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Does health aid matter?☆

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ABSTRACT

This paper examines the relationship between health aid and infant mortality, using data from 118 countries between 1973 and 2004. Health aid has a beneficial and statistically significant effect on infant mortality: doubling per capita health aid is associated with a 2 percent reduction in the infant mortality rate. For the average country, this implies that increasing per capita health aid by US$1.60 per year is associated with 1.5 fewer infant deaths per thousand births. The estimated effect is small, relative to the 2015 target envisioned by the Millennium Development Goals. It implies that achieving the MDG target through additional health aid alone would require a roughly 15-fold increase in current levels of aid.

1. Introduction

Foreign aid is widely believed to improve health outcomes in developing countries.[2] Although a large literature has failed to provide robust evidence that aid promotes economic growth (Rajan and Subramanian, 2005a; Roodman, 2004), foreign aid is often credited with saving lives by providing vaccines, eradicating deadly diseases, and improving medical services. This belief stems in part from successful large-scale health interventions funded with international assistance.[3]

Aid's effect on health outcomes relates closely to the long-standing debate about the effectiveness of aid in general. Skeptics argue that aid can adversely affect a country's competitiveness (Rajan and Subramanian, 2005b; Younger, 1992), encourage dependency and reduce incentives to adopt good policies (Bauer, 1982), overwhelm the management capacity of governments (Kanbur et al., 1999) or be used inefficiently to benefit the political elite (Bauer, 1971; Friedman, 1958). On the other hand, advocates argue that aid leads to improved outcomes in poor countries by relaxing resource constraints and directly improving health service delivery (Levine et al., 2004). For example, Sachs (2005) advocates a massive scaling up of aid to help countries achieve the Millennium Development Goals (MDGs). In addition, some studies contend that particular types of aid, such as short-term aid or multilateral aid, can promote economic growth (Clemens et al., 2004; Reddy and Minoiu, 2006).

For empirical support, participants on all sides of the aid effectiveness debate often turn to the voluminous literature on aid and growth. This research, however, faces the daunting challenge of detecting a significant effect of aid, not only because aid is endogenously determined by growth, but also because the impact of aid on growth is complex and multifaceted. Overall foreign aid and economic growth are too distantly linked (with several channels in between) to be able to detect any significant relationship in the data. Since health aid and infant mortality are more closely linked, the relationship between the two may be easier to detect statistically.

The belief that aid has little or no effect on growth but substantially improves health is consistent with evidence that economic growth plays a limited role in explaining health outcomes. Many

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[2] For example, see Kristof (2006).

[3] One of several examples is the national diarrheal control program in Egypt. At a cost of US $43 mn (60 percent of which was funded by international donors), this program increased the use of life-saving oral rehydration therapy, which reduced infant diarrheal deaths by 82 percent between 1982 and 1987. See Levine et al. (2004) and Soares (2007) for success stories of public health programs.

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countries have shown remarkable improvements in health with little or no economic growth and vice versa (Cutler et al., 2006; Acemoglu and Johnson, 2007). Existing estimates suggest that economic growth explains less than half of the overall improvements in health in the past 50 years in developing countries (Bloom et al., 2004; Fogel, 1994; WHO, 1999). Therefore, while previous studies fail to find an effect of aid on growth, aid may improve health outcomes directly.

Given the micro-level evidence on the success of selected public health intervention programs, the ongoing debate over aid effectiveness, and the limited role of economic growth in explaining health improvements, it is important to understand the relationship between foreign aid and health outcomes. Despite the vast empirical literature considering the effect of foreign aid on growth, there is little systematic empirical evidence on how overall aid affects health, and none (to our knowledge) on how health aid affects health.[4] This is surprising, given the recent attention devoted to promoting health in developing countries. The adoption of the MDGs reflects the increased importance of aid for poverty reduction, including improved health outcomes, and many multilateral and bilateral donors have already made explicit commitments to scale up aid significantly over the medium term.[5] The primary contribution of this paper is to present new, systematic and comprehensive cross-country evidence on the effect of health aid on infant mortality. To the best of our knowledge, this paper presents the first macro study of the effect of health aid on health outcomes.

Infant mortality is the primary health indicator for four reasons. First, data on infant mortality are available for a large set of countries and are more reliable than other indicators, such as life expectancy, child mortality and maternal mortality.[6] Second, infant mortality is more sensitive than life expectancy to changes in economic conditions, and is considered to be a flash indicator of the health conditions of the poor (Boone, 1996). Third, reductions in infant and child mortality largely explain the substantial improvements in life expectancy over the last fifty years in poor countries (Cutler et al., 2006). Finally, past studies indicate that in developing countries, infant mortality depends on access to medicines and health facilities, water and sanitation, fertility patterns, maternal health, maternal and infant nutrition, maternal and infant disease exposure, and female literacy in addition to per capita GDP and economic inequality.[7] Therefore, infant mortality is a proxy for a broad set of human development outcomes.

Two identification strategies are employed to estimate the effect of aid on health outcomes. The first is OLS with a rich set of control variables, on a sample that pools all country–year observations. The second strategy is based on a dynamic panel data model with country fixed effects, and is estimated using the Generalized Method of Moments (GMMs). In this model, all predetermined and endogenous variables are instrumented by their appropriate lags, to avoid introducing a spurious correlation between these variables and the error term. GMM estimation requires a sufficiently large number of observations to provide robust estimates. We rely on a substantially larger dataset than previous studies on aid, covering 118 countries from 1973 to 2004.[8]

The main finding is that health aid has a discernible effect on infant mortality. On average, a doubling of per capita health aid is associated with a 2 percent reduction in infant mortality. For the average country in our sample, this implies that increasing per capita health aid from US$1.60 to $3.20 per year will lead to roughly 1.5 fewer infant deaths per thousand births, which is small relative to the MDGs targets. The estimates imply that a massive increase in health aid (on the order of a 15-fold increase for each average aid recipient country) would be needed to achieve the MDG target by 2015.[9] Specifically, an annual flow of US$5.8 bn would be needed per country to achieve the target. In addition, there is weaker evidence that health aid has become more effective in reducing infant mortality since 1990, and that it is more effective in countries with higher quality policies and institutions.

If both health aid and overall aid primarily relax government budget constraints, they should have similar effects on health outcomes. In order to assess whether characteristics unique to health aid explain its positive impact on infant mortality, we also examine the effect of *overall aid* as well as other types of aid (e.g., education; population; economic infrastructure; conflict, peace and security) on infant mortality. In our preferred specification, the estimated effect of overall aid is half that of health aid and is not statistically significant. In addition, we fail to detect any significant effect of other types of aid in reducing infant mortality. This result provides some support for the position that health aid is not entirely fungible, perhaps because much of it is directed towards specific projects in particular regions.

Finally, we examine the effect of aid on health spending, which is one channel through which aid may reduce infant mortality. Data on health spending are limited, but suggestive evidence indicates that doubling health aid is associated with a 7 percent increase in health spending per capita (which is statistically significant). For a typical country, this implies that a one dollar increase in health aid per capita is associated with a more than US$1.50 increase in health spending per capita. On the other hand, the estimated effect of overall aid on health spending is smaller and not statistically significant. The results are consistent with increased health spending being one channel through which health aid reduces infant mortality.

In summary, the results suggest that the well-known "micro–macro paradox"—where aid is demonstrably effective in specific cases but has little effect in the aggregate—does not fully apply in the case of health aid. The numerous success stories of international assistance from bilateral and multilateral donors appear to be borne out, to a small extent, in the aggregate data. Health aid constitutes only 6 percent of overall aid and the findings suggest that increased allocation of aid towards health purposes in the future could improve recipients' health outcomes.

[4] Only few existing papers (Boone, 1996; Masud and Yontcheva, 2005; Fielding et al., 2005; Burnside and Dollar, 1998) have examined the impact of overall foreign aid on infant mortality or life expectancy. In addition to looking at the impact of health aid, our paper differs from these existing papers in (i) employing additional identification strategies, (ii) testing for effects of aid conditional on regions, periods, policies and institutions, (iii) using a significantly larger sample, and finally (iv) exploring health spending as a possible channel through which foreign aid could affect health outcomes.

[5] The G5 at its 2005 summit at Gleneagles, Scotland committed to an increase in total aid for an amount of US$50 billion, half of which would be devoted to doubling aid to Sub-Saharan Africa by 2010 (Bourguignon and Leipziger, 2006).

[6] The estimates of life expectancy are not reliable because they are based on predictive equations since most developing countries lack complete vital registration systems. Moreover, mortality reductions reflected in changes in life expectancy took place among different age groups in different countries, hence it is not a suitable measure for comparing health changes between countries (Deaton, 2006; Cutler et al., 2006). Data on other health indicators like child and maternal mortality are scarce.

[7] See among others, Filmer and Pritchett (1999), Wagstaff (2000), Wolpin (1997), Cutler et al. (2006), Pritchett and Summers (1996), Easterly (1999), and Galiani et al. (2005).

[8] The overall development aid sample covers 1960–2004. The maximum coverage of data in previous studies is in Rajan and Subramanian (2005a), who included 61–81 countries from 1960 to 2000.

[9] The MDGs target is that under 5 child mortality will be reduced by two-thirds of its 1990 level by 2015. We assume the same target for the reduction in (under one year) infant mortality from 81 to 27 deaths per 1000 births for the average country.

The outline of the paper is as follows. Section 2 presents the empirical specifications. Section 3 discusses the data and shows simple descriptive statistics. Section 4 presents the results on the relationship between aid and infant mortality. Section 5 shows several alternative specifications that demonstrate the robustness of the main results. Section 6 discusses the impact of health aid in different environments, and Section 7 presents preliminary evidence on aid and health spending. Section 8 concludes.

2. Empirical framework

2.1. Ordinary least squares

We follow the bulk of the previous literature and average our annual data over five-year periods, to reduce annual fluctuations and measurement error. Our most basic OLS regression equation specifies infant mortality as a function of aid in the previous period, as follows:

$$\log\ IM_{rt} = \alpha \log A_{rt-1} + \gamma \log IM_{rt-1} + \beta X_{rt-1} + \delta_1 HIV_{rt} + \delta_2 W_{rt} + v_t + \varepsilon_{rt} \quad (1)$$

where IM_{rt} is the infant mortality in aid recipient country r in period t, A_{rt-1} is the aid per capita in country r during the previous period, IM_{rt-1} is one-period lagged infant mortality, and X_{rt-1} is a vector of other control variables lagged one period. HIV_{rt} is a scalar representing the incidence of HIV/AIDS, while W_{rt} indicates the presence of a war in country r at time t. v_t is a vector of period dummies, which captures universal time trends.

Infant mortality and aid are both specified in logarithmic form, as is common in the literature.[10] The log–log specification smoothes the data and also allows for the interpretation of the coefficients as elasticities. Specifying infant mortality in logs also allows for a given increase in health aid to have a larger impact on infant mortality when the initial infant mortality rate is higher.[11]

Lagged infant mortality and the other control variables are introduced in the model to capture the country's initial health and economic status. We include the incidence of HIV/AIDS to address the concern that countries with high rates of infection receive more aid. Of course, the coefficient on health aid does not capture the effect of health aid on health outcomes through any short-term effects on AIDS.[12] All control variables (except HIV and war) are lagged one period to address potential endogeneity of the controls.[13] The parameter α gives the percent change in infant mortality due to a one percent increase in the previous period's aid per capita. α is identified by using both across- and within-country variation.[14]

[10] See, for example, Aturupane et al. (1994), Waldmann (1992), Flegg (1982), and Bross and Dean (1982).

[11] The results in the paper are robust to specifying infant mortality in levels (instead of logs) (see Table 5).

[12] The estimated effect of health aid on infant mortality is unchanged if we drop HIV/AIDS from the model (results available upon request). Moreover, AIDS projects are relatively rare in our data. We examined the short descriptions of projects reported for the 2000–2004 period (where aids projects are likely to be more prevalent, and classified projects as AIDS-related if their short descriptions contained the words "HIV" or "AIDS." Out of the 13,551 projects in the data, only 181 or 1.3 percent were aids-related, and these aids-related projects only accounted for 1.5 percent of the total health aid during this period.

[13] The results presented in the paper are qualitatively similar if the contemporaneous values of control variables are used.

[14] The results in the paper are similar if we use the ratio of aid to GDP (in logs) as the explanatory variable (Table 5 below).

2.2. Dynamic panel data models with fixed effects

The OLS results are biased if lagged aid is correlated with the unobserved component of infant mortality. In particular, if countries receive more health aid as infant mortality increases, the beneficial effect of aid would be underestimated. Another potential source of bias is measurement error. Since the health aid data is reported by donors, any measurement error is likely to be uncorrelated with the characteristics of the recipient country, which would imply that any beneficial effect of aid would be further underestimated.

Country fixed effects can be introduced in the model to control for unobserved country-specific and time-invariant factors determinants of infant mortality. The fixed effects regression is specified as

$$\log IM_{rt} = \alpha \log A_{rt-1} + \gamma \log IM_{rt-1} + \beta X_{rt-1} + \delta_1 HIV_{rt} + \delta_2 W_{rt} + s_r + v_t + \varepsilon_{rt} \quad (2)$$

where s_r is a vector of country fixed effects which denotes time-invariant differences in infant mortality across countries. The presence of the lagged dependent variable and country fixed effects on the right-hand side implies that α is identified by the difference between within-country change in aid over time and the average observed in the sample (across countries).

Three main concerns remain after controlling for country-specific heterogeneity. First, the residual may contain time-*varying* and country specific factors that affect infant mortality, such as initial access to health clinics, clean water, and the fertility rate in poor households. If these time varying, country specific factors are correlated with health aid, then the estimated coefficient of interest, α, would be biased. For example, if countries tend to receive more aid as the quality of their health facilities declines, then α would be biased towards zero and underestimate the beneficial effect of health aid. Second, in panel data models with a lagged dependent variable, predetermined variables, and fixed effects, the within-estimators of the lagged dependent and predetermined variables are inconsistent. This inconsistency derives from the presence of the lagged error term in the residual, after subtracting within-country means. Finally, the presence of classical measurement error in health aid would bias the OLS coefficient towards zero. Because Eq. (2) would provide inconsistent estimates, it is not estimated.

One common method used to address these three sources of bias in the presence of fixed effects is to estimate a system of moment equations using the Generalized Method of Moments (GMMs). The following regression equations are estimated using a system GMM specification (Blundell and Bond, 2000; Bond, 2002):

$$\log\ IM_{rt} = \alpha \log A_{rt-1} + \gamma \log IM_{rt-1} + \beta X_{rt-1} + \delta_1 HIV_{rt} + \delta_2 W_{rt} + s_r + v_t + \varepsilon_{rt} \quad (3)$$

$$\Delta \log IM_{rt} = \alpha(\Delta \log A_{rt-1}) + \gamma(\Delta \log IM_{rt-1}) + \beta(\Delta X_{rt-1}) + \delta_1 \Delta HIV_{rt} + \delta_2 \Delta W_{rt} + \Delta v_t + \Delta \varepsilon_{rt} \quad (4)$$

Lagged differences of the endogenous variables ($\log IM_{rt-1} - \log IM_{rt-2}$), ($A_{rt-1} - A_{rt-2}$), ($X_{rt-1} - X_{rt-2}$) are used as instruments in the level equation (3). Lagged levels of the endogenous variables, IM_{rt-2}, A_{rt-2}, X_{rt-2} are used as instruments in the first differenced equation (4). HIV_{rt} and W_{rt} are assumed to be exogenous. System GMM obtains the estimated coefficients by solving the appropriately weighted set of the moment conditions based on Eqs. (3) and (4). In other words, system GMM identifies the effect of aid on future infant mortality by comparing two observably similar countries, using the portion of health aid attributable to their aid histories.

We use system GMM rather than first difference GMM (Arellano and Bond, 1991), which estimates only Eq. (4). System GMM is preferred because exploiting the additional moment conditions in the levels equations provides a dramatic improvement in the accuracy of the estimates when the dependent variable is persistent (Blundell and Bond, 2000). This is the case in our data, as the coefficient on lagged infant mortality is close to one.[15] This implies that the infant mortality series is nearly a random walk, making lagged levels of infant mortality weak instruments for first differences. As a result, the first-difference GMM estimator suffers from problems associated with weak instruments, such as substantial finite sample bias. The system GMM specification is estimated using the xtabond2 command in Stata (Roodman, 2005).[16]

The system GMM estimator entails the following assumptions (Blundell and Bond, 2000)[17]:

$$\begin{aligned} &E(s_r) = E(\varepsilon_{rt}) = E(s_r\varepsilon_{rt}) = 0 \\ &E\varepsilon_{rs}\varepsilon_{rt} = 0, \quad s \neq t \\ &E(IM_{r1}\varepsilon_{rt}) = 0, \quad t = 2, \ldots, T \\ &E(A_{r1}\varepsilon_{rt}) = 0, \quad t = 2, \ldots, T \\ &E(\Delta IM_{r2}s_r) = 0 \\ &E(\Delta A_{r2}s_r) = 0 \end{aligned} \tag{5}$$

The last four equations in (5) constitute the initial conditions underlying the system GMM estimates. These conditions assume that the initial *levels* of aid and infant mortality are uncorrelated with all future unobserved shocks in infant mortality, and that the initial *changes* in infant mortality and aid are uncorrelated with the unobserved country fixed effects. These can be derived from the conditions underlying the validity of the instruments, whereby the level and difference instruments are uncorrelated with the error term—$E[y_{rt-1}\Delta\varepsilon_{rt}] = 0, t \geq 3, l \geq 2$ and $E[\Delta y_{rt-1}\varepsilon_{rt}] = 0, t \geq 3$, y denoting infant mortality or one of the explanatory variables in Eq. (3).

One potential pitfall when implementing this type of GMM estimation is the inclusion of excessive numbers of instruments. These estimators by default generate instrument sets whose numbers grow quadratically as the number of periods increases. Adding additional instruments, for a fixed number of observations, increases finite-sample bias in the estimates. Additional instruments also weaken the power of Hansen's J test for over identifying restrictions, leading to cases where the test falsely fails to reject the null hypothesis that the instruments are valid (Roodman, 2008). We use only two lags to avoid overfitting the model. In addition, we verify that the estimated coefficients are robust to a reduction in the number of instruments and that the specification tests exceed the conventional significance levels by a comfortable margin.

The identification assumptions underlying the system GMM are strong. Also, the estimator relies on the number of countries to be sufficiently large for the asymptotic properties to hold. However, this estimator has been commonly applied in cross-country contexts (Spilimbergo, 2009; Cheng and Kwan, 2000; Fajnzylber et al., 2002; Serven, 2003). Most importantly, given the lack of convincing external instruments for aid, of all estimators that control for unobserved country effects and lagged infant mortality, the system GMM estimator is likely to provide the most accurate estimates.

3. A first look at the data

The data on health and overall aid are both taken from the OECD, but are derived from two different sources. The data on net Official Development Assistance (ODA) are obtained from the Development Assistance Committee (DAC). The OECD database also provides data on ODA commitments by purpose, taken from the Creditor Reporting System (CRS). According to the OECD, the term "purpose of aid" signifies the sector of the recipient's economy that the aid activity is designed to assist, such as health, energy, or agriculture. Aid activities are classified into 26 broad three-digit sector/purpose categories, each of which is further classified into five-digit purpose codes. The three and five digit codes corresponding to the health sector are shown in Table A1.

The CRS data suffer from two limitations. First, the CRS collects data on donor commitments rather than disbursements, although the two are strongly correlated. Data on health aid disbursements are available from 1990 to 2004, and the correlation coefficient between disbursements and commitments over this period is 0.66. Second, aid totals in CRS are significantly less than those in the DAC, reflecting the underreporting of aid in the CRS data. The extent of underreporting in the CRS varies by sector, donor and time period (Development Assistance Committee, 2002). However, since health aid is reported by donors, there is no reason to believe that the underreporting is systematically related to characteristics of the recipient.

Aid is defined as the sum of grants and concessionary loans (loans with a grant element of at least 25 percent, based on a 10 percent reference rate of interest). Net ODA to a recipient is the difference between the value of aid disbursed by all donors and the return of unspent balances and principal repayments of earlier loans. Aid flows are converted into constant 2003 US dollars using the DAC deflator. We confine the sample of aid recipient countries to developing countries based on 2005 GNI per capita, as classified by the World Bank (World Bank, 2006). Outliers are

Table 1
Estimated effect of health aid on infant mortality, 1975–2004.

Dependent variable:	Log infant mortality rate (per 1000)	
	OLS	System GMM
Lagged log health aid per capita	−0.0110** (0.005)	−0.0206** (0.008)
Lagged log infant mortality	1.0408*** (0.021)	1.0004*** (0.055)
Lagged log per capita income	−0.0169** (0.008)	−0.0986*** (0.025)
Lagged log population	−0.0094** (0.004)	−0.0175 (0.013)
Lagged log fertility rate	0.028 (0.033)	−0.0191 (0.064)
War dummy	0.0053 (0.012)	−0.0325 (0.023)
HIV AIDS rate	0.0021*** (0.000)	0.0012 (0.001)
Hansen test: *P*-value		0.467
AR1 test: *P*-value		0.009
AR2 test: *P*-value		0.765
Number of instruments		79
Number of countries	118	118
Number of observations	465	465

Standard errors are denoted in parentheses, and clustered at the country-level. The regressions include country and period fixed effects. All variables are averages over five year periods (except for war dummies). In the GMM specifications, one period lags of aid per capita, infant mortality, population, fertility, and per capita GDP are treated as endogenous; two lags are used as instruments.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

[15] Since we have a large cross-section of countries (118 countries) and relatively small number of time periods (seven periods), the asymptotic properties of the estimators are based on the cross-sectional dimension becoming large.

[16] The robust two-step GMM procedure is used, which includes Windmeijer's correction for finite sample bias. The results in the paper are unchanged when we use the recently available official command in stata – xtdpdsys – to implement the GMM regressions.

[17] For simplicity, we only lay out the initial condition assumptions required for the consistency of estimates of the coefficients on lagged infant mortality and aid. Similar initial conditions also apply to the predetermined variables in the model, such as per capita income, population and fertility.

Table 2
Estimated effect of health aid on infant mortality 1975–2004, falsification tests.

Dependent variable:	Log infant mortality rate (per 1000)								
	[1] OLS	[2] GMM	[3] OLS	[4] GMM	[5] OLS	[6] GMM	[7] OLS	[8] GMM	[9] OLS
Lagged log overall aid per capita	−0.0100* (0.005)	−0.0139 (0.011)							
Lagged log education aid per capita			0.0117 (0.024)	0.0584 (0.041)					
Lagged log population aid per capita					−0.037 (0.028)	0.0113 (0.076)			
Lagged log infrastructure aid per capita							−0.007 (0.011)	−0.0143 (0.010)	
Lagged log conflict, peace and security aid per capita									0.0345** (0.016)
Hansen test: *P*-value		0.768		0.372		0.11		0.312	
AR2 test: *P*-value		0.768		0.58		0.557		0.452	
Number of countries	118	118	118	118	118	118	118	118	61
Number of observations	700	700	570	570	570	570	570	570	73

Only OLS results are shown for peace and security aid since there are not enough observations to enable meaningful GMM estimation. The controls are the same as in Table 1. See notes to Table 1.
***Significance at 1 percent.
* Significance at 10 percent.
** Significance at 5 percent.

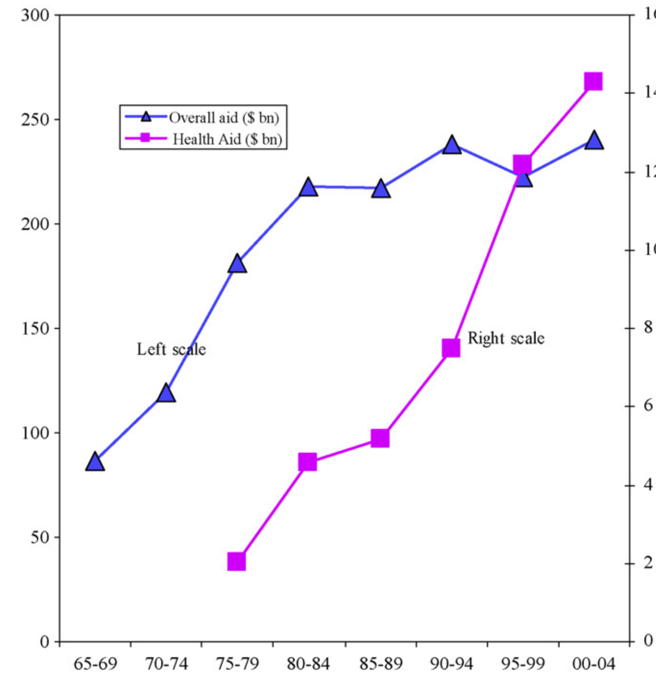

Fig. 1. Health aid and overall aid trends (2003 US$ billion).

trimmed manually and also according to the Hadi (1992) procedure (see Appendix B for details). The final sample consists of 465 country-period observations.

Data on infant mortality come from the United Nations (UN, 2004).[18] The infant mortality rate represents the number of infants who die before reaching the age of one year, per 1000 live births in a given year. The HIV/AIDS prevalence rate, as measured by the number of reported AIDS cases per 100,000 people, is taken from Papageorgiou and Stoytcheva (2006). All the variables and the data sources are described in detail in Table A3. The list of countries in the sample is shown in Table A4, and Table A5 shows the summary statistics for all the variables used in the paper.

Fig. 1 shows trends in the total amount of reported health aid (right scale) and overall aid (left scale) during each five-year period between 1960 and 2004. Health aid is only available beginning in the 1970–1975 period. Reported health aid constitutes a very small fraction of overall aid, with the share ranging between 0.5 and 7 percent. Fig. 1 shows that health aid increased during 1973–2004. Overall aid also increased for most of the period, though the increase was at a much slower rate after 1980–1984.[19] Fig. 2 shows that both health aid and overall aid have been decreasing in per capita terms, at least since 1975.

Fig. 3 looks at the various components (or "purposes") of health aid for 2000–2004. Health policy and administrative management is the largest component, constituting about 30 percent of total aid, followed by basic health care (25 percent), infectious diseases control (15 percent), medical services (9 percent) and basic health infrastructure (6 percent). Over time, the health aid allocated towards health policy and administrative management has

[18] World Development Indicators (WDI) also has data on infant mortality. We prefer to use the UN data due to substantially wider coverage in terms of countries and years. The two sources are highly correlated, as the correlation coefficient is 0.99 in the roughly half of the sample observations for which WDI data are available.

[19] The aid data from DAC and CRS do not include private health aid, which is becoming increasingly important. See Appendix A for a discussion on private aid.

Table 3
Estimated effect of health aid on infant mortality, alternative samples.

Dependent variable:	Log infant mortality (per 1000)			
	Outliers included		Non-reports as zeros	
	OLS	GMM	OLS	GMM
Lagged health aid per capita (2003 US$)	−0.0133** (0.005)	−0.0242*** (0.007)	−0.0120** (0.005)	−0.0218*** (0.008)
Hansen test: *P*-value		0.313	0.299	0.414
AR2 test: *P*-value		0.782	0.711	0.67
Number of countries	119	119	118	118
Number of observations	486	486	465	465

The controls are the same as in Table 1. See notes to Table 1.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

Table 4
Estimated effect of health aid on infant mortality, GMM, robustness checks.

Number of lags	1	2	3	4	All
Dependent variable:	Log infant mortality (per 1000)				
Lagged log health aid per capita	−0.0207*** (0.008)	−0.0206*** (0.008)	−0.0179*** (0.007)	−0.0199** (0.008)	−0.0196** (0.008)
Hansen test: *P*-value	0.237	0.467	0.571	0.483	0.785
AR2 test: *P*-value	0.817	0.765	0.802	0.925	0.9
Number of instruments	59	79	94	104	109
Number of countries	118	118	118	118	118
Number of observations	465	465	465	465	465

See notes to Table 1.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

Table 5
Estimated effect of health aid on infant mortality, alternative explanatory variables.

Dependent variable:	Log infant mortality (per 1000)		Log infant mortality (per 1000)	
	OLS	GMM	OLS	GMM
Lagged health aid per capita (2003 US$)	−0.0049*** (0.002)	−0.0084*** (0.003)		
Lagged log health aid to GDP			−0.0103** (0.005)	−0.0142*** (0.005)
Hansen test: *P*-value		0.493		0.45
AR2 test: *P*-value		0.827		0.605
Number of instruments		79		79
Number of countries		118	118	118
Number of observations	465	465	465	465

The controls are the same as in Table 1. See notes to Table 1.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

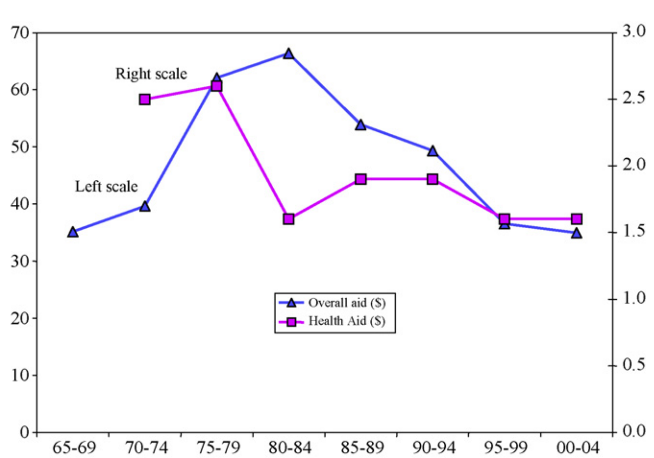

Fig. 2. Overall aid and health aid per capita trends (2003 US$).

decreased whereas medical services and basic health care have become more important (not shown).

Table A2 examines the three largest CRS purposes for 2000–2004 in greater detail. The CRS data contain a short text description of the aid that can be used to better understand the broad purposes described in Fig. 3. Table A2 lists the ten most important descriptions in the three largest CRS purposes shown in Fig. 3. Some of the largest categories under "health policy and administrative management" include health aid by the World Bank to three large Indian states (Uttar Pradesh, Rajasthan and Tamil Nadu) targeted towards health systems development. Under "basic health care", major projects include health aid given for "young child health" and "child survival". Finally, health aid given for "infectious diseases control" is targeted largely to immunization programs devoted to polio eradication, and immunization programs for specific countries like India. Although the short descriptions of health aid contain limited information, the table suggests that a significant portion of health aid is directed to specific projects in particular regions.

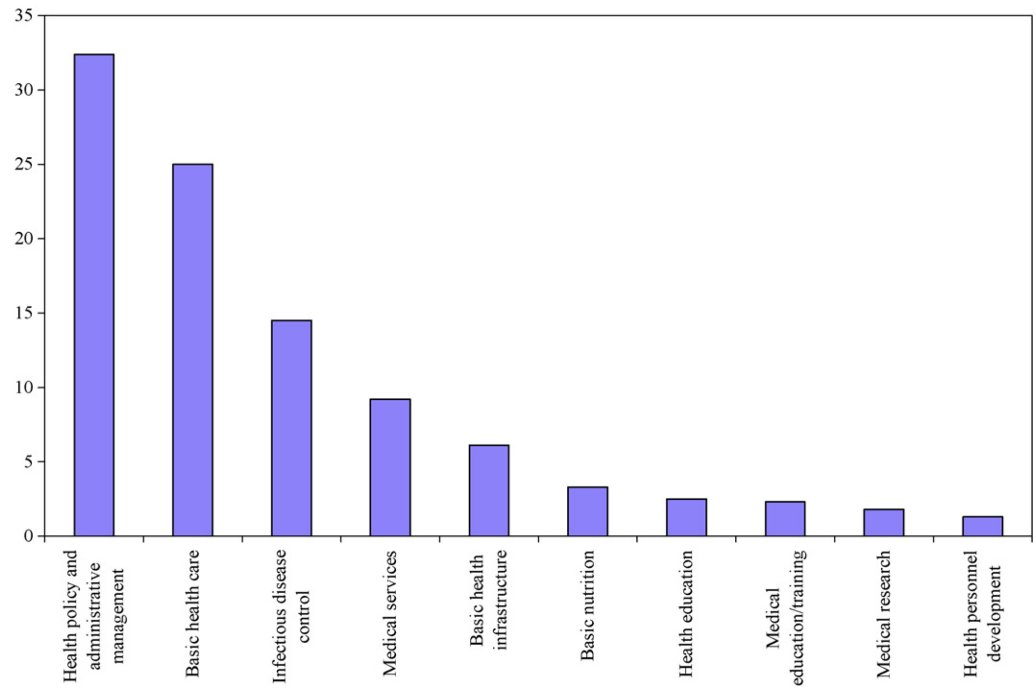

Fig. 3. Components of health aid, 2000–2004 (in percent of total health aid).

Bilateral aid constitutes about 70–90 percent of health aid, and the fraction is relatively stable over time. Health aid is comprised predominantly of grants, as the loan component varies between 3 and 10 percent (not shown).

Finally, before proceeding to the regression analysis, we examine the bivariate relationship between infant mortality and health aid. Fig. 4 shows a weak positive correlation between health aid and infant mortality, after controlling for country and year fixed effects. This positive association likely reflects the endogeneity of aid, as more aid flows to countries when health indicators are worsening. Of course, the scatter plot is only suggestive, and the next section presents results from regression analysis that includes additional control variables.

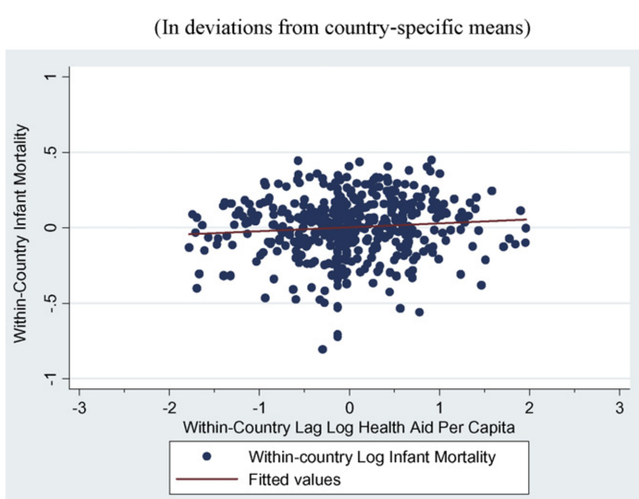

Fig. 4. Scatter plot of infant mortality and health aid, 1975–1979 to 2000–2004 (in deviations from country-specific means). Health aid is averaged over five-year periods. The scatter plots show the relationship between health aid in a given period and health outcomes in the following periods. The plots are based on regressions that control for country fixed effects and period dummies.

4. Aid and infant mortality

4.1. Health aid and infant mortality

This section examines the effect of per capita health aid on infant mortality. Our main focus is on infant mortality as the primary health indicator, for reasons discussed above. In the basic specifications, we analyze the effect of increasing per capita health aid during a given five-year period on health outcomes in the following period.

The regression results for the impact of health aid on infant mortality are shown in Table 1. The dependent variable is the log of the average number of infant deaths (per thousand births) during a five-year period. The key explanatory variable is the log of the average annual health aid per capita received during the previous period.[20] All regressions include period dummies, the war dummy, and additional controls—lagged infant mortality, lagged population, lagged per capita income, lagged fertility rate, and the prevalence of HIV/AIDS. Since we are controlling for the prevalence of AIDS in the current period, the estimates do not capture the effect of health aid on health outcomes through any contemporaneous effect on AIDS prevalence rates. The standard errors in all reported regression results are robust to heteroskedasticity and are clustered within country.

Specification I shows the OLS regression results without country fixed effects. The estimated coefficient on lagged aid per capita is

[20] Log health aid is truncated for amounts below 25 cents per person, to avoid placing too much weight on small changes at low levels of aid. The log transformation gives too much weight to small changes close to zero, since log aid approaches minus infinity as per capita health aid approaches zero. For example, we expect that a change in per capita aid from 5 to 10 cents would have a much smaller effect on infant mortality than a change from $1 to $2. In addition, measurement error is likely to account for a higher percentage of reported aid when aid is low. To address these issues, we truncate the log per capita health aid variable at 25 cents, which is approximately the 25th percentile. Table A6 shows the estimated coefficients for truncation at various percentiles, and demonstrates how the magnitude of the estimated effect is attenuated towards zero as fewer observations are truncated.

Table 6
Estimated effect of health aid on infant mortality:OLS with additional controls.

	OLS
Lagged health aid per capita	−0.0096** (0.004)
Lagged log infant mortality	1.0130*** (0.0017)
Lagged log per capita income	0.0053 (0.008)
Lagged log population	−0.0037 (0.004)
Lagged log fertility rate (births per woman)	0.0673*** (0.026)
Lagged log female literacy (percent of females age 15 and above)	−0.001 (0.008)
Log undernutrition (% of population)	0.0176** (0.008)
Log physicians (per 1000 people)	0.0657*** (0.019)
Log sanitation (% population with access)	0.0118 (0.013)
Log improved water source (% population with access)	−0.0601*** (0.021)
War dummy	−0.0053 (0.009)
HIV AIDS rate	0.0015*** (0.000)
Dummy for Sub-Saharan Africa	0.0041 (0.018)
Dummy for East Asia	−0.0196 (0.019)
Dummy for Middle-East and North Africa	−0.0752*** (0.022)
Dummy for Latin America and Caribbean	−0.0531*** (0.021)
Number of countries	110
Number of observations	448

Standard errors are denoted in parentheses and clustered at the country-level. The regressions include period dummies. All variables are averages over five year periods (except for war dummies). Malnutrition, access to improved water and sanitation, number of physicians are country-specific and time-invariant.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

negative and statistically significant (at the 5 percent level) in the OLS specification. Doubling aid reduces infant mortality in the next five-year period by approximately 1 percent.

Specification II shows the results from the system GMM estimation. In this case, identification is based on the lags of health aid (in addition to the lags of other predetermined variables). Two and three period lagged levels of health aid and the other predetermined variables, when available, are used as instruments in the difference equation whereas one and two period lagged differences are used in the level equations. The GMM results indicate that doubling health aid within a country reduces infant mortality in the next five-year period by about 2 percent. The beneficial effect is precisely estimated with the 95 percent confidence interval ranging from 0.5 to 3.6 percent. The Hansen's test for over-identifying restrictions passes at the 1 percent significance level. In addition, the null hypothesis of no two-period serial correlation in the residuals cannot be rejected. The magnitude of the GMM estimate of the effect of health aid in reducing infant mortality is higher than that of the OLS estimate. This is consistent with a positive correlation between the unobserved components of infant mortality and health aid. This suggests that increased health aid is allocated to countries when health outcomes are worsening. The increased magnitude of the GMM estimate relative to the OLS estimate may also be attributable to noise in the per capita health aid variable, which would attenuate the OLS estimates towards zero.

Turning to the coefficients on the other explanatory variables in Table 1, infant mortality is highly persistent, as the coefficient on lagged infant mortality is close to one (the GMM estimate is not statistically different from one (*P*-value = 0.99)). This necessitates the use of system rather than difference GMM, for reasons discussed above. The magnitude of the coefficient being a little over one suggests that, during the six five-year periods captured in the data, countries on average exhibited virtuous (an accelerating decrease in infant mortality) or vicious (an accelerating decrease in infant mortality) cycles that reinforce changes in infant mortality.[21] The coefficient on lagged per capita income is negative and significant at the 1 percent level. This is consistent with higher levels of income leading to improved public health infrastructure, such as water and sanitation, better nutrition, better housing and the ability to pay for health care (Cutler et al., 2006; Pritchett and Summers, 1996). The coefficient on HIV/AIDS is positive (and statistically significant at the l percent level in the OLS regression), suggesting that a greater prevalence of AIDS is associated with higher infant mortality.[22,23]

4.2. Discussion of the results

As there are no previous studies on the effect of health aid on health outcomes, it is difficult to place these results in context. However, the estimated percentage impact of health aid on infant mortality reported above can be recast as the number of infants saved for a given increase in health aid, for the average country in the sample. The average infant mortality rate in the health aid sample is approximately 73 per 1000 live births. The GMM coefficient estimate in Table 1 implies that doubling health aid reduces infant mortality by approximately 2 percent. The average amount of annual per capita health aid is US$1.60. Therefore, for the average country, increasing per capita health aid from US$1.60 to $3.20 is associated with about 1.5 fewer infant deaths per 1000 live births. Since the average number of live births per year is 1 million, the estimated effect translates to approximately 1560 fewer infant deaths per year for a typical country. For the world as a whole, the estimates imply that doubling health aid would save approximately 170,000 infants per year. In other words, the resource cost of saving 170,000 infants is approximately US $ 76 mn.

The estimates also suggest that the effect of doubling health aid on reducing infant mortality, controlling for other factors, is small relative to the goals envisioned by the MDGs. The MDGs call for the under-five child mortality rate to fall by two-thirds by 2015, relative to its level in 1990. Assuming the same target for infant mortality, the calculations suggest that a massive increase in health aid would be needed to achieve the MDG target by 2015. Specifically, the estimates imply that an annual flow of US$5.8 billion of health aid would be needed per country by 2015 in order to achieve the target. This would imply raising the current annual flow of health aid to an average country by a factor of 15. These calculations should be interpreted with caution, however, since the underlying estimates used

[21] Since the coefficient on lagged infant mortality is close to one, the estimated long-run effect of health aid (as the number of periods approaches infinity) is infinite, and the steady state level of infant mortality is not defined. However, a finite long-term effect of health aid is not required to estimate the effect of lagged health aid, since the asymptotic properties of the estimator are based on the presence of a sufficiently large number of countries rather than periods. Nonetheless, we estimate an alternative specification where the dependent variable is the change in log infant mortality and obtain qualitatively similar results (available upon request).

[22] The sign on lagged fertility is negative (but insignificant) in the GMM specification, where higher fertility is associated with lower infant mortality. The effect of changes in fertility on infant mortality has been a subject of debate in the health literature. In fact, there is little evidence that declines in fertility have a net positive impact on infant and child survival (LeGrand and Phillips, 1996). For example, Bongaarts (1987) using cross-country evidence finds that the percentage of birth intervals of less than 24 months that are associated with high infant-health risks rises as fertility falls.

[23] We also included lagged female literacy as additional control in the two key specifications. The estimated coefficient was negative, but statistically insignificant, and the coefficient on aid was unchanged. Women's education is considered an important determinant of infant mortality (Cutler et al., 2006). However, female literacy may be highly correlated with other control variables, such as lagged infant mortality.

to derive these figures approximate the effect of marginal rather than large changes in aid.[24]

The estimates of the effect of health aid are based on OLS and GMM regressions. Both of these specifications are vulnerable to bias, if differential time trends in health improvements, across countries, are correlated with trends in aid. It is difficult to know the direction of this bias. To the extent that health aid is motivated by altruism, donors may provide more health aid to countries whose unobserved health outcomes are worsening.[25] In this case, the estimated coefficient on health aid would be biased upwards towards zero, and underestimate the magnitude of the true beneficial effect of health aid on infant mortality. On the other hand, it is also possible that donors are more likely to give to countries that are demonstrating greater progress in reducing infant mortality. Although the GMM specification addresses these endogeneity concerns using lags of explanatory variables as instruments, the consistency of these estimates requires strong assumptions.

Table 7
Estimated effect of health aid on infant mortality 1975–2004, short-run vs long-run effect.

Dependent variable:	Log infant mortality rate (per 1000)	
	OLS	System GMM
Current log aid per capita	−0.0085 (0.006)	−0.0127** (0.006)
Hansen test: *P*-value		0.485
AR2 test: *P*-value		0.468
Number of countries	118	118
Number of observations	559	559
Twice lagged aid per capita	−0.0019 (0.006)	−0.006 (0.007)
Hansen test: *P*-value		0.481
AR2 test: *P*-value		0.154
Number of countries	110	110
Number of observations	361	361

The controls are the same as in Table 1. See notes to Table 1.
*Significance at 10 percent.
***Significance at 1 percent.
** Significance at 5 percent.

4.3. Overall aid, other types of aid and infant mortality

Aid given specifically for health purposes should have a larger effect on health outcomes than overall aid, if there is a greater probability that these resources are spent on health specific projects (as suggested by Table A2). However, economic theory would suggest that aid may be fungible (Rajan and Subramanian, 2005a). In theory, to the extent that different types of aid are not tied to specific purposes, they primarily relax the government's budget constraint, and therefore have identical effects on economic and social outcomes. We therefore examine the effect of overall aid and other types of aid (e.g., education; population economic infrastructure; and conflict prevention and resolution, peace and security) on health outcomes to assess whether there is something specific about "health aid" that affects health, or whether health aid is fungible with other types of aid. Data on other types of aid are taken from the CRS. Education and population aid correspond to sectors 120 and 130 respectively. Infrastructure aid is the sum of aid towards (i) water supply and sanitation (140), (ii) transports and storage (210), (iii) communications (220), and (iv) energy generation and supply (230). Conflict, peace and security aid corresponds to sector 152.

The regression results for the impact of overall aid on infant mortality are shown in the first two columns of Table 2. Specification I shows the OLS regression results without country fixed effects. The estimated coefficient on lagged aid per capita is negative and statistically significant (at the 5 percent level) in the OLS specification. The magnitude of −0.01 implies that a doubling of aid is associated with a one percent reduction in infant mortality.

Specification II shows the GMM estimates, where the identification is based on the lags of aid. As in the health aid estimation, two and three period lagged levels of these variables are used as instruments in the difference equation whereas lagged and twice-lagged differences are used in the level equations. The estimated coefficients are also close to −0.01 but are no longer statistically significant in the GMM specifications. The Hansen's test of over identifying restrictions passes and the hypothesis of no second-order correlation in residuals cannot be rejected.[26]

In a similar vein, we fail to detect any significant effect of other types of aid in reducing infant mortality (columns [3]–[10] in Table 2). Aid targeted towards economic infrastructure (e.g., water supply and sanitation, transport and energy) does reduce infant mortality, though the effect is not statistically significant. On the other hand, peace and security aid is associated with rising infant mortality, which likely reflects the targeting of this type of aid towards conflict-ridden countries that are experiencing deteriorating health outcomes.

These estimated effects of overall aid are more beneficial than three of the four previous studies that have examined the effect of overall aid on infant mortality, and far more precisely estimated than all four. Boone (1996), using a fixed effects specification, finds a harmful and statistically insignificant effect of aid on infant mortality with a coefficient estimate of 0.165 (se = 0.61). Masud and Yontcheva (2005) also find a harmful but statistically insignificant effect in a fixed effects specification. The magnitude of the coefficient on bilateral aid per capita is 0.006 (se = 0.648), which is closer to our estimate, but the standard errors in that paper are much higher. Burnside and Dollar (1998) also find a harmful and insignificant effect of overall aid to GDP on infant mortality, using instrumental variables, with a coefficient estimate of 0.02 (se = 0.16). Finally, Fielding et al. (2005) find a statistically significant and beneficial effect of overall aid on child (less than five-year) mortality, with a relatively large magnitude of the effect of −0.14 (se = 0.05). Our results differ from the existing literature possibly due to a broader coverage of the data (both across countries and over time). For, example, the results in Fielding et al. (2005) are based only on a single cross-section of 48 countries (in different time periods). Also, unlike the existing papers, we use GMM estimators to allow for dynamics in infant mortality in the presence of fixed effects.

[24] These estimates are not comparable to MDG costing studies that exist for several African countries (e.g., see the MDGs Needs Assessment Synthesis Report for Ethiopia at www.et.undp.org/rcs/Doc/MDG%20synthesis 20January%203 202006.pdf). The primary difference is that while the costing exercises *assume* parameter estimates and *simulate* the cost of attaining the MDGs, we *estimate* elasticities from the data and use it to derive the amount of aid required to achieve a given reduction in infant mortality. On the other hand, while these costing exercises are country-specific, our estimates represent an average across countries.

[25] Table A7 shows that when we drop the additional determinants of infant mortality from the estimations in Table 1, the estimated coefficient on health aid is biased upwards, implying a positive correlation between health aid and the observed determinants of infant mortality. To the extent that the unobserved determinants are positively correlated with observables, the estimates underestimate the beneficial effect of health aid on infant mortality.

[26] As the data on overall aid extends to 1960, the number of observations is higher in columns [1] and [2] in Table 2 (700 compared to 465 in Table 1). For robustness, we also restricted the overall aid regressions to the health aid sample. The estimated coefficients in the GMM specification are −0.0175 and are statistically insignificant. Thus, maintaining a consistent sample does not produce robust results for the impact of overall aid on infant mortality.

Table 8
Estimated effect of health aid on infant mortality: 1975–2004—fixed effects model.

Dependent variable:	Log infant mortality rate (per 1000)	
	FE1	FE2
Lagged log health aid per capita	−0.004 (0.005)	−0.0065* (0.004)
Number of countries	118	119
Number of observations	347	367

Standard errors are denoted in parentheses. The estimators are within estimators and allow for first order autoregressive disturbance term. The regressions include country and period fixed effects. The controls are identical to Table 1 (except lagged infant mortality). All variables are averages over five year periods (except for war dummies). In the GMM specifications, one period lags of aid per capita, infant mortality, population, fertility, and per capita GDP are treated as endogenous; two lags are used as instruments.
**Significance at 5 percent.
***Significance at 1 percent.
* Significance at 10 percent.

To summarize, we fail to find a robust effect of overall aid or other types of aid in reducing infant mortality. The effect of overall aid is precisely estimated relative to previous studies, and is close to zero.

5. Robustness checks

5.1. Alternative samples

In the analysis presented above, we drop 21 outliers based on Hadi (1992) procedure and by eye-balling the data. Table 3 shows that the main results are not sensitive to dropping these observations and hold in a broader sample as well. In addition, in calculating the 5-year averages of health aid for any recipient, the analysis above omits years for which health aid is not reported. Table 3 also shows that the results are similar if we treat these non-reports as zeros. A detailed description of the outliers is provided in Appendix B.

5.2. Alternative instruments

One common criticism of GMM estimation is that it confers on the researcher considerable degrees of freedom in determining how many lags of the endogenous and predetermined variables are used as instruments. Table 4 shows that the estimated effect of health aid on infant mortality is robust to using different lag structures as instruments. The Hansen's test for over identifying restrictions and the AR2 test for no second-order serial correlation pass in all the specifications.[27]

5.3. Alternative explanatory variables

Table 5 shows the results when per capita health aid is expressed in levels rather than logs. The estimated coefficient from the GMM specification is roughly −0.01, implying that a one dollar increase in per capita health aid lowers infant mortality by 1 percent, and is statistically significant. The magnitude of the estimated effect is consistent with Table 1.[28] Often, aid is measured as a percentage of GDP rather in per capita terms. Table 5 also presents results using health aid to GDP as the main independent variable. The estimated effect of health aid on infant mortality is similar to the basic estimates in Table 1.

5.4. Additional controls

Finally, to reduce the possibility that omitted variables are biasing the OLS estimates, we add additional controls to the estimating equation. Table 6 displays the results. The additional controls include determinants of infant mortality, such as the prevalence of undernutrition, number of physicians, the percentage of the population with access to water and sanitation, and female literacy, as well as regional dummies. The data on these variables is obtained from the World Bank (2006). The additional variables, except female literacy, are available for only 2 or 3 years between 1970 and 2004. Hence, the averages of these variables over the period are introduced as country-specific time-invariant controls in the OLS specification.

The goal is to estimate the partial effect of increasing health aid, controlling for as many predetermined variables as possible. The estimated effect of health aid on infant mortality is similar to that in Table 1.[29]

5.5. Alternative lags in health aid

Table 1 examines the short-term effect of health aid on health outcomes, defined as the effect of aid in a given period on health outcomes in the following five-year period. We also examine two alternative specifications where (i) infant mortality is regressed on contemporaneous health aid and (ii) infant mortality is regressed on the two-period lag of aid. The regression results are shown in Table 7. We find that health aid also has a significant contemporaneous effect on infant mortality (at least in the GMM specification), though the magnitude of the estimated effect is slightly smaller than that in Table 1. Doubling health aid during a given period reduces infant mortality in that period by about 1 percent. There is no robust evidence, however, that health aid provided ten years ago continued to reduce infant mortality in the most recent period. There are two possible explanations for the reduced estimated effect of health aid over a longer horizon: First, the sample size is smaller because the exclusion of an additional period. Second, the regressions in Table 7 estimate the effect of 10-year lagged health aid, controlling for five-year lagged infant mortality, i.e., the estimates on 10-year lagged health aid capture only the additional reduction in infant mortality beyond that occurring during the first five-year period. Health aid given ten years ago may not continue to reduce infant mortality. For example, health aid targeted towards basic nutrition (e.g., direct feeding programs—maternal and child feeding) and towards infectious diseases control (e.g., aid towards distribution of medicines for control

[27] Note that in Table 4 using different lags as instruments does not change the number of observations (though it adds extra moment conditions). This is due to the fact the GMM estimation includes separate instruments for each time period. For example, in the differenced equation, $\Delta y_{i3} = \alpha \Delta y_{i2} + \Delta \varepsilon_{i3}$, the instrument for Δy_{i2} takes the value y_{i1} in period 3 and zero otherwise (see Roodman, 2008 for a discussion of this issue).

[28] As discussed below, Table 1 implies that for the average country, a US $1.60 increase in per capita health aid is associated with a 2 percent reduction in infant mortality. In comparison, the estimates in Table 5 imply that a US $1.60 increase in health aid is associated with a 1.6 percent reduction in infant mortality. We also estimated a specification where both infant mortality and health aid are specified in levels. The estimated coefficient on health aid is −0.23 and is statistically significant (results available upon request).

[29] We also estimated the OLS regressions using data on health aid disbursements rather than commitments. The data is available only for 3 periods, and since we use lags, there are only 2 periods with about 100 available observations. For comparison, we also restricted the data on health aid commitments to the same period. The estimated effect of health aid on infant mortality is not statistically different whether we use disbursements or commitments. However, in this small sample, the estimated effect is statistically insignificant in both cases. The estimates are also robust to including a time trend in the empirical specification. Finally, we did not find any significant evidence of non-linearities when we introduced the square of health aid in the basic specification in Table 1 (results are available upon request).

Table 9
Estimated effect of health aid on infant mortality, 1975–2004—interactions.

Dependent variable:	Log infant mortality (per 1000)	
	OLS	System GMM
Panel A: Regions		
Aid per capita (excluded Sub-Saharan Africa)	−0.0183*** (0.006)	−0.0089 (0.011)
Aid per capita*Asia and Pacific	0.0306** (0.012)	−0.0026 (0.023)
Aid per capita*MENA, Europe and Central Asia	0.0136 (0.016)	−0.0266 (0.033)
Aid per capita*LAC	0.0058 (0.010)	−0.0091 (0.014)
Hansen test: *P*-value		0.493
AR2 test: *P*-value		0.735
Number of observations	465	465
Panel B: Periods		
Aid per capita (excluded 1970–1989)	−0.0073 (0.006)	−0.0078 (0.008)
Aid per capita*1990–2004	−0.0062 (0.008)	−0.0197** (0.009)
Hansen test: *P*-value		0.632
AR2 test: *P*-value		0.854
Number of observations	465	465
Panel C: Policies and Institutions		
Aid per capita (excluded low CPIA)	−0.01 (0.008)	0.0024 (0.011)
Aid per capita*high CPIA	−0.0001 (0.009)	−0.0410*** (0.014)
Hansen test: *P*-value		0.545
AR2 test: *P*-value		0.814
Number of observations	460	460

CPIA stands for the Country Policies and Institutions Index developed by the World Bank. Sub-Saharan Africa in the regions interaction, 1970–1989 in the period interactions, and CPIA countries below the median in the CPIA interactions are the excluded categories. The regressions include the same controls as in Table 1. One lag of predetermined and endogenous variables are used as instruments. Standard errors are denoted in parentheses, and clustered at the country-level.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

Table 10
Estimated effect of types of health aid on infant mortality 1975–2004.

Dependent variable:	Log infant mortality rate (per 1000)			
	OLS	System GMM	OLS	System GMM
Lagged log general health aid per capita (DAC 5 code = 121)	−0.0051 (0.004)	−0.0085* (0.005)	−0.0085** (0.004)	−0.0127*** (0.005)
Lagged log basic health aid per capita (DAC 5 code = 122)	−0.0087** (0.004)	−0.0128** (0.006)	−0.0132*** (0.005)	−0.0204*** (0.006)
Lagged log general health aid per capita interacted with lagged log basic health aid per capita			−0.0054** (0.003)	−0.0078** (0.003)
Hansen test: *P*-value		0.661		0.569
AR2 test: *P*-value		0.734		0.801
Number of observations	465	465	465	465

The regressions include the same controls as in Table 1. One lag of predetermined and endogenous variables are used as instruments. Standard errors are denoted in parentheses, and clustered at the country-level.
* Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

of diarrhea) can be reasonably assumed to have more immediate effects.[30]

5.6. *Fixed effects model (with no lagged dependent variable)*

Table 8 reports results from an alternative specification with fixed effects, excluding lagged infant mortality (since the within-estimator is inconsistent in the presence of the lagged dependent variable). The estimator is the standard within-estimator, allowing for first-order autocorrelation in the disturbance term.[31] The estimated effect is negative and statistically significant at 10 percent (when we allow for a broader sample). The magnitude of the estimated effect (in column 2) is about two-thirds of the OLS estimate and about one-third of the GMM estimate reported in Table 1. The fixed effects estimates, however, could be more susceptible to omitted variable bias than the OLS and GMM specifications. This is because the initial infant mortality is both an important determinant of current infant mortality and of health aid. If countries

[30] The estimated effect of overall aid on infant mortality in Table 2 also withstands various robustness checks (Tables A8 and A9).

[31] Note that we lose one observation per country. The fixed effects specification is estimated using "xtregar" command in stata.

Table 11
Effect of aid on health spending, 1985–2004.

Dependent variable:	Health spending per capita	
	OLS	OLS
Log health aid per capita	0.0735** (0.035)	
Log overall aid per capita		0.05 (0.031)
Lagged log spending per capita	0.8285*** (0.044)	0.8235*** (0.044)
Log per capita income	0.2351*** (0.072)	0.2220*** (0.070)
Lagged log population	0.0046 (0.021)	0.0056 (0.023)
War dummy	−0.1504** (0.080)	−0.1776** (0.081)
HIV AIDS rate	0.0005 (0.001)	0.0006 (0.001)
Number of countries	108	108
Number of observations	229	231

Both spending and aid are averages over five-year periods. The regressions include period dummies. Standard errors are denoted in parentheses, and clustered at the country-level.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

with worsening health status receive more health aid, the fixed effects estimates will be biased towards zero, underestimating the beneficial effects of aid. In addition, the fixed effects model may be subject to a greater attenuation bias than the OLS estimates, if measurement error accounts for a greater portion of the within-country component of health aid than the cross-country component.

5.7. Alternative dependent variables

While infant mortality is our preferred health indicator, health aid may also affect life expectancy. The regression results for the impact of health aid on life expectancy suggest that the estimated coefficient is close to zero and statistically insignificant (available upon request). Even outside of Sub-Saharan Africa, where the onset of AIDS has distorted life expectancy measures, the estimated impact of health aid on life expectancy remains close to zero. This finding appears to be surprising, given that life expectancy data is derived from infant mortality in many countries (Deaton, 2006). However, despite a high unconditional correlation between infant mortality and life expectancy (0.86 in our data), the correlation is substantially lower after conditioning on the controls. The conditional correlation is calculated by correlating residuals from regressions of (log) infant mortality and life expectancy on controls (as in Table 1, column 1), and estimated to be equal to 0.46. Hence, it is possible that infant mortality, has a stronger relationship with health aid after controlling for a set of plausible variables.

The lack of a significant relationship between health aid and life expectancy may also point to serious measurement issues in adult mortality which could lead to attenuation bias in the estimates. The accurate estimation of adult mortality rates depends on having a complete vital registration system through which all births and deaths are reported to a government agency. (Deaton, 2006). Vital registration systems are still incomplete in most parts of the world. In practice, adult mortality rates are estimated from information on infant mortality and importantly, the formulas for calculating adult mortality and life expectancy have not been adjusted over time. In comparison, infant mortality rates are sufficiently high in poor countries to be estimated using household surveys, such as the widespread Demographic and Health Surveys.

Despite the potentially important role of measurement issues, it is also possible that health aid in fact affects infant mortality more than adult mortality. For example, adult mortality is affected by a lifetime of health behaviors, including the childhood health and economic conditions of adults. These may be less responsive to current health aid than infant mortality. In addition, health aid may in fact, be targeted more towards infants and mothers. Unfortunately, even in its most disaggregated classification (as shown in Table A1

Table A1
The list of CRS purpose codes.

DAC 5 Code	CRS code	Description	Clarifications/additional notes on coverage
120		Health	
121		Health, general	
	12110	Health policy and administrative management	Health sector policy, planning and programmes; aid to health ministries, public health administration; institution capacity building and advice; medical insurance programmes; unspecified health activities.
	12181	Medical education/training	Medical education and training for tertiary level services.
	12182	Medical research	General medical research (excluding basic health research).
	12191	Medical services	Laboratories, specialised clinics and hospitals (including equipment and supplies); ambulances; dental services; mental health care; medical rehabilitation; control of non-infectious diseases; drug and substance abuse control [excluding narcotics traffic control (16063)].
122		Basic health	
	12220	Basic health care	Basic and primary health care programmes; paramedical and nursing care programmes; supply of drugs, medicines and vaccines related to basic health care.
	12230	Basic health infrastructure	District-level hospitals, clinics and dispensaries and related medical equipment; excluding specialised hospitals and clinics (12191).
	12240	Basic nutrition	Direct feeding programmes (maternal feeding, breastfeeding and weaning foods, child feeding, school feeding); determination of micro-nutrient deficiencies; provision of vitamin A, iodine, iron, etc.; monitoring of nutritional status; nutrition and food hygiene education; household food security.
	12250	Infectious disease control	Immunisation; prevention and control of malaria, tuberculosis, diarrheal diseases, vector-borne diseases (e.g., river blindness and guinea worm), etc.
	12261	Health education	Information, education and training of the population for improving health knowledge and practices; public health and awareness campaigns.
	12281	Health personnel development	Training of health staff for basic health care services.

Source: OECD, Development Assistance Committee. http://www.oecd.org/document/21/0,2340,en_2649_34469_1914325_1_1_1_1,00.html

Table A2
Description of major CRS purposes.

	Donor	Recipient	Short description	Percent of total
Health Policy and Administrative Management, 2000–2004				
1	Multiple	Multiple	Health Policy & Admin. Management	8.3
2	IDA	India	Up Health Systems Development	2.9
3	United Kingdom	Pakistan	National Health Facility	2.6
4	Multiple	Multiple	Health Sector Support Project	2.4
5	IDA	India	Tamil Nadu Health Systems Project	2.4
6	IDA	Indonesia	Provincial Health	2.1
7	IDA	Ghana	Second Health Sector Program Support Project	2.1
8	IDA	Indonesia	Health, Nutrition & Population	2.1
9	Netherlands	Ghana	Support To The Ghanaian Ministry Of Health:Implementat Prog. Of Work	2.0
10	IDA	India	Rajasthan Health Systems Development Project	1.9
11	Multiple	Multiple	Other	71.1
Basic Health Care, 2000–2004				
1	Multiple	Multiple	Basic Health Care	11.4
2	IDA	Nigeria	Health Systems Development Project	4.4
3	United Kingdom	India	Healthy Life Services Guarantee Scheme: Basic Health Care	3.0
4	UNICEF	Multiple	Young Child Health	1.8
5	IDA	India	Food And Drugs Capacity Building Project	1.7
6	Australia	Papua New Guinea	Basic Health Services Support Program	1.6
7	United States	Multiple	Child Survival & Health Programs Fund	1.6
8	Denmark	Tanzania	Support To Health Sector Strategic Plan Through Basket Funds	1.5
9	UNICEF	Multiple	Health, General	1.5
10	Multiple	Ghana and Uganda	Health Sector Programme	1.5
11	Multiple	Multiple	Other	70
Infectious Disease Control, 2000–2004				
1	IDA	India	Immunization Strengthening Program	5.8
2	United Kingdom	India	Pulse Polio	5.4
3	United States	Multiple	Polio Immunizations In-Country Activities	3.8
4	IDA	India	India Immunization Strengthening Project	3.0
5	EC	Nigeria	Prime-Partnership To Reinforce Immunization	2.8
6	United Kingdom	India	Polio Eradication Programme	2.6
7	United Kingdom	Multiple	Human Disease Control	2.5
8	Multiple	Multiple	Polio Eradication	2.1
9	United Kingdom	China	China: Projects/Health	1.8
10	United Kingdom	Kenya	Basic Health: Social Marketing	1.8
11	Multiple	Multiple	Other	68.5

in the appendix), the CRS does not identify aid targeted particularly towards reducing infant mortality).[32]

6. Regions, institutions, periods, and types of aid

Until now, the reported estimated represent averages of the impact of health aid across all countries and periods in the sample. One prevalent view in the aid literature is that aid promotes growth in particular environments. In the sections that follow, we estimate how the effect of health aid depends on the region and institutional quality of the recipient, and when it is received. The results are shown in Table 9.

First, we examine how the effect of health aid on health outcomes varies by region. Table 9, panel A, suggests (in the GMM specification) that compared to Africa, the magnitude of the estimated effect of health aid on infant mortality is slightly larger in Asia and much larger in a large region that includes the Middle-East and North Africa (MENA), Europe, and Central Asia. However, the

[32] We also estimated the effect of health aid on various other health indicators, such as (i) adult (15–60) mortality from the WDI, and (iii) crude death rates from the UN, but failed to find any robust evidence for a discernible relationship with health aid. The data on adult mortality from WDI is very limited particularly and reported only once a decade for the earlier period. We linearly interpolate the data to fill in missing values for 1975, 1985 and 1995.

Table A3
List of variables and data sources.

Variable	Source
Infant mortality (per 1000 live births)	UN (2004)
Life expectancy (years)	UN (2004)
Aid ('03 $)	OECD DAC
Health Aid ('03 $)	OECD CRS
Population	IMF, World Economic Outlook (2006)
Wars	Heidelberg Institute for International Conflict Research and World Bank
Institutional quality index (CPIA)	World Bank
Per capita GDP ('03 $)	World Bank, WDI (2006)
Health Spending ($)	IMF Fiscal Affairs Department
HIV AIDS (cases per 100,000)	Papageorgiou and Stoytcheva (2006)
Fertility (children per woman)	UN (2004)
Female Literacy (percentage of females age 15 and above)	World Bank, WDI (2006)
Prevalence of undernourishment (percentage of population)	World Bank, WDI (2006)
Number of physicians per 1000 people	World Bank, WDI (2006)
Improved water source (% of population with access)	World Bank, WDI (2006)
Improved sanitation facilities (% of population with access)	World Bank, WDI (2006)

Table A4
Countries in sample.

Country	Observations	Country	Observations	Country	Observations
Albania	2	Hungary	2	South Africa	2
Algeria	2	India	6	Sri Lanka	6
Angola	5	Indonesia	6	Sudan	5
Argentina	6	Iran	1	Swaziland	4
Armenia	2	Iraq	1	Syria	3
Azerbaijan	2	Jamaica	4	Tajikistan	2
Bangladesh	6	Jordan	5	Tanzania	6
Belarus	2	Kazakhstan	2	Thailand	6
Benin	6	Kenya	6	Togo	5
Bolivia	5	Kyrgyzstan	2	Trinidad And Tobago	3
Bosnia	2	Lao Pdr	5	Tunisia	6
Botswana	4	Latvia	2	Turkey	6
Brazil	5	Lebanon	5	Turkmenistan	2
Bulgaria	1	Lesotho	4	Uganda	5
Burkina Faso	5	Liberia	2	Ukraine	2
Burundi	5	Libya	1	Uruguay	5
Cambodia	3	Lithuania	2	Uzbekistan	2
Cameroon	5	Macedonia	1	Venezuela	2
Central African Republic	6	Madagascar	6	Vietnam	5
Chad	5	Malawi	5	Yemen	2
Chile	4	Malaysia	4	Zambia	5
China	4	Mali	5	Zimbabwe	3
Colombia	5	Mauritania	6		465
Congo, Dem. Rep. Of	6	Mauritius	5		
Congo, Rep Of	6	Mexico	3		
Costa Rica	3	Moldova	2		
Cote D'Ivoire	5	Mongolia	1		
Croatia	2	Morocco	4		
Cuba	3	Mozambique	5		
Czech Republic	1	Myanmar	6		
Dominican Republic	5	Nepal	5		
Ecuador	5	Nicaragua	6		
Egypt	5	Niger	5		
El Salvador	5	Nigeria	5		
Eritrea	2	Oman	2		
Estonia	2	Pakistan	6		
Ethiopia	6	Panama	5		
Fiji	4	Papua New Guinea	3		
Gabon	4	Paraguay	6		
Gambia	4	Peru	6		
Georgia	2	Philippines	5		
Ghana	5	Poland	2		
Guatemala	5	Romania	2		
Guinea	5	Russia	2		
Guinea-Bissau	4	Rwanda	4		
Guyana	2	Senegal	5		
Haiti	6	Sierra Leone	5		
Honduras	5	Slovakia	1		

Table A5
Sample summary statistics.

	Observations	Mean	Standard deviation
Infant mortality (per 1000 live births)	465	72.75	42.94
Life expectancy (in year)	465	59.01	10.58
Lagged per capita health aid ('03 $)	465	1.67	2.43
Lagged per capita overall aid ('03 $)	465	48.61	56.52
War dummy	465	0.09	0.29
HIV AIDS rate (reported cases per 100,000 people)	465	4.22	11.67
Missing HIV AIDS rate	465	0.53	0.50
Lagged CPIA	465	2.90	1.32
Lagged per capita income ('03 $)	465	1279.5	1484.6
Lagged population	465	4.E+07	1.E+08
Lagged fertility rate (children per woman)	465	4.88	1.83
Lagged female literacy (percentage of females age 15 and above)	465	40.81	36.74
Missing lagged female literacy	465	0.31	0.47
Lagged percent of population malnourished	455	21.01	16.01
Lagged physicians per 1000	460	0.73	1.01
Lagged percent of population with sanitation access	453	53.71	25.95
Lagged percent of population with water access	455	72.16	19.46
Per capita health spending (in '03 $)	297	35.12	59.36

Table A6
Estimated effect of health aid on infant mortality, alternative truncation.

Threshold on health aid	$0		$0.05		$0.17		$0.39	
Percentile of health aid	0		10		20		30	
	OLS	Sys GMM	OLS	Sys GMM	OLS	Sys GMM	OLS	Sys GMM
Lagged log health aid per capita	−0.0046 (0.003)	−0.0069* (0.004)	−0.0059 (0.004)	−0.0102** (0.005)	−0.0096** (0.005)	−0.0172*** (0.006)	−0.0121** (0.006)	−0.0235*** (0.008)
Hansen test: *P*-value		0.303		0.371		0.408		0.479
AR2 test: *P*-value		0.738		0.704		0.731		0.697
Number of instruments		79		79		79		79
Number of countries	118	118	118	118	118	118	118	118
Number of observations	465	465	465	465	465	465	465	465

The controls are the same as Table 1. The alternative specifications show the results when we truncate the health aid series at various percentiles. Standard errors are denoted in parentheses, and clustered at the country-level.
* Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

Table A7
Estimated effect of health aid on infant mortality without lagged controls.

Dependent variable:	Log infant mortality rate (per 1000)	
	OLS	
	No controls	With controls
Lagged log health aid per capita	0.1403*** (0.041)	−0.0110** (0.005)
Lagged log infant mortality		1.0408*** (0.021)
Lagged log per capita income		−0.0169*** (0.008)
Lagged log population		−0.0094*** (0.004)
Lagged log fertility rate		0.028 (0.033)
War dummy	0.3351*** (0.181)	0.0053 (0.013)
HIV AIDS rate	0.0068** (0.004)	0.0021*** (0.000)
Number of countries	118	118
Number of observations	465	465

See notes to Table 1.
*Significance at 10 percent.
** Significance at 5 percent.
*** Significance at 1 percent.

differences are not statistically significant and are not apparent in the OLS estimates.[33]

Aid in general may have become more effective since the end of the Cold War, when it became less dictated by political motives (Bourguignon and Leipziger, 2006). In order to see whether the end of the Cold War improved the effectiveness of health aid, per capita health aid is interacted with a post-1990 indicator variable in Table 9, Panel B. The results from the GMM specification suggest that the effect of health aid strengthened after 1990, as a doubling of health aid is associated with a 0.8 percent reduction in infant mortality before 1990 and a 2.8 percent reduction after 1990. The increased effectiveness of aid in the post-1990 era could also reflect changes in mechanisms of aid delivery towards system-wide and government led intervention in health, rather than the small and isolated projects typical of the early 1970s.

Aid may have stronger effects in countries that have better policies and institutions. (Burnside and Dollar, 2000). Table 9 (panel C) reports results from specifications in which health aid was interacted with World Bank's Country Policy and Institutions Index (CPIA), a measure of the quality of polices and institutions in a country. Countries whose average CPIA score over the period fall below and above the median are treated as low and high CPIA countries, respectively. Table 9 shows some evidence, in the GMM specification, that health aid is more effective in reducing infant mortality in countries with higher institutional quality (significant at 1 level). In high CPIA countries, doubling health aid leads to a 4 percent decline in infant mortality. However, in the OLS specification, health aid is not demonstrably more effective in high CPIA countries. Furthermore, the existing indices of institutions like the CPIA do not fully capture the institutional characteristics of countries that are especially relevant for the management of aid (e.g., monitoring of aid-related spending, program indicators, etc.). Therefore, the GMM results showing a stronger effect in high CPIA countries should be interpreted with appropriate caution.

Finally, we disaggregate health aid into the two primary categories listed in Table A1, to see if the estimated effect of aid varies by category. The first category is general health aid, the largest component of which is health policy and administrative management, which includes aid to health ministries and public health administration. The second is basic health aid, where the large components

[33] We also interact health aid with a dummy for richer countries (defined as average per capita GDP above the median). The richer countries exhibit a stronger relationship between aid and infant mortality, but the difference is not statistically significant.

Table A8
Estimated effect of overall aid on infant mortality: GMM robustness check.

Number of lags	1	2	3	4	All
Dependent variable:	Log infant mortality (per 1000)				
Lagged log aid per capita	−0.0043 (0.011)	−0.0139 (0.011)	−0.0154 (0.010)	−0.0142 (0.010)	−0.015 (0.010)
Hansen test: *P*-value	0.14	0.497	0.953	0.999	0.353
AR2 test: *P*-value	0.786	0.768	0.792	0.767	0.764
Number of instruments	81	103	103	103	103
Number of countries	118	118	118	118	118
Number of observations	700	700	700	700	700

See notes to Table 2. This table repeats the System GMM specification in Table 2 with different lags.

are basic health care—basic and primary health care programs, supply of drugs, medicines and vaccines, and infectious diseases control. Table 10 shows that both types of health aid have a negative and statistically significant effect on infant mortality.

The difference in the estimated effects of the two different types is not statistically significant, however.[34] In addition, we also examine whether the effectiveness of one type of aid depends on the other type of aid received. Columns III and IV show results from a specification where the two types of health aid are interacted. The results are consistent with a beneficial interactive effect, as the negative association between basic health aid and infant mortality is strongest when countries receive a high amount of general health aid.

To summarize, the effect of health aid did not vary across regions, but there is some evidence that health aid has led to relatively larger reductions in infant mortality since 1990 and in countries with better policies and institutions. In addition, there is some evidence that different types of health aid may be complementary.

Table A9
Estimated effect of overall aid on infant mortality 1965–2004: short-run vs. long-run effect.

Dependent variable:	Log infant mortality rate (per 1000)	
	OLS	System GMM
Current log aid per capita	−0.0073 (0.006)	−0.0025 (0.012)
First stage *F* stat		
Hansen test: *P*-value		0.605
AR2 test: *P*-value		0.59
Number of countries	118	118
Number of observations	697	697
Twice lagged aid per capita	−0.0162*** (0.006)	−0.0230* (0.014)
First stage *F* stat		
Hansen test: *P*-value		0.364
AR2 test: *P*-value		0.73
Number of countries	118	118
Number of observations	617	617

The controls are the same as in Table 2. See notes to Table 2.
**Significance at 5 percent.
* Significance at 10 percent.
*** Significance at 1 percent.

7. Aid and government spending

Why are overall aid inflows not significantly associated with reduced infant mortality while health aid inflows are? One possible explanation is that overall aid is not allocated towards increased health spending, while health aid is directed specifically towards health purposes. In other words, health aid may be less fungible than overall aid. In this section, we make a preliminary attempt to explore the effect of aid on health spending. Increased government spending on health is neither a necessary nor sufficient condition for a beneficial effect of aid on health outcomes. Nonetheless, aid advocates often argue that aid will help increase health spending, and higher spending is a natural channel by which higher overall aid might improve health.

First, we estimate the relationship between health aid on health spending. Table 11 shows the results. Data on health spending come from the IMF's fiscal database and are available only for four periods. Since the GMM estimates are unreliable in such a small sample, only the OLS estimates are shown. The OLS results suggest a positive and significant correlation between health aid and health spending. Doubling per capita health aid is associated with a close to 7 percent increase in health spending per capita. For the average country, the estimates imply that US$1.0 increase in per capita health aid is associated with more than a US$1.50 increase in health spending per capita. Hence, the results suggest that health aid "crowds in" health spending by attracting additional domestic resources allocated towards health. This could occur, for example, if aid allocated towards building health facilities required additional doctors and nurses. The beneficial effect of health aid on reducing infant mortality is consistent with an association between the increased health aid and higher health spending.[35]

In contrast, overall aid is associated with a positive but statistically insignificant (though positive) impact on health spending. Thus, the results could suggest that (i) increased overall aid does not tend to be allocated towards health purposes or (ii) even if it is allocated towards health purposes, that overall aid "crowds out" other domestic spending on health, or (iii) that there is relatively greater leakage of overall aid. The results are consistent with the ineffectiveness of overall aid in improving health outcomes.

8. Caveats and conclusions

Although past studies have failed to document robust evidence that aid encourages economic growth, there remains hope among academics, policy makers, and the media that aid serves

[34] We also examine the effect of more disaggregated categories of health aid. We looked at the following four largest categories in Fig. 3 (described in detail in Table A1): (i) health policy and administrative management (code 12110), (ii) basic health care, (iii) infectious diseases control, (iv) medical services. We aggregated the remaining categories into 2 sub-categories: (v) other general health and (vi) other basic health. Aid targeted towards the four largest categories have a statistically significant impact in reducing infant mortality, with the magnitudes being similar. "Other basic health aid" (which includes aid targeted towards maternal and child nutrition and health infrastructure) also has a statistically significant impact, though the estimated magnitude in GMM is smaller relative to the four large categories. Finally, aid targeted towards "other general health" (which includes medical education and medical research) does not appear to be effective.

[35] We also explored the relationship between health aid, and other health inputs, like number of physicians and hospital beds but failed to find any significant effects. These data however have very limited coverage, and show no significant relationship with health spending as well.

a critical role by saving lives. This hope is consistent with micro-level evidence of the success of specific public health intervention programs. In addition, economic growth plays a limited role in explaining changes in health outcomes, implying that focusing exclusively on the effect of aid on growth may overlook important health benefits from aid.

Despite the vast empirical literature considering the effect of foreign aid on growth, systematic evidence that aid improves health outcomes is surprisingly scarce. The main contribution of this paper is to present new and comprehensive cross-country evidence on the effect of health aid on a key health outcome—infant mortality. To the best of our knowledge, this paper is the first empirical study to examine the effect of health aid on health outcomes.

In a sample of 118 countries from 1970 to 2004, we find that increased health aid is associated with a statistically significant reduction in infant mortality. The estimated effect of doubling health aid is a 2 percent reduction in infant mortality rates, which is small relative to the goals envisioned by the MDGs. In contrast, we fail to find robust evidence for a statistically significant effect of overall aid in reducing infant mortality. The results are consistent with suggestive evidence that unlike overall aid, health aid is associated with a statistically significant rise in health spending.

The estimated effect of health aid on infant mortality should be qualified because the health aid data are likely to suffer from underreporting. However, health aid is reported by donors, and there is no reason to believe that the cost of accurately reporting aid commitments depends on the recipient. Therefore, measurement error due to the underreporting of health aid should be independent of the characteristics of the recipient country. In this case, the estimated effect of health aid would be attenuated, and our estimates would understate the true beneficial effect of health aid, particularly in the OLS specification.

Because there exists no clean natural experiment to identify the effect of health aid on health outcomes, both the OLS and GMM estimates should be interpreted with due caution. If changes in health outcomes lead to countries' receiving more or less health aid, the estimates could be biased. In the GMM estimations, the effect of aid is identified using variation in a country's aid history, while controlling for several predetermined variables. As with GMM estimates in general, the estimates are inconsistent if the model's initial conditions are violated (Bond, 2002). This could occur, for example, if donors' aid decisions in the initial period partially reflected their expectations of the recipients' economic and social conditions in the future. This concern is ameliorated to some extent by the failure to reject both the null hypotheses of no second order serial autocorrelation in the residuals, and the validity of the over-identifying moment conditions.

Finally, the paper takes a cross-country approach to estimate the effect of foreign aid on health similar to the existing literature on aid and growth. Although the effect of aid is identified using within-country changes in aid and health outcomes over time, the estimated effect is nonetheless an average across a very heterogeneous set of countries. The use of cross-country data to address this question should therefore be considered as a first step, to be complemented by detailed case studies of the nature and effects of health aid in individual countries.

Appendix A. Private health aid

The aid data from DAC and CRS do not include private health aid, which is becoming increasingly important as suggested by anecdotal evidence. However, "data on private sector contributions, including those from household, corporate and foundation sources is severely limited—this, despite the fact that in many developing countries, private funding constitutes close to 50 percent of total spending" (CGD, 2007).

At best, we could obtain some aggregate figures on health aid from some private sources. Existing estimates suggest that the total international development assistance from private foundations in 2005 was roughly $1.6 billion (Marten and Witte, 2008) which is approximately half of the annual health aid commitments in CRS. The Bill and Melinda Gates Foundation, which is one of the largest private foundations, has committed approximately $6.6 bn towards development assistance for health between 2000 and 2008 (Marten and Witte, 2008; Michaud, 2003), which is roughly one-quarter of the annual health aid commitments in the CRS data (during the time period of our analysis). However, these numbers may not be comparable due to reasons discussed above.[36]

To the best of our knowledge, there has not been a serious attempt to match the funding in the health sector from private foundations to particular countries. This may be because often private health aid is not directly targeted to countries. For example, the Bill and Melinda Gates Foundation, which is the largest grant-giving private foundation in the world, may only be indirectly providing aid to countries through public private partnerships like the Global Fund to Fight AIDS, Tuberculosis and Malaria, hence it may be difficult to isolate the private component of funding from Gates to particular countries. Furthermore, private foundations spend a large fraction of their grants either directly or indirectly towards research on infectious diseases like malaria, TB and AIDS, hence are not targeted to particular countries.

Furthermore, we also obtained from confidential sources some information on donor tracking exercise from the Ministry of Health for Rwanda (not shown). It turns out that private funding is not a major factor in Rwanda in *direct* funding of a health plan. Private foundations like Gates may fund e.g., Columbia University for research on infectious diseases, and it also funds public-private partnerships like Global Alliance for Vaccines and Global Fund for AIDS, Malaria and TB. Overall this may give an idea about how difficult it is to identify separately the contribution of private funding to particular countries in the health sector.

Appendix B. Discussion of outliers

B.1. Outliers

The sample before dropping outliers comprises 486 observations. In what follows, we discuss the 21 country–year observations which have been dropped from the analysis in the text.

First, we use the Hadi procedure to identify outliers in infant mortality. This procedure is based on Hadi (1992) which uses the concept of "Mahalonobis distance" from a center estimator to establish outliers in a sample. The Hadi procedure identifies 3 outliers in our sample: Botswana 2000–2004, Swaziland 2000–2004, and Rwanda 1990–1994. A fourth outlier was dropped based on eyeballing the data: Guinea-Bissau in period 9 (2000–2004).

In addition, nine outliers are trimmed based on the distribution of the deviations from country means in health aid. Observations below the 1st percentile and above the 99th percentile are trimmed—Bolivia: 1975–1980; Colombia: 1975–1980; Costa Rica: 1980–1985; El Salvador: 1980–1985; Guyana: 1980–1985; 1990–1994 and 1995–1999; and Trinidad and Tobago: 1975–1980.

[36] Michaud (2003) suggests that the Gates foundation committed approximately US$596 mn in 2002 towards development assistance for health, which is about one-fifth of the health aid commitments in the CRS data.

Similarly, 5 observations are trimmed based on the deviation from country means in overall aid—Chile: 1985–1989; Costa Rica: 2000–2004; Mongolia: 2000–2004; Namibia: 1995–1999 and 2000–2004. Finally, three observations with high deviations in life expectancy from country means are also trimmed—Cambodia: 1975–1979; Lesotho: 2000–2004; and Zimbabwe: 2000–2004.

After dropping the outliers, the sample used in the regressions (see for example, Table 1) comprises 465 observations.

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