Did the Millennium Development Goals Change Trends in Child Mortality?
Declan French

Queen's University Belfast

Working Paper FIN 14-11

Did the Millennium Development Goals change trends in child mortality?

Declan French, Queens University Management School.

Abstract

There has been little assessment of the role the MDGs have had in progressing international development. There has been a 41 per cent reduction in the under-5 mortality rate worldwide from 1990 to 2011 and an acceleration in the rate of reduction since 2000. This paper explores why this has occurred and results indicate that it is not due to more healthcare or public health interventions but is driven by a coincidental burst of economic growth. A thorough analysis of the successes and failures of the MDGs is therefore necessary before embarking on a new round of global goals.

*Corresponding author: Declan French, Queens University Management School, 185 Stranmillis Road, Belfast, BT9 5EE.
email : declan.french@qub.ac.uk Tel. : 0044-2890974757

Did the Millennium Development Goals change trends in child mortality?

1. Introduction

In the Millennium Declaration in 2000, the UN General Assembly resolved to reduce under-five child mortality by two thirds of their existing rates by the year 2015. The most recent Millennium Development Goals Report 2013 reports a 41 per cent reduction in the child death rate worldwide from 1990 to 2011 and an acceleration in the rate of reduction globally and in many regions since 2000 (UN, 2013). While it is debatable whether the original ambitious target will be met by 2015, this acceleration in progress since the Millennium Declaration is to be welcomed. In light of discussions to develop policy post-MDG it is useful to ask the question: why has this improvement occurred?

In this paper we consider data drawn mainly from the World Development Indicators Database and find that faster rates of reduction in child mortality after 2000 have little to do with healthcare or public health interventions but are driven by coincidental economic growth. Across the 129 developing countries considered, there is no evidence that rates of growth in private health expenditure accelerated or that trends in measles immunisation rates or access to safe drinking water or basic sanitation have improved. Growth rates in public health expenditure and the trend in immunisation rates for diphtheria, pertussis and tetanus have been faster post-MDG but these have not caused child death rates to fall. In contrast, many regions have experienced rapid economic growth during this period and reducing poverty significantly reduces child mortality. We find that a one per cent improvement in GDP per capita reduces under-five mortality by 0.18 per cent. In our estimates, average annual rates of GDP per capita growth rose from 0.5 per cent in 2001 to 5.0 per cent in 2006 causing an annual reduction in under-five mortality rates which rose from 0.1 per cent to 0.9 per cent.

Official monitoring reports mainly focus on the degree to which progress towards the MDGs has been achieved (see review in Fukuda-Parr et al., 2013). There has been little evaluation of whether the pace of progress on these measures has improved since the Millennium Declaration. The UN's Millennium Development Goals Report (UN, 2013) reports progress towards the set targets mainly using the year 1990 as its baseline. Trends since 2000 are also occasionally included but there is no formal analysis of changes in trends before and after the signing of the Declaration. The World Bank's Global Monitoring reports follow the same structure considering the degree to which countries are 'on-track' or 'off-track' to meeting the targets. In the 2013 report, for example, it is reported that when measured against the original target, only 25 of developing countries have already met the target of a two-thirds reduction by 2015 in under-five mortality and a further 26 have made sufficient progress (World Bank, 2013a). There is no consideration as to whether progress has accelerated post-MDG.

The academic literature provides some insights. Kenny and Sumner (2011) assess whether current levels of the MDG indicators are better or worse than predicted by a simple model of historical trends. In a similar vein but using a more sophisticated non-linear model, Klasen and Lange (2012) compare current levels against their model predictions. Following a different approach, Fukuda-Parr et al. (2013) argue that it is more relevant to assess whether the pace of improvement has accelerated post-MDG since the MDGs were intended to encourage greater effort and coherence. This is the starting point for our paper. We extend their analyses comparing rates of improvement pre and post-MDG finding that under-five mortality decline has generally accelerated worldwide. We also contribute to the literature by explaining why any progress observed has occurred and the degree to which the Millennium Declaration was responsible for this change. Although the effect of the Declaration on resource mobilization and national development priorities has been considered elsewhere, an analysis of how this may have then impacted on child mortality is still currently lacking due to its perceived analytical difficulty (Kenny and Sumner, 2011 ; Molenaar, 2012).

Economic growth rates worldwide picked up significantly in the 2000s compared to the previous decade (OECD, 2010). The United Nations report that GDP per capita growth rates in developing countries were an impressive 5.8 per cent from 2000-2008 (UN, 2010).   This acceleration is unrelated to the MDGs but can be attributed to a commodities boom, less conflict, new information and communication technologies as well as avoiding bad macroeconomic policies (Arbache and Page, 2010; Rodrik, 2011 ; Subramanian, 2011).

Higher GDP per capita is correlated with lower mortality at the country-level (Preston, 2007). Pritchett and Summers (1996) argued that 'wealthier nations are healthier nations' due to increased income buying greater quantities of health-enhancing public and private goods. Richer countries can expand the public provision of housing, healthcare and education (Anand and Ravallion, 1993) and have better institutions (Cutler et al., 2006) while richer individuals can purchase greater amounts of the inputs to good health for example nutrition, medicines and private healthcare (Schultz 1999; Gwatkin et al., 2007).

The response of child mortality to short run variations in incomes due to a recession or boom could however be different. A boom could allow greater consumption of nutritious foodstuffs, mosquito nets and medicines. However, a boom could also increase work opportunities making a mother's time more valuable which would draw her away from time-intensive activities such as antenatal and postnatal healthcare visits, breast-feeding, cooking healthy meals and collecting clean water (Baird et al., 2011). Studies also argue that booms increase consumption of health-reducing goods such as alcohol and tobacco and increase pollution (Ruhm, 2000 ; Granados, 2012). The composition of births can also change as the state of the economy varies (Paxson and Schady, 2005) with higher risk women deferring birth during a recession or suffering foetal loss through spontaneous abortion or still birth.

In a review of the empirical literature on child mortality in developing countries, Ferreira and Schady (2009) find that child mortality is generally counter-cyclical (decreasing in booms and

increasing in recessions). This finding contrasts with the pro-cyclicality of US child mortality (Dehejia and Lleras-Muney, 2004). Bhalotra (2010) argues that developing countries are different due to the lack of social welfare support and greater household credit constraints and finds that recessions in India drive mothers into distress working with reduced use of antenatal and postnatal healthcare facilities. Although the focus is on the mortality effect of recession, she finds no evidence of asymmetry in the effect of positive and negative macroeconomic shocks on infant mortality.

Many other factors impact on child health and there are other plausible explanations for greater progress in under-five mortality post-MDG. It is clear that the amount of resources available to developing countries for improving health has increased mainly due to increases in foreign aid. Between 2002 and 2011, disbursements of ODA for health rose from US$ 6.2 billion to US$ 18.4 billion (WHO, 2013). Following the establishment of the Global Alliance for Vaccines and Immunization (GAVI) in 2000 over 250 million children were immunised with GAVI-supported vaccines (Clemens et al., 2010). Access to safe drinking water and basic sanitation has also been steadily improving since 1990 (WHO/UNICEF, 2013). These explanatory factors will all be considered in the analysis.

In the UN Secretary-General's statement to the General Assembly on his Five-Year Action Agenda on 25th January 2012, he stated the need to 'to forge consensus on a new generation of sustainable development goals that build on the MDGs' (UN, 2012). Frameworks for version two of the MDGs after the 2015 deadline should really consider first whether the original MDGs had any effect on health objectives. The motivation for this paper is therefore to provide some analysis to ascertain whether the MDGs in particular changed trends in child mortality.

The paper is structured as follows: Section 2 introduces the methods; section 3 discusses the data; section 4 presents results and the final section concludes.

2. Methods

Consistent with the UNICEF Average Annual Rate of Reduction (AARR) methodology, Fukuda-Parr et al (2013) compare the percentage reduction in child mortality pre and post-MDG. This equates to comparing parameter estimates for the trend in a simple linear regression of $\log(Y_t)$ against time for each country before and after the year 2000 where Y_t is under-five mortality. Writing y_t for $\log(Y_t)$, we can use the single regression model

$$y_t = \alpha_1 + \alpha_2 D_t + \tau_1 Trend_t + \tau_2 (D_t Trend_t) + \varepsilon_t \tag{1}$$

where $D_t = 0$ in 1990-1999 and $D_t = 1$ in 2000-2010. A result of τ_2 less than zero indicates an increase in the rate of decline of child mortality post-MDG. Aggregating across countries gives the panel model

$$y_{it} = \alpha_{1i} + \alpha_{2i} D_t + \tau_1 Trend_t + \tau_2 (D_t Trend_t) + \varepsilon_{it} \tag{2}$$

This model provides a simple test of the overall pace of progress in child mortality across all developing countries. It will also be used to determine if there has been any acceleration in progress in the determinants of child mortality. Including the contribution of a set of explanatory variables, $\boldsymbol{X_{it}}$, to rates of decline gives:

$$y_{it} = \alpha_{1i} + \alpha_{2i} D_t + \tau_1 Trend_t + \tau_2 (D_t Trend_t) + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \tag{3}$$

The set of explanatory variables includes gross domestic product per capita, public health expenditure, private health expenditure, access to safe water, access to basic sanitation, the percentage of children receiving DPT vaccinations and the percentage of children receiving measles vaccinations. The trend terms here capture the trend in global levels of health technology. Similar formulations have been used elsewhere for analysing secular trends in child mortality (for example Farahani et al., 2009) and are consistent with the theoretical framework used in health production function models (Thornton, 2002 ; Folland et al., 2007). Alternative specifications (for example

Klasen and Lange, 2012) are not considered here. To control for endogeneity, the model will be estimated by the two-step generalised method of moments (GMM) estimator which is more efficient than the standard two-stage least squares estimator in the presence of heteroskedasticity and autocorrelation (Schaffer, 2010). A number of alterative specifications for fixed effects and trend terms are also considered.

In aggregate analyses, results will be unweighted for population as the focus here is on how nations responded to the MDGs. At first sight, this may appear to be at odds with the Millennium Summit Declaration which was targeted at a global population. However, later announcements have often indicated that they were intended to be further applied at national level (UN, 2001) and much of the progress reports consider whether individual countries are on or off-track (UNDP, 2010 ; UN, 2013 ; World Bank, 2013a).   Also this approach is natural since an achievement at global level driven by a few very populous countries and leaving many countries off-track would be unsatisfactory (Manning, 2009).

Results will be analysed across developing countries only as the focus of the MDGs is in practice mostly on developing countries (Manning, 2009). Although not an MDG in itself but an additional indicator of progress towards MDG 4, estimates of these models for infant mortality will also be considered.

3. Data

Infant (*IMR*) and under-five mortality (*U5M*) rates per 1,000 live births in 129 developing countries for years 1990-2010 were sourced from the World Development Indicators Database (World Bank, 2013b) and used in log form. These data were ultimately produced by the United Nations Inter-agency Group for Child Mortality Estimation (IGME). For most developing countries vital registration systems are incomplete and child deaths must be estimated using other sources which vary in data quality and availability. The main alternative source is complete or summary birth histories collected

through censuses and surveys (e.g. Demographic and Health Surveys, Multiple Indicator Cluster Survey) and child mortality estimates based on these sources are subject to various data quality issues such as sampling error and recall bias as well as methodological biases in converting birth histories into mortality estimates. IGME therefore employ modelling approaches to smooth out irregularities and correct for biases. Although these have been recently further refined to flexibly capture changes in U5M rates over time (Alkema and New, 2013), they may unfortunately also remove informative temporal variation from the data creating a challenge for the empirical researcher to find statistically significant relationships.

Explanatory variables were sourced from the same dataset but were only available 1995-2010. The percentage of the population with access to an improved water source (for example piped water) (*Water*), the percentage of the population with access to improved sanitation facilities (for example piped sewer system) (*Sanitation*), the percentage of children ages 12-23 months who received diphtheria, pertussis and tetanus vaccinations (*ImmDPT*) and the percentage of children ages 12-23 months who received measles vaccinations (*ImmMeasles*) were all entered into the model as given.   Public health expenditure (*Public HE*) was found by multiplying total health expenditure per capita (adjusted for purchasing power parity and in constant 2005 $) by the percentage which was public. This includes government spending and donations from international agencies and nongovernmental organizations. The remainder was then regarded as private health expenditure (*Private HE*). These were then logged. Gross Domestic Product per capita (adjusted for PPP and in constant 2005 $) (*GDP*) was sourced from Penn World Tables v.7.1 (Heston et al., 2012) and used in log form.

These data were complete over 1995-2010 for 112 countries while the remaining 17 countries had some missing data for some of these variables. The remaining six developing countries had insufficient data to be included.

Supplementary data on child causes of death by country 2000-2010 was sourced from CHERG (2014) and is described in Liu et al. (2012). These estimates aggregate to the earlier 2011 IGME U5M data release and total child deaths are therefore not comparable with figures presented here. Where mortality vital registration systems were not of good quality and mortality was low, cause of death estimates were based on a multi-cause regression model using data from comparable countries. Where mortality vital registration systems were not of good quality and mortality was high, estimates were based on a multi-cause regression model revised with additional study data. Otherwise cause of death was extracted from the WHO mortality database adjusted for a lesser degree of coverage incompleteness where necessary.

4. Results

4.1 Main results

Unweighted means for 129 developing countries are given for all variables in Table 1 for selected years. Both under-five and infant mortality have fallen over this period and the explanatory variables which are all plausibly mortality-reducing have generally been rising. It is clear that a substantial proportion of deaths to children before reaching their fifth birthday occur in infancy.

[TABLE 1 HERE]

The distribution of under-five mortality rates by country for 1990, 2000 and 2010 are plotted in Fig 1. There is a noticeable secular shift towards lower mortality rates. The most striking change is in the right-tail. For example, death rates at the 90th percentile fell pre-MDG by 15 per cent from 202 per 1000 births in 1990 to 171 per 1000 births in 2000 then post-MDG by 35 per cent to 112 per 1000 births in 2010. In the first instance then, model 1 was used to determine if rates of decline were consistently faster for each developing country after the year 2000.

[FIGURE 1 HERE]

Results in Table 2 indicate that slightly over two-thirds of developing countries (68%) have had accelerated improvement in under-five mortality since 2000. In 91 per cent of countries in sub-Saharan Africa, under-five mortality has declined more rapidly post-2000 compared to pre-2000. Rates of decline have also accelerated in the majority of developing countries in every region except Latin America and East Asia. Table 8 in Fukuda-Parr et al (2013) has generally lower numbers of countries improving post-MDG in each region. This is due to their inclusion of non-developing countries and to more recent improvements in the accuracy of data (Alkema and New, 2013). Applying the stricter criterion of a statistically significant accelerated improvement does not change the overall picture although progress in Latin America becomes even scarcer. Infant mortality has followed a similar pattern but faster progress has been slightly more extensive. The rest of this paper will explore why faster progress has generally occurred.

[TABLE 2 HERE]

The individual country results can be aggregated using a panel approach (model 2) and allow the estimation of an average increase in the pace of decline for developing countries (Table 3). Under-five mortality was declining in developing countries at an annual rate of 2.5 per cent pre-MDG and the annual rate of decline was a statistically significant 1.5 per cent faster after the Millennium Declaration implying a total percentage reduction of 58 per cent from 1990 to 2015.[1] For a country to have successfully reached the MDG of a reduction by two thirds from 1990 to 2015, the annual rate of reduction would have had to be 4.3 per cent throughout this period.[2] Nevertheless, at first glance, it would appear that there was a significant change in child mortality after the Millennium Declaration. The pattern of infant mortality over this period is very similar with at an annual rate of reduction of 2.3 per cent pre-2000 and 1.3 per cent faster post-2000.

[TABLE 3 HERE]

To understand whether the determinants of child mortality have changed, a number of potential explanatory variables have been analysed pre and post-MDG. The data here are generally more limited and so the model in (2) is applied to the periods 1995-1999 and 2000-2010. A positive increase in any of these variables would be expected to improve child mortality. A general trend upwards in these variables over the whole period 1995-2010 is clear from the first row of Table 4 although statistically insignificant for DPT immunisation rates. The second row indicates that a minority of these variables displayed more rapid progress in the period 2000-2010 compared to 1995-1999 (i.e. $\tau_2 > 0$). There have been significant improvements in GDP per capita and public health expenditure with annual growth rates increasing by 1.3 per cent and 3.5 per cent respectively post-MDG. The annual trend in the percentage of one-year olds being immunised for DPT increased by 0.59 percentage points after the Millennium Declaration. None of the other potential explanatory variables showed any noticeable increase post-MDG. The very large standard errors for immunisation rates and relatively low R^2 indicate large variation around the overall positive trend. Measles immunization activities have accelerated in target countries since 2000 (WHO, 2014) but trends in measles immunisation rates have also declined elsewhere. In a country-by-country analysis (not shown), 56 countries showed a decline in trend post-MDG ranging from 0.05 percentage points lower annually in Tonga to 10.5 percentage points lower annually in Venezuela. In many countries, this was due to having already reached close to universal coverage by 2000.

[TABLE 4 HERE]

In order to assess the relative contribution of these variables to progress towards Goal 4, the model in (3) was estimated. It is conventional to model mortality, GDP and health expenditure in log form. An unlogged form for the remaining variables (*Water, Sanitation*, *ImmDPT* and *ImmMeasles*) which are all expressed in percentages allows for a convenient interpretation as a one percentage point increase in X_j can then be said to cause a $100\beta_j$ per cent change in the under-five mortality rate. This functional form is validated by statistical testing (Table 5). Model 3 with the remaining

variables all unlogged (labelled M1) is tested against the same model with these variables all logged

(M2). For both the Davidson–MacKinnon test (J test) and the Cox and Pesaran test, the unlogged

specification is accepted (first row) and the logged specification rejected (second row) at the five per

cent significance level. See Greene (2012) for details on these tests.

[TABLE 5 HERE]

The trend terms in model (3) representing trends in global levels of health technology are

assumed exogenous. However, it is unclear whether *a priori* the other explanatory variables should

be treated as exogenous or endogenous in estimation. Both public and private health care

expenditure would be expected to increase in a year with especially high child mortality which would

lead to reverse causation. It is less likely but possible that access to water and sanitation facilities

and immunization rates should also be contemporaneously correlated with shocks to child mortality.

In Baird et al (2011), it is assumed that infant mortality does not reverse cause income while in

Farahani et al (2009) income is regarded as endogenous. Estimates are given in Table 6 for the case

of all exogenous explanatory variables ('OLS') and for the case of all endogenous explanatory

variables ('IV-GMM') where the variables are instrumented by their values lagged by one to three

years.

[TABLE 6 HERE]

In the OLS estimates with under-five mortality as dependent variable, few of the explanatory

variables are statistically significant at the five per cent level. GDP per capita is significant in

explaining under-five mortality. A one per cent increase in GDP per capita decreases under-five

mortality by about 0.14 per cent. Immunisation against measles has also reduced deaths before five

years of age. Increasing measles immunisation rates in a country by one percentage point decreases

child death rates by 0.1 per cent. In addition, an increase in the percentage of the population with

access to basic sanitation by one percentage point decreases child mortality by 0.6 per cent. There is

a significant downwards trend of under-five mortality of 1.8 per cent per year which is unaccounted for by these explanatory variables reflecting global technological improvements. Since the inception of the Millennium Development Goals there has been no significant improvement in trend.

There is evidence of endogeneity and therefore the IV-GMM estimates are to be preferred. The endogeneity test rejects the null of exogenous regressors testing all seven explanatory variables. The OLS estimates are therefore likely to be biased although, *a priori*, the direction of the bias is uncertain. Where there is reverse causation of child mortality on the explanatory variables, OLS estimates will exaggerate their effect and coefficient estimates will be biased away from the null. On the other hand, effects may actually be underestimated in the OLS model. First, the explanatory variables used here will undoubtedly be subject to measurement error which is eliminated by instrumenting and measurement error causes effects on child mortality in the OLS model to be underestimated. Second, the direction of the endogeneity bias is ambiguous in multivariate regression (Ettner, 1996). Second-order effects through correlations of any variable with the other regressors may change the predicted sign of the bias; it is therefore possible that eliminating endogeneity may lead to a larger estimate rather than a smaller estimate of the effect of any particular variable on child mortality.

The effect of income on child mortality is seen to be larger than before: a one per cent increase in GDP per capita decreases under-five mortality by about 0.18 per cent. This would imply a six per cent reduction in under-five mortality due to economic growth from 2000 to 2010 since average GDP per capita grew by 33 per cent over this period.

Increasing measles immunisation rates in a country by one percentage point now decreases child death rates by 0.5 per cent. This estimate is reasonable. Average measles immunization rates increased by 7.5 percentage points between 2000 and 2010 in the 129 developing countries considered while measles mortality fell by 3.1 deaths per 1000 births or 3.9 per cent of the under-five mortality rate in 2000 (author's calculations based on WDI Database and CHERG, 2014). This

implies increasing measles immunisation rates by one percentage point decreases child death rates by 0.5 per cent. Access to safe drinking water now has a statistically significant effect on child mortality whereas improving basic sanitation does not have a significant effect. An increase in the percentage of the population with access to improved water facilities by one percentage point decreases child mortality by 0.6 per cent. There is a slightly larger downwards trend than before of under-five mortality of 2.4 per cent per year but no improvement in trend post-MDG. The coefficient on DPT immunisation which suggests rising immunisation rates increase under-five mortality appears counterintuitive at first glance. However this is consistent with studies showing that DTP-vaccinated children especially girls have significantly higher mortality than DTP-unvaccinated children in high-mortality countries in Africa and Asia (Aaby et al., 2012) perhaps due to the DTP vaccine being administered too early (Valentiner-Branth et al., 2007) or in conjunction with the live measles vaccine (Breiman et al., 2004; Chan et al, 2007) or as a booster in the second year of life.

Public health expenditure did not make any difference to child survival. This is perhaps not surprising.   Although, as reported earlier, disbursements of ODA for health tripled between 2002 and 2011, much of this went towards fighting HIV/AIDS. Spending on MDG 6 (combating HIV/AIDS, malaria and other diseases) increased five-fold in this period and during 2009-2011, 58 per cent of ODA for health went to MDG 6 (WHO, 2013). In a review of policy documents of 21 aid programmes, Fukuda-Parr (2008) found surprisingly limited emphasis on child survival in donor priorities. She also found in 22 national poverty reduction strategies that the health priority was HIV/AIDS and less explicitly child survival and maternal health.

Also reported are tests for misspecification. The standard specification test for instrument validity in two-step GMM is the Hansen J-test and this test also indicates whether the instruments are correctly excluded from the model. This test is consistent in the presence of heteroskedasticity and autocorrelation. The Hansen test statistic estimated here indicates that the null hypothesis of valid instruments and no misspecification is accepted.   The underidentification test shows that the

instruments are correlated with the endogenous regressors and hence are not weak. The number of

observations available for IV-GMM estimation is reduced from the OLS estimation as there are no

instruments for the first three years from the period 1995-2010 for each country.

Results for infant mortality rates are very similar. Coefficient estimates of GDP per capita,

safe drinking-water access, immunisation rates and the trend term for the IV-GMM specification are

statistically significant and are of the same order as for under-five mortality. Safe drinking water

access and measles immunisation have less effect on infant mortality than on under-five mortality.

As the average infant mortality over this period in these countries was 45.8 deaths per 1000 live

births, the estimate of the effect of average income on infant mortality here - one per cent increase

in GDP per capita decreases infant mortality by 0.20 per cent - equates to a one per cent increase in

GDP per capita approximately decreasing infant mortality by 0.09 deaths. This is conservative

compared to the 0.24 to 0.40 change in infant mortality per 1,000 births reported in Baird et al.

(2011) where the authors use Demographic and Health Survey data.

To explain the acceleration in the downwards trend of under-five mortality post-2000, an

explanatory variable has to have a statistical relationship with under-five mortality of the correct

sign and has to exhibit an increasing trend post-2000. Increasing measles immunisation, access to

safe water and economic growth all explain under-five mortality (Table 6) but of these only

economic growth improved at a faster rate post-MDG (Table 4). The only available explanation for

accelerated progress towards Goal 4 after the Millennium Declaration is therefore economic growth.

This conclusion is reinforced graphically in figure 2.   The cross-country average of under-5 mortality

rates is calculated and its annual rate of decrease is displayed for each year over 2000-2010

(*Observed*). There is a clear acceleration in the downwards trend over this decade going from an

annual decrease of 3.0 per cent in 2000 to 3.9 per cent in 2008 slowing down to 2.6 per cent in 2010.

The estimate for the trend from Table 6 - 2.4 per cent decrease annually – is also graphed

(*Trend_effect*).   Applying the statistically significant estimates from Table 6 to annual changes in

cross-country averages of the corresponding variables we get the *GDP effect*, *Water effect* and *Immunization effect*. The only one of these effects to increase over this decade is the *GDP effect*. The change in GDP per capita has almost no effect on under-five mortality in 2001 but becomes steadily greater every year until it is reducing under-five mortality annually by almost 0.9 per cent in 2006 and 2007. The slowdown in the annual growth in GDP per capita at the end of the decade mirrors the slow-down in the downwards trend in under-five mortality. In addition, we see that the most substantial factor explaining annual change in under-five mortality over most of the decade (2003-2008) was economic growth. This has been neglected in policy discussions where child mortality reductions have generally been attributed to initiatives related to the Millennium Development Goals.

[FIGURE 2 HERE]

If faster economic growth has accelerated the decline in under-five mortality then which causes of death did it reduce? CHERG data cannot answer this question conclusively as the multi-cause models used to produce many of these child cause of death estimates rely on regression models with country-level covariate data which includes income per capita. Therefore variation of some causes with economic growth is to be expected. The annual decline in under-five mortality averaged across the 129 developing countries is given in Figure 3 and follows a similar pattern to before - accelerating decline until the middle of the decade and a subsequent gradual slowdown. As stated earlier, these data are based on less accurate earlier U5M estimates and hence the overall annual rate of decrease does not exactly match that given in Figure 2 especially in the second half of the decade. The contribution of each cause of death to the annual decrease in child mortality is also given. The only causes of death following the general overall pattern and the pattern of economic growth over this decade are malaria (6.1% of all deaths in 2000) and the 'Other causes' category which includes birth defects, injury, meningitis and other conditions (34.2% of all deaths in 2000). The lack of influence of economic growth on pneumonia and diarrhoea is surprising as these

diseases are associated with regions of food insecurity and economic underdevelopment (Kaler, 2008).

[FIGURE 3 HERE]

4.2 Robustness checks

The specification in model (3) was chosen so as to maintain consistency with models (1) and (2) but it can be shown that the results in the previous section are robust to a number of alternative specifications. The model in (3) with the level break terms (α_{2i}) and trend break term (τ_2) omitted are first considered:

$$y_{it} = \alpha_{1i} + \tau_1 Trend_t + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \tag{3a}$$

Time effects (τ_t) common across all countries are then used instead of the trend and trend break terms:

$$y_{it} = \alpha_{1i} + \alpha_{2i} D_t + \tau_t + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \tag{3b}$$

The level break terms are then omitted from model 3b:

$$y_{it} = \alpha_{1i} + \tau_t + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \tag{3c}$$

In the last specification, country-specific trends are used instead of global trends:

$$y_{it} = \alpha_{1i} + \tau_{1i} Trend_{it} + \boldsymbol{\beta X_{it}} + \varepsilon_{it} \tag{3d}$$

The models are estimated for under-5 mortality using the two-step GMM estimator as before and results are presented in Table 7 along with the corresponding estimates from the previous section (model 3). All models are seen to be well-specified. Not surprisingly, the goodness of fit statistic R^2 decreases when country-specific parameters are dropped (e.g. 3a vs. 3) while there is no change when time effects are used instead of trend terms (3b and 3c vs. 3 and 3a). Income is statistically significant in each specification. Coefficients increase when the level breaks are dropped (3a and 3c) and decrease when country-specific trends are included (3d) although they still remain well within

the confidence interval of the estimate from the original model (95% confidence interval using the estimate of -0.178 is -0.084, -0.272). The other variables previously identified as statistically significant - *Water, ImmDPT* and *ImmMeasles* - remain so except in the final estimates. However, this model only allows for covariation between the explanatory and dependent variables around trends at country-level and hence, arguably, it is empirically infeasible bearing in mind the U5M data quality issues and statistical modelling approaches used to rectify them which were discussed above.

[TABLE 7 HERE]

Although results are robust to specification, a number of caveats should be taken into account when making definitive conclusions based on the analysis presented here. Estimates given are for all developing countries taken as whole and may mask the significant contribution of non-economic factors in particular regions. In addition, the model of the determinants of child health mortality is incomplete due to a lack of data. The use of insecticide-treated bed nets rapidly increased in Sub-Saharan Africa from 2005 to 2011 (WHO, 2013) but data on their usage across countries and over time is limited. Also, the irrelevance of health expenditure (which includes aid flows) to child mortality could be due to resources being used to prevent the situation getting worse due to the AIDS pandemic (as intimated by Kenny and Sumner, 2011). This is probably not the case as AIDS causes only a small fraction of deaths among children under-five in the countries considered here - 2.71 per cent in 2000 and 2.16 per cent in 2010 (CHERG, 2014).

Conclusion

The MDGs are considered by policy makers and civil society to have played an important part in securing progress against poverty, hunger and disease (Sachs, 2012). However there is very little evidence to back this viewpoint up.

From the analysis in this paper, it would appear that the Millennium Development Goals did not change trends in child mortality. It is clear that there has been acceleration in the rate of

reduction of under-five mortality rates from 2000-2010. But across the 129 developing countries considered, there is no evidence that rates of growth in private health expenditure accelerated or that trends in access to improved water sources, improved sanitation facilities or measles immunisation rates have improved. Growth rates in public health expenditure and the trend in DPT immunisation rates have been faster post-MDG but these have not caused child death rates to fall. In contrast, many countries have experienced rapid economic growth during this period. Income per capita is seen to clearly influence the child mortality rate and this relationship is robust when accounting for endogeneity or a variety of model specifications. The pattern of accelerating economic growth and a slowdown towards the end of the decade in developing countries is also clearly reflected in secular trends in under-five mortality. Furthermore, the most significant factor explaining annual decreases in child mortality over the decade was economic growth.

A thorough analysis of the successes and failures of the Millennium Development Goals would be welcome before embarking on a new round of global goals. The vast resources mobilized due to this initiative have undoubtedly progressed international development. But what is not clear is where such effects have taken place and to what extent the MDGs were responsible. This paper is intended to provide an initial investigation.

References

Aaby, P., Benn, C., Nielsen, J., Lisse, I. M., Rodrigues, A., & Ravn, H. (2012). Testing the hypothesis that diphtheria-tetanus-pertussis vaccine has negative non-specific and sex-differential effects on child survival in high-mortality countries. *BMJ Open, 2*(3), 10.1136/bmjopen-2011-000707. Print 2012.

Alkema, L., & New, J. R. (2013). Global estimation of child mortality using a bayesian B-spline bias-reduction method. *ArXiv Preprint arXiv:1309.1602.*

Anand, S., & Ravallion, M. (1993). Human development in poor countries: On the role of private incomes and public services. *Journal of Economic Perspectives*, 7(1), 133-150.

Arbache, J. S., & Page, J. (2010). How fragile is Africa's recent growth? *Journal of African Economies*, 19(1), 1-24.

Baird, S., Friedman, J., & Schady, N. (2011). Aggregate income shocks and infant mortality in the developing world. *Review of Economics and Statistics, 93*(3), 847-856.

Bhalotra, S. (2010). Fatal fluctuations? cyclicality in infant mortality in India. *Journal of Development Economics*, 93(1), 7-19.

Breiman, R. F., Streatfield, P. K., Phelan, M., Shifa, N., Rashid, M., & Yunus, M. (2004). Effect of infant immunisation on childhood mortality in rural bangladesh: Analysis of health and demographic surveillance data. *The Lancet, 364*(9452), 2204-2211.

Chan, G. J., Moulton, L. H., Becker, S., Munoz, A., & Black, R. E. (2007). Non-specific effects of diphtheria tetanus pertussis vaccination on child mortality in Cebu, the Philippines. *International Journal of Epidemiology, 36*(5), 1022-1029.

CHERG. (2014). *Child causes of death annual estimates by country 2000-10.* Retrieved 03/12/14 from http://cherg.org/datasets.html

Clemens, J., Holmgren, J., Kaufmann, S. H., & Mantovani, A. (2010). Ten years of the global alliance for vaccines and immunization: Challenges and progress. *Nature Immunology, 11*(12), 1069.

Cutler, D., Deaton, A., & Lleras-Muney, A. (2006). The determinants of mortality. *The Journal of Economic Perspectives, 20*(3), 97-120.

Dehejia, R., & Lleras-Muney, A. (2004). Booms, busts, and babies' health. *The Quarterly Journal of Economics*, 119(3), 1091-1130.

Ettner, S. L. (1996). New evidence on the relationship between income and health. *Journal of Health Economics,* 15(1), 67-85.

Farahani, M., Subramanian, S. V., & Canning, D. (2009). The effect of changes in health sector resources on infant mortality in the short-run and the long-run: A longitudinal econometric analysis. *Social Science & Medicine, 68*(11), 1918-1925.

Ferreira, F. H., & Schady, N. (2009). Aggregate economic shocks, child schooling, and child health. *The World Bank Research Observer*, 24(2), 147-181.

Folland, S., Goodman, A. C., & Stano, M. (2007). *The economics of health and health care,* Pearson Prentice Hall Upper Saddle River, NJ.

Fukuda-Parr, S. (2008) : Are the MDGs priority in development strategies and aid programmes? Only few are!, Working Paper No. 48, International Poverty Centre for Inclusive Growth (UNDP).

Fukuda-Parr, S., Greenstein, J., & Stewart, D. (2013). How should MDG success and failure be judged: Faster progress or achieving the targets? *World Development, 41*, 19-30.

Greene, W. (2012). *Econometric analysis* (7th ed.). Pearson Education, England.

Gwatkin, D. R., Rutstein, S., Johnson, K., Suliman, E., Wagstaff, A., Gonzalez-Castell, D., et al. (2007). Socio-economic differences in health nutrition and population within developing countries. an overview. *Salud Publica De Mexico, 49*(5), 345-356.

Heston, A., Summers, R., & Aten, B. (2012). *Penn World Table version 7.1.* (Nov 2012 ed.) Center of comparisons of production, income and prices at the University of Pennsylvania.

Kaler, S. G. (2008). Diseases of poverty with high mortality in infants and children. *Annals of the New York Academy of Sciences, 1136*(1), 28-31.

Kenny, C., & Sumner, A. (2011). More money or more development: What have the MDGs achieved. *Center for Global Development Working Paper, 278*.

Klasen, S., & Lange, S. (2012). *Getting progress right: Measuring progress towards the MDGs against historical trends.* No. 87. Courant Research Centre: Poverty, Equity and Growth-Discussion Papers.

Liu, L., Johnson, H. L., Cousens, S., Perin, J., Scott, S., Lawn, J. E., et al. (2012). Global, regional, and national causes of child mortality: An updated systematic analysis for 2010 with time trends since 2000. *The Lancet, 379*(9832), 2151-2161.

Molenaar, B. (2012). Do we need a new POST-2015 framework to promote health-related goals ? *Health Diplomacy Monitor, 3*(1), 7-7-10.

OECD. (2010). *Perspectives on global development 2010: Shifting wealth* OECD.

Paxson, C., & Schady, N. (2005). Child health and economic crisis in peru. The World Bank Economic Review, 19(2), 203-223.

Preston, S. H. (2007). The changing relation between mortality and level of economic development. *International Journal of Epidemiology,* 36(3), 484-490.

Pritchett, L., & Summers, L. H. (1996). Wealthier is healthier. *The Journal of Human Resources, 31*(4), 841-868.

Rodrik, D. (2011). The Future of Economic Convergence, NBER Working Paper 17400.

Ruhm, C. J. (2000). Are recessions good for your health?. *Quarterly Journal of Economics*, 115(2), 617-650.

Sachs, J. D. (2012). From millennium development goals to sustainable development goals. *The Lancet*, 379(9832), 2206-2211.

Schaffer, M. E. (2010.). *xtivreg2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models.* http://ideas.repec.org/c/boc/bocode/s456501.html

Stuckler, D., Basu, S., & McKee, M. (2010). Drivers of inequality in millennium development goal progress: A statistical analysis. *PLoS Medicine, 7*(3), e1000241.

Subramanian, A. (2011). *Eclipse: Living in the shadow of china's economic dominance,* Peterson Institute for International economics, Washington D.C.

Thornton, J. (2002). Estimating a health production function for the US: Some new evidence. *Applied Economics, 34*, 59-62(4).

UN. (2010). *World economic situation and prospects - statistical annex,* United Nations Conference on Trade and Development, United Nations. Dept. of Economic and Social Affairs, New York.

UN. (2013). *Millennium development goals report* . United Nations, New York.

UNDG. (2005), *Making the MDGs matter: A country perspective, report of a UNDG survey*. United Nations Development Group, New York.

UNDP. (2010). *Beyond the midpoint - achieving the millenium devlopment goals.* United Nations Development Programme, New York.

Valentiner-Branth, P., Perch, M., Nielsen, J., Steinsland, H., Garly, M., Fischer, T. K., et al. (2007). Community cohort study of cryptosporidium parvum infections: Sex-differential incidences associated with BCG and diphtheria–tetanus–pertussis vaccinations. *Vaccine, 25*(14), 2733-2741.

WHO (2013). *World health statistics*. World Health Organisation, Geneva.

WHO (2014). *Measles fact sheet N°286.* Retrieved 03/03/14 from

http://www.who.int/mediacentre/factsheets/fs286/en/

WHO/UNICEF. (2013). *Progress on sanitation and drinking water* . World Health Organization and UNICEF. Geneva / New York.

World Bank. (2013a). *Global monitoring report 2013 : Rural-urban dynamics and the millennium development goals*. International Bank for Reconstruction and Development / The World Bank, Washington DC.

World Bank. (2013b). *World Development Indicators Database*, Retrieved 01/11/13 from

http://data.worldbank.org/data-catalog/world-development-indicators

---

[1] $(1 - 0.025)^{10} * (1 - 0.040)^{15} = 0.42$
[2] Since $(1 - 0.043)^{25} = 0.33$

Tables

Table 1 Unweighted means across developing countries 1990-2010 for selected years

Year	Under-5 mortality (per 1000)	Infant mortality (per 1000)	GDP † ($ per cap.)	Public Health Exp † ($ per cap.)	Private Health Exp † ($ per cap.)	Water access (%)	Sanitation access (%)	Immuniz. DPT (%)	Immuniz. Measles (%)
1990	93	63	-	-	-	-	-	-	-
1992	90	60	-	-	-	-	-	-	-
1994	87	58	-	-	-	-	-	-	-
1996	83	56	3778	99	74	75	54	76	76
1998	80	54	3932	109	84	76	55	77	77
2000	75	51	4047	115	88	77	57	78	77
2002	70	48	4121	129	94	78	58	79	79
2004	65	45	4395	149	109	80	59	81	80
2006	60	42	4820	171	126	81	60	84	83
2008	55	39	5208	201	144	82	61	85	84
2010	52	37	5369	222	157	83	62	86	85

Note: † Adjusted for purchasing power parity and in constant 2005 $.

Table 2: Percentage of developing countries with faster progress in child mortality post-MDG

Region	Total	Faster progress post-MDG : U5M		Faster progress post-MDG : IMR	
		$\tau_2 < 0$	$\tau_2 < 0$ at 5% sig. level	$\tau_2 < 0$	$\tau_2 < 0$ at 5% sig. level
East Asia & Pacific	19	42%	42%	42%	42%
Europe & Central Asia	19	79%	79%	79%	79%
Latin America & Caribbean	26	31%	19%	46%	38%
Middle East & North Africa	12	75%	75%	92%	83%
South Asia	8	88%	88%	88%	75%
Sub-Saharan Africa	45	91%	87%	91%	87%
Total	**129**	**68%**	**64%**	**73%**	**68%**

Note: The percentage of countries with $\tau_2 < 0$ in equation (1) is reported. The hypothesis test is one-sided at 5% level. Standard errors used in hypothesis tests are robust to autocorrelation and heteroskedasticity.

Table 3: Panel estimate of progress in child mortality 1990-2010

	log (U5M)		log (IMR)	
Trend, τ_1	-0.025	**	-0.023	**
	(0.001)		(0.001)	
Trend (>=2000), τ_2	-0.015	**	--0.013	**
	(0.002)		(0.002)	

R^2	0.91	0.90
No. of observations	2709	2709
No. of countries	129	129

Note: *significant at 5%.**significant at 1%. Estimation of equation (2) is by fixed-effects. Standard errors in parentheses are robust to autocorrelation and heteroskedasticity.

Table 4: Panel estimate of progress in the determinants of child mortality 1995-2010

	log(GDP)	log(PublicHE)	log(PrivateHE)	Water	Sanitation	ImmDPT	ImmMeasles
Trend, τ_1	0.018**	0.047**	0.055**	0.576**	0.583 **	0.337	0.477*
	(0.003)	(0.006)	(0.005)	(0.042)	(0.039)	(0.185)	(0.198)
Trend (>=2000), τ_2	0.013**	0.035**	0.009	0.006	-0.002	0.588**	0.337
	(0.004)	(0.007)	(0.005)	(0.049)	(0.045)	(0.210)	(0.219)
R^2	0.73	0.70	0.74	0.80	0.83	0.49	0.45
No. of observations	2064	2035	2035	2040	2036	2045	2045
No. of countries	129	129	129	129	129	129	129

Note: *significant at 5%.**significant at 1%. Estimation of (2) is by fixed-effects. Standard errors in parentheses are robust to autocorrelation and heteroskedasticity.

Table 5 : Non-nested hypothesis tests to select between alternative functional form specifications

	J test for non-nested models		Cox-Pesaran test for non-nested models	
	Distribution	Test statistic	Distribution	Test statistic
H0:M1 / H1:M2	t(1717)	1.52	N(0,1)	-1.17
H0:M2 / H1:M1	t(1718)	9.98 **	N(0,1)	-15.86**

Note: *significant at 5%.**significant at 1%. Models are

M1: $y_{it} = \beta_4 Water_{it} + \beta_5 Sanitation_{it} + \beta_6 ImmDPT_{it} + \beta_7 ImmMeasles_{it} + \mathbf{\Gamma Z}_{it} + v_{it}$

M2: $y_{it} = \beta_4 \log(Water_{it}) + \beta_5 \log(Sanitation_{it}) + \beta_6 \log(ImmDPT_{it}) + \beta_7 \log(ImmMeasles_{it}) + \mathbf{\Gamma Z}_{it} + v_{it}$

where $\mathbf{\Gamma Z_{it}} = \beta_1 \log(GDP)_{it} + \beta_2 \log(PublicHE)_{it} + \beta_3 \log(PrivateHE)_{it} + \alpha_{1i} + \alpha_{2i} D_t + \tau_1 Trend_t + \tau_2(D_t Trend_t)$

and y_{it} is log (U5M)

Table 6 : Regression results

	Dependent variable : log(U5M)				Dependent variable : log(IMR)			
	OLS		IV-GMM		OLS		IV-GMM	
β_1, log GDP	-0.137	**	-0.178	**	-0.147	**	-0.197	**
	(0.035)		(0.048)		(0.032)		(0.043)	
β_2, log public health expenditure	-0.015		-0.033		-0.014		-0.026	
	(0.011)		(0.021)		(0.010)		(0.018)	
β_3, log private health expenditure	-0.029		-0.018		-0.025		-0.019	
	(0.015)		(0.022)		(0.013)		(0.020)	
β_4, water	-0.005		-0.006	**	-0.003		-0.005	**
	(0.002)		(0.002)		(0.002)		(0.002)	
β_5, sanitation	-0.006	**	-0.004		-0.005	**	-0.003	
	(0.002)		(0.002)		(0.002)		(0.002)	
β_6, immunization DPT	0.0008		0.005	**	0.001	**	0.005	**
	(0.0004)		(0.001)		(0.0003)		(0.001)	
β_7, immunization measles	-0.001	**	-0.005	**	-0.0009	**	-0.004	**
	(0.0004)		(0.001)		(0.0003)		(0.001)	
τ_1, trend	-0.018	**	-0.024	**	-0.018	**	-0.022	**
	(0.002)		(0.005)		(0.002)		(0.004)	
τ_2, trend (>=2000)	-0.009		-0.001		-0.007		-0.0008	
	(0.002)		(0.005)		(0.002)		(0.005)	

		OLS	IV-GMM		OLS	IV-GMM	
R^2		0.91	0.85		0.91	0.85	
No. of observations		1982	1595		1982	1595	
No. of countries		129	129		129	129	
Underidentification test	$\chi^2(15)$		35.6	**		35.6	**
Hansen-J test	$\chi^2(14)$		17.3			15.5	
Endogeneity test	$\chi^2(7)$		20.3	**		19.7	**

Note: *significant at 5%.**significant at 1%. Standard errors in parentheses are heteroskedastic and autocorrelation-robust. (OLS) All explanatory variables are exogenous. (IV-GMM) All explanatory variables except trends and fixed effects are endogenous. Instruments are lags 1-3. Estimated using two-step feasible GMM. Tests are the Anderson canonical correlations test with a null hypothesis of underidentification, the Hansen J-test with the null hypothesis of valid instruments and the difference-in-Hansen endogeneity test with the null hypothesis of exogenous regressors.

Table 7 : Regression results

	Dependent variable : log(U5M) IV-GMM									
	(3)		(3a)		(3b)		(3c)		(3d)	
β_1, log GDP	-0.178	**	-0.221	**	-0.182	**	-0.226	**	-0.125	**
	(0.048)		(0.043)		(0.048)		(0.043)		(0.036)	
β_2, log public health expenditure	-0.033		-0.027		-0.035		-0.031		-0.004	
	(0.021)		(0.017)		(0.020)		(0.018)		(0.021)	
β_3, log private health expenditure	-0.018		-0.025		-0.019		-0.027		-0.012	
	(0.022)		(0.019)		(0.022)		(0.019)		(0.016)	
β_4, water	-0.006	**	-0.006	**	-0.006	**	-0.005	**	-0.003	
	(0.002)		(0.002)		(0.002)		(0.002)		(0.003)	
β_5, sanitation	-0.004		-0.003		-0.004		-0.003		0.002	
	(0.002)		(0.002)		(0.002)		(0.002)		(0.003)	
β_6, immunization DPT	0.005	**	0.003	**	0.005	**	0.003	**	0.002	
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
β_7, immunization measles	-0.005	**	-0.004	**	-0.005	**	-0.004	**	-0.004	**
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
τ_1, trend	-0.024	**	-0.024	**						
	(0.005)		(0.002)							
τ_2, trend (>=2000)	-0.001									
	(0.005)									
Fixed effects	YES		YES		YES		YES		YES	
Level breaks	YES		NO		YES		NO		NO	
Time effects	NO		NO		YES		YES		NO	
Country-specific trends	NO		NO		NO		NO		YES	
R^2	0.85		0.78		0.85		0.78		0.96	
No. of observations	1595		1595		1595		1595		1853	
No. of countries	129		129		129		129		129	
Underidentification test	35.6	**	52.8	**	35.0	**	52.6	**	17.1	**
Hansen-J test	17.3		21.5		17.2		21.7		0.6	
Endogeneity test	20.3	**	14.6	*	22.1	**	16.7	*	38.1	**

Note: *significant at 5%.**significant at 1%. Standard errors in parentheses are heteroskedastic and autocorrelation-robust. Estimated using two-step feasible GMM. All explanatory variables except trends and fixed effects are endogenous. Instruments are lags 1-3 except (3d) where instruments are 1st lags and trend break . Tests are the Anderson canonical correlations test with a null hypothesis of underidentification ($\chi^2(2)$ in 3d and $\chi^2(15)$ elsewhere) , the Hansen J-test with the null hypothesis of valid instruments ($\chi^2(1)$ in 3d and $\chi^2(14)$ elsewhere) and the difference-in-Hansen endogeneity test with the null hypothesis of exogenous regressors ($\chi^2(7)$) .
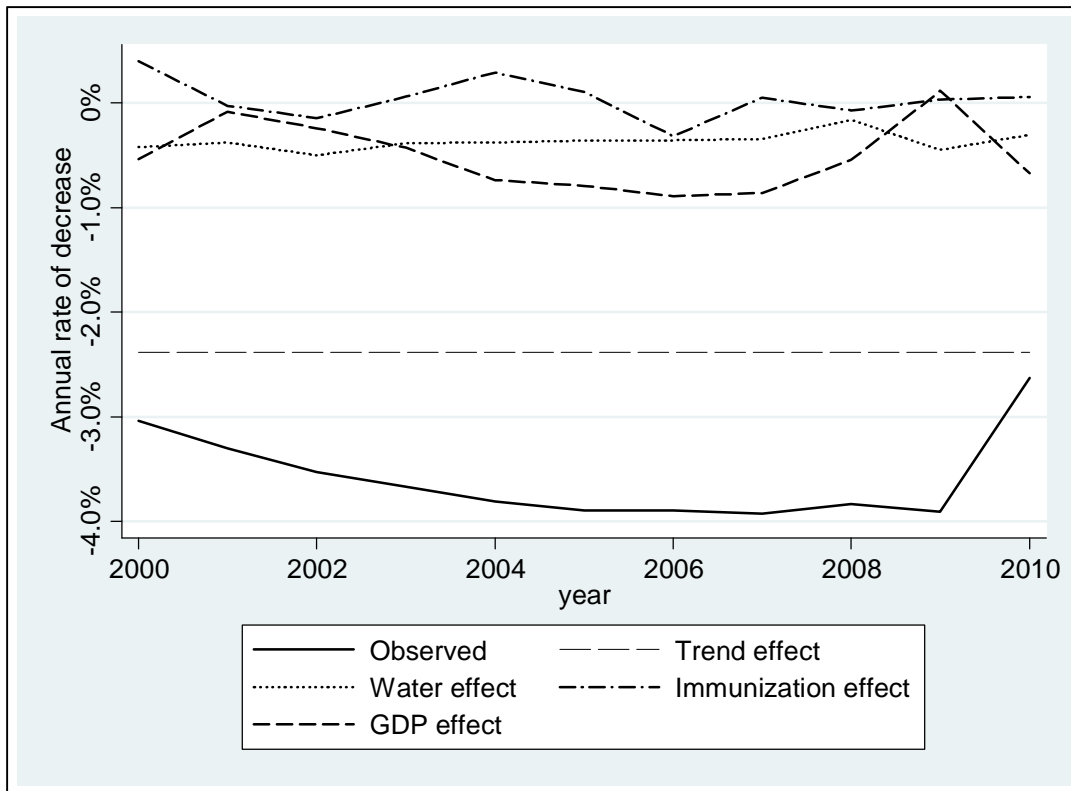
FIGURES

Figure 1: Under-five mortality rates for developing countries by year
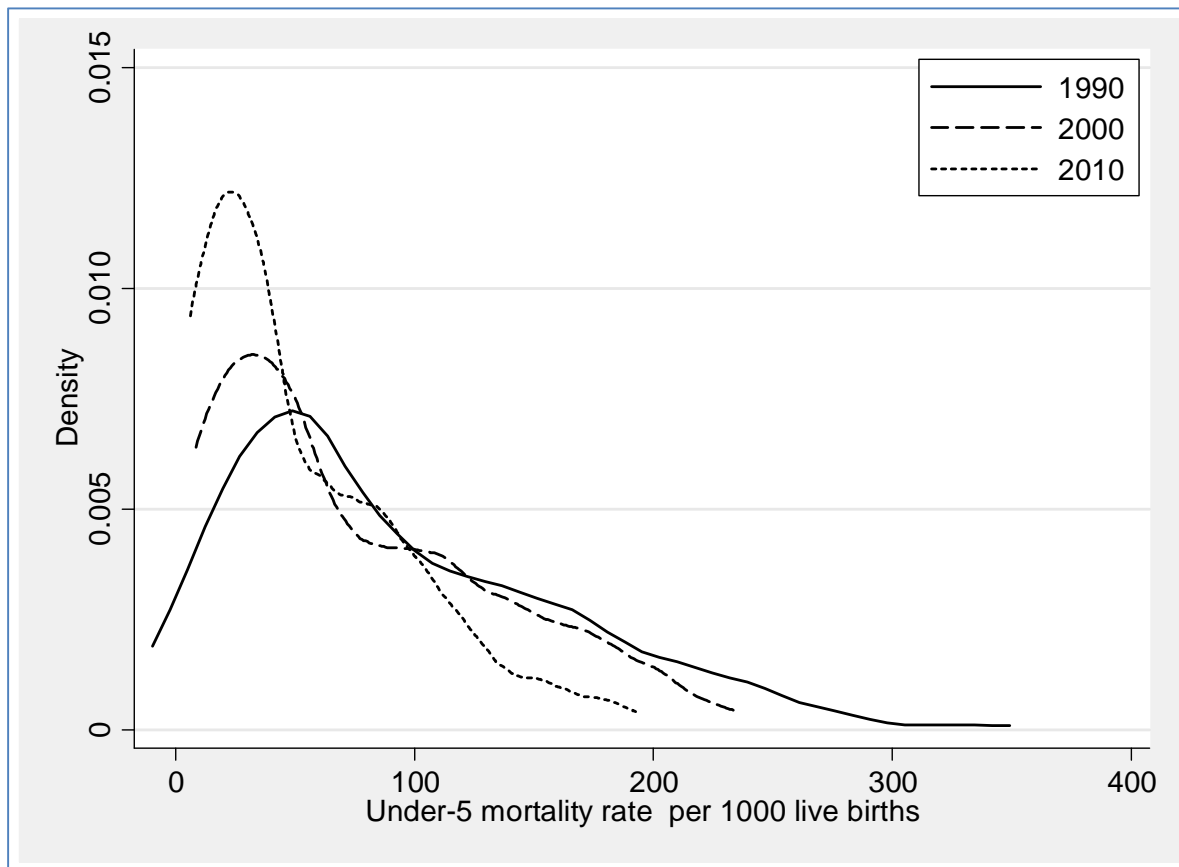

Note: Calculated using the Epanechnikov kernel with optimal bandwidth. Densities are scaled so that the area under each graph is 1.

Figure 2 : Annual rate of decrease of under-five mortality rates in developing countries 2000-2010

Note: Estimates from Table 6 applied to the annual change in the averages of the explanatory variables in Model 3. *GDP effect* is $\left(\beta_1\{\overline{\log(\text{GDP})}_t - \overline{\log(\text{GDP})}_{t-1}\}\right)$, *Water effect is* $(\beta_4\{\overline{Water}_t - \overline{Water}_{t-1}\})$ and *Immunization effect* is $\left(\beta_6\{\overline{ImmDPT}_t - \overline{ImmDPT}_{t-1}\} + \beta_7\{\overline{ImmMeasles}_t - \overline{ImmMeasles}_{t-1}\}\right)$

Figure 3 : Annual rate of decrease of under-five mortality rates by cause of death in developing countries 2003-2010
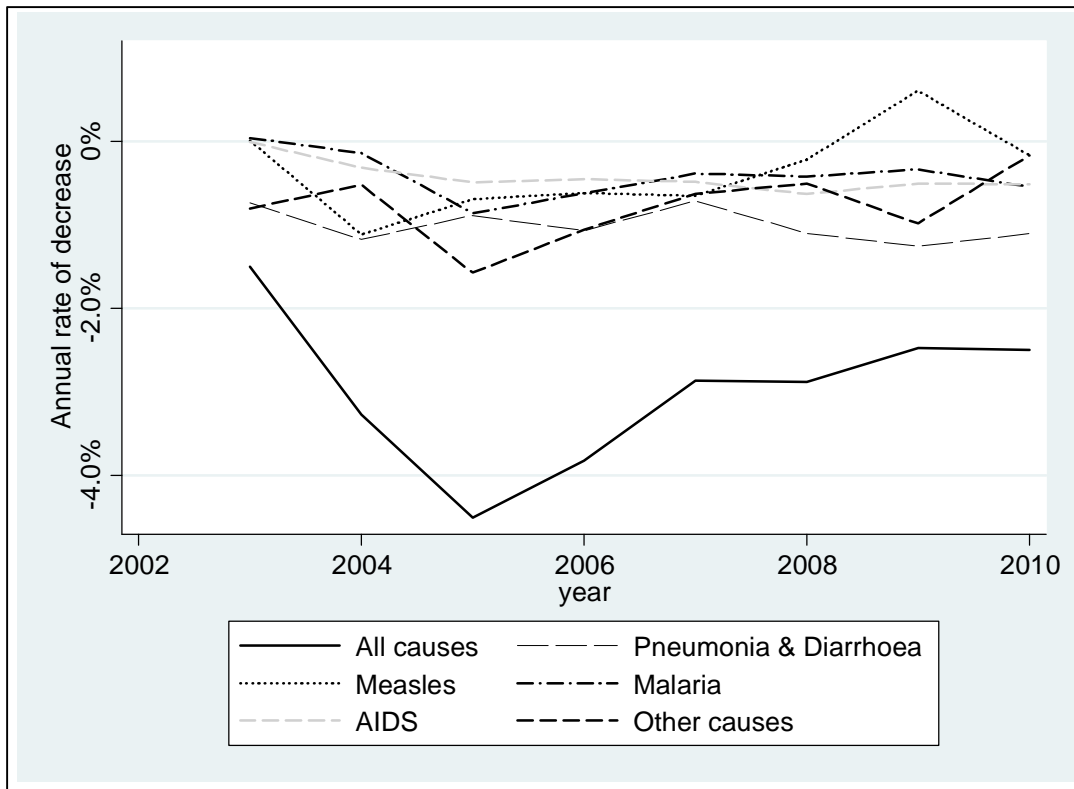
Note: Annual reduction in average mortality rate by cause of death expressed as a percentage of the average All Causes mortality rate.