

# Are Remittances More Effective Than Aid To Improve Child Health? An Empirical Assessment using Inter and Intra-Country Data

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## Abstract

*The objective of the paper is to analyze the respective impact of aid and remittances on human development as measured by infant and child mortality rates. Panel data on a sample of 109 developing countries, and cross-country quintile-level data on a sample of 47 developing countries are alternatively used. In addition to assessing the extent to which health aid and remittances contribute to reduce child health disparities between countries, the paper addresses two other questions. What is the net effect of migration when the brain drain of health workers is accounted for? What is the effective impact of aid and remittances on intra-country child health disparities? Our results tend to show that remittances significantly improve child health and that the impact of health aid is non-linear, suggesting that aid to the health sector is more effective in the poorest countries. By contrast, medical brain drain, as measured by the expatriation rate of physicians, is found to have a harmful impact on health outcomes. The net impact of migration on human development is therefore mitigated. Last, remittances seem to be much more effective in improving health outcomes for children belonging to the richest households, whereas neither pro-poor nor anti-poor effect is found for health aid.*

**Keywords:** Child Health, Remittances, International Migration, Foreign Aid.

**JEL Codes:** F24, F22, F35, I10, O15.

## I. Introduction

Poverty reduction is increasingly put forward as the main objective of official development assistance (ODA) to developing countries. Both national leaders and the international community have indeed pledged to meet, by 2015, a series of poverty reduction targets known as the Millennium Development Goals (MDGs).<sup>2</sup> The pursuit of these MDGs, however, calls for a dramatic increase both in infrastructure finance and in the provision of basic services to the population of the developing world that official development assistance alone cannot accomplish. The Monterrey Consensus following the 2002 United Nations International Conference on Financing for Development has thus highlighted the need to find new sources

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<sup>2</sup> The eight Millennium Development Goals are: 1) to halve extreme income poverty; 2) to achieve universal primary education; 3) to promote gender equality; 4) to reduce by two-thirds the under-five mortality rate; 5) to reduce by three-quarters the maternal mortality rate; 6) to reduce the incidence of AIDS; 7) to promote sustainable development and to halve the percentage of people without access to safe drinking water; 8) to set up a global partnership for development involving more generous, more widespread official development assistance.

of financing and the idea that more private funds should be invested in developing countries has received strong support since then.

Given this context and their ever-increasing volume, international migrant remittances have attracted a lot of attention in recent years. According to the latest World Bank estimates (see Ratha and others, 2007), recorded remittances to developing countries reached \$240 billion in 2007. Their actual size is even larger when transfers going through informal channels are taken into account. In 36 out of 153 developing countries, remittances are larger than all capital flows, public and private, and voices have already been raised here and there to call for a progressive substitution of official aid by remittances.

Little is known, however, about the respective effectiveness of aid and remittances in alleviating poverty. Despite a burgeoning literature examining the impact of ODA on aggregate welfare, there exists to our knowledge almost no study analyzing to what extent aid and remittances may substitute in terms of external flows, and how they are related to inequality and poverty reduction. Exceptions include Chauvet and Mesplé-Soms (2007) who analyze the distributive impact of trade flows, foreign direct investment (FDI), official aid and migrants' remittances using Branco Milanovic's World Income Distribution database. They find that FDI increases intra-country disparities, while remittances tend to decrease them. They also find that trade and aid have a non-linear relationship with income distribution.

The objective of this paper is to fill this knowledge gap by analyzing the respective impact of aid and remittances on human development as measured by infant or child mortality rates. To what extent do aid and remittances contribute to reduce child health disparities *between* countries? What about their respective impact on child health disparities *within* countries? How do remittances compare to aid when migration costs, namely brain drain, are accounted for? Here is the list of questions this paper seeks to answer.

We choose basic indicators of human welfare instead of a monetary measure of poverty for three reasons. First, comparable cross-country data on monetary poverty over time are extremely scarce. Second, child health figures prominently in the list of MDGs. Donors have indeed committed themselves to reduce by two thirds the mortality rate among children under five (Goal 4). To this end, they have devoted an increasing share of official aid to the health sector. There is however very few empirical evidence on the effectiveness of increased aid flows on health outcomes in recipient countries. Whether donors are right to prioritize the health sector in the intra-country allocation of aid is thus an unanswered question that needs to be addressed. Third, the relationship between migration and health is increasingly emphasized in the microeconomic literature and donor agencies regularly report the success of most of their projects and programs in the health sector. It is therefore interesting to investigate whether successful health interventions from the donors' or the migrants' side at the micro-level translate into improved health outcomes at the macro-level and whether Paul Mosley's micro-macro paradox also applies to the health sector.

We follow Mishra and Newhouse (2007) and use aid granted to the health sector instead of aggregate aid in our empirical analyses. Our implicit assumption is that not all types of aid can reasonably be expected to affect health outcomes and that narrowing the aid variable should help us to better measure, if any, the impact of official development assistance on basic indicators of human development.

Our empirical strategy relies on two econometric exercises. We first examine the respective impact of aid, remittances and medical brain drain on child health indicators using panel data on a sample of 98 developing countries. We explore whether aid and/or remittances contribute to improve health outcomes, and whether the brain drain of health workers mitigates the positive impact of remittances. This first econometric exercise raises substantial methodological issues such as measurement errors and endogeneity of our core explanatory variables, which we try to address in the paper. Keeping in mind the inherent weaknesses of this macro approach, our econometric results suggest that both remittances and health aid significantly reduce infant and child mortality rates. The impact of health aid is non-linear, though, suggesting that aid to the health sector is likely to be more effective in the poorest countries. By contrast, medical brain drain, as measured by the expatriation rate of physicians, is found to have a harmful impact on health outcomes. The net impact of migration on human development is therefore mitigated.

We then assess the respective effectiveness of aid and remittances in reducing health disparities *within* countries using cross-country quintile-level data. Results of this second econometric exercise using cross-country quintile-level data show that remittances are effective in reducing infant and child mortality rates, but only for the richest quintiles. This result suggests that while remittances contribute to improve mean health outcomes in recipient countries, they tend to increase intra-country health inequality. The impact of health aid, by contrast, is hardly ever significant in our within-country regressions.

The remainder of the paper is organized as follows. Section II reviews the macro-literature on the poverty and inequality impact of aid and remittances. The data, method of estimation and results of the cross-country and intra-country analyses are presented in Section III and IV respectively. Section V offers concluding remarks and discusses the policy implications of our findings.

## **II. The Impact of Aid and Remittances on Poverty and Inequality: A Literature Review**

### *2.1. Poverty and Inequality Impact of Aid*

From the early 1960s to the mid 1990s, the literature investigating the macro-impact of aid exclusively focused on the link between aid and growth. The emerging picture from this literature is that aid can enhance growth, but that this result is very fragile and highly dependent on the choice of data, sample composition and estimation methods (Roodman, 2007). The adoption of the United Nations Millennium Declaration by UN members in 2000 and the obligation taken up by donors to financially support developing countries' efforts to achieve the eight Millennium Development Goals by 2015 have progressively shifted the focus from the aid-growth nexus to the relationship between aid flows and welfare or poverty indicators.

The few existing studies belonging to this strand of the literature have adopted quite standard cross-country growth regression approaches, and replaced growth with an indicator of welfare or poverty as the dependent variable (see, *e.g.*, Boone, 1996; Mosley, Hudson and Verschoor, 2004; Gomanee and others, 2005; Gomanee, Girma and Morrissey, 2005). Since comparable cross-country data on poverty over time are extremely scarce, most studies have concentrated on the effectiveness of aid in improving human development indicators such as infant or under-five mortality rate, life expectancy or primary schooling. In a famous paper, Boone

(1996) finds no evidence that aid succeeds in improving human development indicators in recipient countries. While aid could reduce infant mortality either through an increase in private consumption or through greater provision of public services to the poor, his results suggest that aid increases the size of recipient governments, but that it has no impact on basic measures of human indicators. Boone pushes his analysis further and investigates whether his result varies between alternative political regimes. He finds some evidence that liberal political regimes all else equal have lower infant mortality rates, which may reflect a willingness of liberal regimes to deliver more public services to the poor. Boone's paper has been much criticized on two grounds. First, some authors have argued that the welfare impact of aid is not direct but goes through its impact on the amount of government spending allocated to social areas. Boone's regressions would thus be inappropriately specified. Mosley, Hudson and Verschoor (2004) estimate a system of three equations with poverty, aid and pro-poor expenditure as their dependent variables. They find that aid is associated with higher levels of pro-poor spending, and that such spending is associated with lower levels of headcount poverty. Aid is also found to increase health spending which in turn decreases infant mortality. Gomanee, Girma and Morrissey (2005) reach the same type of conclusion using quantile regressions. In a companion paper, however, Gomanee and others (2005) find evidence that aid improves welfare indicators and this effect is predominantly through direct impacts. Other authors opposed to Boone's conclusions have argued that while it may be true that aggregate aid has not impact on health, particular types of aid among which health aid are effective in improving human development indicators (see, *e.g.*, Masud and Yontcheva, 2005; Dreher, Nunnenkamp and Thiele, 2006; Michaelowa and Weber, 2007; Mishra and Newhouse, 2007). Mishra and Newhouse (2007) in particular rely on a large dataset covering 118 countries between 1973 to 2004 to measure the effect of health aid on infant mortality. They estimate both OLS regressions and a system of moment equations using GMM and find that increased health aid is associated with a statistically significant reduction in infant mortality. The estimated effect of health aid is small, however, since doubling health aid within a country would reduce infant mortality in the next five-year period by only 2%. As an additional result, they do not find any significant impact of overall aid. Masud and Yontcheva (2005) use data on nongovernmental (NGO) and bilateral aid and assess the effectiveness of these financial flows on two social indicators, namely infant mortality and adult illiteracy. Their underlying assumption is that NGOs intervene at the grassroots level and could be more effective to alleviate poverty than other types of aid. Using an unbalanced panel of 58 countries from 1990 to 2001, they find that health expenditure per capita reduces infant mortality as does greater NGO aid per capita. By contrast they do not find any significant impact of total bilateral aid on infant mortality. The authors then list a number of reasons why NGO aid would work better than bilateral aid in reducing infant mortality. First, NGO aid would be allocated more toward countries with high infant mortality rate while bilateral aid would favor countries with lower infant mortality. Second, NGOs would have more direct links to the poor and vulnerable, which would make them more efficient; third, in line with Boone (1996), aid transiting through recipient governments could be diverted for the benefit of wealthy elites. Pushing their analysis further, the authors do not find any evidence of a positive impact of NGO and bilateral aid on the share of spending on health care in total expenditure.

Overall, as for the literature examining the aid impact on growth, the few existing papers examining the links between aid and aggregate welfare as measured by human development indicators do not allow to draw clear conclusions. Some papers find no impact at all while some other papers find evidence that aid decreases infant mortality rates, either directly or indirectly through higher levels of pro-poor spending. This lack of consensus in the macro

literature is surprising given the number of successful health interventions financially supported by international assistance (Levine and the What Works Working Group, 2004).

## 2.2. *Poverty and Inequality Impact of Remittances*

Despite the increasing size of remittances, empirical macro-evidence on the poverty or inequality impact of these financial flows is even scarcer than that related to aid. Here again, this lack of evidence stems mainly from the absence of reliable and comparable cross-country data on several of the relevant variables (*e.g.* emigration rate by country, amounts remitted) and the absence of long-series that are required if use is to be made of the latest macroeconometric tools. Consequently, most of the empirical literature is confined largely to a few case-studies on villages or countries based on microeconomic data (see, *e.g.*, Lachaud, 1999; Leliveld, 1997; Adams, 2004, 2006).

At the cross-national level, there are, to our knowledge, only four recent studies that have looked at the poverty impact of remittances (Adams and Page, 2005; World Economic Outlook, 2005; Gupta, Patillo and Wagh, 2007; Acosta and others, 2008). In addition, despite strong micro-evidence on a positive impact of remittances on education and health (see, *e.g.*, Kanaiaupuni and Donato, 1999; Cox-Edwards and Ureta, 2003; Hildebrandt and McKenzie, 2005 and Mansuri, 2007), no one has ever investigated the impact of remittances on human development indicators at a macroeconomic level. Adams and Page use a panel of 71 low-income and middle-income countries for which data on migration, remittances, poverty and inequality are available and test whether countries producing more international migration or receiving more international remittances have less poverty. After instrumenting for the potential endogeneity of remittances, they find that a 10% increase in per capita official remittances leads to a 3.5% decline in the share of people living in poverty. Using a broader sample of 101 countries, World Economic Outlook (2005) provides further evidence that remittances have an effect on poverty, even though this effect is rather small: on average, a 2.5 percentage point increase in the remittances to GDP ratio is associated with less than a 0.5 percentage point decrease in poverty. As argued by the authors, this (disappointing) result could be due to the fact that average income and inequality are included as regressors next to remittances. Since these variables are themselves likely to be influenced by remittances, the true impact of remittances on poverty could actually be larger. Using a sample of 76 countries in which Sub-Saharan countries are substantially represented, Gupta, Patillo and Wagh (2007) adopt the same methodology as that of Adams and Page (2005) and model poverty as a function of mean income, some measures of income distribution and remittances. Their findings indicate that a 10% rise in remittances is associated with about a 1% fall in the incidence of poverty. In the case of Sub-Saharan Africa, however, their results suggest that the impact of poverty on migration and remittances is greater than the impact of remittances and poverty. Last, Acosta and others (2008) use both cross-country and household survey data to assess the impact of remittances on growth, poverty and inequality in Latin America. Their cross-country estimates suggest that remittances have a positive and statistically significant effect on growth on average, but that they tend to increase the level of income inequality. The effect for the average Latin American country is different, however, since an increase in remittances tends to be associated with lower levels of inequality. Turning to their microeconomic analyses, their findings suggest that the poverty and inequality impact of remittances strongly varies across Latin American countries, depending on whether recipients are concentrated at the bottom or at the top of the distribution of non-remittances income.

In what follows, our aim is to provide additional insights into the question of whether aid and remittances as sources of external financing are effective in improving child health outcomes.

### III. The Impact of Aid and Remittances on Health Outcomes: a Cross-Country Analysis

The aim of this section is to assess the impact of health aid and remittances on child health outcomes, using panel data on a sample of 98 countries from 1987 to 2004 (Table A.1 in Appendix provides the full list of countries included in the sample). After a brief presentation of the empirical strategy and description of the data, results of our baseline model are discussed. The analysis is then pushed further by testing for non-linearities in the aid-health relationship, and investigating the impact of the medical brain drain on health outcomes.

#### 3.1. Model and Data

To explore the relative impacts of aid and migration on child health indicators, we estimate a model of the following form:

$$\text{LnHealth}_{i,t} = \alpha_i + \tau_t + \beta \text{LnX}_{i,(t-1,t-4)} + \delta \text{LnRemittances}_{i,(t-1,t-4)} + \theta \text{LnHealth aid}_{i,(t-1,t-4)} + \varepsilon_{i,t} \quad (1)$$

$\text{Health}_{i,t}$  is either the under-five or the infant mortality rate from the World Development Indicators (WDI, 2006). Under-five mortality rate is the probability (per 1000) that a newborn baby will die before reaching the age of five, if subject to current age-specific mortality rates. Infant mortality rate is the number of infants dying before reaching one year of age, per 1000 live births in a given year.

Since our dependent variables are bounded, we use a logarithmic transformation. To ease interpretation of our results and account for potential non-linearities, all our independent variables are also log-linearized.

We measure  $\text{Health aid}_{i,t}$  using aid commitments to the health sector as defined by the Country Reporting System (CRS) of the OECD.<sup>3</sup> The main advantage of the CRS is to provide data on aid commitments with a high degree of disaggregation by purpose (sector). Its main disadvantage, though, is that the data are only reliable for recent years, as reflected in Figure 1 by the large underreporting of aid in the CRS data compared to those of the Development Assistance Committee (DAC). As noted by Mishra and Newhouse (2007), the extent of underreporting varies by sector, donor and time period and therefore missing data are omitted from the sample rather than considered as zero health aid. We also restrict our sample to relatively recent observations, starting in the mid-eighties.<sup>4</sup> Figure 1 also shows that the share of aid commitments to the health sector has gradually increased since the eighties: at that time health aid was around 2% of total commitments, while it is now around 5%. This increase in health aid reflects the switch in donors' priorities – notably from aid to infrastructures to aid to social sectors – which goes along with the adoption of the Millennium Development Goals.

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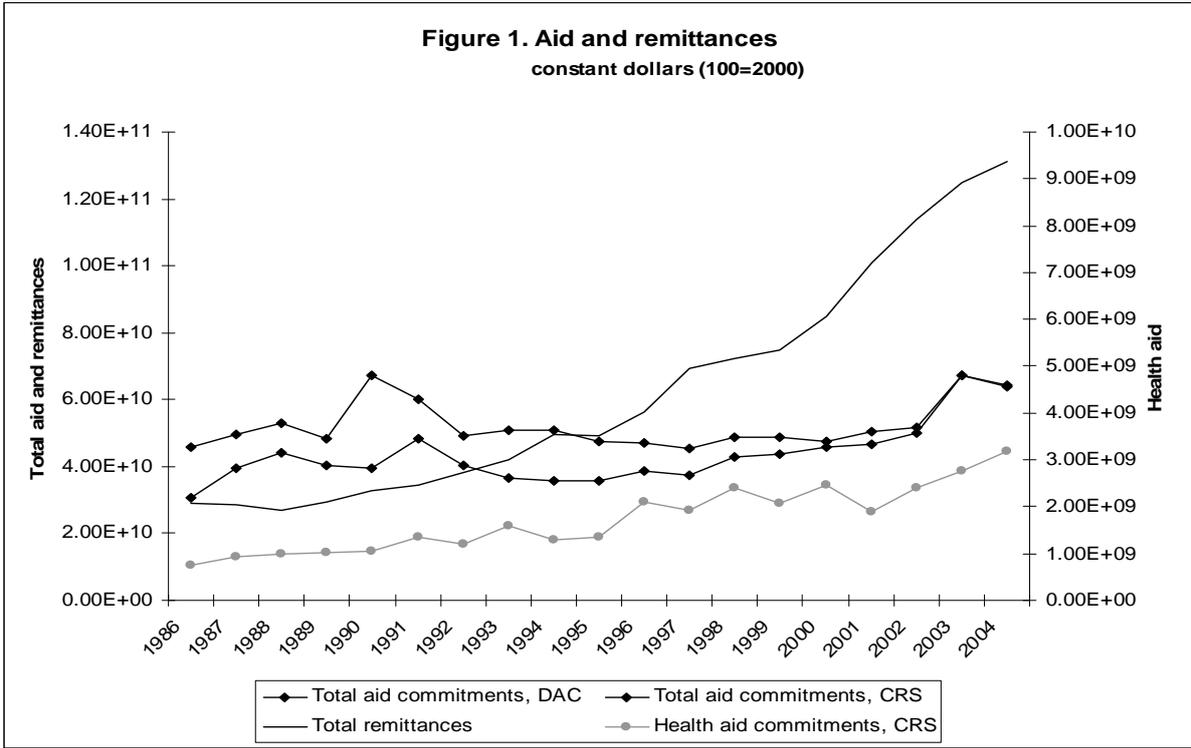
<sup>3</sup> CRS data is available at:

[http://www.oecd.org/document/0/0,2340,en\\_2649\\_34447\\_37679488\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/0/0,2340,en_2649_34447_37679488_1_1_1_1,00.html).

<sup>4</sup> Unlike us, Mishra and Newhouse (2007) include in their sample data on health commitments covering the sixties and seventies.

The CRS also provides a disaggregation of disbursements by sector. Unfortunately disbursements are even more underreported than commitments. As an alternative variable for  $Health\ aid_{i,t}$ , we proxy aid disbursements in the health sector by weighting total net disbursements with the share of health commitments in total commitments.  $Health\ aid_{i,t}$  is expressed in per capita constant terms (using DAC deflator).

$Remittances_{i,t}$  are defined as current transfers by migrants who are employed for more than a year in another country in which they are considered residents (WDI, 2006). We use the same deflator for remittances as for aid in order to transform this variable into per capita constant terms. As shown by Figure 1, worker’s remittances have been increasing both in absolute and in relative terms since the mid-eighties: while they only accounted for around 60% of total aid commitments in the eighties, they have represented more than 200% of aid commitments since 2000, reflecting the growing importance of this financing for developing economies. This remittance growth is partly due to the rise in the number of international migrants worldwide. But it also indicates that over the last years people have been shifting from informal to formal channels to send funds. This potentially important source of measurement error is addressed in our econometric analysis. First, we include a time trend in our list of regressors in order to capture the increasing trend in remittances. Second we control for unobservable heterogeneity among countries hoping to account for some omitted variables that could explain simultaneously the increasing trend in remittances and the decreasing trend in child and infant mortality. Finally, this latter issue is also tackled through the instrumentation of remittances (see 3.2).



Source of the data: OECD-DAC, OECD-CRS, WDI (2006).

Following the existing literature on cross-country determinants of child health outcomes, equation (1) controls for a set of relevant socioeconomic variables,  $X_{i,t}$ . Since Ravallion (1993), and Pritchett and Summers (1996), a consensus has emerged concerning the negative relationship between child mortality and national income. Female education – measured either

by educational attainment or illiteracy rates – has also been shown to be negatively correlated with child mortality (Filmer and Pritchett, 1999; Anand and Bärnighausen, 2004; Fay and others, 2005; McGuire, 2006; Ravallion, 2007). We measure income per capita in PPP constant terms (WDI, 2006) and female education using the average years of schooling of the female population aged 15 and over (Barro and Lee, 2000).

Anand and Bärnighausen (2004) show that the density of human resources in the health sector is significantly correlated with child health indicators. We proxy human resources for health with the number of physicians (per 1000) provided by Bhargava and Docquier (2008).

Other cross-country determinants of child health have been identified in the literature, such as the size of the population (Mishra and Newhouse, 2007), the share of urban population (Masud and Yontcheva, 2005; Fay and others, 2005; Ravallion, 2007), inequality indicators (Filmer and Pritchett, 1999; McGuire, 2006; Fay and others, 2005; Ravallion, 2007) and poverty rates (Anand and Bärnighausen, 2004), but none were significant in our analysis. Two other variables – ethnic fragmentation and whether the country is predominantly Muslim – were also significantly correlated with infant mortality in Filmer and Pritchett (1999) and McGuire (2006). Both are time invariant and could not be introduced in our fixed effects analysis.

Finally, there has been an intense debate concerning the impact of public spending on health outcomes. Because our core independent variable is health aid, and since the impact of health aid goes through the route of public spending, we exclude this variable from our analysis. Moreover, when public spending is introduced into the regressions, we lose half of the countries in the sample.

Equation (1) is estimated on a panel of 98 developing countries, among which 40 African countries, from 1987 to 2004 (the full list of countries included in the sample is provided in Table A1 in Appendix). Child health data is leaping every four or five years (1990, 1995, 2000 and 2004). The right-hand side variables are averaged over three years from  $t-1$  to  $t-4$  and are measured in logarithm. This is true for all variables but education, because Barro and Lee (2000) database on education is also leaping every five years and is available only up to 2000. We therefore use the 2000 level of education to explain 2004 health outcomes, etc. We control for unobservable heterogeneity with country fixed effects,  $\alpha$ . We also include time dummies  $\tau_t$

### *3.2. Endogeneity of Aid, Remittances and Income*

There are two potential sources of endogeneity of aid and remittances to child health indicators. First, aid and remittances are given purposively and both donors and migrants are likely to take into account the situation of child health when allocating their flows. Even if aid is determined at the macro-level and remittances are determined at the micro-level both are likely to reflect, to some extent, the chances of survival of children. Second, there could be some omitted variables which affect aid, remittances and child health. For example, natural disasters are likely to induce both a deterioration of child health indicators and an increase in aid and remittances inflows.

We therefore instrument health aid and workers' remittances.<sup>5</sup> As instruments for health aid, we use a set of variables that capture historical and cultural relationships between developing countries and donor/destination countries. These variables are more likely to be exogenous to child health than any recipient/origin countries' own characteristics. More specifically, we use the total aid budget of the five main donors weighted by cultural distance between receiving and donor/destination countries (whether they have the same religion) and by geographic distance (distance to Washington, Brussels and Tokyo).<sup>6</sup> As an instrument for health aid, we also use health aid lagged twice. Workers' remittances are instrumented using the ratio of broad money supply (M2) to GDP, as countries that are more financially developed have been found to receive larger remittances. Income per capita is also endogenous to health indicators (Pritchett and Summers, 1996; Filmer and Pritchett, 1999). It is instrumented using twice lagged income per capita.

We also suspected education to be endogenous to health indicators. We tested this hypothesis. It turned out that the exogeneity of education could not be rejected by our test, a result which can partly be explained by the fact that education in  $t-5$  (or  $t-4$ ) is used to explain health outcomes in  $t$ .

The excludability and relevance of our instruments being legitimate concerns here, tests for their validity (Sargan test of overidentification, test of underidentification, test of weak instruments, partial R squared) have been systematically performed.<sup>7</sup>

### *3.3. Estimation of the Baseline Model*

Our estimation of the baseline model proceeds in three steps. Equation (1) is first estimated with simple OLS. We then introduce country fixed effects to take into account unobservable heterogeneity in our sample. Finally aid, remittances and income are instrumented using 2SLS including country fixed effects and time fixed effects.<sup>8</sup> Instrumentation equations are provided in Table A2 in Appendix.

Regressions (1)-(6) of Table 1 present the estimations of the baseline model when the dependent variable is either the under-five mortality rate or the infant mortality rate. Income per capita is highly significant and tends to decrease child mortality. The impact is quite strong: the coefficients of income in regressions (3) and (6) suggest that a one percent increase in income decreases child mortality by around 0.59 percent and infant mortality by around 0.50. The coefficients of income per capita are interestingly close to the coefficients found by Pritchett and Summers (1996) in their IV estimations of infant mortality (around 0.3) using a different set of instruments. They are even closer for the fixed effect estimations (0.31 in Pritchett and Summers).

Surprisingly, the number of physicians is not significant in Table 1 except in OLS estimations. When significant, it is negative, suggesting that more doctors imply lower child and infant mortality rates. Anand and Bärnighausen (2004) find a strong impact of doctor and

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<sup>5</sup> Note that the introduction of country fixed effects contributes to solving, although imperfectly, the omitted variable bias.

<sup>6</sup> Tavares (2003) and Rajan and Subramanian (2005a, 2005b) use similar instruments for aid and/or remittances.

<sup>7</sup> Tests of overidentification and underidentification are reported in each table. Test for weak instruments, excludability and partial R squared are available upon requests.

<sup>8</sup> Following the literature on the determinants of health and contrary to Mishra and Newhouse (2007), we do not estimate a system of moment equations using Generalized Method of Moments (GMM) with a lagged dependent variable. The main reason is that the number of time periods is too small.

nurse density on various health indicators, which in their case is more robust than in our regressions. Again, only in OLS estimations does female education have a significant impact on child and infant mortality rates. In Table 1, the negative impact of the time dummies – 1990 is the omitted time dummy – reflects the decreasing trend in child and infant mortality rates over the last two decades.

Finally aid and remittances both have a negative coefficient in regressions (1)-(6), but contrary to Mishra and Newhouse (2007), we find no significant impact of health aid, at this stage of our empirical analysis. By contrast, remittances are found to be strongly significant in most regressions, with the expected sign. When instrumented, the coefficient of remittances is multiplied by more than four: a one percent increase in remittances decreases child mortality by 0.12 percent and infant mortality by 0.10 percent.

Table 1. Impact of health aid and remittances on child and infant mortality, baseline model.

	Child mortality			Infant mortality		
	OLS (1)	Within (2)	2SLS (3)	OLS (4)	Within (5)	2SLS (6)
GDP per capita (a)	-0.553 (6.64)***	-0.263 (3.03)***	-0.595 (2.39)**	-0.482 (6.49)***	-0.218 (2.78)***	-0.500 (2.26)**
Number of physicians per 1,000	-0.157 (3.93)***	-0.032 (0.82)	0.048 (0.89)	-0.107 (2.88)***	-0.022 (0.62)	0.050 (1.04)
Female educational attainment	-0.156 (1.97)*	0.034 (0.61)	-0.009 (0.09)	-0.151 (2.15)**	0.049 (0.95)	0.004 (0.05)
Dummy for missing education var.	-0.181 (1.82)*	0.008 (0.15)	-0.217 (1.28)	-0.170 (2.08)**	0.038 (0.81)	-0.168 (1.08)
Remittances per capita (a)	-0.054 (2.37)**	-0.031 (2.37)**	-0.122 (2.97)***	-0.045 (2.16)**	-0.023 (2.09)**	-0.104 (2.76)***
Health aid per capita (a)	-0.012 (0.60)	-0.012 (1.26)	-0.008 (0.31)	-0.009 (0.44)	-0.011 (1.29)	-0.000 (0.01)
<b>Year = 1995</b>	-0.058 (1.74)*	-0.102 (4.07)***	0.068 (1.29)	-0.048 (1.64)	-0.094 (4.16)***	0.081 (1.74)*
<b>Year = 2000</b>	-0.088 (2.14)**	-0.198 (6.92)***	0.032 (1.27)	-0.085 (2.27)**	-0.189 (7.34)***	0.037 (1.68)*
<b>Year = 2004</b>	-0.139 (2.94)***	-0.274 (7.98)***		-0.139 (3.24)***	-0.265 (8.68)***	
<b>Constant</b>	8.704 (13.88)***	6.360 (9.30)***		7.872 (13.93)***	5.669 (9.19)***	
Fixed effects	No	Yes	Yes	No	Yes	Yes
Observations	358	358	237	358	358	237
Number of countries	109	109	86		109	86
R-squared	0.75	0.57		0.72	0.57	
Sargan ( <i>p</i> -value)			0.31			0.27
Underidentification test ( <i>p</i> -value)			0.03			0.03
Income instrument. <i>F</i> -Stat ( <i>p</i> -value)			0.000			0.000
Aid instrument. <i>F</i> -Stat ( <i>p</i> -value)			0.100			0.100
Remit. instrument. <i>F</i> -Stat ( <i>p</i> -value)			0.000			0.000

Notes: Robust *t*-statistics in parentheses. All variables except the education variable are averages over three-year periods, from *t*-1 to *t*-4, measured in logs. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. In equations 1 and 4, standards errors are clustered by country. (a) Instrumented regressors in equations 3 and 5. Instruments include twice lagged GDP per capita, twice lagged aid, and instruments for aid and remittances in the tradition of Tavares (2003), namely total aid budgets of the five largest donors (USA, Japan, France UK, Germany) in constant dollars weighted by cultural (same religion) and geographical distance variables. The ratio of broad money supply (M2) to GDP is also included as an instrument for remittances. Tests of excludability of the instruments are available upon request.

### 3.4. Non-Linearities in the Aid-Health Relationship

As a next step to our analysis we explore in more detail the relationship between health aid and child health indicators. So far, we find no significant impact of health aid commitments. However, a relative consensus has emerged in the literature regarding the fact that aggregate aid disbursements impact macro outcomes, such as economic growth, in a non-linear way.<sup>9</sup>

Similarly, the impact of health aid on health outcomes may be non-linear. This non-linearity may be due to constrained absorptive capacity. A way to proxy constrained absorptive capacity in the health sector is through an interaction of health aid with income per capita: health aid would be relatively more effective in richer countries because they have a higher capacity to absorb aid.

In order to explore this kind of non-linearity in the health-aid relationship we estimate an equation of the following form:

$$\begin{aligned} \text{LnHealth}_{i,t} = & \alpha_i + \tau_t + \beta \text{LnX}_{i,(t-1,t-4)} + \delta \text{LnRemittances}_{i,(t-1,t-4)} \\ & + \theta_1 \text{LnHealth aid}_{i,(t-1,t-4)} + \theta_2 \text{LnHealth aid}_{i,(t-1,t-4)} \cdot \text{LnIncome}_{i,(t-1,t-4)} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where  $\text{LnHealth aid} \cdot \text{LnIncome}$  is an interaction variable of aid with income per capita. It is instrumented using the same set of instruments as those for health aid and income per capita.

Results are presented in columns (1) and (2) of Table 2. The absorptive capacity hypothesis is not supported by our results. The impact of health aid is non-linear, but the non-linearity suggests that aid to the health sector is more effective in poorer countries. The threshold in income per capita corresponding to a switch to harmful aid is around 4,100US\$ per capita (in PPP). Figures 2 and 3 depict the impact of aid on child mortality rate respectively below and above this income threshold. This threshold is quite high and implies that most African countries belong to the decreasing part of the relationship between health aid and health outcomes. Out of the 38 sub-Saharan African countries in our sample, aid increases the child mortality rate in eight of them: Botswana, Cap Verde, Gabon, Mauritius, Namibia, Swaziland, Seychelles and South Africa. In the remaining 30 African countries, aid tends to improve child health indicators.

It is worth noting that our baseline specification implies that we capture the direct effects of aid and remittances on child health indicators. Another channel through which aid and remittances could impact health outcomes is through their impact on GDP per capita.. Since GDP per capita is included among our set of regressors, this indirect impact is not taken into account. Assuming that both remittances and aid tend to improve income, we therefore probably underestimate the impact of these sources of financing on child health indicators.

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<sup>9</sup> The kind of non-linearity is still debated, though. Some authors argue that the relationship is quadratic (Hansen and Tarp, 2001; Lensink and White, 2001). Other claim that aid's impact depends on economic policy (Burnside and Dollar, 2000), on the vulnerability to external shocks (Guillaumont and Chauvet, 2001), on export price shocks (Collier and Dehn, 2001), on the fact of being a tropical country (Dalgaard et al., 2004).

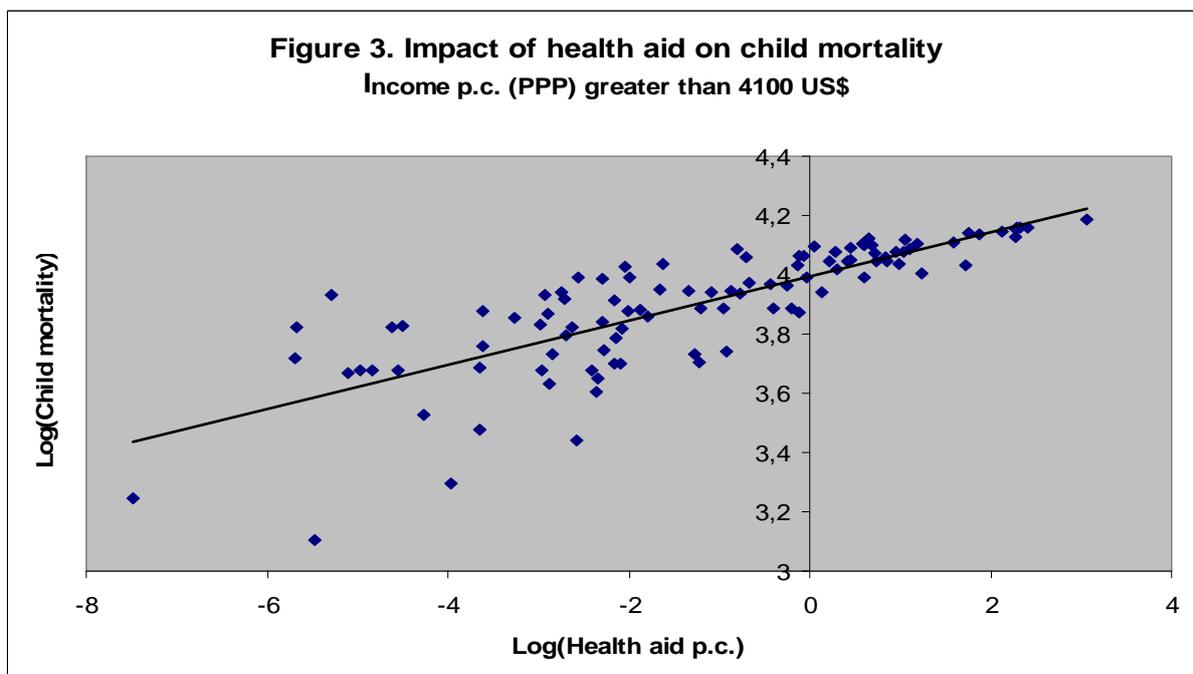
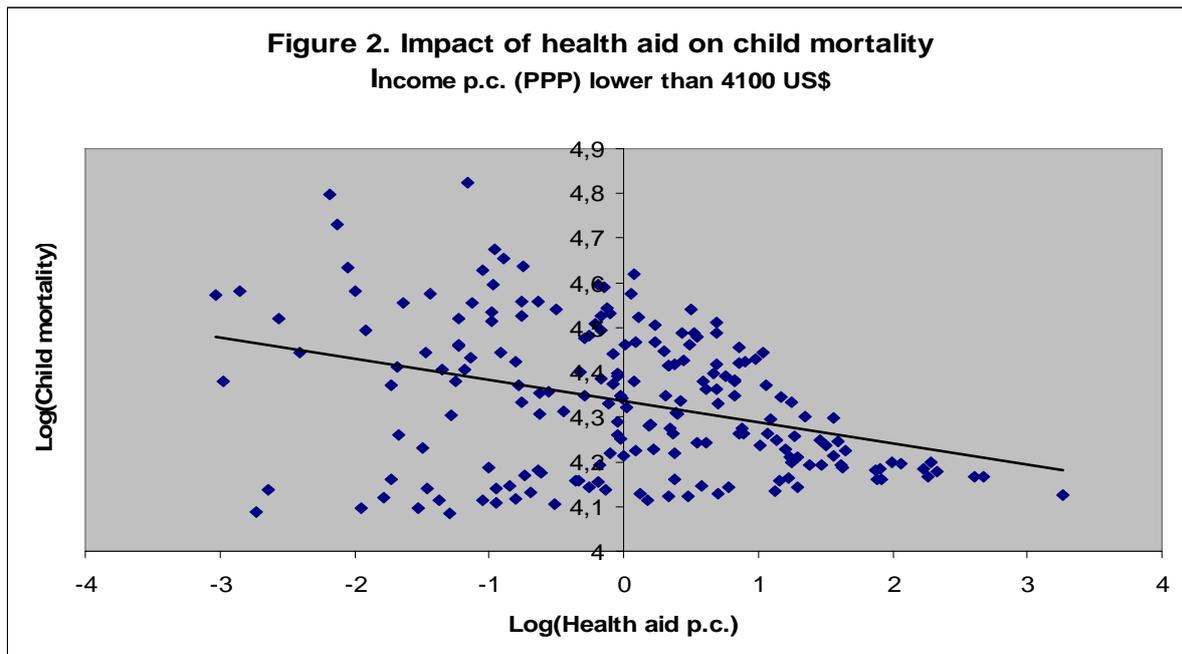
Table 2. Non-linearity in the health-aid relationship, 2SLS with fixed effects.

Dependent variable	Child mortality	Infant mortality
2SLS estimations	(1)	(2)
GDP per capita (a)	-0.355 (1.41)	-0.264 (1.16)
Number of physicians per 1,000	0.023 (0.40)	0.026 (0.49)
Female educational attainment	-0.063 (0.53)	-0.050 (0.45)
Dummy for missing education variable	-0.305 (1.39)	-0.255 (1.26)
Remittances per capita (a)	-0.115 (2.72)***	-0.097 (2.46)**
Health aid per capita (a)	-0.839 (1.87)*	-0.815 (1.99)**
Health aid per capita x Income per capita (a)	0.100 (1.85)*	0.098 (1.98)**
Year = 1995	0.071 (1.24)	0.084 (1.62)
Year = 2000	0.044 (1.69)*	0.049 (2.09)**
Fixed effects	Yes	Yes
Observations	237	237
Number of countries	86	86
Sargan ( <i>p</i> -value)	0.31	0.25
Underidentification test ( <i>p</i> -value)	0.04	0.04
Income instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.00	0.00
Aid instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.10/0.12	0.10/0.12
Remittances instrument <i>F</i> -Stat ( <i>p</i> -value)	0.00	0.00

Notes: Robust *t*-statistics in parentheses. All variables except the education variable are averages over three-year periods, from *t*-1 to *t*-4, measured in logs. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. (a) Instrumented regressors. Instruments include twice lagged GDP per capita and aid as well as instruments for aid and remittances in the tradition of Tavares (2003), namely total aid budgets of the five largest donors (USA, Japan, France UK, Germany) in constant dollars weighted by cultural (same religion) and geographic distance variables. The ratio of broad money supply (M2) to GDP is also included as an instrument for remittances. Tests of excludability of the instruments are available upon request.

An alternative way of testing the constrained absorptive capacity hypothesis is to introduce the square of health aid into the regression. A quadratic relationship between health aid and health indicators would reflect marginal decreasing return to aid – after a given threshold of aid received, an additional dollar of aid is less effective, because the country no longer has the capacity to absorb it. Aid square is never significant when introduced in any of the regressions.<sup>10</sup> Moreover, its sign is negative, as is that of health aid. The absence of a quadratic relationship between health aid and health outcomes confirms our previous finding of no absorptive capacity constraints of aid to the health sector. Health aid seems to be more effective where the prospects of improvements in health indicators are higher *i.e.* in poorer countries.

<sup>10</sup> Results are available from authors on request.



Finally, we explore whether the results using health aid disbursements are similar to those with aid commitments.<sup>11</sup> Regressions (1) and (3) of Table 3 reproduce the baseline model: health aid disbursements are not significantly different from zero. In regressions (2) and (4), health disbursements interacted with income are significant, confirming our previous result. The resulting income threshold – 4,000 US\$ – is close to the one corresponding to regressions including commitments.

<sup>11</sup> We also re-run all our regressions using aggregate aid disbursements instead of health aid disbursements, but the variable was never significant, suggesting that not all types of aid affect health outcomes. Results are available upon request.

Table 3. Impact of health aid disbursements on health indicators, 2SLS with fixed effects.

Dependent variable	Child mortality		Infant mortality	
	(1)	(2)	(3)	(4)
2SLS estimations				
GDP per capita (a)	-0.619 (2.47)**	-0.264 (1.00)	-0.516 (2.33)**	-0.176 (0.73)
Number of physicians per 1,000	0.044 (0.77)	0.039 (0.61)	0.046 (0.90)	0.041 (0.70)
Female educational attainment	-0.020 (0.19)	-0.134 (1.02)	-0.005 (0.05)	-0.114 (0.94)
Dummy for missing education variable	-0.248 (1.36)	-0.445 (1.80)*	-0.194 (1.16)	-0.383 (1.68)*
Remittances per capita (a)	-0.124 (2.95)***	-0.123 (2.70)***	-0.106 (2.74)***	-0.104 (2.46)**
Health aid disbursements per capita (a)	-0.028 (0.96)	-0.983 (2.25)**	-0.019 (0.73)	-0.937 (2.28)**
Health aid disbursements per capita x PIB per capita (a)		0.118 (2.16)**		0.113 (2.20)**
Year = 1995	0.061 (1.20)	0.075 (1.38)	0.075 (1.64)	0.088 (1.79)*
Year = 2000	0.029 (1.17)	0.047 (1.79)*	0.035 (1.55)	0.051 (2.16)**
Fixed effects	Yes	Yes	Yes	Yes
Observations	233	233	233	233
Number of countries	86	86	86	86
Sargan ( <i>p</i> -value)	0.29	0.47	0.26	0.36
Underidentification test ( <i>p</i> -value)	0.03	0.03	0.03	0.03
Income instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.00	0.00	0.00	0.00
Aid instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.08	0.08/0.11	0.08/0.11	0.08/0.11
Remittances instrument <i>F</i> -Stat ( <i>p</i> -value)	0.00	0.00	0.00	0.00

Notes: Robust *t*-statistics in parentheses. All variables except the education variable are averages over three-year periods, from *t*-1 to *t*-4, measured in logs. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. (a) Instrumented regressors. Instruments include twice lagged GDP per capita and aid as well as instruments for aid and remittances in the tradition of Tavares (2003), namely total aid budgets of the five largest donors (USA, Japan, France UK, Germany) in constant dollars weighted by cultural (same religion) and geographic distance variables. The ratio of broad money supply (M2) to GDP is also included as an instrument for remittances. Tests of excludability of the instruments are available upon request.

### 3.5. Medical Brain-Drain

Our baseline model suggests that migrants' remittances help improving health outcomes in developing countries. We now turn to analyzing the counterpart of workers' remittances: the impact of the brain drain induced by migration on health outcomes in developing countries. More specifically, we explore the impact of the *medical* brain drain (MDB). Bhargava and Docquier (2008) provide a rich dataset containing information on the expatriation rate of physicians.<sup>12</sup> We therefore introduce this latter variable into our model and estimate an equation of the following form:

<sup>12</sup> The expatriation rate is also provided disaggregated by destination countries.

$$\begin{aligned} \text{LnHealth}_{i,t} = & \alpha_i + \tau_t + \beta \text{Ln}X_{i,(t-1,t-4)} + \delta \text{LnRemittances}_{i,(t-1,t-4)} + \gamma \text{MedicalBrainDrain}_{i,(t-1,t-4)} \\ & + \theta_1 \text{LnHealth aid}_{i,(t-1,t-4)} + \theta_2 \text{LnHealth aid}_{i,(t-1,t-4)} \cdot \text{LnIncome}_{i,(t-1,t-4)} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where  $\text{MedicalBrainDrain}_{i,(t-1,t-4)}$  is the expatriation rate of physicians, averaged over three years sub-period and transformed in logarithm. Health outcomes and medical brain-drain may be correlated to omitted variables – such as the quality of health infrastructures. We therefore instrument this variable using the same set of instruments as for aid and remittances.

Regressions (1) and (2) of Table 4 present the results when MBD is introduced into the analysis. The coefficient of MBD is highly significant and has the expected positive sign: a one percent increase in the rate of expatriation of physicians increases child and infant mortality rates by around 0.5%. The expatriation of human resources in the health sector has a direct harmful impact on health outcomes in developing countries.<sup>13</sup>

Interestingly, the MBD does not really affect the impact of health aid on health outcomes. The threshold of income for which the relationship between aid and child health switches from negative to positive remains similar to that found in Table 2 (between 4,700 and 5,000\$), and the slope does not change a lot: from -0.815 it passes to around -1, suggesting that the health improving impact of aid is not altered when the MBD is taken into account.

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<sup>13</sup> Note that our estimations may under-estimate this impact as the MBD variable provided by Bhargava and Docquier (2008) measures only physicians brain drain but not other medical personnel emigration (nurses, midwife).

Table 4. Medical brain-drain and health outcomes, 2SLS with fixed effect.

Dependent variable	Child mortality	Infant mortality
2SLS estimations	(1)	(2)
GDP per capita (a)	-0.486 (1.77)*	-0.389 (1.56)
Number of physicians per 1,000	0.379 (2.50)**	0.365 (2.67)***
Female educational attainment	-0.205 (0.99)	-0.185 (0.98)
Dummy for missing education variable	-0.536 (1.49)	-0.476 (1.45)
Remittances per capita (a)	-0.134 (2.54)**	-0.114 (2.35)**
Health aid per capita (a)	-1.067 (2.02)**	-1.033 (2.14)**
Health aid per capita x PIB per capita (a)	0.125 (1.99)**	0.122 (2.12)**
Medical brain drain (a)	0.504 (2.61)***	0.481 (2.75)***
Year = 1995	0.093 (1.33)	0.105 (1.64)
Year = 2000	0.086 (2.39)**	0.089 (2.75)***
Fixed effects	Yes	Yes
Observations	237	237
Number of countries	86	86
Sargan ( <i>p</i> -value)	0.99	0.99
Underidentification test ( <i>p</i> -value)	0.07	0.07
Income instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.00	0.00
Aid instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.10/0.12	0.10/0.12
Remittances instrument <i>F</i> -Stat ( <i>p</i> -value)	0.00	0.00
MBD instrumentation <i>F</i> -Stat ( <i>p</i> -value)	0.01	0.01

Notes: Robust *t*-statistics in parentheses. All variables except the education variable are averages over three-year periods, from *t*-1 to *t*-4, measured in logs. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. (a) Instrumented regressors. Instruments include twice lagged GDP per capita and aid, as well as instruments for aid and remittances in the tradition of Tavares (2003), namely total aid budgets of the five largest donors (USA, Japan, France UK, Germany) in constant dollars weighted by cultural (same religion) and geographic distance variables. The ratio of broad money supply (M2) to GDP is also included as an instrument for remittances. Tests of excludability of the instruments are available upon request.

#### IV. Intra-Country Empirical Assessment

In this section, we investigate the intra-country impact of aid and remittances on child health indicators, by analyzing to what extent these transfers are targeted or not to the poorest. The discussion begins with a description of the data and the empirical strategy and ends with comments on our main findings.

##### 4.1. Model and Data

We use the World Bank's comprehensive database of Health, Nutrition and Population (HNP) statistics that compile development indicators from Demographic and Health Survey (DHS) by asset quintiles within countries (Gwatkin and others, 2007). Asset quintiles are computed

using the first principal component in an analysis of the correlations between various consumer durables and other household characteristics, following a method proposed by Filmer and Pritchett (2001).

Few studies have used the HNP database to analyze the determinants of child-health outcomes. To our knowledge, the first one is Fay and others (2005). Using a sample of 39 countries and a country random-effect model, they assert that apart from traditional variables like GDP per capita, assets, education, and direct health interventions, better access to basic infrastructure services has an important impact on infant and child mortality, and stunting incidence. Nevertheless, Ravallion (2007) questions the robustness of their results, and criticizes their empirical strategy on three points. First, the model of Fay and others (2005) is a linear model, whereas a logarithm functional form would have been more appropriate given the fact that the dependent variables are bounded. Second, by estimating a random-effect model, the authors implicitly assume that their country fixed-effects are not correlated with the regressors. This is a strong assumption, though, since many sources of latent heterogeneity across countries are suspected. Finally, there may be a strong presumption of bias due to the omission of within-country differences in women's schooling. Using exactly the same data but estimating a fixed-effect model that includes female education and variables in log-linear form, Ravallion does not find any significant impact of infrastructure access on child health outcomes. His findings suggest a significant effect of health care access and women educational attainment on child health.<sup>14</sup> The paper by Fielding, McGillivray and Torres (2008) also uses the same data. It examines, using a system of simultaneous equations, the relationships between four MDGs related variables (health, educational status and access to water and sanitation) and aid; Fielding and others (2008) also explore the impact of aid on these variables. They find that while aid is effective overall, the poorest sub-groups within each country are typically not the primary beneficiaries of these inflows.

In what follows, we use an updated HNP database in which some countries have multiple year data (the list of countries and years is provided in Table A3 in Appendix). This temporal dimension of the panel makes it possible to assess the impact of country-specific variables such as GDP per capita, aid, and remittances (that vary over time) in a model including country fixed effects. The dataset covers 47 developing countries among which 25 are in Africa, with five asset quintiles for each country-year, giving a total of 380 observations.

Table 5 provides summary statistics on the main variables of interest. It suggests that there are strong health disparities within country that are correlated with asset inequality. Households belonging to the poorest asset quintile have the highest mean infant and child mortality rates. For instance, child mortality is twice as high for the poorest quintile as for the richest one. Such a gap can be observed for female school completion rate that varies from 29.15 for the poorest to 76.34 for the richest. It is also worth noting that the differences in mean health indicators between the poorest and richest quintiles are always smaller than the ranges across countries within each quintile.

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<sup>14</sup> In a forthcoming paper, Fay and others (2007) briefly reply to Ravallion's comments.

Table 5. Summary statistics

<b>Variable</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
<b>Full sample</b>					
Infant mortality (a)	380	72.13	33.75	11.90	187.70
Child Mortality (b)	380	113.80	67.00	14.20	354.90
Female educational attainment (c)	380	50.44	31.94	0.50	99.80
<b>Poorest quintile by an "asset index"</b>					
Infant mortality (a)	76	86.88	31.32	32.00	187.70
Child Mortality (b)	76	140.08	62.82	39.10	297.90
Female educational attainment (c)	76	29.15	25.98	0.50	98.70
<b>Second quintile</b>					
Infant mortality (a)	76	82.62	32.71	23.80	152.30
Child Mortality (b)	76	132.33	69.25	27.30	354.90
Female educational attainment (c)	76	39.24	29.75	1.00	99.50
<b>Third quintile</b>					
Infant mortality (a)	76	75.91	34.14	19.70	157.20
Child Mortality (b)	76	120.08	69.44	23.50	348.30
Female educational attainment (c)	76	48.38	30.98	1.50	99.80
<b>Fourth quintile</b>					
Infant mortality (a)	76	65.64	32.17	11.90	142.00
Child Mortality (b)	76	102.63	64.63	14.20	314.90
Female educational attainment (c)	76	59.09	29.71	4.80	99.60
<b>Richest quintile</b>					
Infant mortality (a)	76	49.58	24.51	13.80	97.20
Child Mortality (b)	76	73.88	45.93	15.80	183.70
Female educational attainment (c)	76	76.34	20.13	27.00	99.80

## Notes

(a) Infant mortality: number of deaths to children under twelve months of age per 1,000 live births, based on experience during the ten years before the survey.

(b) Child mortality: number of deaths to children under five years of age per 1,000 live births, based on experience during the ten years before the survey.

(c) Female educational attainment: percent of women aged 15-49 years who had completed the fifth grade.

The intra-country model to be estimated is very similar to the cross-country model presented in the previous section in the sense that control variables are roughly the same and are expressed in log-linear form. The baseline model may therefore be written as follows:

$$\begin{aligned} \text{LnHealth}_{j,i,t} = & \alpha_i + \beta \text{Ln}X_{i,(t-1,t-4)} + \nu \text{Ln}X_{j,i,t} + \delta \text{LnHealth aid}_{i,(t-1,t-4)} + \gamma \text{LnRemit}_{i,(t-1,t-4)} \\ & + \sum_{j=2}^5 \varphi_j q_j + \sum_{j=2}^5 \tau_j q_j * \text{LnHealth aid}_{i,(t-1,t-4)} + \sum_{j=2}^5 \omega_j q_j * \text{LnRemit}_{i,(t-1,t-4)} + \varepsilon_{j,i,t} \end{aligned} \quad (4)$$

where  $j$  is quintile index and  $q_j$  are quintile dummy variables.<sup>15</sup>

Vector  $X_{i,(t-1,t-4)}$  includes GDP per capita in PPP constant terms and the number of physicians per 1,000 inhabitants. These variables are averaged over three years from  $t-1$  to  $t-4$  and are measured in logarithm. Vector  $X_{j,i,t}$  contains quintile- and time-specific female educational attainment expressed in log-linear form.

In order to test whether the impact of health aid and remittances differs between quintiles,  $\text{LnHealthaid}$  and  $\text{LnRemit}$  are interacted with quintile dummies  $q_2$  to  $q_5$ , the poorest quintile being the reference. We chose not to interact quintile dummies with the other control variables such as GDP per capita to limit the number of instruments when the IV specification is used. Finally, we control for quintile ( $\sum_{j=2}^5 \tau_j q_j$ ) fixed effects as well as for country fixed effects.

As in the cross-country analysis, endogeneity of aid, remittances and income is controlled for using an IV specification. The education variable has also been found to be endogenous to health indicators. This is probably due to the fact that education is measured by contemporaneous school completion rate. Instruments include lagged GDP per capita, ratio of broad money supply (M2) to GDP, lagged health aid per capita, and total aid budgets of France, Japan, UK and USA in constant dollars. We also include lagged GDP per capita and lagged health aid per capita interacted with quintiles  $q_2$  to  $q_5$  among the instruments.

#### 4.2. Estimation Results

The intra-country impact of aid and remittances on child health is assessed using child and infant mortality rates. We proceed in two steps. First, the baseline model is estimated without including any interaction terms between health aid and remittances on the one hand and quintile dummies on the other hand (Table 6). We then add these interaction terms to our set of regressors (Table 7). Even though controlling for endogeneity and countries' unobserved heterogeneity is likely to provide more reliable results (as in regressions (3), (6) and (9)) Tables 6 and 7 also present the results of simple OLS and fixed-effects regressions.

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<sup>15</sup> We are not able to include time dummies because years vary from one country to the other and we only have one year of observation for half of the sample.

Table 6. Intra-country specification without interaction terms.

	Child mortality (CMR)			Infant mortality (IMR)		
	(1) OLS	(2) Within	(3) IV	(4) OLS	(5) Within	(6) IV
GDP per capita (a)	-0.272 (3.41)***	-0.871 (5.21)***	-0.673 (3.16)***	-0.281 (4.52)***	-0.868 (5.04)***	-0.620 (2.71)***
Number of physicians per 1,000	-0.157 (4.55)***	-0.111 (1.61)	-0.016 (0.21)	-0.081 (2.82)***	-0.065 (0.92)	0.034 (0.39)
Female educational attain. (a)	-0.132 (3.26)***	0.047 (2.01)**	-0.220 (1.79)*	-0.100 (3.08)***	0.052 (2.13)**	-0.186 (1.59)
Remittances per capita (a)	-0.031 (1.64)	-0.036 (1.30)	-0.075 (1.53)	-0.022 (1.34)	-0.022 (0.77)	-0.076 (1.56)
Health aid per capita (a)	0.027 (0.71)	0.053 (1.72)*	0.048 (0.90)	0.023 (0.66)	0.047 (1.48)	0.045 (0.83)
Constant	7.054 (11.63)***	11.163 (8.84)***		6.696 (14.07)***	10.738 (8.26)***	
Fixed effects	No	Yes	Yes	No	Yes	Yes
Quintile dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	380	380	370	380	380	370
R-squared	0.79	0.72		0.74	0.64	
Number of id		47	46		47	46
Underidentification test ( <i>p</i> -value)			0.01			0.01
Sargan ( <i>p</i> -value)			0.52			0.20
Income instrum. F-Stat ( <i>p</i> -value)			0.000			0.000
Fem. Edu. instrum.F-Stat ( <i>p</i> -value)			0.044			0.044
Aid instrum. F-Stat ( <i>p</i> -value)			0.000			0.000
Remit. instrum F-Stat ( <i>p</i> -value)			0.000			0.000

Notes: Robust t statistics in parentheses. GDP per capita, number of physicians per 1,000 inhabitants, health aid per capita, and remittances are averages over three-year periods, from t-1 to t-4, measured in logs. Female educational attainment is measured at the same period as the outcome variable by quintile and is in logs.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

(a) Instrumented regressors in equations 3, and 6. Instruments include lagged GDP per capita, lagged Health aid per capita, ratio of broad money supply (M2) to GDP, and total aid budgets of France, Japan, UK, and USA in constant dollars. Tests of excludability of the instruments are available upon request.

As suggested by Table 6, the impact of our control variables is quite similar to the one found using our cross-country specification. GDP per capita for instance tends to decrease infant and child mortality rates. The coefficient of this variable suggests that an increase of 1 percent of GDP per capita decreases child and infant mortality by about 0.6 percent. As in the previous specification, the number of physicians per 1,000 inhabitants is found to have no significant impact on child health outcomes. Female education is found to have a negative impact only on child mortality rate but not on infant mortality rate. This result is in accordance with our previous results, but not with Ravallion's ones (2007) who found a significant negative impact of female education whatever the child health indicators chosen. This lack of robust impact may result from the fact that the education variable we use is less precise than the one used by Ravallion: we use the percentage of women aged 15-49 years who have completed their fifth grade, whereas Ravallion (2007) uses the average number of years of female schooling.

Turning to our variables of interest, estimation results suggest that remittances and health aid have no impact at all. Adding interaction terms substantially alter the picture. As suggested by Table 7, migrants' remittances are now significant and their impact on child health outcomes is found to be stronger for the richest quintiles than for the poorest ones (remittances and remittances interacted with quintile dummies are jointly significant in the child and infant mortality equations). The impact of remittances is nil on health indicators of the poorest quintiles (around 0.01 on child mortality, column (3)) whereas it is stronger for the middle and upper-class (around 0.07, 0.13, and 0.20 respectively on quintiles 3, 4 and 5). Overall, this result suggests that remittances tend to increase health disparities within countries.

By contrast, neither anti-poor nor pro-poor impact is found for health aid. This finding contrasts with that of Fielding, McGillivray and Torres (2008) who estimate a system of simultaneous equations on several welfare measures including health outcomes and find a significant negative impact of total aid (in percentage of GDP) on child mortality and an increased effectiveness of aid for the richest quintile.

As a final step, we check whether including medical brain drain among the set of regressors changes the baseline results (Table 8). The expatriation rate of physicians does not seem to have a direct significant impact but its inclusion among the set of regressors mitigates the impact of remittances: whatever the quintile, the impact of remittances on child and infant mortality becomes indeed very low.

Table 7. Intra-country specification with interaction terms.

	Child mortality (CMR)			Infant mortality (IMR)		
	(1) OLS	(2) Within	(3) IV	(4) OLS	(5) Within	(6) IV
GDP per capita (a)	-0.271 (3.38)***	-0.867 (5.63)***	-0.673 (2.72)***	-0.279 (4.46)***	-0.865 (5.33)***	-0.620 (2.39)**
Number of physicians per 1,000	-0.156 (4.48)***	-0.109 (1.72)*	-0.016 (0.15)	-0.080 (2.79)***	-0.063 (0.95)	0.034 (0.31)
Female educational attainment(a)	-0.137 (3.53)***	0.037 (1.69)*	-0.220 (1.49)	-0.103 (3.29)***	0.045 (1.92)*	-0.186 (1.39)
Remittances p. c. (a)	0.017 (0.73)	0.015 (0.56)	0.035 (0.49)	0.022 (0.99)	0.024 (0.83)	0.011 (0.16)
Remittances p.c. x 2nd quintile (a)	-0.033 (3.37)***	-0.040 (2.75)***	-0.044 (1.00)	-0.034 (2.80)***	-0.040 (2.64)***	-0.029 (0.69)
Remittances p.c. x 3rd quintile (a)	-0.055 (3.64)***	-0.063 (4.35)***	-0.114 (3.15)***	-0.052 (3.60)***	-0.059 (3.84)***	-0.087 (2.58)***
Remittances p.c. x 4th quintile (a)	-0.074 (4.25)***	-0.077 (5.31)***	-0.163 (3.99)***	-0.067 (3.84)***	-0.070 (4.55)***	-0.132 (3.40)***
Remittances p.c. x 5th quintile (a)	-0.085 (3.61)***	-0.076 (5.21)***	-0.232 (2.98)***	-0.068 (3.05)***	-0.060 (3.93)***	-0.187 (2.60)***
Health aid per capita (a)	-0.028 (0.69)	0.003 (0.08)	-0.073 (0.85)	-0.031 (0.79)	-0.002 (0.07)	-0.072 (0.90)
Health aid p.c. x 2nd quintile (a)	0.041 (3.18)***	0.040 (1.75)*	0.078 (1.32)	0.037 (2.24)**	0.037 (1.50)	0.074 (1.28)
Health aid p.c. x 3rd quintile (a)	0.067 (3.11)***	0.062 (2.70)***	0.121 (2.20)**	0.059 (2.62)**	0.055 (2.26)**	0.120 (2.29)**
Health aid p.c. x 4th quintile (a)	0.096 (3.35)***	0.087 (3.75)***	0.194 (2.94)***	0.097 (3.30)***	0.089 (3.63)***	0.178 (2.76)***
Health aid p.c. x 5th quintile (a)	0.074 (1.95)*	0.061 (2.64)***	0.210 (2.17)**	0.076 (2.09)**	0.066 (2.69)***	0.209 (2.30)**
Constant	6.969 (11.43)***	11.069 (9.51)***		6.620 (13.82)***	10.655 (8.70)***	

Table 7. (continued)

	Child mortality (CMR)			Infant mortality (IMR)		
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Within	IV	OLS	Within	IV
Fixed effects	No	Yes	Yes	No	Yes	Yes
Quintile dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	380	380	370	380	380	370
R-squared	0.81	0.76		0.75	0.69	
Number of id		47	46		47	46
Joint significance of aid variables	0.038	0.000	0.073	0.061	0.005	0.100
Joint significance of remittances variables	0.000	0.000	0.000	0.003	0.000	0.007
Underidentification test ( <i>p</i> -value)			0.14			0.14
Sargan ( <i>p</i> -value)			0.66			0.31
Income instrumentation F-Stat ( <i>p</i> -value)			0.000			0.000
Fem. edu. instrum.F-Stat ( <i>p</i> -value)			0.000			0.000
Aid instrumentation F-Stat ( <i>p</i> -value)			0.000			0.000
Aid X q2 instru. F-Stat ( <i>p</i> -value)			0.046			0.046
Aid X q3 instru. F-Stat ( <i>p</i> -value)			0.046			0.046
Aid X q4 instru. F-Stat ( <i>p</i> -value)			0.046			0.046
Aid X q5 instru. F-Stat ( <i>p</i> -value)			0.046			0.046
Remittances instrumentation F-Stat ( <i>p</i> -value)			0.000			0.000
Remit. X q2 instru. F-Stat ( <i>p</i> -value)			0.003			0.003
Remit. X q3 instru. F-Stat ( <i>p</i> -value)			0.003			0.003
Remit. X q4 instru. F-Stat ( <i>p</i> -value)			0.003			0.003
Remit. X q5 instru. F-Stat ( <i>p</i> -value)			0.003			0.003

Notes: Robust t statistics in parentheses. GDP per capita, number of physicians per 1,000 inhabitants, health aid per capita, and remittances are averages over three-year periods, from t-1 to t-4, measured in logs. Female educational attainment is measured at the same period as the outcome variable by quintile and is in logs.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

(a) Instrumented regressors in equations 3, 6. Instruments include lagged GDP per capita, lagged Health aid per capita, ratio of broad money supply (M2) to GDP, total aid budgets of France, Japan, UK, and USA in constant dollars, the lagged GDP per capita and the lagged Health aid per capita both crossed with quintiles q2 to q5. Tests of excludability of the instruments are available upon request.

Table 8. IV Intra-country specification with medical brain-drain.

	(1)	(2)
	CMR	IMR
GDP per capita (a)	-0.823 (3.41)***	-0.814 (2.71)***
Number of physicians per 1,000	-0.913 (1.55)	-1.123 (1.56)
Female educational attainment (a)	0.195 (0.65)	0.348 (0.95)
Medical brain drain (a)	-0.983 (1.50)	-1.268 (1.61)
Remittances per capita (a)	0.115 (1.52)	0.114 (1.18)
Remittances p.c. x 2nd quintile (a)	-0.064 (1.81)*	-0.055 (1.35)
Remittances p.c. x 3rd quintile (a)	-0.126 (3.85)***	-0.102 (2.67)***
Remittances p.c. x 4th quintile (a)	-0.121 (2.78)***	-0.077 (1.53)
Remittances p.c. x 5th quintile (a)	-0.077 (0.69)	0.012 (0.09)
Health aid per capita (a)	-0.116 (1.54)	-0.127 (1.44)
Health aid p.c. x 2nd quintile (a)	0.053 (1.10)	0.041 (0.68)
Health aid p.c. x 3rd quintile (a)	0.061 (0.98)	0.043 (0.56)
Health aid p.c. x 4th quintile (a)	0.096 (1.11)	0.052 (0.49)
Health aid p.c. x 5th quintile (a)	0.068 (0.57)	0.026 (0.18)
Fixed effects	Yes	Yes
Quintile dummies	Yes	Yes

Table 8. (continued)

	(1)	(2)
	CMR	IMR
Observations	370	370
Number of id	46	46
Joint significance of aid variables	0.557	0.804
Joint significance of remittances variables	0.001	0.080
Underidentification test ( <i>p</i> -value)	0.67	0.67
Sargan ( <i>p</i> -value)	0.87	0.66
Income instrumentation F-Stat ( <i>p</i> -value)	0.000	0.000
Fem. edu. instrum.F-Stat ( <i>p</i> -value)	0.000	0.000
Aid instrumentation F-Stat ( <i>p</i> -value)	0.000	0.000
Aid X q2 instru. F-Stat ( <i>p</i> -value)	0.046	0.046
Aid X q3 instru. F-Stat ( <i>p</i> -value)	0.046	0.046
Aid X q4 instru. F-Stat ( <i>p</i> -value)	0.046	0.046
Aid X q5 instru. F-Stat ( <i>p</i> -value)	0.046	0.046
Remittances instrumentation F-Stat ( <i>p</i> -value)	0.003	0.003
Remit. X q2 instrumentation. F-Stat ( <i>p</i> -value)	0.003	0.003
Remit. X q3 instrumentation. F-Stat ( <i>p</i> -value)	0.003	0.003
Remit. X q4 instrumentation. F-Stat ( <i>p</i> -value)	0.003	0.003
Remit. X q5 instrumentation. F-Stat ( <i>p</i> -value)	0.003	0.003
Medical brain drain instrumentation F-Stat ( <i>p</i> -value)	0.000	0.000

Notes: Robust t statistics in parentheses. GDP per capita, number of physicians per 1,000 inhabitants, health aid per capita, and remittances are averages over three-year periods, from t-1 to t-4, measured in logs. Female educational attainment and fertility rate are measured at the same period as the outcome variable by quintile and are in logs. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

(a) Instrumented regressors. Instruments include lagged GDP per capita, lagged Health aid per capita, ratio of broad money supply (M2) to GDP, total aid budgets of France, Japan, UK, and USA in constant dollars, the lagged GDP per capita and the lagged Health aid per capita both crossed with quintiles q2 to q5. Tests of excludability of the instruments are available upon request.

## V. Conclusion

For several years, it has been asserted that achieving Millennium Development Goals by 2015 will require increased external financing coupled with an improved targeting effectiveness in favor of the poorest population. In this context, international migrants' remittances have been increasingly put forward as a promising source of external financing. Nevertheless, empirical assessments of the respective impact of aid and remittances on aggregate welfare as measured either by poverty in monetary terms or human development indicators are rather scarce.

In this paper, we choose to focus on various child health outcomes, namely under-five mortality (Goal 4), and infant mortality, in order to examine the direct impact of aid granted to the health sector and remittances on these human development indicators. Given our primary focus, we do not enter the debate on the relative importance of direct versus indirect (via government pro-poor expenditure) impact of aid. To complete our diagnosis, we push our analysis further and investigate the net impact of migration that is to say the effectiveness of migration including the effect of the medical brain drain. We also examine the intra-country allocation of aid and migrants' remittances.

Our results for health aid are in line with the literature examining the welfare impact of aid using cross-country data in the sense that they suggest a non-robust relationship between aid and welfare. While the impact of health aid is found to be significant in our cross-country regressions (but only when aid is interacted with income per capita), this result vanishes when cross-country quintile level data are used.

On the other hand, and for the first time, the trade-off between the gains from migration and its costs is underlined. As suggested by our paper indeed, the net impact of migration is rather weak when the negative effect of medical brain drain is accounted for. Moreover, remittances are found to be more beneficial for children belonging to the richest households. This result is in line with other microeconomic evidence which suggest that remittances may increase within-country inequality. It is different from Chauvet and Mesplé-Somps (2007), however, who find a pro-poor impact of remittances.

The small estimated impact of health aid and remittances net of “brain drain costs” might well explain why child mortality rates have not substantially improved for three decades as asserted by Murray and others (2007), despite the growing volume of health aid and migrants’ remittances. This does not mean that official assistance is inefficient. Nor does it mean that private remittances should substitute for aid. It means that further investigation into the micro-level determinants of child mortality rates is needed to improve our understanding of the bad performances of child health outcomes in most developing countries and in Africa in particular.

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## Appendix .

**TableA.1. Cross-country regression sample.**

Country name		Country name	
Algeria	Egypt,Arab Rep.	Malawi	Seychelles
Argentina	El Salvador	Malaysia	Sierra Leone
Azerbaijan	Ethiopia	Mali	Solomon Islands
Bangladesh	Fiji	Mauritania	South Africa
Belize	Gabon	Mauritius	SriLanka
Benin	Gambia	Mexico	St.Lucia
Bolivia	Georgia	Moldova	St.Vincent Grenadines
Bosnia Herzegovina	Ghana	Mongolia	Sudan
Botswana	Grenada	Morocco	Swaziland
Brazil	Guatemala	Mozambique	Tajikistan
Burkina Faso	Guinea	Namibia	Tanzania
Cambodia	Guinea-Bissau	Nepal	Thailand
Cameroon	Guyana	Nicaragua	Togo
Cape Verde	Haiti	Niger	Tonga
Central African Rep.	Honduras	Nigeria	Tunisia
Chad	India	Oman	Turkey
Chile	Indonesia	Pakistan	Uganda
China	Iran	Panama	Uruguay
Colombia	Jamaica	Papua New Guinea	Vanuatu
Comoros	Jordan	Paraguay	Venezuela
Congo, Rep.	Kenya	Peru	Vietnam
Costa Rica	LaoPDR	Philippines	Yemen
Cote d'Ivoire	Lebanon	Rwanda	Zimbabwe
Dominican Republic	Lesotho	Samoa	
Ecuador	Madagascar	Senegal	

**Table A.2. Instrumentation equations**

	Instrumentation equation for :		
	GDP per capita	Health aid per capita	Remittances per capita
Number of physicians per 1,000	0.027 (1.050)	-0.665 (-2.040)**	0.510 (1.670)*
Female educational attainment	0.019 (0.310)	0.582 (0.780)	0.204 (0.260)
Dummy for missing education variable	-0.059 (-0.560)	0.886 (0.660)	-1.425 (-1.130)
Year = 1995	-0.187 (-2.180)**	-0.012 (-0.010)	-0.923 (-1.580)
Year = 2000	-0.138 (-1.630)	0.487 (0.600)	-1.178 (-2.140)**
Twice lagged health aid per capita	0.004 (0.860)	-0.244 (-2.160)**	0.074 (1.680)*
Twice lagged GDP per capita	0.289 (3.630)***	-0.170 (-0.310)	-0.500 (-1.320)
M2/GDP	-0.054 (-1.050)	0.093 (0.230)	0.738 (2.170)**
Total aid budget of France x Same religion	0.175 (1.030)	-0.970 (-0.740)	3.606 (4.140)***
Total aid budget of France x Distance	0.000 (-1.080)	0.000 (0.940)	0.000 (0.750)
Total aid budget of UK x Same religion	-0.294 (-1.600)	0.272 (0.160)	-3.825 (-3.620)***
Total aid budget of UK x Distance	0.000 (-1.470)	0.000 (0.940)	0.000 (1.990)**
Total aid budget of Germany x Same religion	-0.272 (-1.040)	-1.517 (-0.620)	-6.228 (-4.090)***
Total aid budget of USA x Same religion	0.151 (1.200)	0.228 (0.150)	1.825 (2.400)**
Total aid budget of USA x Distance	0.000 (0.620)	0.000 (0.620)	0.000 (-3.400)***
Total aid budget of Japan x Same religion	-0.146 (-0.590)	-4.828 (-1.550)	6.449 (1.630)
Total aid budget of Japan x Distance	0.000 (1.150)	0.000 (0.360)	0.000 (1.620)
Fixed effects	Yes	Yes	Yes
Observations	237	237	237
F-Statistic (p-value)	0.0002	0.0997	0.0000
Partial R <sup>2</sup> of excluded instruments	0.3139	0.1760	0.2102

**TableA.3. Intra-country regression sample.**

Country name	Year	Country name	Year
Armenia	2000	Madagascar	1997
Bangladesh	1996, 1999	Malawi	1992
Benin	1996, 2001	Mali	1995, 2001
Bolivia	1998, 2003	Mauritania	2000
Brazil	1996	Morocco	1992, 2003
Burkina Faso	1993, 1999, 2003	Mozambique	1997, 2003
Cambodia	1997	Namibia	1992, 2000
Cameroon	1991, 1998, 2004	Nepal	1996
Colombia	1995, 2000, 2005	Nicaragua	1997
Comoros	1996	Niger	1998
Dominican Republic	1996, 2002	Nigeria	1990, 2003
Ethiopia	2000	Peru	1996
Gabon	2000	Philippines*	1998
Ghana	1993, 1998, 2003	Rwanda	2000
Guatemala	1995, 1998	South Africa*	1998
Guinea	1999	Tanzania	1996, 1999
Haiti	1994, 2000	Chad	1996, 2004
India	1992, 1998	Togo	1998
Indonesia*	1997	Turkey	1993, 1998
Ivory Coast	1994	Uganda	1995, 2000
Jordan	1997	Vietnam*	1997, 2002
Kazakhstan	1995	Yemen	1997
Kenya	1993, 1998, 2003	Zimbabwe	1994, 1999
Kyrgyz Republic	1997		

Note: \* Country not in the sample of the Stunting regressions.