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SEVEN MILLION LIVES SAVED

UNDER-5 MORTALITY SINCE THE LAUNCH OF THE MILLENNIUM DEVELOPMENT GOALS

John W. McArthur

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and Development
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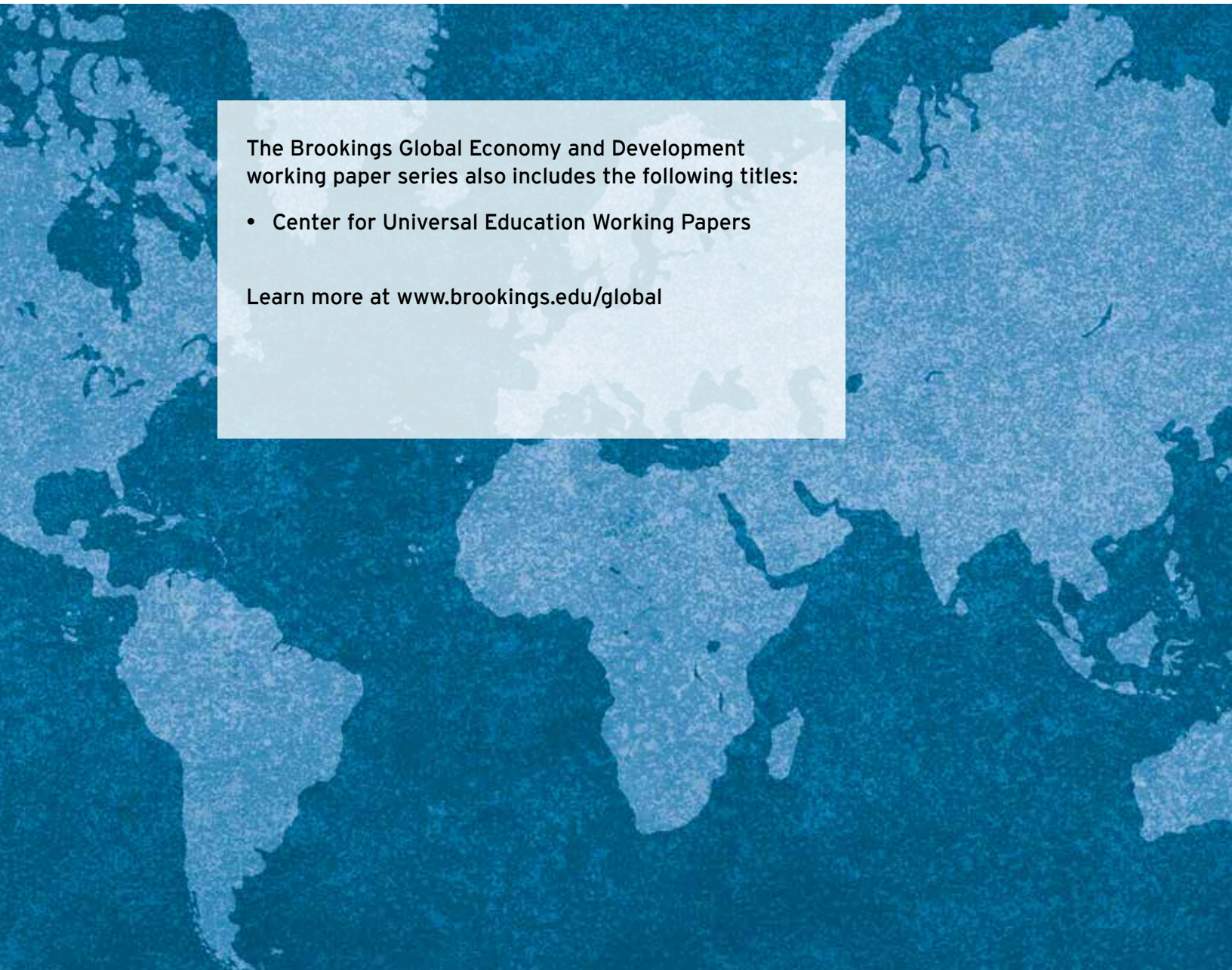

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Abstract:

To what extent have developing countries' patterns in reducing under-5 mortality rates (U5MR) changed since the advent of the Millennium Development Goals (MDGs)? This paper investigates that question across multiple time horizons, with attention to the fact that countries' progress had already begun to accelerate during the late 1990s compared to the early 1990s. The paper gives special consideration to countries the MDGs were primarily intended to support, including initially "Off Track" and low-income countries. Although only 21 percent of originally Off Track countries and 34 percent of originally low-income countries are now on a path to achieve the MDG target by 2015, at least 80 percent of each group has seen accelerated progress since 2001. Approximately 90 percent of countries in sub-Saharan Africa have accelerated. Most importantly, regression analysis indicates that cross-country trends since 2000 differ considerably from previous decades. The years since the launch of the MDGs include the first extended period in at least four decades during which rates of U5MR decline have not been negatively correlated with U5MR levels. Compared to a conservative counterfactual trend from 1996 to 2001, at least 7.5 million additional children's lives are estimated to have been saved between 2002 and 2013. The results suggest that much of the greatest structural progress has been achieved by countries not likely to achieve the formal MDG targets, even if their progress might be linked to the pursuit of those targets. Implications are considered for setting U5MR targets through to 2030.

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SEVEN MILLION LIVES SAVED

UNDER-5 MORTALITY SINCE THE LAUNCH OF THE MILLENNIUM DEVELOPMENT GOALS

John W. McArthur

1. INTRODUCTION

Over the past decade, the Millennium Development Goals (hereafter MDGs or "Goals") have become a central framework in organizing global health efforts. Many developing countries have made significant progress toward the official targets, including Goal 4, which is to achieve a two-thirds reduction in under-5 mortality rates (U5MR) by 2015 compared to 1990. According to the United Nations' latest estimates, the developing world's 2013 aggregate U5MR had declined 40 percent since 2000, and 50 percent since 1990 (United Nations Inter-agency Group for Child Mortality Estimation [UN IGME] 2014).

But progress *toward* the Goals is not the same as progress *because of* the Goals. Nor can the mere setting of targets be considered the full scope of what might be called the "MDG agenda." The broader agenda includes policy, organizational, and advocacy efforts to mobilize targeted resources in the practical pursuit of goals. It also includes the consolidation of common global reference points across diverse public, private, and non-profit actors, which might in turn have prompted incremental efforts toward results. As Manning (2009) has pointed out, "it is intrinsically difficult to distinguish the impact of the MDG framework itself from the strands of thinking that helped to create it" (p. 5).

Although causal pathways are difficult to discern in aggregate, one highly correlated trend since the launch of the MDGs is a significant expansion in global health budgets. The Institute for Health Metrics and Evaluation (2014) estimates that total development assistance for health nearly tripled, from U.S. $10.9 billion in 2000 to more than $30 billion in each of 2011, 2012 and 2013 (all in constant $2011). These resources have helped to launch and expand important new international institutions, including the GAVI Alliance, the Global Fund to Fight AIDS, Tuberculosis and Malaria, and the U.S. presidential initiatives for both AIDS and malaria, all of which have helped to expand dramatically the country-level coverage of preventive and therapeutic health interventions.

Skeptics tend to question the MDGs based on four categories of critiques. One focuses on shortfalls in results. Many countries are not on course to achieve individual Goals, either because policy efforts or resources are inadequate. A second criticizes the establishment of political targets considered too ambitious to begin

with. A third asserts that the developing world was making advances prior to the establishment of the MDGs, so the Goals should not be given credit for progress that would have been made in any case. A fourth argues that global aggregates might reflect success, but these are driven by results in the most populous developing countries, China and India, which made progress independently of the MDGs.

With these questions in mind, and as the international community considers the next generation of intergovernmental targets beyond the 2015 deadline, it is an appropriate juncture to examine the overarching "macro" hypothesis that the establishment of the MDGs and related efforts to support their achievement have been associated with accelerated progress on intended development outcomes. This paper does so with specific focus on MDG 4 for reducing under-5 mortality. The analysis focuses only on discerning long-term variations in outcomes that coincide with the establishment of the Goals. This is distinct from an investigation of "micro" hypotheses regarding how the MDGs might have been linked to variations in U5MR outcomes within countries.

The results are striking. They show that the period since the establishment of the MDGs has seen unprecedented rates of progress among the poorest countries, even when they are not on a path to achieve the formal MDG targets. As of the end of 2013, at least 7.5 million more children's lives have been saved compared to the trajectory of progress as of 2001. The majority of these lives have been saved in sub-Saharan Africa. Moreover, the period since the turn of the millennium appears to show convergent rates of progress across developing regions. At a minimum, the period from 2002 to 2012 was the first to show a clear break in the previous long-run trend whereby countries with higher U5MR saw systematically slower rates of U5MR decline.

The paper is divided into ten sections. Following this introduction, the second section describes the core hypotheses used to test MDG performance. The third section describes the data used in the analysis. The fourth section describes key methodological assumptions, including the definition of pre-MDG reference periods and the distinction between On Track versus Off Track countries at the outset of the MDG period. The fifth section describes the results for the three key tests of MDG performance, including variations by region and country income group. Section 6 then considers whether U5MR reduction trends have been subject to deeper structural shifts. Section 7 presents longer-term regression results evaluating trends over more than five decades. The results suggest a structural change in global trends since the onset of the MDGs, so Section 8 estimates the number of children's lives saved that could be plausibly linked to the MDGs. Section 9 considers future implications for new targets to 2030. A final section concludes.

2. HYPOTHESES FOR MDG RESULTS: THREE SEPARATE TESTS

In testing any hypothesis of MDG success, one needs to avoid two opposing analytical errors. One is to give undeserved credit to the MDGs in cases where countries would have likely achieved MDG-type progress even in the absence of the establishment of the Goals and policy efforts toward achieving them. The other is to give inadequate credit to the MDGs in cases where countries fall short of the formal targets but are making faster progress than they would have in the absence of the Goals.

There is no perfect counterfactual against which global data can be assessed. Trends concurrent with the MDGs should not be presumed to be a product of MDG causality, but our planet is singular, so global policy mechanisms cannot be randomized either. Nonetheless, reasonable counterfactuals can still be constructed on two dimensions. The first is time variation: to consider before-and-after changes in trajectories. The second is countries of focus: to consider the specific policy intentions that originally motivated the MDGs. The Goals were not established to capture trends in developing countries that were already making fast progress. They were established with particular emphasis on the poorest people and countries that were making little progress, in other words countries that were "off track" compared to the rest of the world. In particular, the Millennium Declaration of 2000 explicitly targeted (1) populations that were living in extreme poverty, as measured approximately by "dollar a day" living standards, (2) populations not making progress at rates comparable to those that were seen to be benefiting from globalization, and (3) the "special needs of Africa" (United Nations 2000).

As one illustration of early policy intentions, the U.N. Millennium Project was established in 2002 as the independent MDG policy advisory body to then-Secretary-General Kofi Annan. From the outset, it focused on the question of identifying which countries needed to accelerate progress in order to achieve the Goals and what steps could be taken to help those countries to achieve such progress. For example, the Project's first major written product was the co-authored 2003 UNDP *Human Development Report*, which published a goal-by-goal assessment of which countries were "top priority" and "high priority" based on data available at the time (United Nations Development Programme [UNDP] 2003). The segmentation is important, since a simplistic broad-brush assessment of all developing countries' performance against the MDGs would lend itself to both types of analytical errors described above.

To that end, the MDGs can be subjected to three country-level tests:

1. **MDG achievement – the "Highest" performance test**: This considers U5MR reduction levels measured against the formal MDG target. It asks which countries are on a trajectory to achieve MDG 4.

2. **Fast progress, even if a late start – a "Medium" test:** This considers a **threshold rate of progress**. It asks which countries have achieved U5MR declines in the years *since* the MDG launch at the pace (4.3 percent per year) that would have been considered On Track *as of* the MDG launch.

3. **Acceleration – the "Minimum" test:** This considers the simplest question of which countries experienced faster progress under the MDG period, compared to the period immediately preceding the MDGs.

Figure 1 presents a schematic diagram to illustrate the three different tests. To assess the ways in which the MDGs might have supported progress in alignment with their policy motivation, the tests are applied to developing countries along three categories: by initial

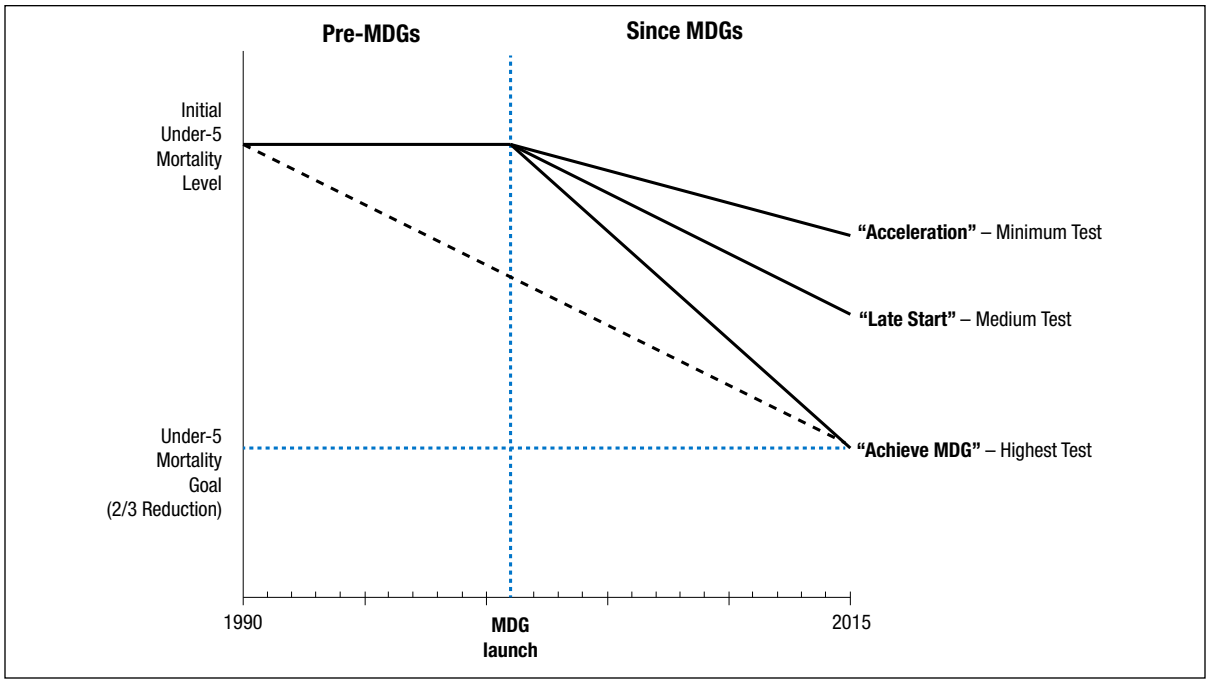
Off Track versus On Track status, by initial income classification, and by region. The first of these tests is the same one presented in standard U.N. and World Bank reports, although those only tend to categorize trends by region and not by country status (e.g., income level or 1990s rate of progress) at the outset of the MDGs (e.g., United Nations 2014, World Bank and International Monetary Fund 2013).

The second test is presented here for the first time, to the author's knowledge. The third acceleration test has been assessed in previous studies, including Wang et al. (2014), Lozano et al. (2011), Kenny and Sumner (2011), and Fukuda-Parr, Greenstein, and Stewart (2013), although with important differences. Those studies use different reference period assumptions for estimating trajectories and place less emphasis on initial country status. The distinction is important because it is not clear that a performance test should count acceleration among countries with initially fast rates of progress as an equivalent benchmark to acceleration among countries with initially slow rates of progress.

The range of MDG test results motivate three key subsequent questions addressed in the remainder of the paper:

- Do cross-country trends in MDG progress simply reflect underlying long-term patterns in reducing under-5 mortality?
- If any countries are estimated to have experienced faster (or slower) progress under the MDGs, what are reasonable approximations of the number of lives that have been saved (or lost) as a result?
- How might recent U5MR trajectories inform the design of post-2015 global development targets that might be set through to 2030?

Figure 1. Schematic Diagram Describing Three MDG Tests



3. DATA

The primary U5MR data are drawn from the U.N. Inter-agency Group for Child Mortality Estimation's (UN IGME) annual report for 2014. The core variable of interest is median under-5 mortality. Our sample includes only countries with a population of at least 200,000 as of 2000, according to the World Bank's (2014) World Development Indicators database, so as to minimize analytical variation that might be driven by small within-country samples.[1] Of the 173 countries that met this population criterion, 141 were considered developing countries as of 2000 in the World Bank's *World Development Report 2000/2001*; these form the core sample for analysis (World Bank 2001). Country income categories are identified as of the World Bank 2001 fiscal year, and regional categories follow World Bank guidelines.

We note that the U5MR data are imperfectly measured and subject to revision, so all results should be interpreted with appropriate caution (e.g., see discussions in Wang et al. 2014). Observations for recent years are more frequently revised, especially among low-income countries. For example, when examining U5MR for 2012, the sample's correlation coefficient between the most recent IGME data release and the previous year's release is 0.992. In some cases, such as Democratic Republic of the Congo, the revisions are material, with estimated U5MR in 2012 being reduced from 146 to 122 per 1,000 live births. Earlier years have fewer revisions. Observations for the years 2000 through 2004, for example, have a correlation coefficient of 0.999 between the 2013 and 2014 IGME data releases.

This paper uses the word "country" as a generic term to describe national political and economic units, recognizing that not all observations with data were recognized as sovereign states or UN members in 2001. South Sudan became a UN member state in 2011 but has annual U5MR observations starting in 1954. The U.N. dataset presents U5MR observations for "State of Palestine" as of 1975, and the World Bank dataset includes corresponding observations under the label of "West Bank and Gaza," the convention we follow in this paper's tables. Both units are included in the core developing country sample in order to have as large a data set as possible. Per capita income data are taken from Penn World Tables Version 8.0 (Feenstra, Inklaar, and Timmer 2013) and are available for 156 sample countries, including 125 developing countries.

4. METHODS

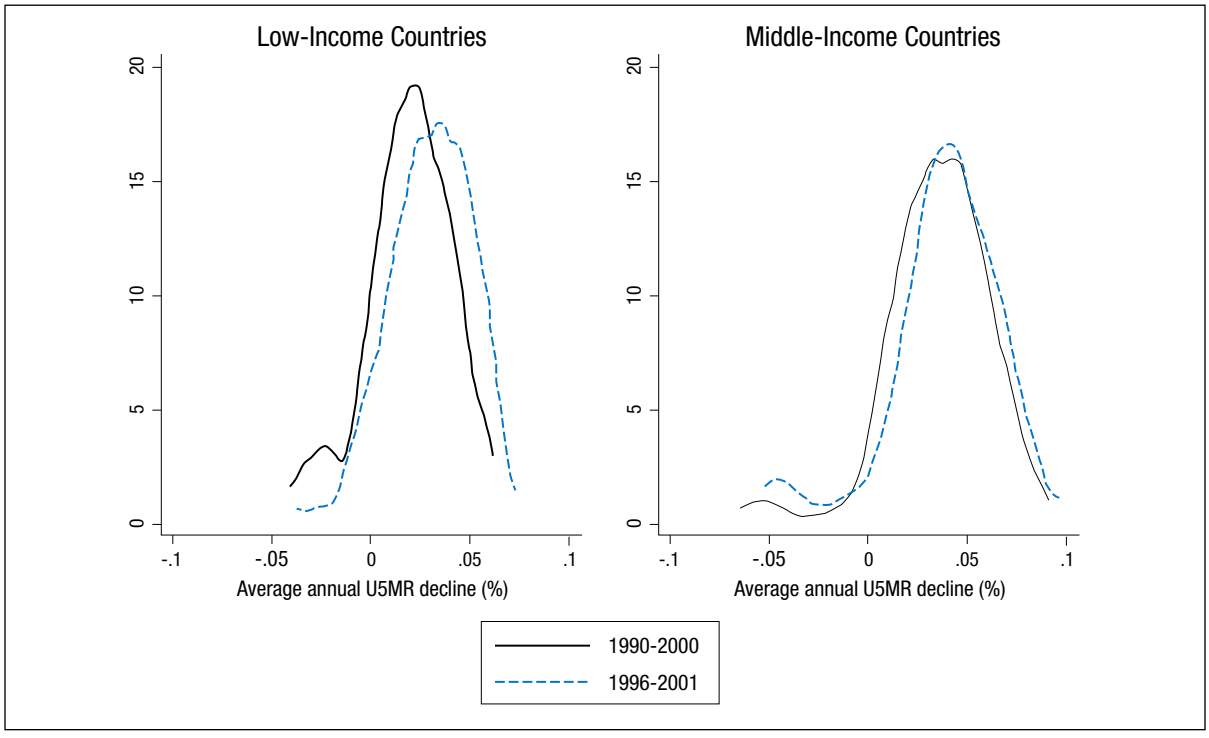
This study adopts a simple exponential equation to calculate rates of decline, r, in reducing under-5 mortality, m, between any year t and $t+n$:

$$m_{t+n} = m_t (1-r)^n \quad (1)$$

Reference Periods

Multiple studies have assessed MDG results by comparing progress from 1990 to 2000 with progress since 2000 (e.g., Kenny and Sumner 2011, Fukuda-Parr, Greenstein, and Stewart 2013, Wang et al. 2014). This is motivated by the initial establishment of relevant intergovernmental targets in the U.N. Millennium Declaration of September 2000 (United Nations 2000). However, the year 2000 forms an imperfect benchmark for two reasons. First, 2000 was the year of the Millennium Declaration, but it was at least another year before the MDGs were distilled as an explicit group of commonly referenced policy targets. The label "Millennium Development Goals" was first formally proposed in Secretary-General Kofi Annan's September 2001 "road map" document on the implementation of the Millennium Declaration, which urged that the Goals be implemented at both global and national levels (United Nations 2001). Then the March 2002 Monterrey International Conference on Financing for Development was considered by many to be the practical launch of global MDG efforts (McArthur 2013). As one prominent reference point, subsequent to the UN Millennium Declaration, *The Lancet* only published its first mention of the MDG terminology in March 2002, linked to the Monterrey

Figure 2. Comparing 1990-2000 versus 1996-2001 as Baseline for MDG Assessments, by Income Group as of 2001



Sources: Author's calculations based on UN IGME 2014; World Bank 2001.

conference (Horton 2002). Thus the practical starting point of global MDG policy efforts took place between late-2001 and early-2002.

The second limitation of the 1990 to 2000 reference period is that many countries experienced different trends during the second half of that decade compared to during the first half. The early 1990s was a period of significant international policy shifts, ranging from the end of the Cold War and dissolution of the Soviet Union to the latter years of structural adjustment policies promoted by the international financial institutions. During the late 1990s a variety of policy shifts also took place, including the OECD Development Assistance Committee's 1996 adoption of the International Development Goals, which served as a precursor to the MDGs (Manning 2009). This was followed by the 1998 election of Gro Harlem Brundtland as an eminent director-general at the World Health Organization, the Group of Eight's major 1999 debt relief agreement for poor countries, and the implementation of an array of macroeconomic stabilization reforms in low-income countries. These events occurred alongside the Asian financial crisis of 1997-1998, a variety of financial crises in Latin America, and the 1997 all-time U.S. low point in official development assistance as a share of national income. Any of these shifts might have contributed to differentiated rates of progress between the early and late 1990s. A full 1990s reference period could therefore mask trajectories that had already started to improve (or worsen), and thereby form too "easy" (or coarse) a standard against which to frame MDG counterfactuals.

For these reasons, the paper evaluates progress against two pre-MDG reference periods. One considers rates of progress from 1990 to 2000. A second considers 1996 to 2001, representing the final five years before the concerted MDG policy efforts began in earnest in 2002. Figure 2 shows the potential significance of using the different reference periods by presenting kernel density estimates for U5MR reduction among both low-income and middle-income countries as of 2001. Both income groups saw an improved (rightward) shift in the distribution over 1996-2001 compared to 1990-2000. A simple 1990s reference period might therefore frame an overly optimistic assessment of U5MR progress since the advent of the MDGs. For balance, this paper uses both reference periods when posing counterfactual assessments.

"On Track" vs. "Off Track" Countries

Countries in the sample are labeled "On Track" or "Off Track" based on their U5MR trends leading up to the launch of the MDGs. The MDG target for under-5 mortality is a two-thirds reduction from 1990 to 2015, equivalent to a 4.3 percent compound average annual rate of decline over 25 years. Countries that achieved this rate of decline from 1990 to 2001 are designated to have been "On Track" at the MDG outset. Countries with slower rates of progress are designated to have been "Off Track."[2] As of 2001, only 41 out of 141 developing countries in the sample were On Track, and 100 were Off Track. For simplicity of exposition, the terms "On Track" and "Off Track" are only used in this paper to describe country status as of 2001. Countries that were initially Off Track can still achieve the MDG, as assessed in Section 5 below.

For the "Medium" test of rates of progress under the MDGs, the 4.3 percent annual rate of decline is used as a benchmark for assessing progress from 2001 onward. The logic is that if countries were considered to be On Track for achieving a 4.3 percent annual rate of progress over the 1990s, then that pace can form one objective threshold for positively evaluating subsequent progress, even if starting from a later date.

5. RESULTS OF THREE MDG TESTS

The Highest test considers which countries are currently on course to achieve the 2015 MDG Targets. The latest data from 2013 of course offer only interim results, since many countries might change trajectories in the final two years of the MDG period. Nonetheless, results based on existing data and recent trajectories are presented in Table 1. The bottom row shows that 39 of 141 developing countries in the sample had already achieved MDG 4 by 2013, and that 52 countries, more than a third, are on a trajectory to achieve the Goal by 2015. This is similar to the 38 percent of countries reported by Leo and Barmeier (2010) and the range of 26 to 41 percent reported by Fukuda-Parr, Greenstein, and Stewart (2013). The estimate of 52 countries reaching the target is significantly greater than that presented by Wang et al. (2014), who predict that only 27 developing countries will meet the MDG by 2015. There is a significant discrepancy between their study and the U.N. data. For example, Wang and colleagues project that Ethiopia and Malawi will fall short of the 2015 target, although the latest U.N. data indicate that those two countries already achieved it as of 2013.

The official U.N. data also indicate that 89 (=141-52) developing countries are not currently on a trajectory to achieve the formal MDG target. Appendix Table A1 shows each country's 2015 trajectory if the average rate of progress from 2008-2013 is continued to 2015, ranked by the rate gap to achieving the goal. In an optimistic light, an additional 12 countries could still meet the target if they achieve 10 percent (or greater) average annual U5MR declines over the final two years. This is a very fast rate of progress but one not without precedent under the MDGs. A more challenging implication is that 77 countries would need to make progress at a rate of greater than 10.7 percent per year, which is the highest rate recorded over the period since 2001, by Maldives.

A more meaningful decomposition of trends is presented in the top two rows of Table 1, which separates the originally Off Track and On Track countries. Only 21 of 100 initially Off Track countries are currently on course to achieve MDG 4 by 2015. In a positive light, this represents a remarkable achievement for those 21 countries, and each provides a clear counterpoint to those who suggested there was "little hope" for achieving MDG 4 (Clemens, Kenny, and Moss 2007, p. 744). Nonetheless, under a more sober assessment it shows the concentration of the overall challenge within the Off Track group. This contrasts with the On Track group, where more than three-fourths of countries (31 of 41) remain on course to achieve the MDG target. This implies that 10 initially On Track countries have fallen off course, but they did so from a strong initial trajectory.

The Medium test shows slightly better success rates, especially for Off Track countries. Within that group, 39 out of 100 countries, or nearly two-fifths, achieved a 4.3 percent annual rate of reduction between 2001 and 2013. This compares to roughly three-fifths of the initially On Track group. Overall, 45 percent of developing countries succeed on the Medium test, for nearly evenly mixed results.

The Minimum test evaluates simple changes in rates of progress. Here the success metrics look dramatically better. Approximately two-thirds of all developing countries in the sample (63 percent or 68 percent, depending on the reference period) saw acceleration in progress compared to both pre-MDG reference periods. This is similar to the results of Wang et al. (2014), and slightly higher than the 55 percent figure reported by Fukuda-Parr, Greenstein, and Stewart (2013) in assessing 195 developed and developing countries. The Off Track group demonstrates widespread positive shifts. Using reference rates from 1990-2000,

Table 1. Tests of MDG Success in Reducing Child Mortality: Comparing "On Track" vs "Off Track" Countries as of 2001

		Highest Test: MDG Level		Medium Test: "MDG Rate"	Minimum Test: Acceleration			
MDG Status as of 2001	N	Achieved in 2013	On trajectory for 2015	Achieved 4.3 % Annual Rate 2001-13	1996-2001 vs 2001-2013		1990-2000 vs 2000-2013	
					≥ 1%	> 0%	≥ 1%	> 0%
Off Track	100	13	21	39	50	80	60	82
		13%	*21%*	*39%*	*50%*	*80%*	*60%*	*82%*
On Track	41	26	31	24	1	9	3	14
		63%	*76%*	*59%*	*2%*	*22%*	*7%*	*34%*
TOTAL	141	39	52	63	51	89	63	96
		28%	*37%*	*45%*	*36%*	*63%*	*45%*	*68%*

Note: percentages in italics represent the share of the row sample under the first column ("N"), and thus do not add up to 100%.
Source: Author's calculations based on UN IGME 2014.

82 percent of Off Track countries experienced acceleration in rates of progress over 2000-2013 and 60 percent accelerated by at least 1 percentage point per year. This last benchmark is significant. A single percentage point average annual improvement implies at least a 16 percent lower mortality rate at the end of 15 years, compared to previous trends. Using reference rates from 1996-2001, 80 percent of Off Track countries experienced acceleration, including 50 percent accelerating by more than 1 percentage point per year. Again, a much smaller share of the already high-performing On Track countries saw acceleration over comparable periods.

Variation by Region and Initial Income Group

Table 2 displays the same three test results broken down by region and by income group at the start of the MDGs. In the upper panel on income groups, the second column shows that only 14 percent of low-income countries were On Track as of 2001, compared to 42 percent of middle-income countries. If the MDGs were most specifically targeted to support faster progress in low-income countries, the remaining columns show that there has been some success. In presenting an argument against MDG feasibility, Clemens, Kenny, and Moss (2007) asserted that only one country with a 1975 income below $1,600 (in 1996 US $) accomplished MDG-consistent rates of progress in child health over the subsequent 25 years (p. 743). The Highest test MDG success of 22 low-income countries over a 25-year period therefore represents a notable improvement, even if only amounting to around one-third of the relevant group. Evaluating the low-income group more broadly across the Medium and Minimum tests, more than half of the countries achieved a 4.3 percent average rate of U5MR decline since 2001, and more than four-fifths achieved acceleration compared to 1996-2001.

The lower panel of Table 2 segments the data by geographic regions. It shows that sub-Saharan Africa was the region most dramatically lagging when the Goals were launched, with only two of 46 countries in the sample being On Track as of 2001. In other regions the

Table 2. Tests of MDG Success in Developing Countries' Child Mortality Rates, by Initial Income Classification and Region

			Highest Test: MDG Level		Medium Test: "MDG Rate"	Minimum Test: Acceleration			
						1996-2001 vs 2001-2013		1990-2000 vs 2000-2013	
Income Group as of 2001	N	On Track as of 2001	Achieved in 2013	On trajectory for 2015	Achieved 4.3 % Annual Rate 2001-13	≥ 1%	> 0%	≥ 1%	> 0%
Low-Income	65	9	14	22	33	31	53	39	56
		14%	*22%*	*34%*	*51%*	*48%*	*82%*	*60%*	*86%*
Middle-income	76	32	25	30	30	20	36	24	40
		42%	*33%*	*39%*	*39%*	*26%*	*47%*	*32%*	*53%*

			Highest Test: MDG Level		Medium Test: "MDG Rate"	Minimum Test: Acceleration			
						1996-2001 vs 2001-2013		1990-2000 vs 2000-2013	
Income Group as of 2001	N	On Track as of 2001	Achieved in 2013	On trajectory for 2015	Achieved 4.3 % Annual Rate 2001-13	≥ 1%	> 0%	≥ 1%	> 0%
Sub-Saharan Africa	46	2	6	10	19	30	42	33	41
		4%	*13%*	*22%*	*41%*	*65%*	*91%*	*72%*	*89%*
East Asia and Pacific	16	5	4	6	7	4	7	4	9
		31%	*25%*	*38%*	*44%*	*25%*	*44%*	*25%*	*56%*
Latin America and Caribbean	26	11	5	6	4	2	7	2	10
		42%	*19%*	*23%*	*15%*	*8%*	*27%*	*8%*	*38%*
Middle East and North Africa	17	9	6	8	7	3	8	5	9
		53%	*35%*	*47%*	*41%*	*18%*	*47%*	*29%*	*53%*
South Asia	8	4	4	4	4	0	5	2	7
		50%	*50%*	*50%*	*50%*	*0%*	*63%*	*25%*	*88%*
Europe and Central Asia	28	10	14	18	22	12	20	17	20
		36%	*50%*	*64%*	*79%*	*43%*	*71%*	*61%*	*71%*

Note: percentages in italics represent the share of the row sample under the first column ("N"), and thus do not add up to 100%.
Sources: Author's calculations based on UN IGME 2014; World Bank 2001.

initial On Track status ranged from 31 to 53 percent of countries. The countries making the fastest progress since 2001 are geographically dispersed. They include Maldives at 10.7 percent per year, Rwanda at 9.3 percent, Estonia at 8.7 percent, China at 7.9 percent, and Cambodia at 7.8 percent. On a proportionate basis, the transition economies of Europe and Central Asia have seen the most success, with 64 percent now on course to achieve the MDG by 2015. Elsewhere the Highest test results are less promising, ranging from 22 percent in sub-Saharan Africa to 50 percent in South Asia. Medium test results are slightly better in most regions. For example, 41 percent of Sub-Saharan countries have averaged a 4.3 percent annual rate of reduction since 2001.

Table 2's Minimum test columns show tremendous geographic variation in patterns of acceleration. In

sub-Saharan Africa, fully 91 percent of countries have seen acceleration since both pre-MDG reference periods. This is again a higher share than the 74 percent reported by Fukuda-Parr, Greenstein, and Stewart (2013). A clear majority of the region's countries also registered acceleration of at least a percentage point per year, including 72 percent compared to 1990-2000 and 65 percent compared to 1996-2001. Meanwhile, roughly half the countries experienced acceleration in both East Asia and the Pacific and the Middle East and North Africa, with precise figures varying by reference period. South Asia saw 7 of 8 countries accelerate compared to the 1990s, and 5 of 8 accelerate compared to 1996-2001.

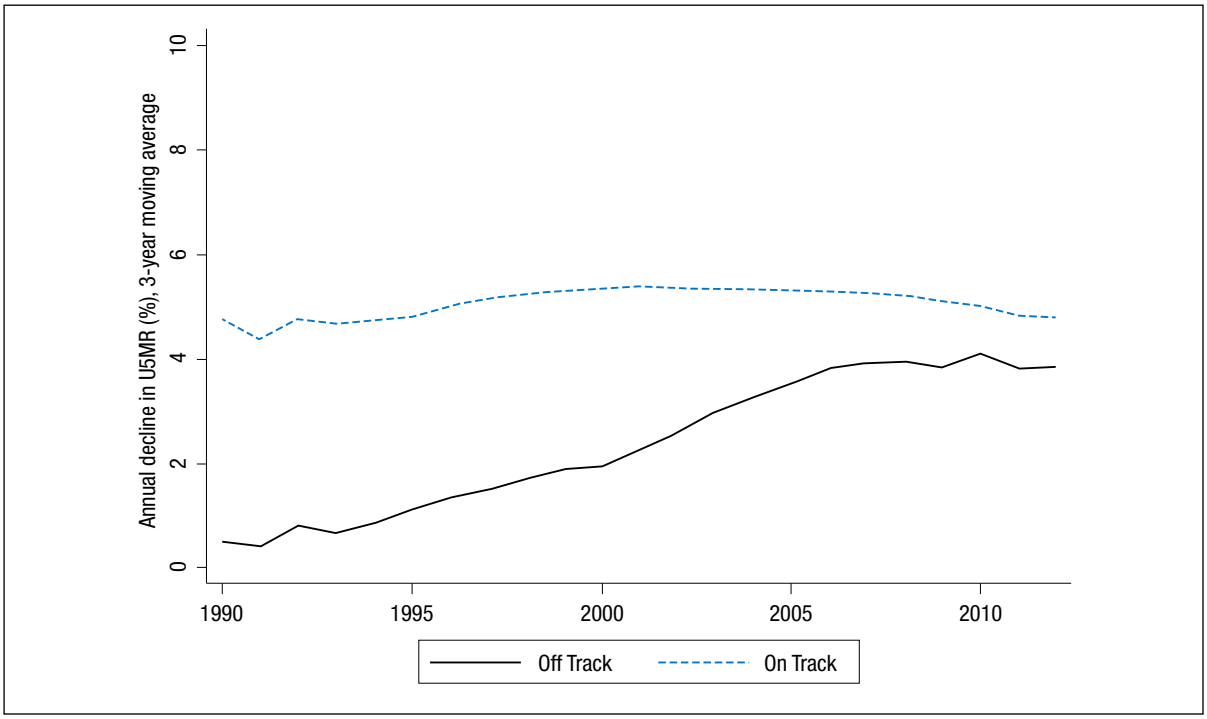
Results for Latin America and the Caribbean stand out for showing the least acceleration. Nearly half (11 out of 26) of the region's countries were On Track in 2001, but only six are now on a trajectory to reach the 2015 target and only four pass the Medium test on rates. Only seven countries in the region saw acceleration since 1996-2001. Twelve countries decelerated by up to 1 percentage point annually and seven decelerated by more. Across all three tests, the results suggest that the MDGs have not been linked to significant progress in Latin America and the Caribbean.

6. UNDERLYING GLOBAL TRENDS

The mixed acceleration in U5MR reduction trends across regions and income groups raises the question of whether the MDG-focused test results are merely a product of reversion toward mean rates of progress or deeper structural shifts. For example, it could be the case that countries with fast rates of progress in one period (e.g., On Track countries as of 2001) tend to have slow rates of progress in the next period, and vice versa. It could also be that countries with higher mortality rates or lower incomes are more likely to see faster progress, a debate that has ranged from Preston's (1975) seminal analysis to more recent evidence presented by Hum et al. (2012). When considering the MDGs, there is a common assumption that countries with lower initial U5MR experience slower rates of U5MR decline (e.g., Fukuda-Parr et al., 2013), although Easterly (2009) reports opposing evidence that countries with higher initial mortality experience slower subsequent declines. The MDG tests presented above, especially the Minimum test, might thus spuriously capture underlying forces of convergence or divergence in rates of progress.

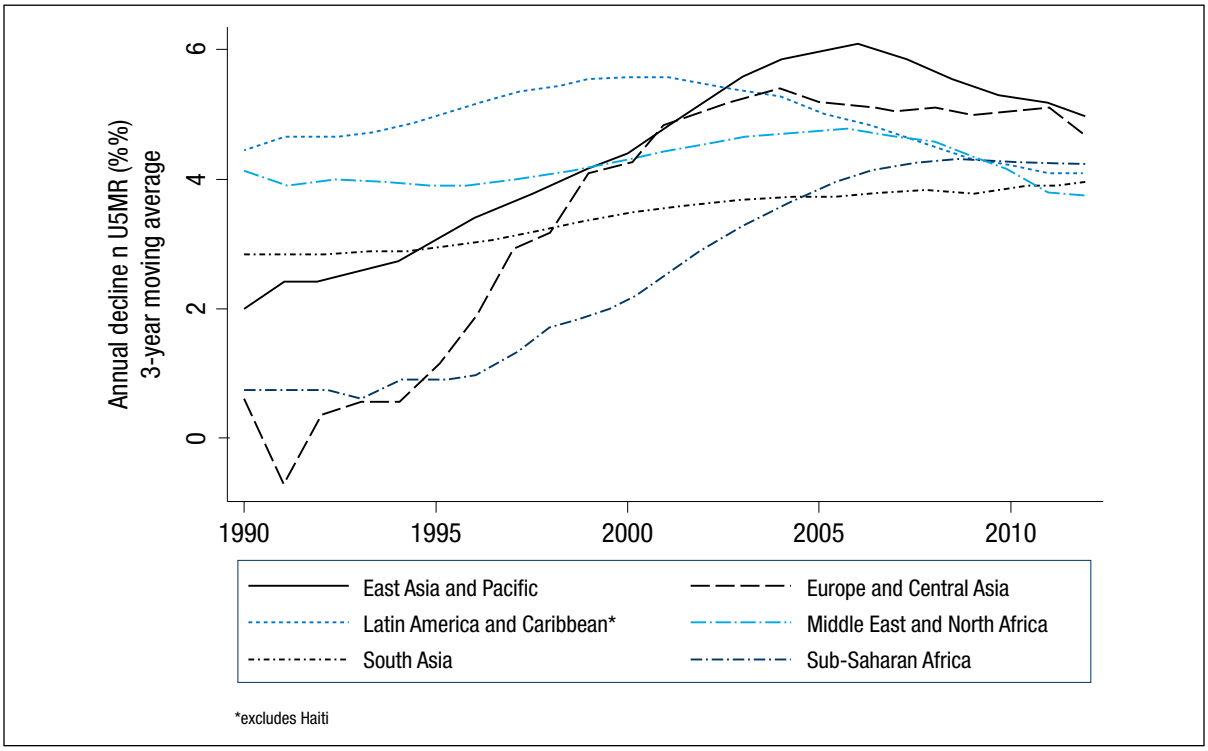
To begin exploring the issue, Figure 3 shows weighted (three-year moving) average trends for the initial Off Track and On Track countries over the 1990 to 2010 period. Annual weightings for each country are calculated as the numbers of estimated births, derived by multiplying total population by the estimated birth rate, which is available for the years up to 2012 in World Bank (2014). The figure shows a clear long-term

Figure 3. Weighted Average Annual Reduction in Under-5 Mortality Rates, 1990-2012, by Developing Country MDG "On Track" vs "Off Track" Status as of 2001 (3-year moving average)



Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

Figure 4. Weighted Average Annual Reduction in Under-5 Mortality Rates, 1990-2012, by Developing Region (3-year moving average)



Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

pattern trending toward convergence in rates of progress, although in aggregate the Off Track countries still trail the On Track group by approximately 1 percentage point per year in the most recent year.

Figure 4 then presents similarly weighted data by region. This shows high variation in trends throughout the 1990s, followed by a pattern of similar progress rates across regions, beginning in the mid-2000s. Latin America's 3-year average sees a stark drop in 2009 due to Haiti's enormous one-time 2010 increase in mortality, linked to the tragic earthquake of that year. For ease of readability, we exclude Haiti from the calculations in the figure. Notably, sub-Saharan Africa's average progress began to improve during the second half of the 1990s, further emphasizing the importance of testing two pre-MDG reference periods, as discussed in Section 4. Sub-Saharan Africa's moving average rate of decline indeed surpasses South Asia's in 2005, then Latin America and the Caribbean's in 2009, and the Middle East and North Africa's in 2010.[3]

Given the large weighting of China and India in their respective regions, Figure 5a pulls out these two unique cases to show their individual rates of annual progress since 1990. The graph shows that China started from very low rates of progress in the early 1990s and then experienced a sustained acceleration in the rate of mortality reduction over the following 15 years, peaking at more than 8 percent annual improvements in the mid-2000s. India meanwhile experienced a very gradual acceleration between the

1990s and 2000s, with the rate of improvement climbing from approximately 3 percent annually to approximately 4 percent from 2004 onward.

Figure 5b shows rates of progress in the weighted average U5MR by pre-MDG income category, excluding India from the low-income group and China from the middle-income group so as not to distort weightings. The results are striking. Middle-income countries have seen the most robust rates of progress over the period, although with only a very slight acceleration. The high-income countries saw their average rate of progress drop in half, from approximately 4 percent per year to 2 percent per year.[4] This could be due to a general slow-down in the rate of progress at the health technology frontier, or an asymptotic relationship as high-income countries begin to approach zero U5MR. Meanwhile, the low-income countries almost flipped their position compared to the high-income countries, jumping from slightly above 1 percent annual improvement in the 1990s to nearly 4 percent after 2004.

Figure 6 demonstrates how regional cross-country distributions of U5MR reduction trends have changed since the MDGs were created. The solid line curve indicates the estimated kernel density of (unweighted) average annual rates of country progress for the years 1996-2001, and the dotted line presents the corresponding distribution for 2001-2013 (Appendix Figure A1 presents corresponding regional distributions for 1990-2000 compared to 2000-2010). Sub-Saharan Africa experienced a clear rightward shift in the distribution, marking an unambiguous overall acceleration in average rates of progress. South Asia experienced only a very slight rightward shift. Meanwhile East Asia and the Pacific saw a modest leftward shift and the Middle East and North Africa saw a narrower distribution around a similar mean. The transition economies of Europe and Central Asia experienced a slightly rightward compression in the distribution, while Latin America and the Caribbean experienced internal convergence toward a lower average rate.

Figure 7 presents (unweighted) distributional trends for initially low-income and middle-income countries, respectively, again including China and India. It shows clear overall improvement for low-income countries, implying another rightward shift in the curve subsequent to the one presented in Figure 2. For middle-income countries, there is a compression and slight leftward shift in the distribution, indicating a reversion toward the average trend of the 1990s. Decadal distributions for the 1990s versus 2000s are presented in Appendix Figure A2.

These income-based comparisons of trends prompt the question of whether U5MR reductions are correlated with initial incomes, as is commonly presumed (e.g., UNICEF 2013, p. 11). Among the 125 developing countries with income data, there was a small positive correlation ($r = 0.17$) between initial income per capita and U5MR decline in the 1990s, and an even smaller negative correlation ($r = -0.09$) for the 2000s, as illustrated in the scatterplot of Appendix Figure A3.

Table 3 extends the retrospective time horizon to present weighted average annual progress by decade, income group and region since 1970. Note that not all countries have observations during the 1970s and 1980s, so those period averages are based on available data. Unweighted cross-country averages are presented in Appendix Table A2. The far-right column presents averages using available data since 2005, in order to allow the possibility for changes in the most recent years. The table shows considerable variation by decade, with signs of a shift in trends since 2000. This is most notable for sub-Saharan Africa, which

Figure 5a. Annual Reduction in Under-5 Mortality Rates in China and India, 1990-2012, (3-year moving average)

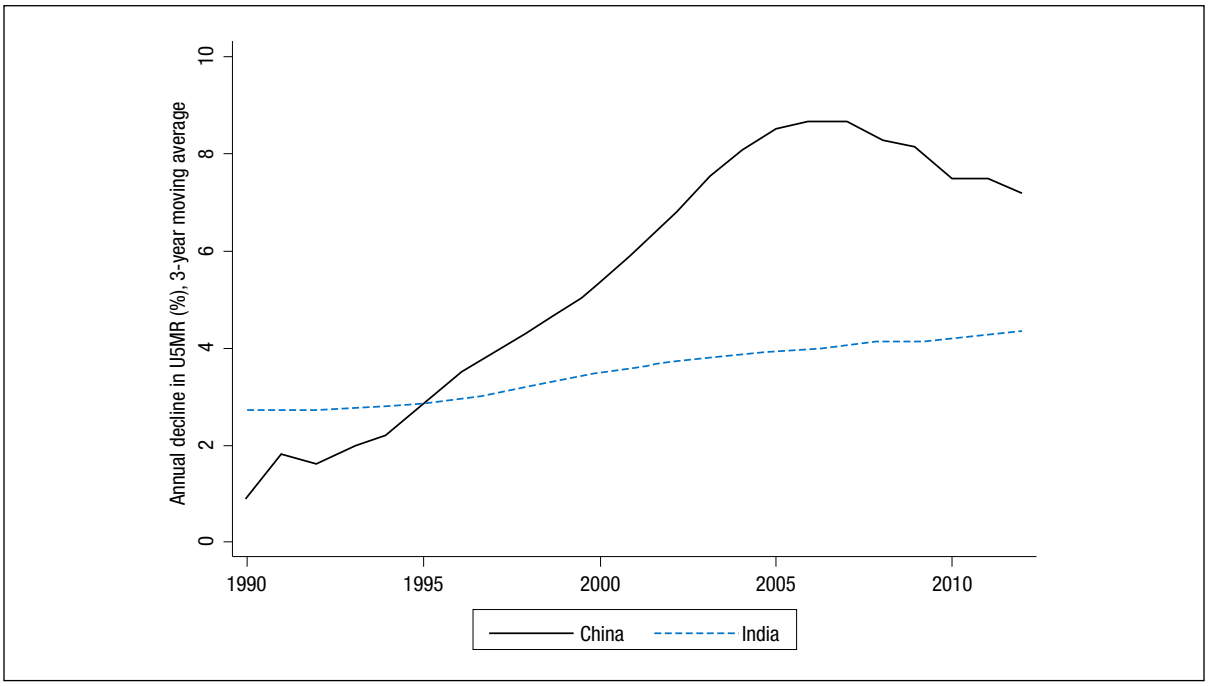


Figure 5b. Weighted Average Annual Reduction in Under-5 Mortality Rates, 1990-2012, by Country Income Group as of 2001 (3-year moving average)

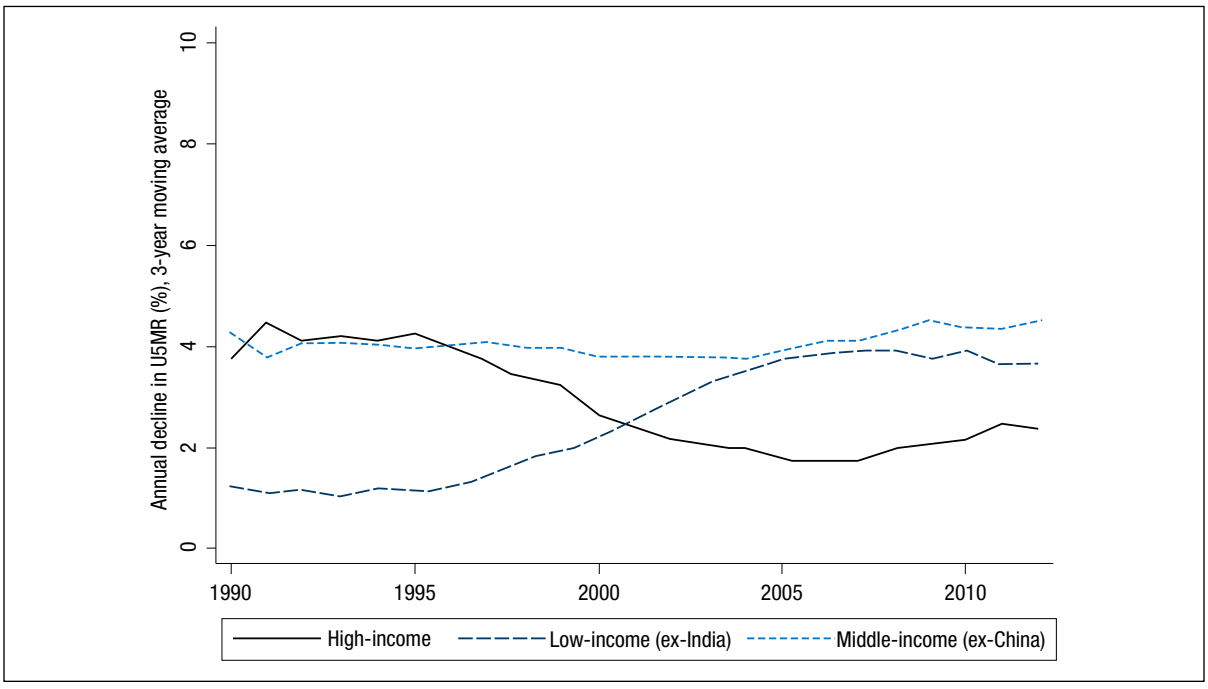
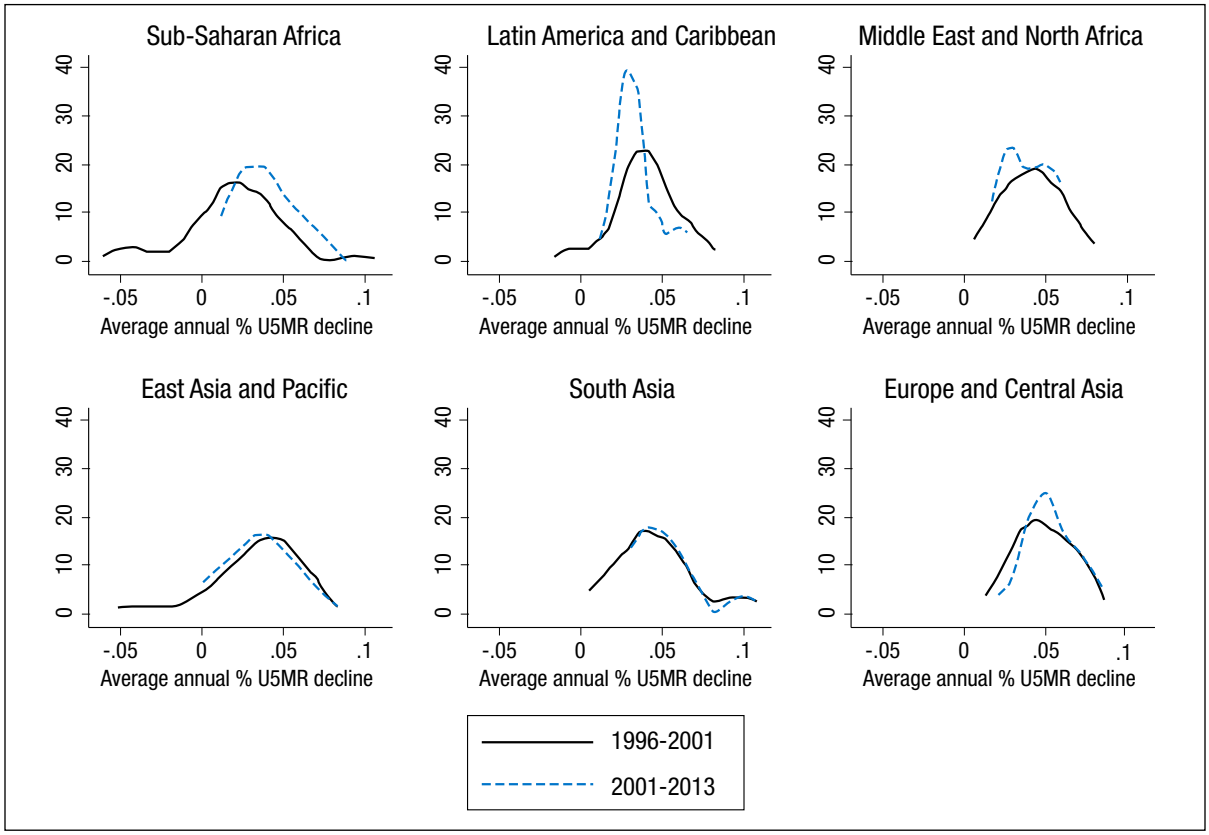


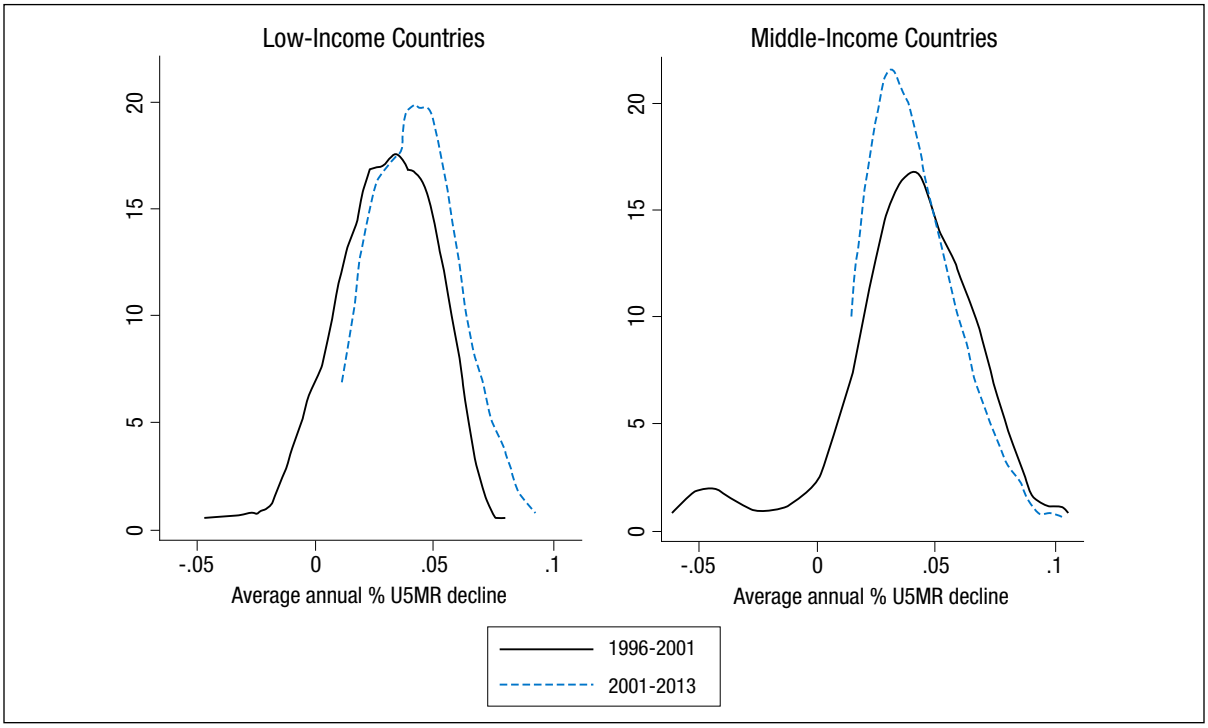
Figure 6. Cross-Country Developing Region Distributions of Decline in Under-5 Mortality Rates, 1996-2001 vs 2001-2013



Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

systematically experienced the slowest rates of progress for multiple decades until the 2000s. Then the 2000s show a major jump in rates of progress. A similar pattern is apparent for the low-income group, which shows a significant acceleration in the years after 2000.

Figure 7. Cross-Country Distributions of Decline in Under-5 Mortality Rates 1996-2001 vs 2001-2013, by Country Income Group as of 2001



Sources: Author's calculations based on UN IGME 2014; World Bank 2001.

Table 3. Weighted Average Annual Percent U5MR Decline, by Decade

	N *	1970-1980	1980-1990	1990-2000	2000-2010	2005-2012
Income Group in 2000						
Low-income	65	2.2	2.1	2.0	3.7	3.8
Middle-income	76	4.4	3.7	3.9	5.5	5.4
High-income	32	4.9	3.8	3.6	2.0	2.2
Developing Region						
Sub-Saharan Africa	46	2.0	1.2	1.4	4.0	4.2
Latin America and Caribbean	26	3.4	4.3	5.1	3.5	4.0
East Asia and Pacific	16	4.1	2.6	3.5	5.6	5.3
South Asia	8	2.2	2.8	3.2	3.8	3.9
Middle East and North Africa	17	5.0	6.3	4.1	4.5	4.0
Europe and Central Asia	28	3.3	3.4	2.5	5.1	5.0

*Notes: (1) * indicates number of countries in final period. (2) Weighting is calculated based on number of births in each country.*
Sources: Author's calculations based on UN IGME 2014; World Bank 2001; World Bank 2014.

7. CROSS-COUNTRY STATISTICAL TESTS

More formal statistical assessments of convergence and divergence trends in U5MR can be conducted through simple regression tests. To that end, Tables 4 through 6 present results for a basic cross-country ordinary least squares (OLS) regression of the core form:

$$r_{i,t} = \alpha + \beta(m_{i,t-n}) + \varepsilon_{i,t} \qquad (2)$$

In this specification, $r_{i,t}$ represents the average annual percentage decline in the U5MR in country i between year t-n and year t; $m_{i,t-n}$ represents the natural logarithm of the U5MR in year t-n; and $\varepsilon_{i,t}$ is an error term, presumed to be normally and randomly distributed. The β term represents a regression coefficient and α is a constant. Table 4 presents regressions run separately for each decade from 1960-1970 through 2000-2010 as a test for "unconditional convergence" in rates of U5MR decline, the "unconditional" term referring to an equation without other potential explanatory or conditioning variables. An additional regression is estimated for the period 2005-2013, motivated by the possibility of recent trends captured in Figure 4. Standard errors are robust to heteroskedasticity. Appendix Table A3 presents descriptive statistics for the sample's decadal mid-points.

To stress, the aim of the regressions is only to test first-order correlation patterns. The limitations of cross-country OLS specifications are well known. These regressions do not aim to test for sources of causality in generating U5MR declines. A time-series regression structure with country fixed effects (or first differences) would be more appropriate for that separate exercise.

The first general result from Table 4 is found in columns (1) through (4). Throughout the latter decades of the 20th century, declines in child mortality were negatively correlated with countries' initial U5MRs. This is consistent with the evidence presented by Easterly (2009). It means that countries with higher mortality experienced slower rates of progress, and the proportionate gap was increasing between high and low mortality countries. Appendix Table A4 shows this finding to be robust to adding high-income countries to the sample.

The second core result is found in columns (5) and (6). These suggest an important break in trends after 2000, whereby initial mortality is no longer correlated with subsequent rates of progress. The constant term also drops slightly and the R-squared drops to near zero. The pattern of mortality-linked rates of decline ends in the 2000s. Appendix Table A7, Panel A shows a similar structural trend when initial U5MR is replaced with initial income per capita as the independent variable. Poorer countries saw significantly slower rates of progress until the 2000s, when the links between income and progress disappear statistically. Historically, child mortality and income per capita are strongly negatively correlated, so it is unsurprising that the two variables are not both significant at 5 percent levels when tested together in Appendix Table A7, Panel B.

Table 5 replicates the basic specification of Table 4 and adds regional dummy variables to test for statistically significant geographic trends. South Asia is the omitted reference region against which the other regional coefficients can be compared. Four basic findings emerge here. One is that including the regional dummies tends to decrease the size and significance of the coefficient on initial under-5 mortality, suggesting that region-specific dynamics might help to explain the broader trends through to the 1990s. A second is that sub-Saharan Africa is the only region

Table 4. Regression Test for Unconditional Convergence on U5MR

Dependent Variable: Under-5 Child Mortality, Average Annual Rate of Decline over Decade

	(1) 1960s	(2) 1970s	(3) 1980s	(4) 1990s	(5) 2000s	(6) 2005-2013
Initial child mortality (Ln)	-0.009***	-0.013***	-0.008***	-0.006***	-0.000	-0.001
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	0.075***	0.096***	0.071***	0.054***	0.042***	0.043***
	(0.015)	(0.018)	(0.008)	(0.008)	(0.007)	(0.008)
N	80	107	128	141	141	141
R-squared	0.08	0.13	0.10	0.05	0.00	0.00
Sample	Developing Countries as of 2001					

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013.*

Table 5. Regression Test for Regional Variation in U5MR Decline

Dependent Variable: Under-5 Child Mortality, Average Annual Rate of Decline over Decade

	(1) 1960s	(2) 1970s	(3) 1980s	(4) 1990s	(5) 2000s	(6) 2005-2013
Initial child mortality (Ln)	-0.003	-0.007*	-0.003	0.005*	0.003	0.001
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Sub-Saharan Africa	-0.005	-0.007	-0.020***	-0.033***	-0.016	-0.010
	(0.003)	(0.005)	(0.006)	(0.007)	(0.011)	(0.009)
Latin America and Caribbean	0.006	0.009	-0.002	0.001	-0.018	-0.017*
	(0.004)	(0.006)	(0.008)	(0.007)	(0.012)	(0.009)
East Asia and Pacific	0.018***	0.013	-0.006	-0.010	-0.011	-0.015
	(0.006)	(0.010)	(0.008)	(0.008)	(0.012)	(0.010)
Middle East and North Africa	0.020**	0.022***	0.013	0.005	-0.009	-0.011
	(0.008)	(0.006)	(0.009)	(0.008)	(0.011)	(0.009)
Europe and Central Asia	0.016**	-0.003	-0.011	0.000	0.005	0.006
	(0.007)	(0.008)	(0.009)	(0.008)	(0.011)	(0.010)
Constant	0.035**	0.065***	0.056***	0.016	0.038**	0.045***
	(0.017)	(0.023)	(0.018)	(0.015)	(0.017)	(0.015)
N	80	107	128	141	141	141
R-squared	0.35	0.32	0.40	0.29	0.13	0.17
Sample	Developing Countries as of 2001					

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013. (4) South Asia is the omitted reference region for interpreting the regional dummy variables.*

to have a significant, large and negative coefficient in more than one period: the 1980s and 1990s. The coefficients suggest that, on average, sub-Saharan African countries lagged South Asia in U5MR reductions by more than 2 percentage points per year across each of those two decades.

A third notable result from Table 5 is in column (4), evaluating the 1990s. When controlling for regional trends, the coefficient on initial mortality changes to a positive sign, although not significant at 5 percent levels. This coefficient indicates that, outside of the significant negative trend still present in sub-Saharan Africa during the 1990s, an otherwise global trend of accelerated progress among high mortality countries might have begun during that decade, or at least in South Asia. A fourth finding is Africa-specific. In column (5) the sub-Saharan Africa coefficient drops in magnitude and is no longer statistically significant, for the first time since the 1970s. It is even smaller in column (6), for 2005-2013. In the 2000s, Africa's U5MR trends were no longer significantly divergent from those of South Asia.

It is possible that the regional effects reflected in Table 5 are driven by underlying trend variation in South Asia as the statistical reference region. Table 6 therefore reports the coefficients on regional dummy variables as applied individually to the respective decadal specifications in Table 4. Note that each column in Table 6 does not represent the results of a single regression. Instead, each column entry presents the result for when each regional variable is added independently to the underlying regression. These regional coefficients therefore have a different conceptual interpretation than in the previous table. In Table 5, the coefficients indicate whether each region has a different intercept than South Asia's when all regions are tested together. In Table 6, the coefficients indicate whether each region, when tested one at a time, has a different intercept from the rest of the developing world.

Table 6 presents even stronger evidence indicating that sub-Saharan Africa experienced uniquely divergent trends in reducing U5MR before the 2000s. The coefficient is negative and significant at 1 percent levels in the 1960s, 1970s, 1980s, and 1990s. It is no longer significant in columns (5) or (6) for the periods since 2000. Easterly (2009) argued that the MDG 4 is "unfair" to Africa, since the region's high mortality rates rendered it less likely to attain a proportionate goal. To the extent that sub-Saharan Africa's accelerated progress during the 2000s is linked to MDG efforts, the MDGs would seem to have helped achieve the opposite effect, by removing a distinctly negative rate of progress. Assessed against long-term trends, this would represent one of the MDGs' biggest global achievements.

Table 6 also indicates that Middle East and North Africa outperformed global averages from the 1960s through the 1990s, and shows that the transition economies of Europe and Central Asia have made uniquely rapid progress during the 2000s. Meanwhile, Latin America and the Caribbean again show evidence of a significant negative trend since 2000, with regional averages lagging global trends even after accounting for initial levels of U5MR and income. Appendix Tables A5 and A6 show that the core regression findings are robust to including high-income countries in the sample or controlling for income.

Timing the Turning Point

The decadal regressions suggest a structural shift to common global rates of progress at some point during the 2000s. To examine more specific year-to-year patterns, the regression specification in equation (2)

Table 6: Coefficients on Regional Dummy Variables when Applied Individually to Table 4 regressions

	(1) 1960s	(2) 1970s	(3) 1980s	(4) 1990s	(5) 2000s	(6) 2005-2013
Sub-Saharan Africa	-0.016***	-0.018***	-0.020***	-0.032***	-0.007	0.001
	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.005)
Latin America and Caribbean	-0.002	0.005	0.005	0.009**	-0.013**	-0.013***
	(0.004)	(0.005)	(0.003)	(0.004)	(0.005)	(0.004)
East Asia and Pacific	0.012*	0.008	0.001	-0.001	-0.002	-0.008
	(0.006)	(0.009)	(0.004)	(0.006)	(0.006)	(0.005)
South Asia	-0.004	-0.002	0.012*	0.018**	0.012	0.009
	(0.003)	(0.005)	(0.006)	(0.007)	(0.010)	(0.008)
Middle East and North Africa	0.018**	0.021***	0.024***	0.014***	-0.001	-0.004
	(0.007)	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Europe and Central Asia	0.007	-0.015**	-0.009**	0.004	0.018***	0.020***
	(0.006)	(0.008)	(0.004)	(0.005)	(0.004)	(0.005)
N	80	107	128	141	141	141
Sample	Developing Countries as of 2001					

Notes: (1) Coefficients are presented for each regional dummy as applied independently to a decadal regression of $r_{i,t} = \alpha + \beta_1(m_{i,t-n}) + \beta_2(\text{regional dummy}) + \varepsilon_{i,t}$ *where* $r_{i,t}$ *represents the average annual percentage decline in the U5MR in country i between year t-n and year t;* $m_{i,t-n}$ *represents the natural logarithm of the U5MR in year t-n; and* $\varepsilon_{i,t}$ *is an error term. (2) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (3) Numbers in parentheses indicate robust standard errors. (4) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013.*

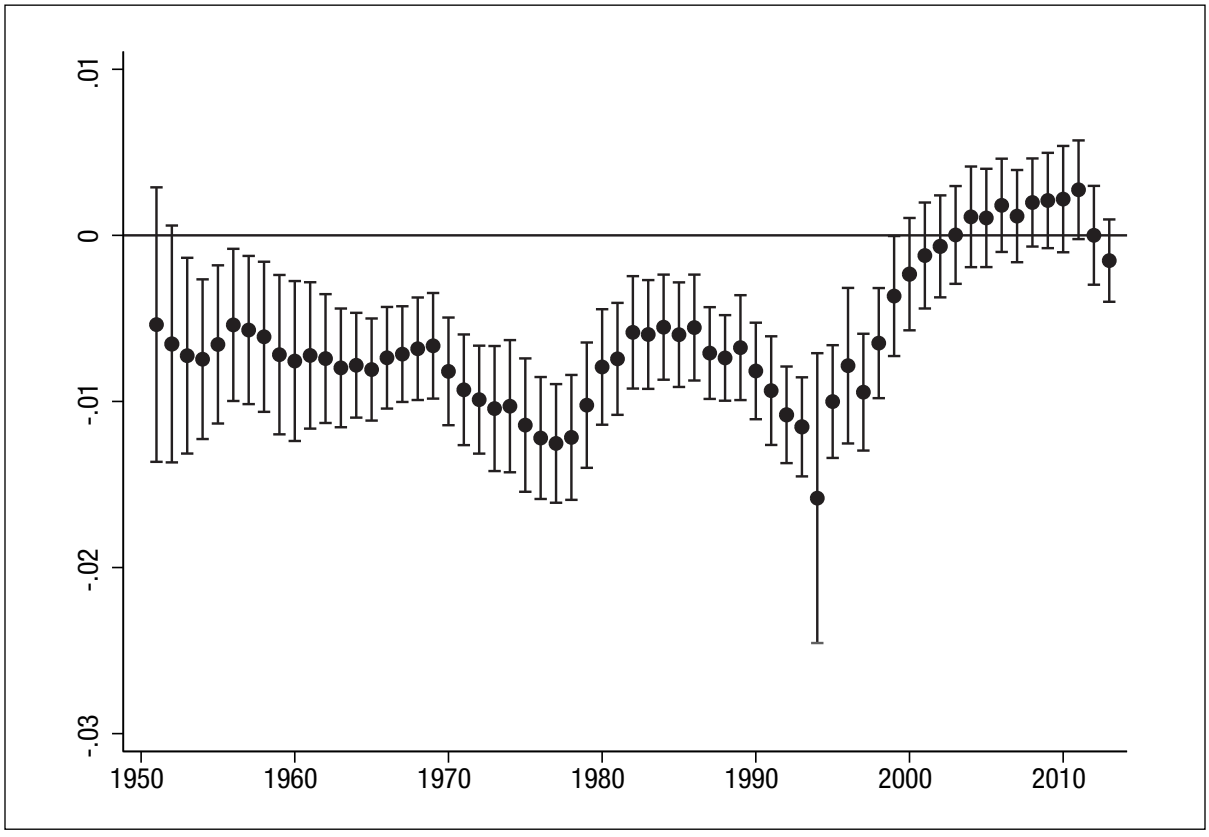
can be estimated with annual rather than decadal data. Using the full sample of developed and developing countries (except Haiti, because it distorts the vertical scale around the 2010 earthquake), Figure 8 presents the results for the coefficient on the initial U5MR level in the annual regressions. The graph presents results for each year from 1951 (i.e., the rate of change from 1950 to 1951) to 2013, noting that the sample in the first year includes only 42 countries and grows until stabilizing at 172 countries as of 1986. The round dots indicate the value of the estimated coefficient, and the vertical bars represent 95 percent confidence intervals around the estimate. A dot below the zero line indicates systematically slower rates of progress for higher mortality countries, although if the vertical bar crosses the zero line then the coefficient is not statistically different from zero.

The annual coefficients on initial U5MR presented in Figure 8 are similar to the coefficients from the decadal regressions in Table 4 (for the developing country sample) and are directly comparable to the coefficients in Appendix Table A4 (for the full global sample). The graph shows that the annual coefficient was negative and statistically significant from 1953 through 2000. Then, since 2000, the coefficient is no longer statistically different from zero, implying that the rate of progress became independent of initial U5MR. The coefficient becomes positive for several years as of 2004, and in 2011 falls just short of 95 percent statistical

significance, which would imply a transition to cross-country U5MR convergence. However, the coefficients drop in value in 2012 and 2013, and in 2013 the coefficient returns to being negative, even if still not statistically significant. This would suggest that any structural shift in cross-country trends still remains fragile and should not be presumed as permanent.

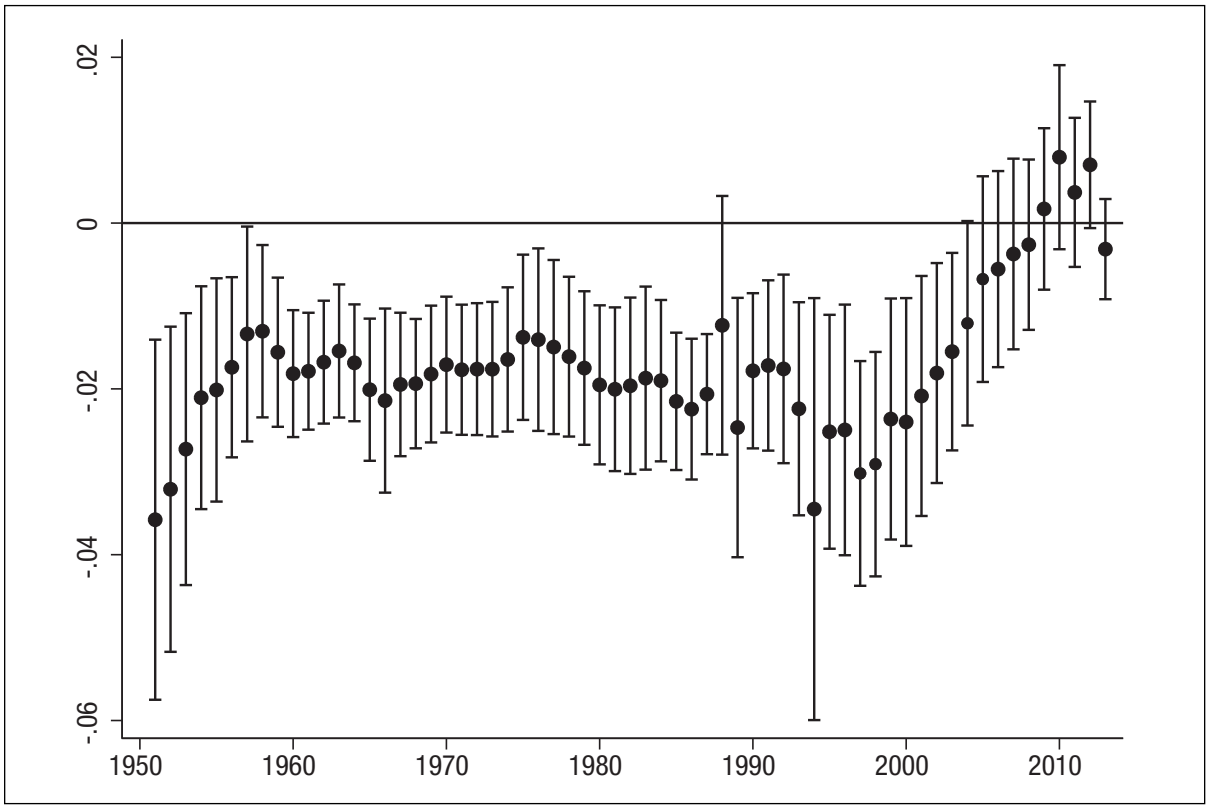
Figure 9 presents the results of a similar year-to-year regression exercise as applied to the regional regression tests of Table 6 and Appendix Table A6. The dots here represent the coefficient on sub-Saharan Africa when tested independently as a single regional dummy variable against the full sample of developed and developing countries (again, with the figure showing values excluding Haiti). The graph shows that Africa trended well behind the rest of the world for most of the second half of the 20th century, even after controlling for initial U5MR. There was only one year over that period—1988—where the regional coefficient was not both negative and statistically significant. But then, as of 2004, the coefficient no longer indicates African progress rates lagging the rest of the world. As of 2009 the coefficient turns positive, if not statistically significant. As in Figure 8, the coefficient drops in 2013, though still not statistically significant, suggesting Africa's average trends that year were still similar to those in the rest of the world.

Figure 8. Regression Coefficient and 95% Confidence Interval for Initial Under-5 Mortality Rate in Year-to-Year Test for Unconditional Global U5MR Convergence, 1951-2013



Sources: Author's calculations based on UN IGME 2014.

Figure 9. Regression Coefficient and 95% Confidence Interval for Sub-Saharan Africa Regional Variable in Year-to-Year Test for Unconditional Global U5MR Convergence, 1951-2013



Sources: Author's calculations based on UN IGME 2014; World Bank 2014

8. HOW MANY LIVES SAVED?

The regression results add weight to the hypothesis that a structural shift in global patterns of progress occurred subsequent to the launch of the MDGs, especially for sub-Saharan Africa. To the extent that this is correct, the ultimate purpose of the MDGs is to save and improve lives, so one central question is to measure progress in corresponding terms. By considering the extrapolation of pre-MDG rates of progress and how those have changed, one can generate a rough estimate of the number of lives that have been saved, potentially linked to MDG efforts.

According to the latest U.N. official estimates, annual under-5 deaths declined from 12.7 million children in 1990 and 9.7 million children in 2000 to less than 6.3 million children in 2013 (UN IGME 2014). UNICEF (2014) and others have stressed the difference in death rates between two years (e.g., 1990 versus 2013) as a measure of "lives saved." Based on that methodology, the most recent UNICEF progress report states that, "almost 100 million children under age 5 have been saved over the past two decades" (Ibid., p. 5). However, since an underlying trend of progress was already underway prior to 2000, a more fundamental counterfactual question to ask is: what would recent death rates have looked like if pre-MDG rates of progress had continued in subsequent years?

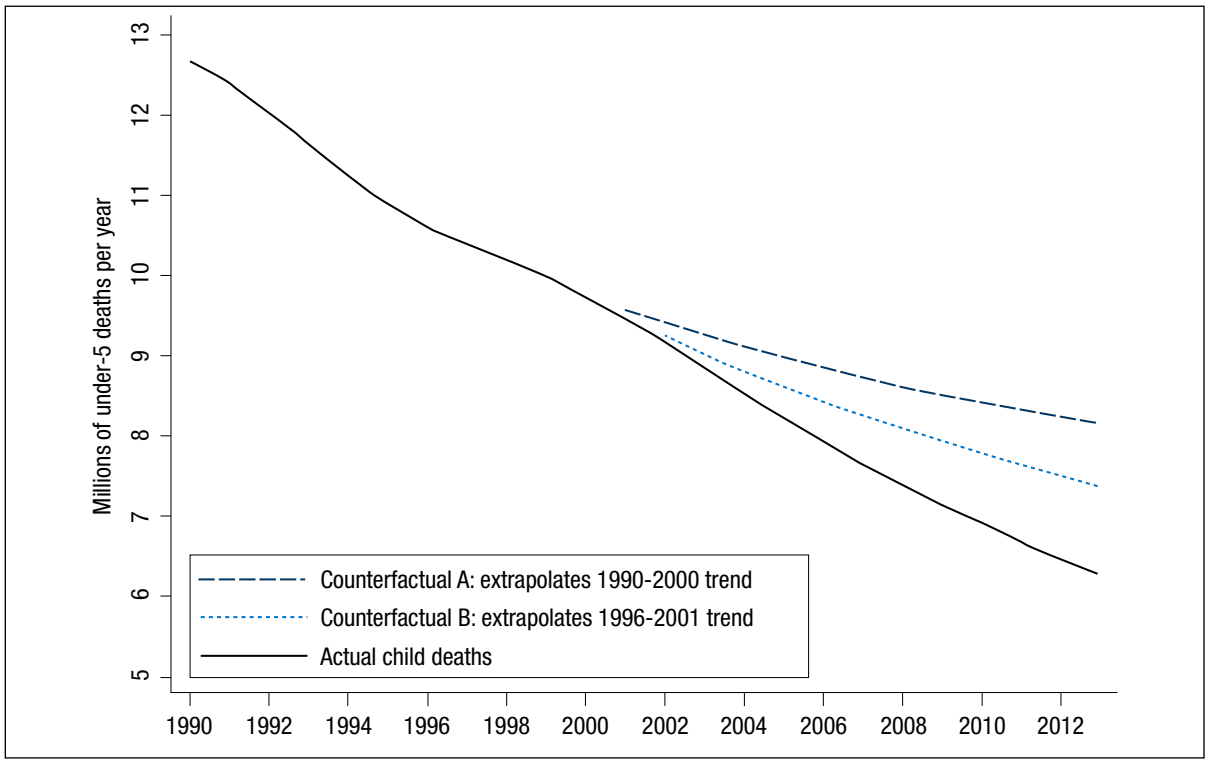
Counterfactual child death levels can be estimated by extrapolating U5MR trajectories. For example, if a country's U5MR declined from 120 per 1,000 live births in 1990 to 100 in 2000, then that would be equal to a 1.8 percent average annual rate of decline. A consistent rate of progress over the next 13 years would result in a U5MR of 79 in 2013. If the actual U5MR turned out to be lower in 2013, for example equal to 70, then the proportional difference (0.13 = 79/70 – 1) can be multiplied by the country's actual number of deaths in 2013 to calculate a more rigorous estimation of "lives saved." For completeness, the exercise requires directional neutrality by calculating the lives that have been "lost" in countries where rates of progress have slowed down. An important caveat is that birth and mortality rates are endogenously determined, so this calculation is only pertinent for short-run estimates indicating approximate orders of magnitude, rather than precise numbers of lives saved.

Drawing from the evidence presented earlier in this paper, two distinct counterfactual trajectories can be constructed to assess progress up to 2013. "Counterfactual A" is established by extrapolating average 1990-2000 trends all the way to 2013. "Counterfactual B" is established by extrapolating average 1996-2001 trends all the way to 2013. Results are presented graphically in Figure 10A. The graph only includes deaths in developing countries, but developed countries account for less than 2 percent of the world's total throughout the period (e.g., 1.4 percent in 2013) so have little effect on the results. When the 32 high-income countries are included in the analysis, aggregate estimates of lives saved are only approximately 0.5 percent lower under Counterfactual A and 0.3 percent lower in Counterfactual B.[5]

Figures 10B and 10C show the counterfactual calculations as applied to aggregate progress across developing countries and all countries, respectively (within the sample). Note that a straight diagonal line represents accelerating progress. Constant rates of annual progress would produce asymptotic curves that appear to "flatten out" from left to right, as illustrated in Appendix Figure A4.

The core quantitative results from the estimated counterfactuals are as follows:

Figure 10A. Aggregate Under-5 Deaths 1990 to 2013 (in millions): Actual vs Counterfactuals A and B



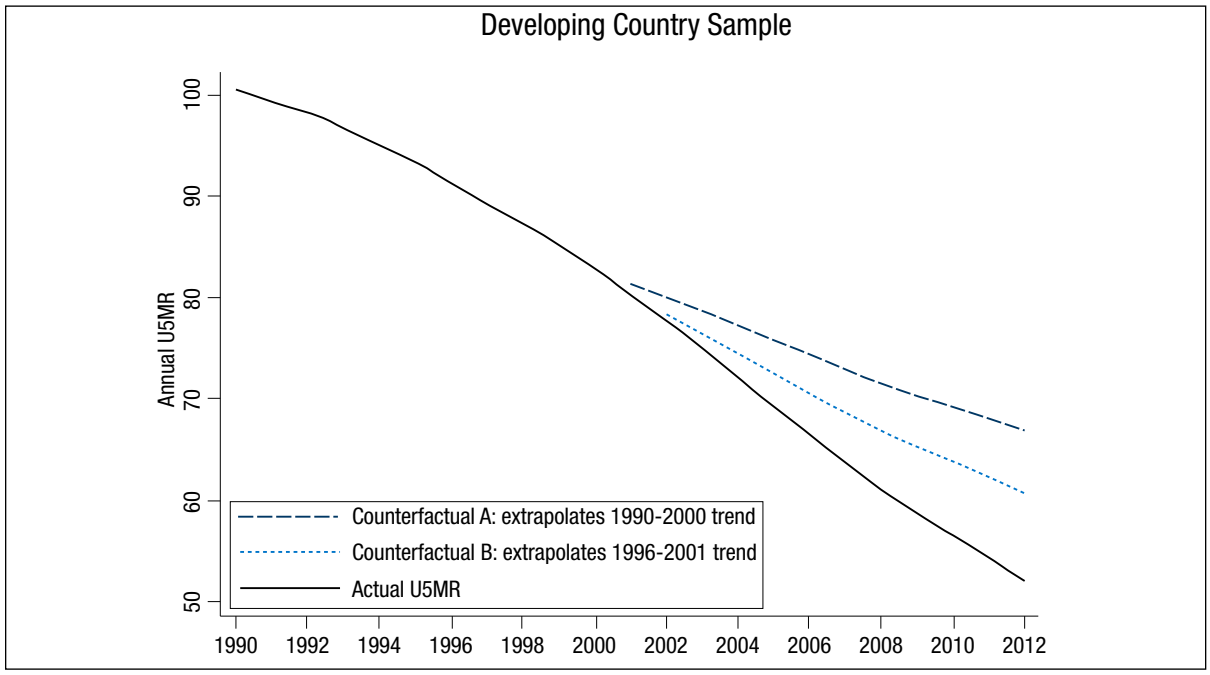
Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

- Under Counterfactual A, if 1990-2000 average U5MR country-level trends had continued, then approximately 1.9 million more children would have died in 2013, implying 8.1 million total deaths that year compared to the actual estimate of 6.2 million. Cumulatively, approximately 13.7 million more children would have died from 2001 through 2013.
- Under Counterfactual B, if 1996-2001 average U5MR country-level trends had continued, then 1.1 million additional children would have died in the year 2013, implying 7.3 million total deaths that year. Cumulatively, approximately 7.5 million more children would have died from 2002 through 2013.

In assessing the two reference periods, Counterfactual B is preferred as the more conservative basis for comparing pre- and post-MDG trends, as discussed in Section 4. Under Counterfactual B's assumptions, the number of incremental lives saved worldwide has increased by approximately 4 to 12 percent per year in recent years. If the trend line is extrapolated for an extra two years beyond 2013, the cumulative number of additional children's lives saved approaches 10 million by 2015.

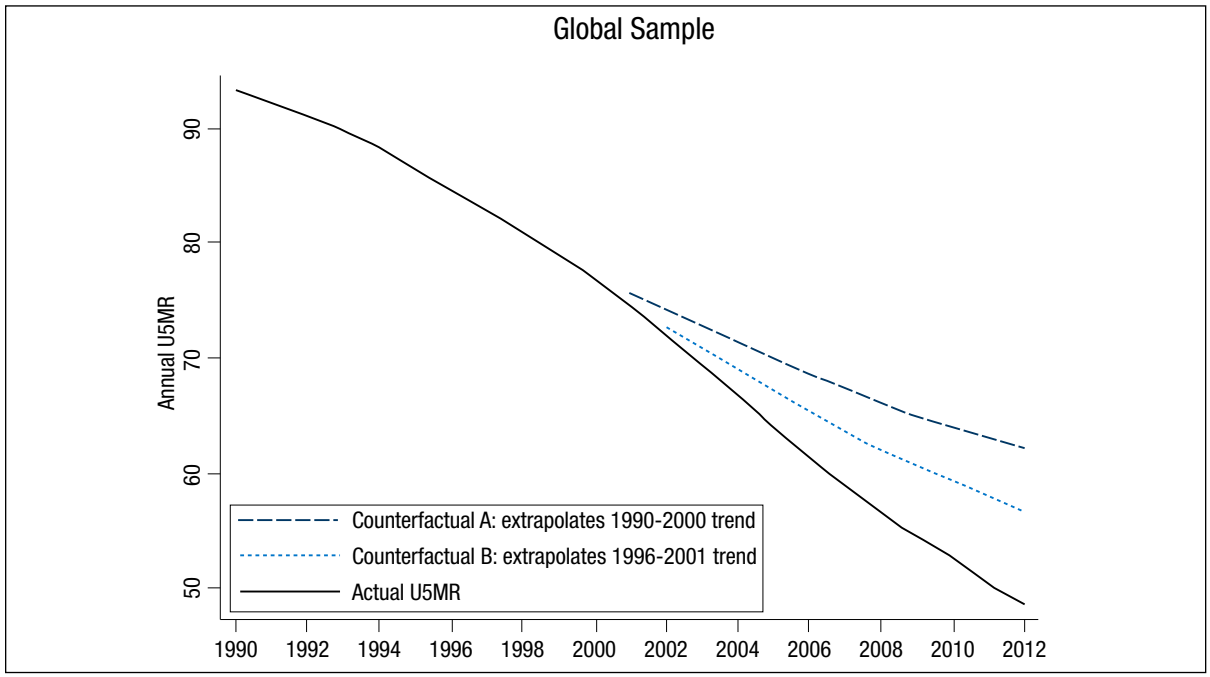
Figure 11 shows a regional breakdown for the counterfactual estimates. The bottom panel for Counterfactual B shows that more than three-fourths (78 percent) of the cumulative lives saved from 2002 through 2013 are in sub-Saharan Africa, 11 percent are in East Asia and the Pacific, and 10 percent are in South Asia. In 2013 alone, approximately 82 percent of the estimated lives saved were in sub-Saharan Africa.

Figure 10B. Aggregate U5MR 1990 to 2012: Actual vs Counterfactuals A and B



Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

Figure 10C. Aggregate U5MR 1990 to 2012: Actual vs Counterfactuals A and B



Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

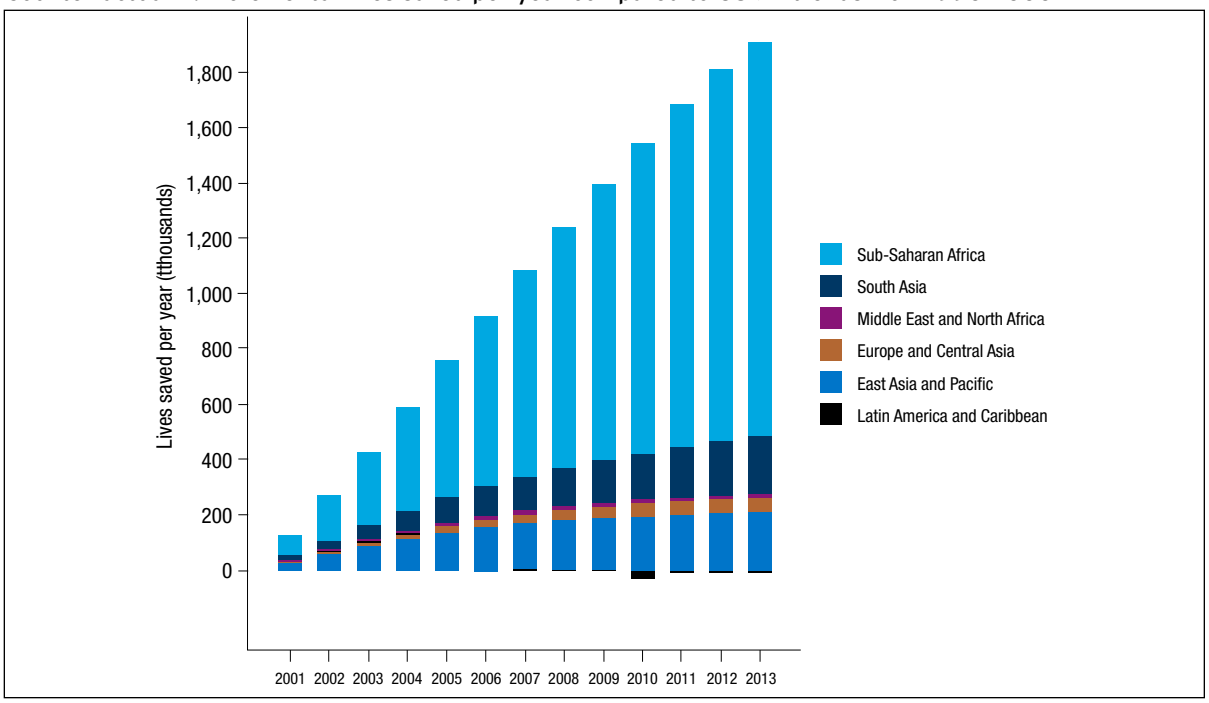
For both counterfactuals, almost all of the lives saved in 2013 are in initially Off Track countries, and more than four-fifths are in low-income countries. Under the preferred Counterfactual B, 1.1 million lives were saved in the Off Track group in 2013 and an aggregate of approximately 29,000 lives were "lost" across the On Track group due to slowdowns in U5MR decline. Meanwhile, approximately 918,000 lives were saved in low-income countries, on aggregate, and approximately 182,000 were saved in middle-income countries. Under Counterfactual A, 1.9 million lives were saved in initially Off Track countries in 2013, compared to roughly 8,000 lives "lost" in the On Track group, again due to slowdowns in U5MR decline. Meanwhile 1.6 million lives were saved in initially low-income countries under Counterfactual A, and approximately 255,000 were saved in initially middle-income countries.

A large majority of the estimated lives saved have occurred in a limited number of countries, as shown in Table 7. The top 20 countries account for 86 percent and 91 percent of cumulative estimates under Counterfactuals A and B, respectively. China and India rank among the top four countries under either counterfactual, indicating that both experienced important accelerations in progress since the 2000/2001 benchmark. However, the two countries combine for only 22 percent of cumulative developing world lives saved under Counterfactual A, and only 18 percent under Counterfactual B. The vast majority of incremental reductions in child deaths have taken place outside of China and India.

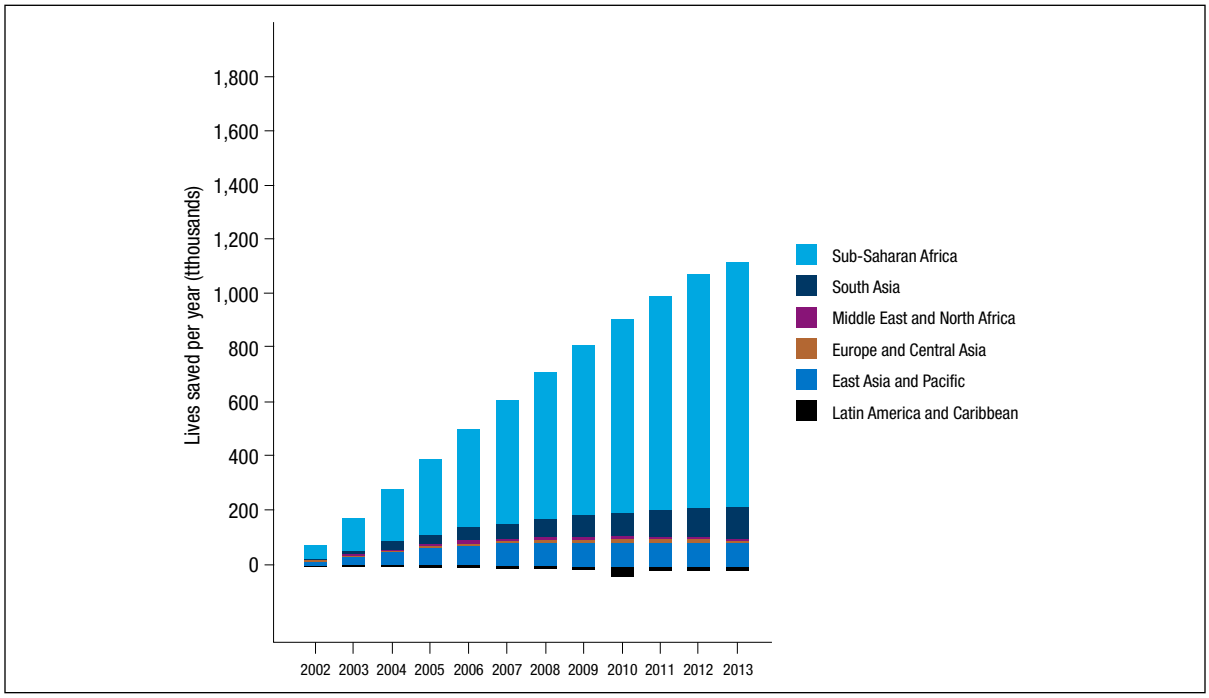
A brief comment on Democratic Republic of the Congo is merited, since the country is not commonly considered a top performer on health metrics. The country is well known to have imperfect national data, and its U5MR estimates for recent years were substantially updated in UN IGME (2014). Over the past decade annual aid flows to the country have averaged more than $1 billion, including significant grants from the Global Fund to Fight AIDS, Tuberculosis and Malaria (OECD 2014). However, to the extent the estimated U5MR levels are accurate, the country's relative progress might also be due more simply to a reduction in large-scale violent conflict. This complex case offers an example of the detailed country-level assessments that form important topics for future MDG-related research.

Figure 11. Regional Decomposition of Incremental Under-5 Lives Saved per Year

Counterfactual A: Incremental lives saved per year compared to U5MR trends from 1990-2000



Counterfactual B: Incremental lives saved per year compared to U5MR trends from 1996-2001



Sources: Author's calculations based on UN IGME 2014; World Bank 2014.

Table 7. Estimated Children Under-5 Lives Saved Compared to Counterfactuals, Top 20 Countries

Counterfactual A			
	Country	in 2013	Cumulative 2001-2013
1	Nigeria	285,414	1,902,579
2	China	182,689	1,647,815
3	India	192,637	1,421,789
4	Congo DR	154,642	974,607
5	Ethiopia	87,358	685,914
6	Tanzania	82,032	670,709
7	Kenya	87,355	562,621
8	Uganda	73,656	550,732
9	Rwanda	74,278	548,336
10	Cameroon	62,024	430,049
11	Mali	39,849	294,382
12	Senegal	39,655	282,140
13	Burkina Faso	45,219	280,649
14	South Africa	56,342	275,472
15	Zambia	32,332	240,672
16	Malawi	26,434	224,341
17	Cambodia	23,716	208,510
18	Niger	30,399	206,868
19	Korea DPR	22,872	193,523
20	Angola	34,744	184,054
All developing countries in sample		1,897,228	13,672,118
Top 20 share of all developing countries		86%	86%

Counterfactual B			
	Country	in 2013	Cumulative 2002-2013
1	Congo DR	147,051	916,370
2	China	85,664	801,072
3	Nigeria	126,483	789,483
4	India	102,287	658,190
5	Ethiopia	74,680	577,726
6	South Africa	93,178	510,387
7	Uganda	47,237	347,456
8	Tanzania	30,983	271,022
9	Kenya	43,208	261,796
10	Rwanda	29,478	237,873
11	Burkina Faso	35,730	214,405
12	Cameroon	29,435	202,048
13	Mali	24,617	182,666
14	Senegal	24,566	174,069
15	Niger	24,578	164,586
16	Zambia	16,800	127,723
17	Malawi	13,853	117,298
18	Cote d Ivoire	18,761	111,475
19	Angola	24,136	111,064
20	Cambodia	9,060	93,107
All developing countries in sample		1,099,567	7,526,282
Top 20 share of all developing countries		91%	91%

Source: Author's calculations based on UN IGME 2014.

9. IMPLICATIONS FOR POST-2015

One of the main implications of the above results is that all trajectories are subject to change. Global structural shifts might have been initiated in recent years, but, as the 2013 data highlight, one must remain careful not to translate trajectories into projections. Some countries might slow down in progress, while still others might accelerate significantly. Given the 2-year window between the latest available data and the final MDG deadline, this prompts the question of what level of progress each country would require in order to achieve the formal target by 2015. It also provides relevant information for the formulation of any global under-5 mortality targets that might take shape for the post-2015 period.

To inform consideration of post-MDG development targets, Table 8 presents an extrapolation of recent U5MR trends across all 173 countries in the sample, including high-income countries, extrapolated to 2030. To attenuate the risk that some countries might have seen unusually high rates of progress in the most recent years, these trajectories are based on a continuation of 12-year average rates of decline from the period 2001 through 2013. The right-side column includes the key countries of interest. (Some trajectories listed on the left side of the table might appear optimistic, at the global technological frontier, but those are less pertinent because rates of change at the global frontier are not the focus of this exercise.) On current trajectory, 135 countries are on a path to achieve under-5 mortality rates of 30 or better by 2030, while 38 countries are not. This threshold is higher than the U5MR of 20 suggested by some as a minimum standard linked to the end of extreme poverty (Save the Children 2013), and nearly twice the target U5MR of 16 proposed by Jamison et al. (2013) as a global goal for 2035.

What has maximum acceleration looked like in recent years? To answer this question, Table 9 examines countries based on backward induction of performance standards. It presents five bands of current trajectory outcomes for 2015, extrapolating most recent trends from 2008 to 2013, and lists the three countries on course to have made the greatest estimated progress to achieve each threshold band since 2000. The bands are set at under-5 mortality rates of 20, 30, 40, 50, and 60, respectively. Each band is distinct because it typically represents different sources of mortality and implied health needs, including for facilities and health systems as neonatal mortality grows as a share of U5MR (Bhutta and Black 2013, Ram et al. 2013).

Band 1 has a U5MR outcome ceiling of 20. Maldives is on course to make the greatest progress in reaching this level by 2015, dropping from an U5MR of 44 in 2000. For Band 2 at an U5MR of 30, Mongolia is the top performer, having dropped from 65 in 2000. A superficial interpretation of Band 2 would suggest that countries with U5MR above 65 would not be able to reach an absolute standard of 30 within 15 years. However, in Band 3, Cambodia is on a path to decline from U5MR of 111 in 2000 to 34 by 2015. A slight further acceleration could see the country still achieve the 30 threshold, and thereby establish a precedent for countries like Mali and Nigeria that, as of 2013, are on course to have U5MRs of around 110 in 2015 (114 in Mali and 109 in Nigeria). Altogether, eight countries are on a path to have mortality rates higher than 110 by 2015: Angola, Central African Republic, Chad, DR Congo, Guinea-Bissau, Mali, Somalia, and Sierra Leone. These countries have a current aggregate population of more than 136 million people, and will require the greatest attention in determining relevant global targets and strategies for change.

Table 8. Under-5 Mortality Trajectories for 2030, Extrapolating 2001-2013 Trends

Luxembourg	1	Canada	4	Honduras	11	Uzbekistan	25
Estonia	1	Cuba	4	Panama	11	Guyana	25
Iceland	1	Kazakhstan	4	Korea DPR	11	India	26
Belarus	1	Brazil	4	Mauritius	11	Namibia	27
Slovenia	1	Ukraine	4	Jordan	11	Myanmar	28
Finland	1	Bosnia & Herzegovina	5	Nicaragua	12	Gabon	32
Norway	1	Malta	5	Barbados	12	Turkmenistan	33
Maldives	1	Sri Lanka	5	Paraguay	13	Zambia	37
Montenegro	1	Qatar	5	Azerbaijan	13	Niger	37
Lithuania	2	New Zealand	5	Mongolia	13	Mozambique	37
Ireland	2	United States of America	5	Bhutan	13	Lao PDR	37
Japan	2	Bulgaria	5	Ecuador	13	Burundi	38
Czech Republic	2	Peru	5	Suriname	13	Kenya	38
Portugal	2	United Arab Emirates	5	Algeria	14	Gambia The	40
Korea Rep	2	Libya	6	Indonesia	14	Burkina Faso	40
Cyprus	2	Chile	6	Congo	14	Benin	42
Denmark	2	Tunisia	6	Trinidad & Tobago	14	Swaziland	42
Singapore	2	El Salvador	6	State of Palestine	14	Djibouti	43
Sweden	2	Moldova	6	Vietnam	14	Papua New Guinea	44
Israel	2	Kuwait	6	Bangladesh	15	South Sudan	45
Croatia	2	Uruguay	6	Tanzania	15	Haiti	46
Macedonia	2	Thailand	6	Nepal	16	Sudan	49
Italy	2	Iran	7	Morocco	16	Cameroon	51
Greece	2	Armenia	7	Bolivia	16	Guinea	51
Australia	2	Costa Rica	7	Guatemala	16	Togo	53
Netherlands	2	Turkey	7	Senegal	16	Comoros	54
Bahrain	2	Mexico	7	Dominican Republic	17	Mali	57
Spain	2	Albania	7	Cape Verde	19	Equatorial Guinea	57
Austria	2	Malaysia	7	Botswana	20	Ghana	57
Poland	2	Oman	7	Malawi	20	Pakistan	60
Germany	3	Argentina	8	South Africa	20	Cote d Ivoire	60
Serbia	3	Syria	8	Tajikistan	20	Afghanistan	63
Switzerland	3	Egypt	9	Philippines	21	Nigeria	63
United Kingdom	3	Venezuela	9	Ethiopia	22	Mauritania	65
Hungary	3	Kyrgyzstan	9	Liberia	22	Congo DR	68
France	3	Cambodia	9	Yemen	23	Zimbabwe	73
China	3	Saudi Arabia	9	Uganda	23	Guinea-Bissau	75
Belgium	3	Belize	10	Timor Leste	23	Lesotho	76
Lebanon	3	Bahamas	10	Fiji	23	Sierra Leone	99
Russian Federation	3	Rwanda	10	Madagascar	23	Central African Republic	102
Latvia	3	Colombia	10	Eritrea	24	Chad	105
Georgia	3	Jamaica	10	Iraq	24	Somalia	113
Slovakia	4	Brunei	11	Solomon Islands	25	Angola	118
Romania	4						

Source: Author's calculations based on UN IGME 2014.

Table 9. Top Performers on Course to Achieve Key U5MR Thresholds by 2015

	U5MR 2000	U5MR 2015 (trajectory)	Percentage reduction, 2000 to 2015
Band 1: Countries on course for U5MR <20			
Maldives	44	8	81%
Kazakhstan	44	14	69%
Turkey	42	17	59%
Band 2: Countries on course for U5MR <30			
Mongolia	65	29	55%
Korea DPR	60	26	57%
Indonesia	52	27	48%
Band 3: Countries on course for U5MR <40			
Cambodia	111	34	69%
Bangladesh	88	36	59%
Nepal	82	36	56%
Band 4: Countries on course for U5MR <50			
Rwanda	182 *	45	75%
Senegal	137	48	65%
Tanzania	132	46	65%
Band 5: Countries on course for U5MR <60			
Malawi	174 *	59	66%
Uganda	147	59	60%
Ethiopia	146	57	61%

*Note: * indicates U5MR greater than the country with the highest current trajectory for 2015, Angola at 158.*
Source: Author's calculations based on UN IGME 2014.

Appendix Table A1 shows that Angola is currently on course to have the world's highest U5MR in 2015, at 158, and Table 8 shows that it is also on course to be the highest in 2030, at 118. Its situation can be compared to the recent histories of Rwanda and Malawi, the top performers on course to reach band 4 (U5MR<50) and band 5 (U5MR<60), respectively. Both countries had mortality rates much greater than 158 in 2000. Rwanda is on a path to decline from U5MR of 182 to 45 over the course of 15 years, while Malawi is on a path to decline from 174 to 59. If precedent is any guide, these two cases suggest that a universal U5MR ceiling of 45 or 50 by 2030 would be a cautiously reasonable if not ambitious upper bound target for all countries. Forthcoming innovations in technology and delivery systems might of course enable even more ambitious targets.

10. DISCUSSION AND CONCLUSIONS

Casual assessments of progress on global development goals are subject to confirmation bias in both positive and negative directions. Those who regularly reference goals as an overarching rationale for their own work risk overestimating the extent to which goal-inspired activities contribute to broader success. Meanwhile, those who do not regularly reference the same goals might underestimate the role targets play in motivating the actions and resource allocations of others.

This paper pursues a rigorous multi-dimensional examination of developing country progress in reducing U5MR since the advent of the MDGs. It distinguishes between countries that were already On Track to achieve the Goals and those that were Off Track at the outset. It also distinguishes between initially low-income and middle-income countries. Recent trends are compared against two different reference periods, one from 1990-2000 and another from 1996-2001.

By applying a series of Highest, Medium, and Minimum tests, the paper demonstrates the inadequate nature of information provided by simply counting the number of countries that are currently on course to achieve an MDG. This does not imply that world leaders should be held to any standard short of their own public commitments. It is only to suggest that different tests provide very different impressions of MDG results. Many countries have registered objective success on the formal MDG target for child mortality. But a more pertinent test is to consider what has happened among the countries which the Goals were most intended to support. In turn, the most important question is whether the MDGs have coincided with structural changes in patterns of global progress.

It is a paradox that many of the greatest gains potentially linked to the MDGs appear to have been registered by groups of countries among which only a minority might achieve the formal MDG targets. This is likely linked to the fact that initially Off Track countries were also low-income countries with limited health systems and minimal or negative momentum in building those systems prior to the early 2000s. It might have been more difficult for the poorest countries to initiate average global rates of U5MR progress than for average performing countries to initiate top quintile-type performance. In any case, approximately four-fifths of initially Off Track countries have experienced faster progress since the advent of the MDGs than they did during reference periods prior to the MDGs. An even greater share of low-income countries has seen progress too. Among sub-Saharan African countries, approximately 90 percent have experienced accelerated progress, and at least 65 percent have accelerated by at least 1 percentage point per year.

Regional progress has varied outside of Africa. In Europe and Central Asia nearly two-thirds (64 percent) of countries are set to achieve the MDG and more than two-thirds (71 percent) saw acceleration. Half the countries in South Asia have already achieved the target and a majority has seen acceleration. East Asia and the Pacific and in the Middle East and North Africa have seen more mixed progress, although the latter was starting from a faster average rate. Latin America and the Caribbean saw the least success against the three different MDG tests. In regression analysis this regional trend still persists even after controlling for initial levels of mortality. The regional assessments draw attention to the relative merits of acceleration tests, since annual U5MR declines in Latin America averaged a healthy 5.1 percent during the 1990s. Nonetheless, the region's limited MDG test

results, in addition to the broader trend of non-acceleration among middle-income countries, highlight the extent to which the MDGs might have had negligible effects in segments of the developing world that were already making steady progress.

The most important evidence in this paper suggests that the 2000s saw structural change in global patterns of progress. The era since the initiation of the MDGs includes the first multi-year period in at least four decades that cross-country patterns of U5MR decline have not been negatively and significantly correlated with initial mortality (or positively correlated with average income). When comparing high- and low-mortality countries, comparable rates of U5MR progress imply a persistent proportionate gap but an accelerated narrowing of the level gap. Another important shift pertains to sub-Saharan Africa, where average rates of progress have been statistically indistinguishable from the rest of the world since 2004, after decades of lagging behind.

The structural progress can be measured through counterfactual-based estimates of lives saved. A conservative estimate based on trends from 1996 to 2001 indicates that approximately 7.5 million children's lives have already been saved, mostly in sub-Saharan Africa, en route to approximately 10 million lives saved by 2015. A less conservative estimate based on trends from 1990 to 2000 indicates that more than 13.7 million extra lives have already been saved. Under both counterfactuals, almost all of the lives saved in 2013 are in countries that were initially Off Track at the beginning of the MDGs; more than four-fifths are in initially low-income countries; and more than three-quarters are in Africa. It is important to note that future data revisions might lead to updates for all of these estimates, especially for low-income countries. But to put the magnitude of these figures in context, the global number of violent conflict-related deaths from 2000 to 2013 has been estimated at approximately 508,000 (Uppsala Conflict Data Program 2014).[6]

This study does not investigate specific pathways of causality. Many MDG-related efforts might well have contributed to the above successes, both through targeted investments in health and through complementary efforts in areas like agricultural productivity, education, and drinking water (Jamison et al., 2001; Jones et al., 2003). Moreover, the major scale-up of health financing over the past decade was often specifically linked to supporting the achievement of the MDGs. For example, when the Council of the European Union issued its seminal May 2005 timetable to achieve the aid target of 0.7 percent of national income by 2015, the title of the press release was, "Council conclusions: Accelerating progress towards achieving the Millennium Development Goals" (European Union External Relations Council 2005). Only a portion of these commitments have since been fulfilled, but the portion that did arrive is likely linked at least partially, if not mostly, to the global focus on the MDGs. Nonetheless, it is not analytically sound to attribute all progress since 2000 to the MDGs. For example, many of the people championing the MDGs would have worked on the same issues in any case. The "macro" results presented here can help to inform more targeted assessments of "micro" hypotheses at the national or sub-national level.

For policy debates, this paper's evidence of accelerated progress among low-income, sub-Saharan African, and initially Off Track countries does provide a clear counterpoint against those who assert that progress under the MDGs was "already happening," or that global progress is mainly due to China and India. The evidence also draws attention to subtleties

of implementing global goals. It might be that the persistent global pursuit of highly ambitious targets played a key role in changing trajectories for a majority of previously trailing countries, even if only a minority of those countries end up registering nominal success against the formal targets.

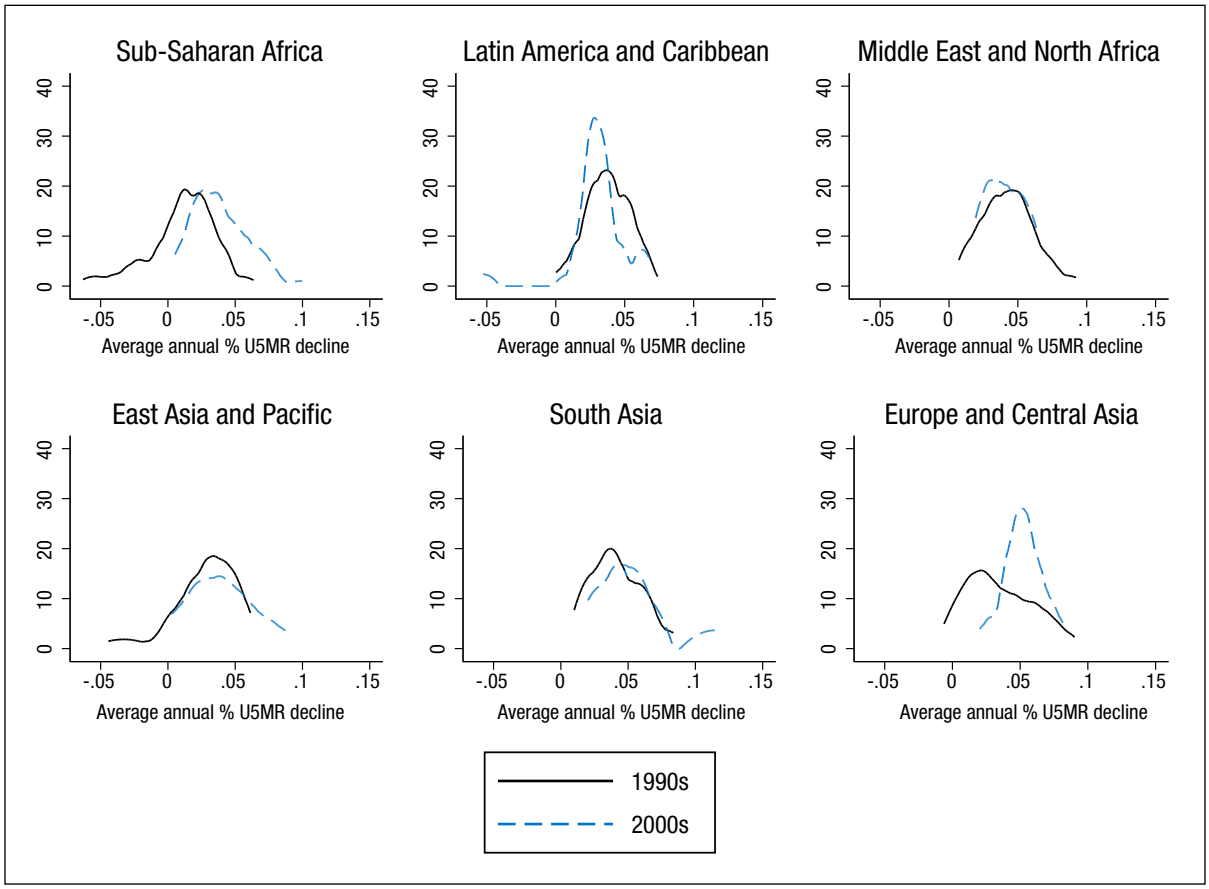
The specific results for China and India are also noteworthy. Although these two countries account for less than a quarter of estimated "extra" children's lives saved, both countries experienced acceleration in progress during the 2000s, indicating that their reductions in U5MR were not simply underway already. It is debatable the extent to which these discontinuities might be linked to the MDGs. The accelerations might have been entirely due to domestic factors. Alternatively, they might have been partially linked to targeted aid received from GAVI and the Global Fund to Fight AIDS, Tuberculosis and Malaria, which might have helped to focus policymakers on key interventions like immunizations and malaria bed net coverage. It might also be that emerging global norms and ambitious targets around U5MR indirectly stimulated the countries to accelerate their efforts on health outcomes. Such questions merit careful review in subsequent research.

To inform consideration of any new U5MR targets to follow the MDGs, the paper presents current trajectories through 2015 and 2030, respectively. In the first instance, these highlight the prospects for additional countries still to achieve MDG4 targets by 2015. In the second instance, it considers a range of absolute value U5MR thresholds for 2030 and describes how they relate to recent top performing countries.

Current 2030 trajectories suggest a world in which most countries' U5MRs are perhaps unimaginably lower than many would have considered practical even fifteen years ago. They also show the extent to which the global child mortality challenge will likely be focused on a few dozen countries where mortality is on course to remain stubbornly high. At the same time, the paper's results caution against presuming the persistence of any trends from one decade to the next. The remainder of the 2010s and the 2020s could still see significant changes in all directions.

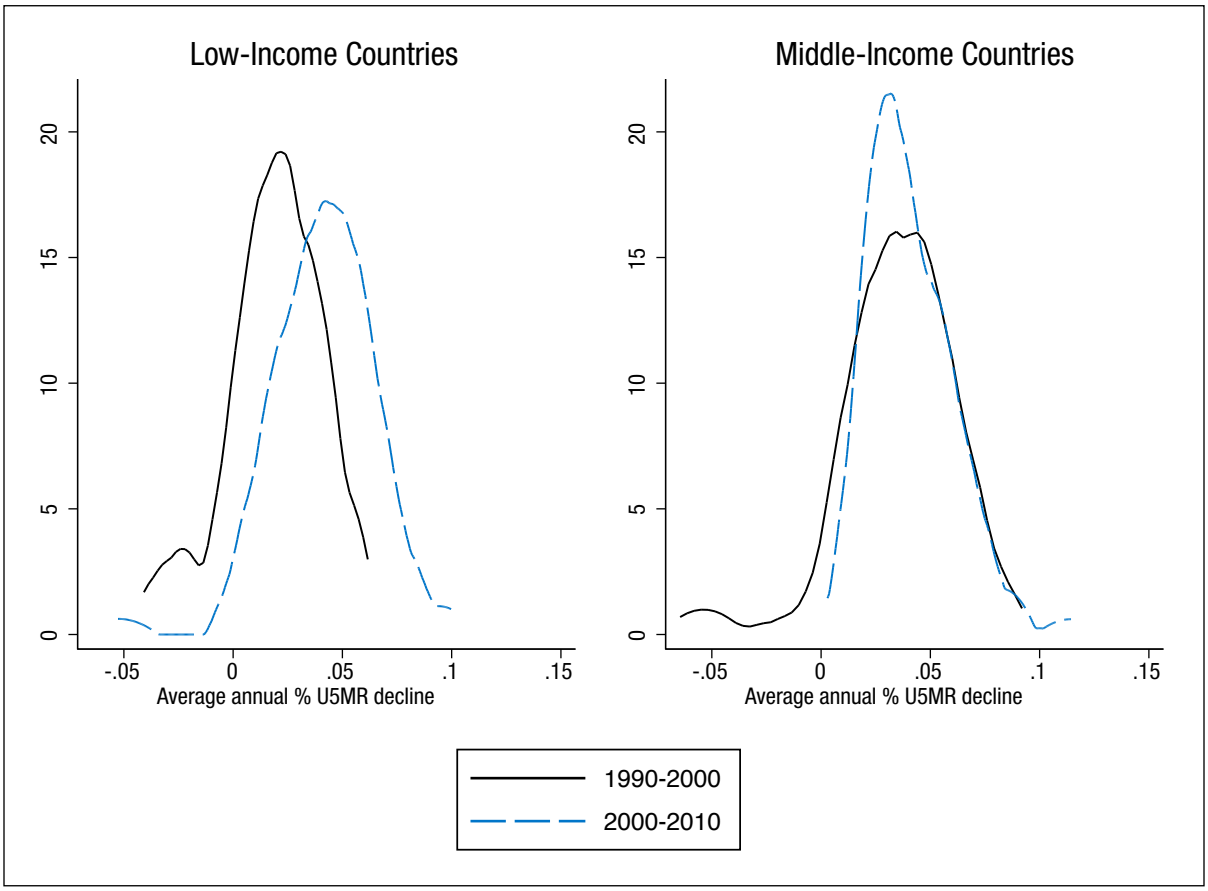
APPENDIX

Appendix Figure A1. Cross-Country Regional Distributions of Decline in Under-5 Mortality Rates, 1990-2000 vs 2000-2010



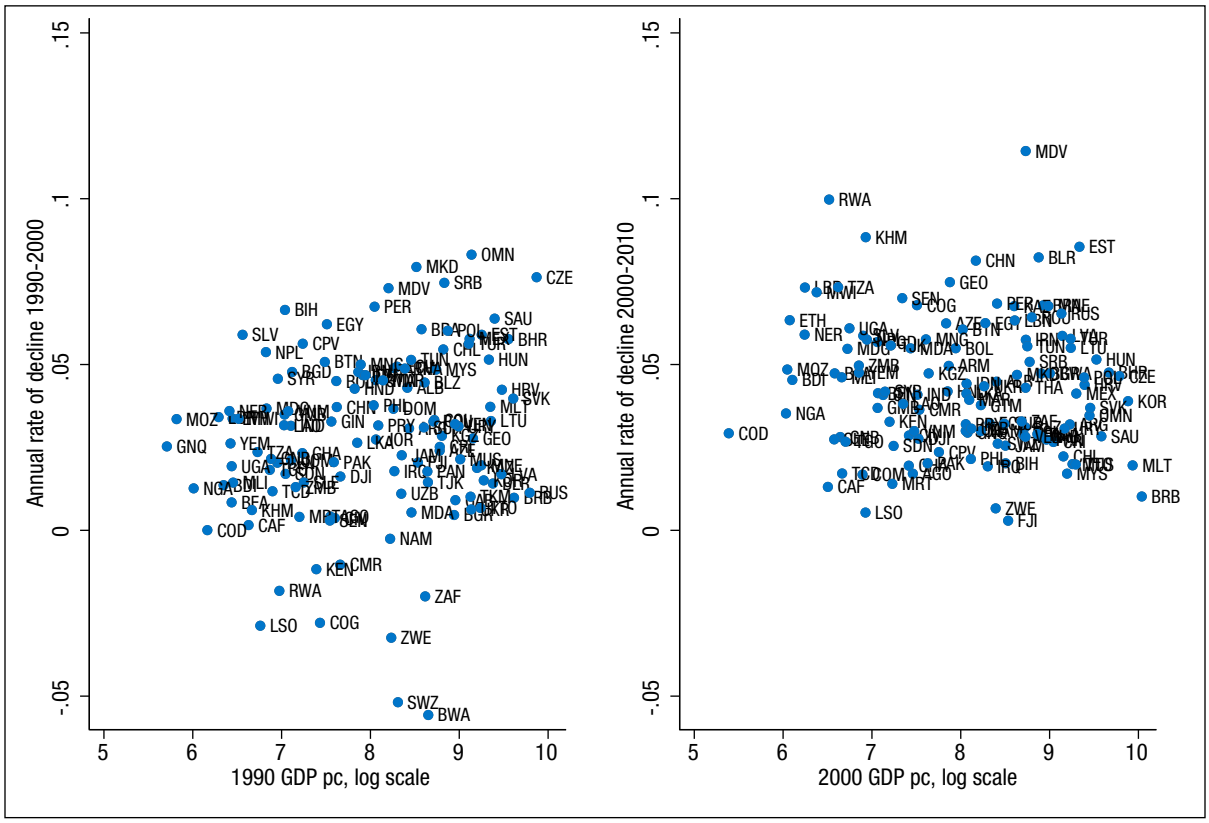
Source: Author's calculations based on UN IGME 2014

Appendix Figure A2. Cross-Country Income Group Distributions of Decline in Under-5 Mortality Rates, 1990-2000 vs 2000-2010



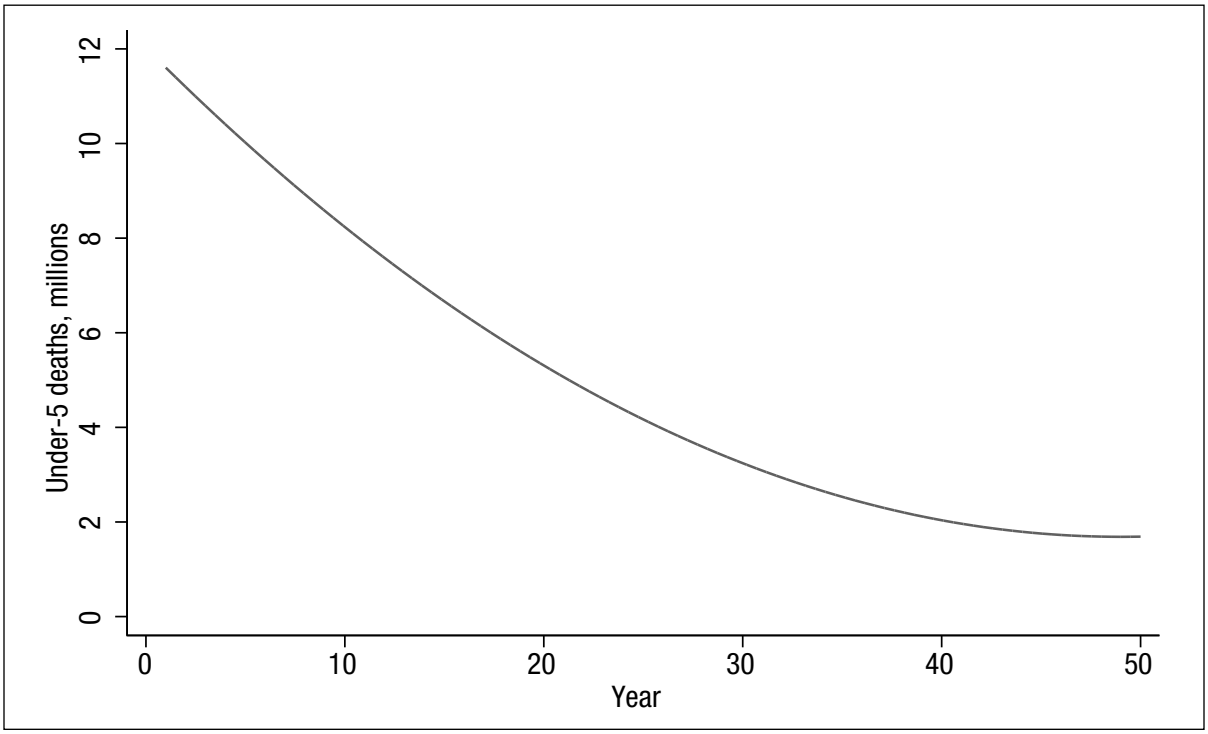
Source: Author's calculations based on UN IGME 2014

Appendix Figure A3. Initial Income versus Annual Rate of Decline in Under-5 Mortality Rate Across Developing Countries, 1990-2000 and 2000-2010



Sources: Author's calculations based on UN IGME 2014; Feenstra et al. 2013.

Appendix Figure A4. Under-5 Deaths over 50 Years Assuming Constant 4.3% Annual Rate of Improvement and Constant Annual Number of Births



Appendix Table A1. Rates of Progress Needed to Achieve MDG by 2015

Country	Under-5 Mortality Rate per 1000 live births		Average annual progress rate		
	2015 at recent trajectory	2015 MDG Target	Most recent (2008-13)	Needed for MDG (2013-15)	Gap
Albania	14	14	3.6%	4.8%	1.2%
Senegal	48	47	6.5%	7.8%	1.3%
Russian Federation	9	9	5.6%	7.4%	1.7%
Honduras	21	20	3.8%	5.8%	2.0%
Morocco	28	27	3.7%	5.9%	2.2%
Guatemala	29	27	3.4%	6.9%	3.5%
South Sudan	92	84	3.8%	7.8%	4.0%
Ecuador	21	19	3.1%	8.2%	5.1%
Yemen	47	42	4.6%	9.9%	5.4%
Syria	14	12	2.4%	7.8%	5.4%
Slovakia	7	6	3.9%	9.5%	5.5%
Latvia	8	7	4.4%	10.0%	5.7%
India	48	42	4.3%	10.8%	6.4%
Guinea	93	79	3.7%	11.3%	7.7%
Belize	16	13	3.2%	11.1%	7.9%
Cape Verde	25	21	1.7%	10.1%	8.4%
Gambia The	69	57	3.4%	12.4%	9.0%
Lao PDR	66	54	3.7%	13.0%	9.3%
Tajikistan	45	36	3.4%	13.0%	9.7%
Zambia	80	64	4.4%	14.3%	9.9%
Sri Lanka	9	7	3.9%	14.0%	10.1%
Chile	8	6	1.6%	11.9%	10.3%
Burkina Faso	87	67	5.7%	16.9%	11.2%
Myanmar	47	36	3.4%	15.3%	11.9%
Moldova	14	11	4.1%	16.4%	12.3%
Benin	79	60	3.7%	16.3%	12.5%
Paraguay	21	15	3.2%	16.1%	12.9%
Dominican Republic	26	20	2.9%	15.8%	12.9%
Vietnam	22	17	2.8%	15.8%	13.0%
Burundi	76	57	4.1%	17.1%	13.0%
Mali	114	85	3.8%	16.9%	13.1%
Suriname	21	16	3.1%	16.5%	13.4%
Congo	42	31	7.4%	20.9%	13.4%
Colombia	16	12	3.1%	16.7%	13.6%
Uruguay	10	8	3.1%	16.7%	13.6%
Argentina	13	9	2.9%	16.8%	13.9%
Ukraine	9	7	5.0%	19.2%	14.2%
Cuba	6	4	0.3%	15.4%	15.1%
State of Palestine	21	14	2.8%	18.5%	15.8%
Haiti	69	48	2.6%	18.6%	16.0%
Jordan	18	12	3.0%	19.1%	16.1%
Korea Rep	3	2	3.8%	20.0%	16.2%
Venezuela	14	10	2.3%	18.8%	16.5%
Equatorial Guinea	90	61	3.2%	20.0%	16.8%

Country	Under-5 Mortality Rate per 1000 live births		Average annual progress rate		
	2015 at recent trajectory	2015 MDG Target	Most recent (2008-13)	Needed for MDG (2013-15)	Gap
Philippines	29	20	2.2%	19.2%	16.9%
Bulgaria	11	7	3.3%	20.3%	17.0%
Algeria	24	16	3.1%	21.1%	18.0%
Nigeria	109	71	3.7%	22.2%	18.5%
Afghanistan	93	60	2.5%	21.7%	19.2%
Guinea-Bissau	117	75	3.0%	22.2%	19.2%
Malta	6	4	1.6%	21.1%	19.5%
Jamaica	16	10	3.1%	22.6%	19.6%
Malaysia	9	6	-0.7%	19.3%	20.0%
Panama	17	10	3.1%	23.9%	20.8%
Togo	80	49	3.0%	24.1%	21.1%
Djibouti	66	40	2.9%	24.6%	21.7%
Gabon	52	31	4.0%	25.8%	21.8%
Uzbekistan	40	24	3.2%	25.2%	22.0%
Costa Rica	9	6	1.2%	23.4%	22.2%
Sierra Leone	151	89	2.9%	25.5%	22.6%
Guyana	35	20	2.7%	25.3%	22.7%
Sudan	73	43	2.6%	25.4%	22.7%
Turkmenistan	52	30	3.1%	26.0%	22.9%
South Africa	37	20	8.7%	31.9%	23.2%
Comoros	73	42	3.0%	26.7%	23.7%
Korea DPR	26	14	3.3%	27.3%	24.0%
Pakistan	82	46	2.2%	26.5%	24.3%
Ghana	76	43	1.6%	26.2%	24.5%
Mauritius	14	8	2.0%	26.6%	24.6%
Iraq	32	18	2.4%	27.6%	25.2%
Namibia	46	25	4.3%	29.8%	25.6%
Cote d Ivoire	94	51	3.1%	28.9%	25.8%
Congo DR	111	59	3.3%	29.6%	26.4%
Cameroon	88	45	3.5%	30.6%	27.1%
Chad	140	72	2.7%	30.3%	27.7%
Trinidad & Tobago	20	10	3.0%	30.8%	27.8%
Papua New Guinea	58	30	2.6%	30.5%	27.8%
Kenya	65	33	3.9%	31.8%	27.9%
Angola	158	75	2.7%	32.9%	30.2%
Mauritania	85	39	2.7%	34.0%	31.3%
Solomon Islands	29	13	2.5%	34.5%	32.1%
Central African Republic	131	59	2.8%	34.9%	32.1%
Somalia	138	60	2.8%	35.9%	33.1%
Barbados	14	6	0.9%	35.3%	34.3%
Fiji	24	10	-0.2%	34.9%	35.1%
Botswana	43	17	4.1%	40.5%	36.3%
Swaziland	69	25	7.0%	44.5%	37.5%
Lesotho	91	29	3.5%	45.8%	42.3%
Zimbabwe	86	25	1.7%	47.0%	45.3%

Source: Author's calculations based on UN IGME (2014)

Appendix Table A2. Unweighted Average Annual Percent U5MR Decline, by Decade

	N *	1970-1980	1980-1990	1990-2000	2000-2010	2005-2013
Income Group in 2000						
Low-income	65	2.0	2.3	1.9	4.1	4.2
Middle-income	76	4.4	4.3	3.6	4.1	4.1
High-income	32	5.1	4.2	4.4	3.2	2.9
Developing Region						
Sub-Saharan Africa	46	2.0	2.0	1.1	3.9	4.1
Latin America and Caribbean	26	4.1	4.0	3.8	3.1	3.2
East Asia and Pacific	16	4.5	3.6	2.8	4.0	3.4
South Asia	8	2.6	4.0	4.1	5.2	5.0
Middle East and North Africa	17	5.2	5.5	4.2	4.0	3.8
Europe and Central Asia	28	3.3	3.2	3.5	5.3	5.4

*Notes: (1) * indicates number of countries in final period. (2) Population-weighting is calculated based on number of births in each country*
Sources: Author's calculations based on UN IGME 2014; World Bank 2001; World Bank 2014.

Appendix Table A3. Descriptive Statistics

	Year	1965	1975	1985	1995	2005
Developing Countries	**Under-5 Child Mortality (Ln)**	5.07	4.78	4.35	4.07	3.69
		(0.61)	*(0.69)*	*(0.82)*	*(0.91)*	*(0.97)*
	Observations	90	116	141	141	141
	Income per capita, PPP (Ln)	7.38	7.69	7.78	7.92	8.20
		(0.78)	(0.88)	(0.88)	(1.04)	(1.08)
	Observations	81	102	102	125	125
All Income Levels	**Under-5 Child Mortality (Ln)**	4.71	4.42	4.01	3.70	3.32
		(0.91)	*(0.96)*	*(1.04)*	*(1.14)*	*(1.18)*
	Observations	115	145	173	173	173
	Income per capita, PPP (Ln)	7.82	8.15	8.25	8.36	8.65
		(1.06)	*(1.17)*	*(1.18)*	*(1.28)*	*(1.32)*
	Observations	107	132	132	156	156

Note: Figures in parentheses indicate standard deviations
Sources: Author's calculations based on UN IGME 2014; World Bank 2001; World Bank 2014.

Appendix Table A4. Regression Test for Unconditional Convergence in U5MR Decline (all income levels)

Dependent Variable: Under-5 Child Mortality, Average Annual Rate of Decline over Decade

	(1) 1960s	(2) 1970s	(3) 1980s	(4) 1990s	(5) 2000s	(6) 2005-2013
Initial child mortality (Ln)	-0.006***	-0.010***	-0.005***	-0.007***	0.002	0.002*
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.062***	0.081***	0.057***	0.059***	0.033***	0.032***
	(0.008)	(0.007)	(0.006)	(0.004)	(0.004)	(0.004)
N	104	135	158	173	173	173
R-squared	0.09	0.16	0.08	0.11	0.01	0.02
Sample	All Income Levels					

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013.*

Appendix Table A5. Regression Test for Regional Variation in U5MR Decline (all income levels)

Dependent Variable: Under-5 Child Mortality, Average Annual Rate of Decline over Decade

	(1) 1960s	(2) 1970s	(3) 1980s	(4) 1990s	(5) 2000s	(6) 2005-2013
Initial child mortality (Ln)	0.000	-0.005*	-0.002	0.000	0.006***	0.006***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Sub-Saharan Africa	-0.005	-0.007	-0.020***	-0.031***	-0.017	-0.013
	(0.003)	(0.005)	(0.007)	(0.007)	(0.011)	(0.009)
Latin America and Caribbean	0.007	0.009	-0.002	-0.003	-0.016	-0.014
	(0.004)	(0.006)	(0.007)	(0.007)	(0.012)	(0.010)
East Asia and Pacific	0.020***	0.013	-0.005	-0.010	-0.011	-0.016
	(0.006)	(0.009)	(0.008)	(0.008)	(0.012)	(0.010)
Middle East and North Africa	0.025***	0.027***	0.014*	0.001	-0.008	-0.008
	(0.007)	(0.006)	(0.009)	(0.008)	(0.011)	(0.010)
Europe and Central Asia	0.018***	0.009	-0.008	-0.001	0.005	0.005
	(0.007)	(0.008)	(0.008)	(0.008)	(0.011)	(0.010)
North America	0.011	0.012	-0.011	-0.012	-0.027**	-0.019*
	(0.008)	(0.009)	(0.010)	(0.008)	(0.012)	(0.010)
Constant	0.021	0.053***	0.052***	0.041***	0.026*	0.028**
	(0.016)	(0.016)	(0.013)	(0.012)	(0.014)	(0.012)
N	104	135	158	173	173	173
R-squared	0.39	0.34	0.38	0.29	0.16	0.17
Sample	All Income Levels					

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013.*

Appendix Table A6. Coefficients on Regional Dummy Variables when Applied Individually to Appendix Table A4 regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	1960s	1970s	1980s	1990s	2000s	2005-2013
Sub-Saharan Africa	-0.019***	-0.020***	-0.022***	-0.028***	-0.008	-0.002
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)
Latin America and Caribbean	-0.002	0.003	0.005*	0.007*	-0.010**	-0.009***
	(0.003)	(0.005)	(0.003)	(0.004)	(0.005)	(0.003)
East Asia and Pacific	0.010*	0.005	0.001	-0.002	-0.004	-0.011**
	(0.006)	(0.007)	(0.003)	(0.005)	(0.005)	(0.005)
South Asia	-0.006*	-0.003	0.010	0.018**	0.012	0.010
	(0.003)	(0.005)	(0.006)	(0.007)	(0.010)	(0.009)
Middle East and North Africa	0.021***	0.024***	0.024***	0.011***	-0.001	-0.003
	(0.007)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
Europe and Central Asia	0.003	-0.006	-0.008**	0.005	0.017***	0.018***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.003)	(0.004)
North America	-0.008	-0.002	-0.009**	-0.014***	-0.026***	-0.018***
	(0.006)	(0.005)	(0.004)	(0.002)	(0.002)	(0.003)
N	104	135	158	173	173	173
Sample	All Income Levels					

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013.*

Appendix Table A7. Regression Test for Links Between U5MR Decline and Initial Income

Dependent Variable: Under-5 Child Mortality, Average Annual Rate of Decline over Decade

PANEL A						
	(1)	(2)	(3)	(4)	(5)	(6)
	1960s	1970s	1980s	1990s	2000s	2005-2013
Initial income per capita (Ln)	0.007***	0.013***	0.010***	0.004**	-0.002	-0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-0.026	-0.064***	-0.042***	-0.004	0.057***	0.049***
	(0.017)	(0.020)	(0.015)	(0.015)	(0.014)	(0.013)
N	59	91	100	125	125	125
R-squared	0.13	0.19	0.21	0.03	0.01	0.00
PANEL B						
	(1)	(2)	(3)	(4)	(5)	(6)
	1960s	1970s	1980s	1990s	2000s	2005-2013
Initial child mortality (Ln)	-0.007	-0.008	-0.006	-0.009**	-0.004	-0.003
	(0.005)	(0.006)	(0.004)	(0.004)	(0.003)	(0.003)
Initial income per capita (Ln)	0.004	0.008*	0.006	-0.002	-0.005*	-0.003
	(0.004)	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)
Constant	0.036	0.015	0.014	0.084**	0.101***	0.079***
	(0.051)	(0.063)	(0.048)	(0.042)	(0.033)	(0.028)
N	57	89	99	125	125	125
R-squared	0.18	0.20	0.24	0.06	0.01	0.01
Sample	Developing Countries as of 2001					

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although column 6 is for the eight year period 2005-2013.*

Appendix Table A8. Regression Test for Regional Variation in U5MR Decline (conditional on initial income)

Dependent Variable: Under-5 Child Mortality, Average Annual Rate of Decline over Decade

	1960s		1970s		1980s		1990s		2000s		2005-2013	
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)	(5A)	(5B)	(6A)	(6B)
Initial income p.c. (Ln)	0.004	0.005	0.007*	0.006	0.005*	0.004	-0.007**	-0.007*	-0.006***	-0.004	-0.002	-0.002
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.002)
Initial child mortality (Ln)		0.001		-0.003		-0.002		0.001		0.003		-0.000
		(0.005)		(0.005)		(0.004)		(0.004)		(0.004)		(0.004)
Sub-Saharan Africa	-0.006	-0.006	-0.007	-0.007	-0.021***	-0.021***	-0.036***	-0.037***	-0.021*	-0.022*	-0.013	-0.013
	(0.004)	(0.004)	(0.006)	(0.006)	(0.008)	(0.007)	(0.008)	(0.008)	(0.011)	(0.012)	(0.009)	(0.010)
Latin America and Caribbean	0.004	0.004	0.007	0.006	-0.005	-0.006	0.002	0.002	-0.015	-0.014	-0.018*	-0.018*
	(0.004)	(0.004)	(0.007)	(0.007)	(0.009)	(0.009)	(0.008)	(0.008)	(0.012)	(0.012)	(0.010)	(0.010)
East Asia and Pacific	0.017*	0.017*	0.017	0.015	-0.003	-0.005	-0.006	-0.005	-0.011	-0.010	-0.016	-0.016
	(0.009)	(0.009)	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)	(0.009)	(0.014)	(0.014)	(0.012)	(0.012)
Middle East and North Africa	0.015**	0.015**	0.018**	0.018**	0.004	0.004	0.007	0.007	-0.010	-0.009	-0.014	-0.014
	(0.006)	(0.007)	(0.007)	(0.008)	(0.010)	(0.010)	(0.009)	(0.010)	(0.013)	(0.013)	(0.010)	(0.010)
Europe and Central Asia	0.002	0.002	0.005	0.003	-0.013	-0.014	0.002	0.002	0.003	0.004	0.004	0.004
	(0.004)	(0.006)	(0.007)	(0.008)	(0.012)	(0.013)	(0.010)	(0.010)	(0.013)	(0.012)	(0.010)	(0.011)
Constant	-0.008	-0.014	-0.021	0.000	0.005	0.024	0.095***	0.088**	0.100***	0.077**	0.072***	0.072**
	(0.019)	(0.051)	(0.026)	(0.048)	(0.019)	(0.043)	(0.023)	(0.039)	(0.015)	(0.032)	(0.017)	(0.030)
N	59	59	91	91	100	100	125	125	125	125	125	125
R-squared	0.39	0.39	0.33	0.33	0.43	0.43	0.36	0.36	0.17	0.18	0.16	0.16
Sample	Developing Countries as of 2001											

*Notes: (1) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (2) Numbers in parentheses indicate robust standard errors. (3) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although columns 6A and 6B are for the eight year period 2005-2013. (4) South Asia is the omitted reference region for interpreting the regional dummy variables.*

Appendix Table A9. Coefficients on Regional Dummy Variables when Applied Individually to Table A7 regressions (Panels A & B)

	1960s		1970s		1980s		1990s		2000s		2005-2013	
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)	(4A)	(4B)	(5A)	(5B)	(6A)	(6B)
Control variables	income	income + mortality	income	income + mortality	income	income + mortality	income	income + mortality	income	income + mortality	income	income + mortality
Sub-Saharan Africa	-0.013***	-0.013***	-0.017***	-0.015***	-0.019***	-0.019***	-0.037***	-0.038***	-0.014***	-0.015***	-0.005	-0.003
	(0.004)	(0.003)	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)	(0.004)	(0.005)	(0.004)	(0.006)
Latin America and Caribbean	0.000	-0.000	0.000	0.000	0.003	0.002	0.010**	0.009*	-0.008**	-0.009**	-0.012***	-0.012***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
East Asia and Pacific	0.017**	0.016*	0.018	0.014	0.009**	0.007	0.007	0.004	-0.001	-0.002	-0.007	-0.008
	(0.008)	(0.008)	(0.012)	(0.012)	(0.004)	(0.005)	(0.005)	(0.006)	(0.008)	(0.008)	(0.007)	(0.008)
South Asia	-0.001	-0.000	-0.000	0.001	0.015**	0.015**	0.019***	0.019**	0.013	0.013	0.011	0.011
	(0.003)	(0.003)	(0.005)	(0.006)	(0.008)	(0.007)	(0.007)	(0.008)	(0.011)	(0.011)	(0.009)	(0.009)
Middle East and North Africa	0.014**	0.013**	0.015***	0.017**	0.015**	0.015**	0.018***	0.017***	-0.001	-0.002	-0.006	-0.006
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.004)	(0.004)	(0.005)	(0.005)
Europe and Central Asia	-0.002	0.004	-0.002	-0.007	-0.007	-0.010	0.005	0.004	0.017***	0.016***	0.018***	0.019***
	(0.003)	(0.006)	(0.005)	(0.006)	(0.008)	(0.009)	(0.007)	(0.006)	(0.004)	(0.004)	(0.005)	(0.005)
N	59	59	91	91	100	100	125	125	125	125	125	125
Sample	Developing Countries as of 2001											

Notes: (1) Coefficients are presented for each regional dummy as applied independently to a decadal regression of $r_{i,t} = \alpha + \beta_1(m_{i,t-n}) + \beta_2(y_{i,t-n}) + \beta_3(regional\ dummy) + \varepsilon_{i,t}$*, where* $r_{i,t}$ *represents the average annual percentage decline in the U5MR in country i between year t-n and year t;* $m_{i,t-n}$ *represents the natural logarithm of the U5MR in year t-n;* $y_{i,t-n}$ *represents (when included) initial per capita income; and* $\varepsilon_{i,t}$ *is an error term. (2) *, **, and *** represent p values below 0.10, 0.05, and 0.01, respectively. (3) Numbers in parentheses indicate robust standard errors. (4) The dependent variable is measured as annual average rate of decline per decade, i.e., 1960-70, 1970-80, 1980-90, 1990-2000, and 2000-10; although columns 6A and 6B are for the eight year period 2005-2013.*

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ENDNOTES

1. Countries with populations below the cut-off in 2000 include: Andorra, Antigua & Barbuda, Dominica, Federated States of Micronesia, Grenada, Kiribati, Liechtenstein, Marshall Islands, Monaco, Palau, Samoa, San Marino, Sao Tome & Principe, Seychelles, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & the Grenadines, Tonga, Tuvalu, and Vanuatu. The Cook Islands, Nauru, and Niue do not have data observations for 2000 in the World Bank data set, but all were estimated by other sources to have populations well below 15,000 as of 2000 and are therefore also excluded from the core developing country sample.
2. Note that this pre-MDG status assessment differs conceptually from Go and Quijada's (2012) "On Target" versus "Off Target" assessment, which uses latest available data.
3. The 2009 figure relative to Latin America and the Caribbean excludes Haiti. If Haiti is included in the calculation then sub-Saharan Africa passes Latin America and the Caribbean in 2008.
4. Japan was a clear exception amidst high-income countries, experiencing a steady average annual decline of more than 3 percent during both the 1990s and 2000s.
5. As per Table 3 and Figure 5b, these countries did experience a slight slowdown in rates of progress between the 1990s and 2000s, but their number of deaths is proportionately very small so they have limited effects on the results of the global calculation.
6. The figure for conflict-related deaths is calculated by summing the Uppsala Conflict Data Program's "best" estimates for deaths from one-sided (87,756), non-state (59,829), and armed/state-based (360,651) conflicts over 2000 to 2013.

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