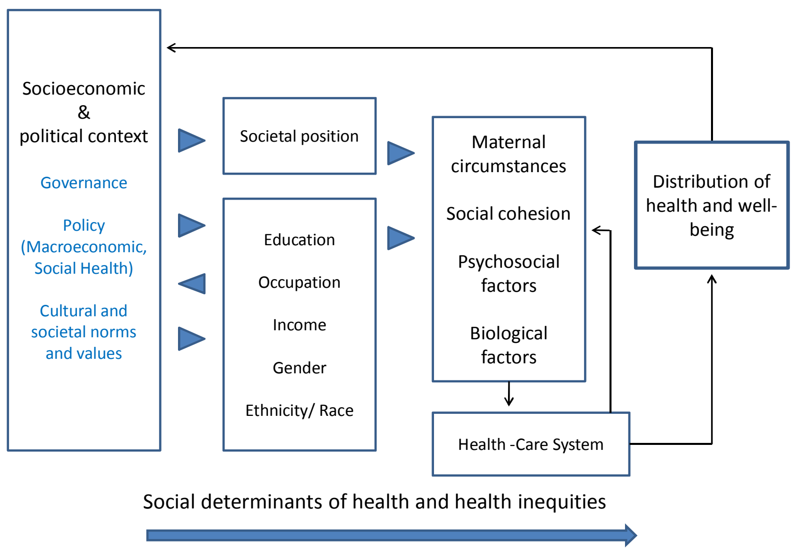
Source: WHO, 2000

Figure 8. Framework of health systems in WHO's "Everybody's Business"



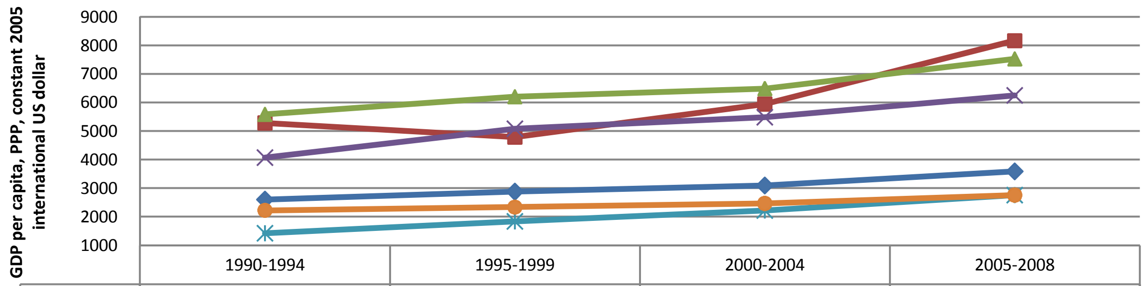
Source: WHO, 2007

Figure 9. Framework of social determinants of health (SDH)



Source: CSDH, 2008

Figure A.1. GDP per capita by the region



	1990-1994	1995-1999	2000-2004	2005-2008
EAP	2,601	2,876	3,090	3,582
ECA	5,284	4,783	5,944	8,160
LAC	5,587	6,202	6,486	7,524
MENA	4,070	5,080	5,485	6,252
SA	1,416	1,839	2,216	2,756
SSA	2,223	2,336	2,461	2,760

Figure A.2. GDP per capita (log) and under-five mortality rate (log)

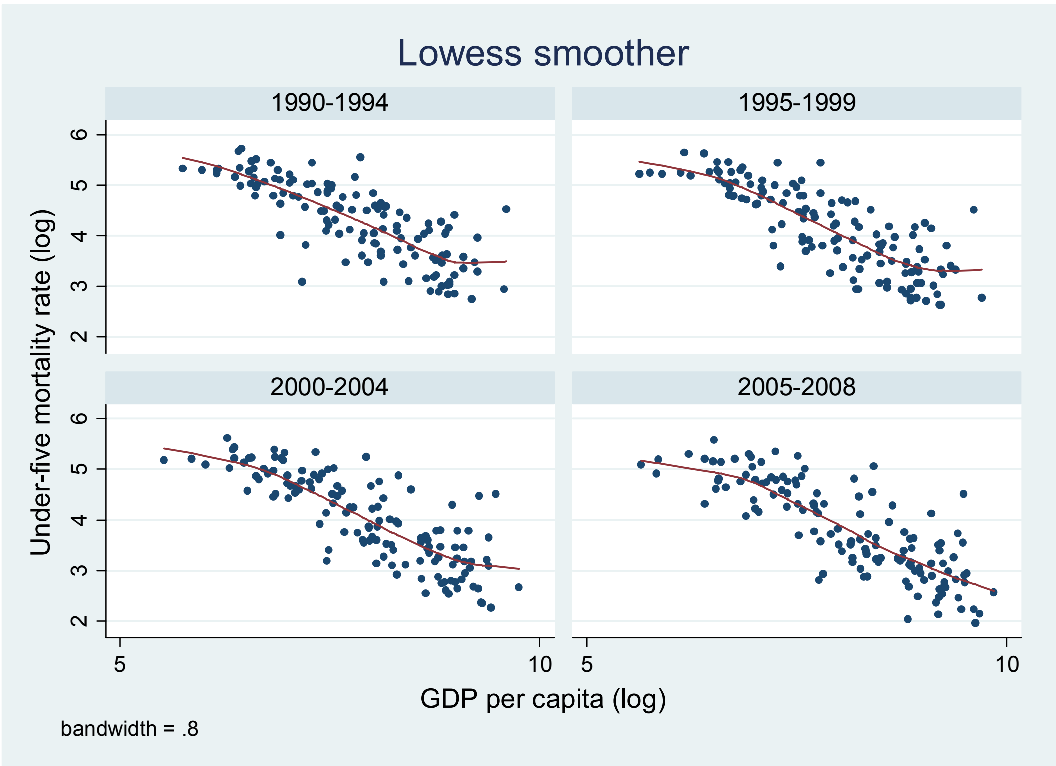
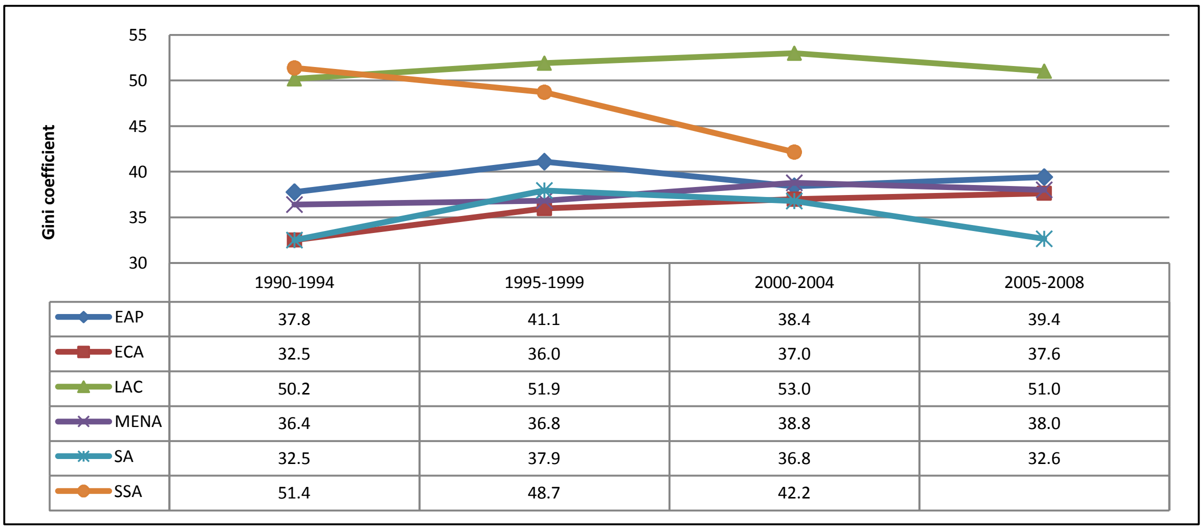


Figure A.3. Gini coefficient by the region



	1990-1994	1995-1999	2000-2004	2005-2008
EAP	37.8	41.1	38.4	39.4
ECA	32.5	36.0	37.0	37.6
LAC	50.2	51.9	53.0	51.0
MENA	36.4	36.8	38.8	38.0
SA	32.5	37.9	36.8	32.6
SSA	51.4	48.7	42.2	

Figure A.4. Gini coefficient and under-five mortality rate (log)

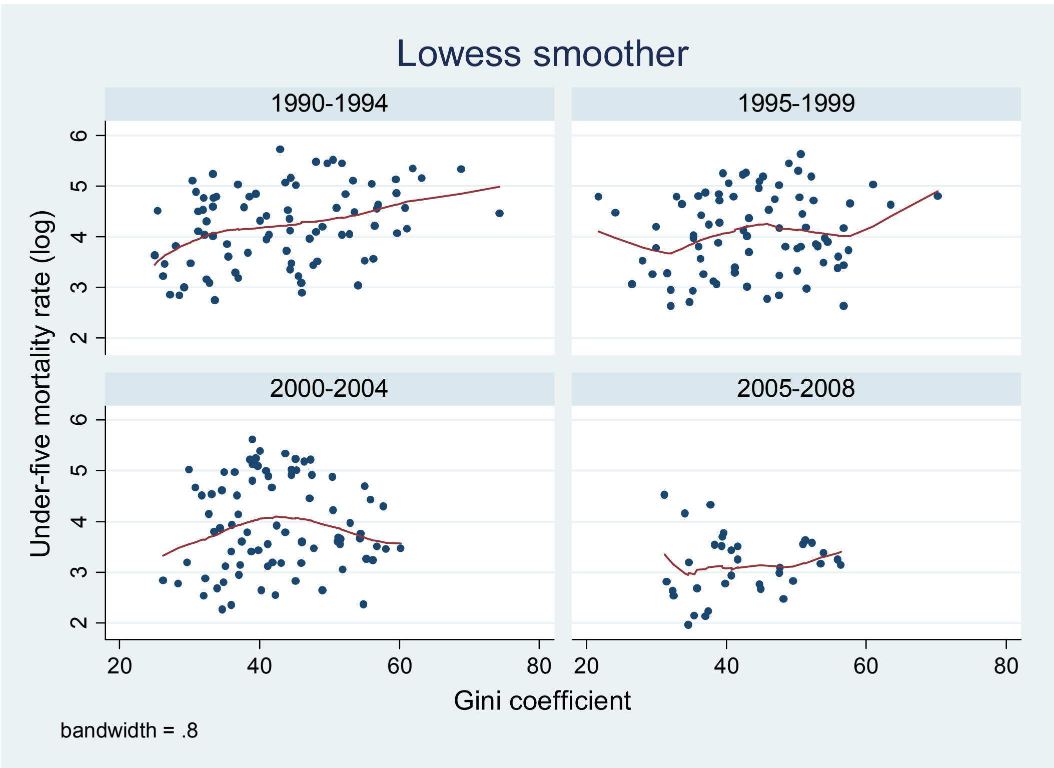
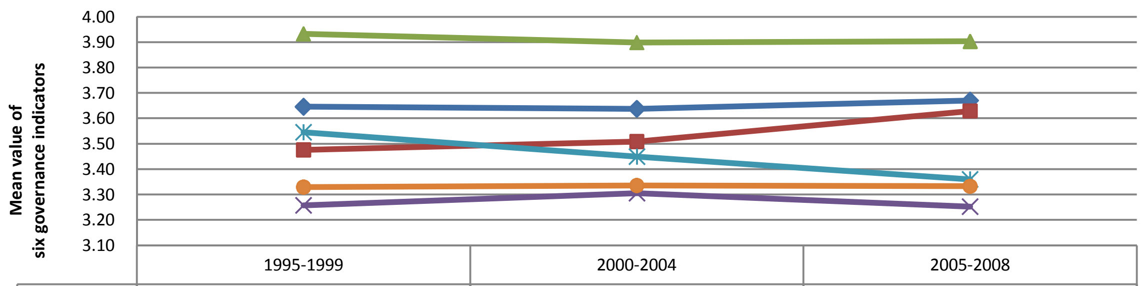


Figure A.5. Mean value of six governance indicators by the region



	1995-1999	2000-2004	2005-2008
EAP	3.65	3.64	3.67
ECA	3.48	3.51	3.63
LAC	3.93	3.90	3.90
MENA	3.26	3.31	3.25
SA	3.54	3.45	3.36
SSA	3.33	3.34	3.33

Figure A.6. Mean value of six governance indicators and under-five mortality rate (log)

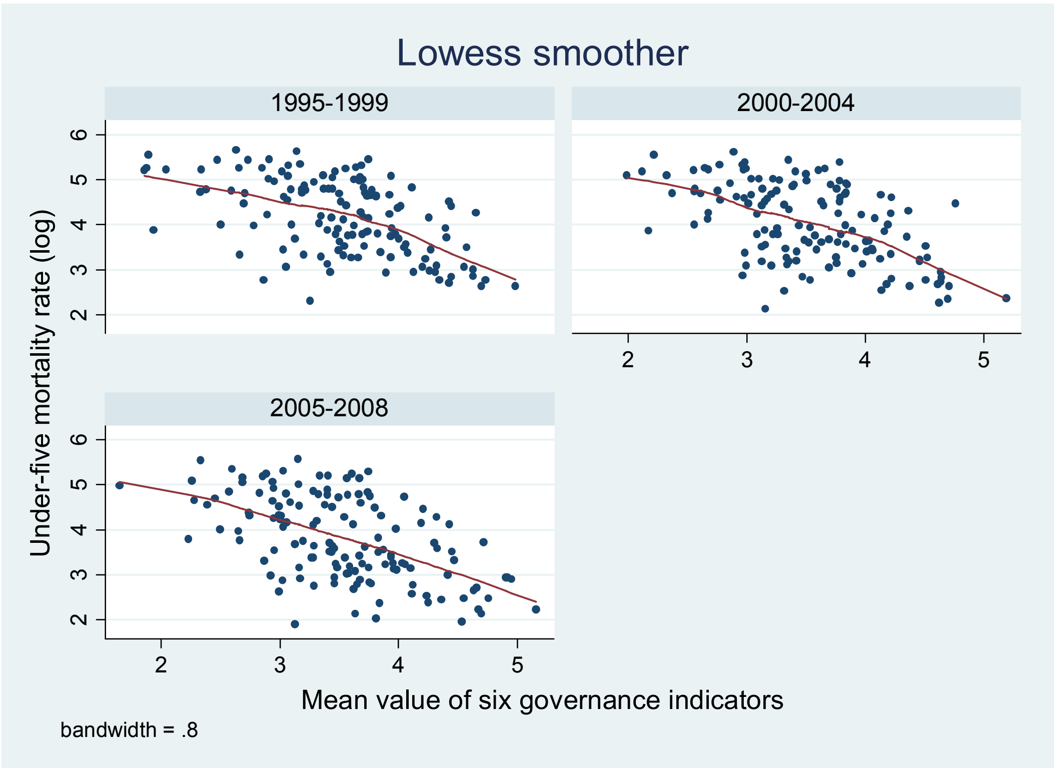
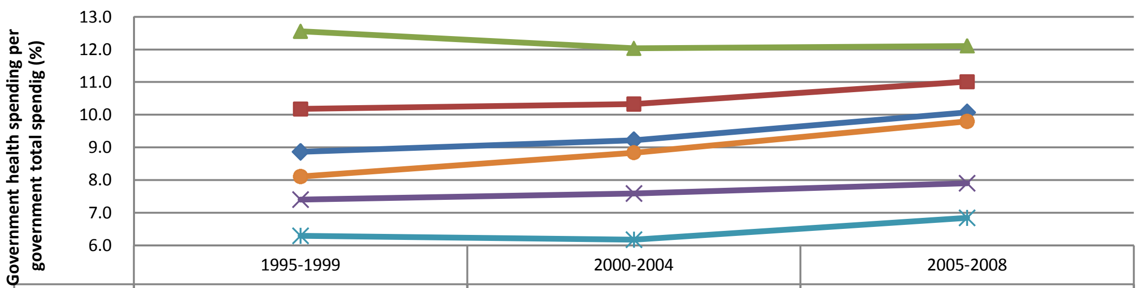


Figure A.7. Government health expenditure per government total expenditure by the region



	1995-1999	2000-2004	2005-2008
EAP	8.9	9.2	10.1
ECA	10.2	10.3	11.0
LAC	12.6	12.0	12.1
MENA	7.4	7.6	7.9
SA	6.3	6.2	6.8
SSA	8.1	8.8	9.8

Figure A.8. Government health expenditure per government total expenditure (log) and under-five mortality rate (log)

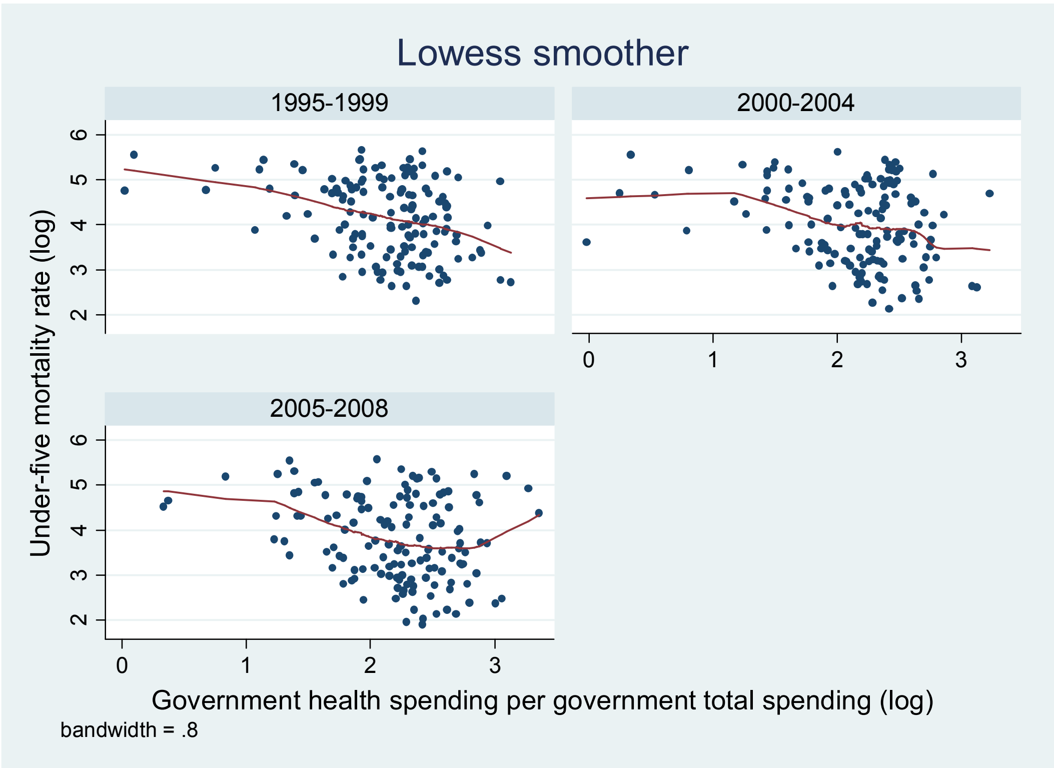


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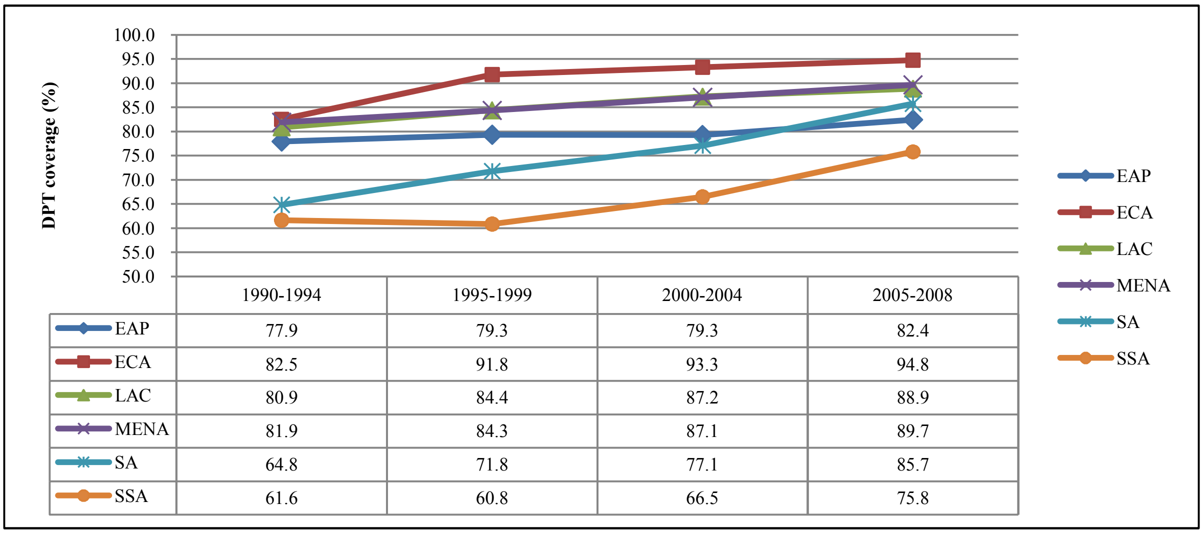
Figure A.9. DPT coverage by the region



	1990-1994	1995-1999	2000-2004	2005-2008
EAP	77.9	79.3	79.3	82.4
ECA	82.5	91.8	93.3	94.8
LAC	80.9	84.4	87.2	88.9
MENA	81.9	84.3	87.1	89.7
SA	64.8	71.8	77.1	85.7
SSA	61.6	60.8	66.5	75.8

Figure A.10. DPT coverage and under-five mortality rate (log)

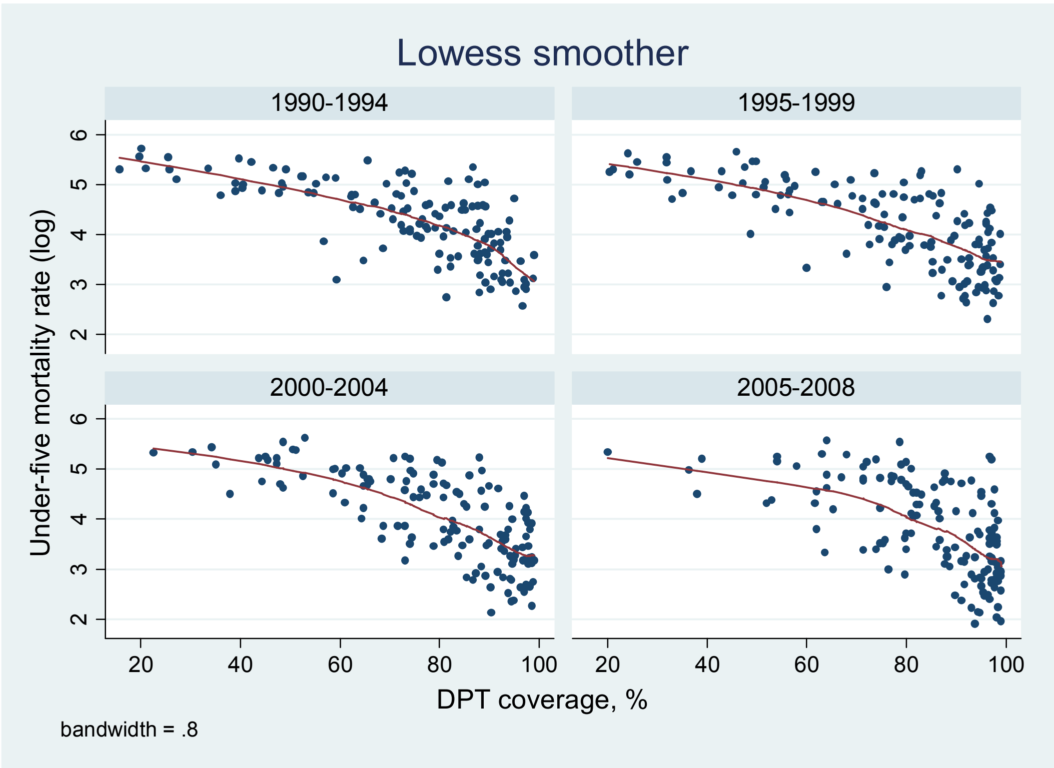
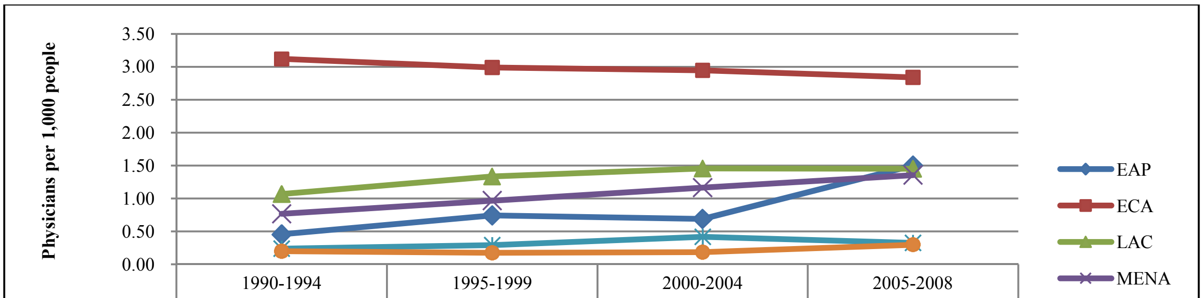


Figure A.11. Physician per 1,000 people by the region



	1990-1994	1995-1999	2000-2004	2005-2008
EAP	0.46	0.74	0.69	1.50
ECA	3.12	2.99	2.95	2.84
LAC	1.07	1.33	1.46	1.45
MENA	0.77	0.97	1.17	1.36
SA	0.24	0.29	0.42	0.33
SSA	0.20	0.18	0.19	0.30

Figure A.12. Physician per 1,000 people (log) and under-five mortality rate (log)