METHODS ANNEX

FINANCING GLOBAL HEALTH 2016

Development Assistance, Public and Private Health Spending for the Pursuit of Universal Health Coverage

Contents

SECTION 1. INTRODUCTION

This year's report is a complete analysis of health spending in 184 countries with special emphasis on development assistance for health. As in the past, the analysis of development assistance for health looks comprehensively at the sources, recipients, and health focus area of funding. Additionally, data on the three remaining sources of funding – government spending, prepaid private spending and out-of-pocket spending – were collated and aggregated to provide estimates of total health spending.

The purpose of this annex is to describe in detail the methodology used in our analyses. It provides a detailed description of the sources of data and estimation techniques and assumptions. Section 2 details how funds for development assistance for health are tracked. Section 3 describes how the other sources of funding, type of care, and total health spending are aggregated. Section 4 describes the forecast models used to estimate future health spending as well as the frontier analysis used to determine potential health spending as presented in the report. eTable 1 below presents the definitions for the various health spending sources.

eTable 1. Definitions of health spending sources

Health spending type	Definition
Development assistance for health	Financial and in-kind contributions from global health channels that aim to improve or maintain health in low- or middle-income countries.
Government health expenditure as source	Government health expenditure as source only includes domestically financed government expenditure on health.
Out-of-pocket spending	Payment by individuals for health services; considered catastrophic if exceeding 40% of a household's annual income.
Prepaid private health spending	Private risk pooling against catastrophic health expenditure; includes private insurance and non-governmental organizations.

SECTION 2. TRACKING DEVELOPMENT ASSISTANCE FOR HEALTH

Overview

Development assistance for health (DAH) estimates were obtained from the Institute for Health Metrics and Evaluation's development assistance for health database. We summarize the original methodology as well as updates for this year's estimates below. A more detailed description of the original methodology used to obtain the estimates in the database can be found in Dieleman et al.[1] All known, systematically reported, available data on health-related disbursements and expenditures were extracted, as well as income and revenue from existing project databases, annual reports, and audited financial statements. The channels included and the corresponding data sources are summarized in eTable 2. Data sources obtained via personal correspondence are summarized in eTable 3.

DAH for bilateral agencies included all health-related disbursements from bilateral donor agencies, excluding funds that they transferred to any of the other channels we tracked in order to avoid double-counting. This information was extracted from the Creditor Reporting System (CRS) and Development Assistance Committee (DAC) databases of the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD-DAC). In some cases, donor agencies did not report disbursement data to the CRS. A method for predicting disbursements from commitment data was implemented to address this challenge. For a detailed description of this method see the "Tracking development assistance for health from bilateral aid agencies and the European Commission" section below as well as in Dieleman et al.[1]

For other grant- and loan-making institutions, annual disbursements on health grants and loans were similarly included, excluding transfers to any other channels and ignoring any repayments on outstanding debts. For a more detailed description of this process see Dieleman et al.[1] The annual disbursements for grant- and loan-making institutions only reflect the financial transfers made by these agencies. Therefore, in-kind transfers from these institutions in the form of staff time for providing technical assistance and the costs of managing programs were estimated separately.[1]

Estimates of DAH for the United Nations (UN) agencies included annual expenditures on health both from their core budgets and from voluntary contributions. Calculating DAH for the United Nations Children's Fund (UNICEF) involved estimating the fraction of its total expenditure spent on health prior to 2001.[1]

Non-governmental organizations' (NGOs) DAH estimates utilized data from US government sources and a survey of health expenditure for a sample of NGOs to estimate DAH from US-based and internationally based NGOs receiving support from the US government. We were unable to include other NGOs due to the lack of audited and comparable data.

The database also included an analysis of the composition of health funding by recipient country, as well as by health focus area. Although our methods for this year's estimates did not change significantly, we made two key changes – improvement to preliminary estimation for some bilateral donors (Italy, Spain, United Kingdom and France) and improvements to our health focus area keyword search terms – that are detailed in eTable 5 and in the section below titled "Disaggregation by health focus area," respectively.

For many channels, reporting-time lags prevent primary disbursement data for the most recent year(s). For those years, the values of DAH were predicted, using channel-specific time trends. The methods employed to obtain these predictions are summarized in eTable 4. In general, these methods depend on data availability. The estimates are based on channel-specific budget, commitment, and appropriations data, and in many cases assume the most recent disbursement patterns persist. Due to the lack of more detailed disaggregated data, estimates are not provided by recipient.

All results are presented in real 2015 US dollars. All disbursement sequences were converted into real 2015 US dollars by taking disbursements in nominal US dollars in the year of disbursement and adjusting these sequences into real 2015 US dollars using US gross domestic product (GDP) deflators. Analyses were conducted in Stata (version 13.1).

eTable 2. Summary of primary data sources and databases

Channel	Source
Bilateral agencies	OECD-DAC and CRS databases[2]
European Commission	OECD-DAC and CRS databases[3]
Joint United Nations Programme on HIV/AIDS (UNAIDS)	Financial reports and audited financial statements[4]
United Nations Children's Fund (UNICEF)	Financial reports and audited financial statements[5–7]
United Nations Population Fund (UNFPA)	Financial reports and audited financial statements[8]
Pan American Health Organization (PAHO)	Financial reports and audited financial statements[9]
World Health Organization (WHO)	Financial reports and audited financial statements[10]
World Bank	Online project database and correspondence[11,12]
Asian Development Bank (ADB)	Online project database[13]
African Development Bank (AfDB)	Online project database and compendium of statistics[14,15]
Inter-American Development Bank (IDB)	Online project database and correspondence[16,17]
Gavi, the Vaccine Alliance	Online project database, cash received database, International Finance Facility for Immunisation (IFFIm) annual reports, Advance Market Commitment for Pneumococcal Vaccines (AMC) annual reports, and annual reports[18–21]
The Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund)	Online grant database, contributions report and annual reports[22–24]
NGOs registered in the US	United States Agency for International Development (USAID) Report of Voluntary Agencies (VolAg), tax filings, annual reports, financial statements, RED BOOK Expanded Database, and WHO's Model List of Essential Medicines[25–28]
Bill & Melinda Gates Foundation (Gates Foundation)	Online grant database, IRS 990 tax forms, and correspondence[29,30]
Other private US foundations	Foundation Center's grants database[31]

eTable 3. Data sources received via personal correspondence

Channel	Data received
World Bank	Health project-level disbursement data, 1990 to September 2016[12]
Gates Foundation	Health disbursement data, 2015[30]
IDB	Health project-level loan disbursement data, 2016[17]

eTable 4. Additional data sources, databases, and model choices used for preliminary estimates of DAH

Channel	Data source	Variables used	Years of budget data used for modeling*	Years underlying DAH data not available; thus modeled*	Model used
National agencies					
Australia	Australia's International Development Assistance (2008–2016); Australia's Overseas Aid Program (1998–2008)[32,33]	Health official development assistance (ODA): International development assistance budget	1998–2016	2015–2016	Weighted average of actual DAH/budgeted DAH
Austria	Austria Federal Ministry of Finance budget[34]	General ODA: Federal ODA budget	2007–2016	2015–2016	Weighted average of DAH/budgeted ODA
Belgium	Project Budget General – general expenses[35]	General ODA: Foreign affairs, foreign trade development and cooperation	2000–2016	2015–2016	Weighted average of DAH/budgeted ODA
Canada	Canadian International Development Agency – Report on Plans and Priorities[36]	General ODA: Financial summary – planned spending	1996–2016	2015–2016	Weighted average of DAH/budgeted ODA
Denmark	Danish Ministry of Foreign Affairs Budget[37]	General ODA: Budgeted expenditures on overseas development assistance	2000–2016	2015–2016	Weighted average of DAH/budgeted ODA
European Commission	General budget[38]	Data not used as they were inconsistent with disbursements	–	2015–2016	Based on weighted average of trends in member countries
Finland	Document Assembly in budget years 1998–2016[39]	General ODA: Ministry of Foreign Affairs' administrative appropriations, international development	2002–2016	2015–2016	Weighted average of DAH/budgeted ODA
France	Budget and Financial documents[40,41]	General ODA: aggregated project data; Total ODA	2009–2016	2015–2016	Weighted average of DAH/budgeted ODA
Germany	Plan of the Federal Budget[42]	General ODA: Development expenditure	2001–2016	2015–2016	Weighted average of DAH/budgeted ODA

Channel	Data source	Variables used	Years of budget data used for modeling*	Years underlying DAH data not available; thus modeled*	Model used
Greece	Ministry of Finance Budget (2013–2016); OECD Data (1996–2012)[2,43]	General ODA; ODA commitments	1996–2013	2015–2016	Weighted average of DAH/budgeted ODA
Ireland	Department of Finance – budget 2000–2004; Estimates for Public Services and Summary Public Capital Programme, 2005–2016 [44]	General ODA: Summary of adjustments to gross current estimates – international co-operation	2002–2016	2015–2016	Weighted average of DAH/budgeted ODA
Italy	The Italian Agency for Development Cooperation[45]	General ODA: Net development corporation	2007–2016	2015–2016	Weighted average of DAH/budgeted ODA
Japan	Highlights of the Budget for FY1999–2016[46]	General ODA: Major budget expenditures	2003–2016	2015–2016	Weighted average of DAH/budgeted ODA
Korea, South	ODA Korea comprehensive implementation plan[47]	General ODA: Plan for international development cooperation	2008–2016	2015–2016	Weighted average of DAH/budgeted ODA
Luxembourg	State Budget[48]	General ODA: Ministry of Foreign Affairs – budgeted international development cooperation and humanitarian aid	2001–2016	2015–2016	Weighted average of DAH/budgeted ODA
Netherlands	Netherlands International Cooperation Budget (2001–2016)	General ODA: Total annual official development assistance expenditure	2001–2016	2015–2016	Weighted average of DAH/budgeted ODA
New Zealand	Vote Foreign Affairs and Trade (1998–2001); VOTE Official Development Assistance (2002–2016)[49]	General ODA: Total annual official development assistance expenditure	1998–2016	2015–2016	Weighted average of DAH/budgeted ODA

Channel	Data source	Variables used	Years of budget data used for modeling*	Years underlying DAH data not available; thus modeled*	Model used
Norway	Norwegian Ministry of Finance National Budget (2014–2016); Correspondence (2000–2013)[50,51]	General ODA: ODA budget	2000–2016	2015–2016	Weighted average of DAH/budgeted ODA
Portugal	Ministry of Finance and Public Administration State Budget 2003–2016[52]	General ODA: Integrated service expenditure – external cooperation budget	2003–2016	2015–2016	Weighted average of DAH/budgeted ODA
Spain	Annual Plans of Spanish International Cooperation[53]	General ODA: Spanish total development cooperation	2003–2016	2015–2016	Weighted average of DAH/budgeted ODA
Sweden	Correspondence (2000–2010); Ministry of Foreign Affairs Budget (2010–2016)[54]	General ODA: Ministry for Foreign Affairs budgets for expenditure – international development cooperation	2000–2016	2015–2016	Weighted average of DAH/budgeted ODA
Switzerland	Foreign Affairs (2000–2006); Budget – Further Explanations and Statistics (2007–2016)	General ODA: Direction of development and cooperation (2000–2006); foreign affairs – international cooperation, development aid (in the South and East) (2007–2016)	2000–2016	2015–2016	Weighted average of DAH/budgeted ODA
United Kingdom	IATA (Department for International Development (DFID)) [55,56]	General ODA: assistance for international development; Sum (revised) - aggregated project data	1998–2016	2015–2016	Weighted average of DAH/budgeted ODA
United States	Foreign Assistance Dashboard (2006–2016); Budget of the US Government (2005–2016)[57,58]	Global health ODA: Planned foreign assistance for health; Department of Health and Human Services global health budget	2005–2016	2015–2016	Weighted average of actual DAH/budgeted DAH
UN agencies					
WHO	Programme budget[59]	DAH budget: Programme budget	2002–2016	2015–2016	Weighted average of DAH/budget

Channel	Data source	Variables used	Years of budget data used for modeling*	Years underlying DAH data not available; thus modeled*	Model used
UNAIDS	Unified Budget and Workplan, bienniums 2002–2016[60,61]	DAH budget: Unified Budget and Workplan	2002–2016	2015–2016	Weighted average of DAH/Core Budget
UNICEF	Financial report and audited financial statements; correspondence[7,62,63]	Total expenditure; Total health expenditure	2001–2015	2015–2016	Weighted average of DAH/budget
UNFPA	Audited Financial report and contributions report [64,65]	Total health expenditure	2002–2015	2015–2016	Weighted average of DAH/budget
PAHO	Proposed program budget[9]	Total regular budget, estimated voluntary contributions	2000–2016	2015–2016	Weighted average of DAH/budget
NGOs	VolAg (1990–2011), GuideStar (2014), sample of top NGOs (2011–2012) [25,26]	Revenue breakdowns for: US public, non-US public, private, in-kind, Gates Foundation; total overseas expenditures	1990–2013	2014–2016	Regression on DAH, US GDP, and USAID and private voluntary organization (PVO) revenue

* Years of budget data used for modeling versus years underlying DAH data unavailable thus modeled: The data used to estimate DAH by channel vary across channels. eTable 2 reports our primary data used for each channel. Due to reporting lags there are some years we need to estimate disbursement using additional data sources. These additional data sources, the years in which the primary data are modeled, the years the additional data are available, and the methods for this estimating these modeled years are reported in eTable 4. Years of budget data used for modeling are the years of additional data available to us. We rely on historic trends to inform our estimates so we rely on many years of additional data despite only modeling a few years of primary data. Years underlying DAH data unavailable thus modeled are the years the primary data are incomplete and thus estimated using additional data. See example below for more details for Australia.

Box 1. EXAMPLE - Australia's primary and additional data sources

Project-level data for health-related projects funded by Australia's bilateral aid agencies are available from the OECD's CRS database through 2014. This is the primary data source used to estimate DAH channeled by Australian aid agencies, as described in eTable 2. 2015–2016 are incomplete because of lags in reporting. To estimate DAH disbursed for 2015 and 2016, additional data are available from Australia's International Development Assistance budget (2008–2016) and Australia's Overseas Aid Program budget (1998–2008), as described in eTable 4. These sources provide health-specific official development assistance (ODA) budgeted by Australia, 1998–2016. To estimate DAH disbursed 2015–2016, we calculated the ratio of disbursed DAH (from the CRS database) relative to budgeted DAH (from the International Development Assistance and Overseas Aid Program budgets) for 1998–2014. We combine the most recent three ratios into a single estimate by taking a weighted average, weighting substantially higher the most recent year. We multiply this ratio – the estimated disbursed DAH to budgeted DAH – by the 2015 and 2016 budgeted DAH to estimate disbursed DAH in those years. These methods are described more fully in Dieleman et al.[1]

DISAGGREGATING BY HEALTH FOCUS AREA

We improved our analysis of the disaggregation of health funding by health focus areas by augmenting our keyword search terms. In particular, we added health system strengthening as a category under each health focus area. Similar to our previous work, the analysis of health focus areas included assessments of development assistance for HIV/AIDS; tuberculosis (TB); malaria; maternal health; newborn and child health; other infectious diseases; non-communicable diseases; and health system strengthening and sector-wide approaches (SWAps), using keyword searches within descriptive fields. These were chosen as the areas of focus because of their relevance to current policy debates about global health financing and data availability.

In effect, DAH was disaggregated into eight health focus areas: HIV/AIDS; tuberculosis; malaria; maternal, newborn, and child health; non-communicable diseases; health system strengthening/SWAps; other infectious diseases; and other. For most data sources, project-level data were available only through 2014. Methods to estimate health focus area allocations for 2015 and 2016 are described in more detail below. Keyword searches were performed for a subset of global health channels that provide project-level data with project titles or descriptions. These sources include the bilateral development assistance agencies from 23 DAC member countries, the EC, the Global Fund, the World Bank, ADB, AfDB, IDB, the Gates Foundation, NGOs, and US foundations. The keywords used are outlined in eTable 5 below. Descriptive fields were adjusted so that they were in all capitalized letters, and search terms with multiple words were put between quotation marks. All keywords were translated into nine major languages (English, Spanish, French, Portuguese, Italian, Dutch, German, Norwegian, and Swedish) used in the OECD CRS, checked for double meanings across all languages, and adjusted accordingly.

Total DAH was split across the health focus areas using weighted averages based on the number of keywords present in each project's descriptive variables. If, for example, three keywords suggested the project focused on HIV/AIDS and two keywords related to tuberculosis were also tagged, three-fifths of the project's total DAH was allocated to HIV/AIDS and two-fifths was allocated to tuberculosis. To account for the sensitivity of this method, several checks were implemented after the keyword searches to ensure the project was accurately categorized. First, projects that were tagged as child and newborn vaccines and other infectious diseases were categorized as child and newborn vaccines only. Second, projects that were tagged as one of the three major infectious diseases (HIV/AIDS, tuberculosis, or malaria) and other infectious diseases were categorized under only HIV/AIDS, tuberculosis, or malaria.

Box 2. EXAMPLE. Post-keyword search weighting

A project in the CRS database had a value of $1,000 of DAH. A keyword search conducted on this project's title and description tagged five keywords: 3 keywords related to HIV/AIDS and 2 keywords related to tuberculosis. Therefore, $600, or 3/5 of total DAH, was allocated to HIV/AIDS, while $400, or 2/5 of total DAH, was allocated to tuberculosis.

In addition to keyword searches, funds were allocated to health focus areas based on characteristics of the channel or additional channel variables. For the bilateral agencies and the EC, purpose codes from the CRS were used to supplement keyword searches. For the World Bank-IDA and -IBRD, health focus areas were also determined by the project sector codes and theme codes, which included percentages of health funds that targeted each theme. All funds from Gavi were allocated to child and newborn vaccines, health system strengthening, and non-communicable diseases, and all funds from UNICEF to maternal, newborn, and child health, unspecified. Funds from the Global Fund were distributed to malaria, HIV, TB, and health system strengtening based on disease components. Within each disease component, keyword searches on programmatic budget data and project descriptions were conducted to distribute among program areas. Funds from UNAIDS were allocated to HIV/AIDS, and specific program areas were determined by budget information. UNFPA and WHO funds were allocated to specific health focus areas based on project expenditure data from their annual reports and annual financial reports. For all channels, projects listed as HIV/TB were distributed evenly among the two health focus categories. See eTable 6 below for more details on these categorizations.

eTable 5. Terms for keyword searches

Health focus area level I	Health focus area level II	Keywords
HIV/AIDS	HIV envelope/unidentified	" HUMANIMMUNODEFVIRUS " " SIDA " " OVC " " H I V " " HIV " " AIDS " " HUMAN IMMUNODEFICIENCY " " REVERSE TRANSCRIPTASE INHIBITOR " " ACQUIRED IMMUNE DEFICIENCY SYNDROME " " ACQUIRED IMMUNNODEFICIENCY " " RETROVIRAL " " VCT " " MALE CIRCUMCISION " " ART " " ARV " " CD4 COUNT " " HAART " " PMTCT " " MOTHER TO CHILD TRANSMISSION" " MOTHER TO CHILD AIDS TRANSMISSION" " PARENT TO CHILD TRANSMISSION" " PRESIDENT'S EMERGENCY PLAN FOR AIDS RELIEF " " PEPFAR " " THREE DISEASE FUND " " 3 DISEASE FUND "
	Care and Support	" CAREANDSUPPORT " " CARE ACTIVIT" " PAIN RELIEF " " SYMPTOM RELIEF " " SOCIAL SUPPORT " " CHRONICALLY ILL " " CLINICAL MONITORING " " CARE AND SUPPORT " " PSYCHOLOGICAL SERVICE" " PSYCHOLOGICAL SUPPORT " " PSYCHOSOCIAL SUPPORT " " PSYCHOSOCIAL SERVICE" " MATERIAL SUPPORT "
	Counseling and Testing	" COUNSELING " " TESTING " " VCT " " COUNSELLING "
	Orphans and Vulnerable Children	" VULNUERABLECHILD" " OVC " " ORPHAN" " VULNERABLE CHILD" " INFECTED CHILD" " VULNERABLE GROUP" " MOST AT RISK "
	Prevention of mother-to-child transmission (PMTCT)	" MOTHERTOCHILD" " MOTHER TO CHILD" " PARENT TO CHILD" " PMTCT "
	Prevention	" CONDOM" " PREVENT" " HIV EDUCATION " " AIDS EDUCATION " " REDUCING THE TRANSMISSION OF HIV " " REDUCE THE TRANSMISSION OF HIV " " MALE CIRCUMCISION" " SAFE BLOOD SUPPL" " SAFE INJECTION" " ABSTINENCE " " AWARENESS " " BLOOD SAFETY " " MICROBICIDE"
	Treatment	" RETROVIRAL " " TREAT" " ART " " ARV " " CD4 COUNT " " HAART " " VIRAL LOAD " " VIRAL BURDEN " " VIRAL TITER " " ESSENTIAL SERVICE" " DRUG REGIMENS " " IMPACT REDUCTION " " REDUCE IMPACT "
Tuberculosis		" TUBERCULOS" " TB " " TUBERCULAR" " DOTS " " DIRECTLY OBSERVED TREATMENT " " RIFAMPICIN " " ISONIAZID " " MULTI DRUG RESISTANT " " THREE DISEASE FUND " " 3 DISEASE FUND "
Malaria	Malaria envelope/unidentified	" MALARIA " " PLASMODIUM FALCIPARUM " " ANOPHELES " " ARTEMISININ " " PRIMAQUINE " " INDOOR RESIDUAL SPRAY" " INDOORRESIDUALSPRAY" " IRS " " PLASMODIUM VIVAX " " BEDNETS " " BED NETS " " SMITN " " ITN " " LLIN " " INSECTICIDAL NET" " INSECTICIDE TREATED NET" " THREE DISEASES FUND " " 3 DISEASES FUND "

Health focus area level I	Health focus area level II	Keywords
	Diagnosis	" DIAGNOSIS " " DIAGNOSTIC " " CASE DETECTION " " MICROSCOPY " " BLOOD SURVEY " " RAPID DIAGNOSTIC TESTING " " MOBILE MALARIA CLINIC " " BIOLOGICAL TESTING " " LABORATORY SERVICES " " EDT " " LAMP " " RDT "
	Community outreach	" COMMUNITYOUTREACH " " COMMUNITY OUTREACH " " COMMUNITY MOBILIZATION" " AWARE" " COMMUNICATION STRATEGY " " SOCIAL COMMUNICATION " " HEALTH EDUCATION " " PARTNERSHIP" " PUBLIC SECTOR" " ACTIVITIES NEAR COMMUNITIES "
	Vector control: bed nets	" BEDNET" " BED NET" " SMITN " " ITN " " LLIN " " INSECTICIDAL NETS " " INSECTICIDE TREATED NET" " INSECTICIDE TREAT"
	Vector control: indoor residual spray	" INDOORRESIDUALSPRAY" " IRS " " REDUCE THE PARASITE RESERVOIR " " FOGGING " " COILS " " LARVICID" " LARVACID" " VECTOR CONTROL" "RESIDUAL SPRAY " " RESIDUALSSPRAY " "INDOOR SPRAY" " INDOORSPRAY "
	Vector control: other than bed nets and indoor residual spray	" PREVENT"
	Treatment	" ARTEMISININ " " PRIMAQUINE " " ACT " " DRUG ADMINISTRATION " " TREAT " " TREATMENT " " CASE MANAGEMENT " " COMBINATION THERAPY " " ANTI MALARIAL " " ANTIMALARIAL "
Maternal, newborn, and child health	envelope/unidentified	" FERTILITY " " FAMILY PLANNING " " FP " " BIRTH" " WOMEN HEALTH " " WOMEN S HEALTH " " WOMENS HEALTH " " CONTRACEP" " IPPF " " INTERNATIONAL PLANNED PARENTHOOD FOUNDATION " " ABORTION" " UNFPA " " POSTPARTUM " " POST PARTUM " " MATERNAL " " MATERNITY " " MOTHERHOOD " " SBA " " ANTENATAL " " PRENATAL " " NEONATAL " " PERINATAL " " POSTNATAL " " FETUS" " FETAL" " IPTP " " REPRODUCTIVE HEALTH " " OBSTETRIC" " PREGNANCY " " RH " " REPRODUCTIVE HEALTH " " REPROD " " RHCS " " SEXUAL HEALTH " " SYPHILIS " " FISTULA " " SEPSIS " " ANEMI" " ANAEMI" " FOETUS" " FOETAL " " FGM " " FEMALE GENITAL MUTILATION " " FEMALE GENITAL CUTTING " " FEMALE CIRCUMCISION " " SBAS " " NUTRITION " " VITAMIN A " " BREAST FE" " BREASTFE" " FEEDING " " MICRONUTRIENT" " ZINC " " FORTIFICATION " " STUNT" " WASTING " " BABY FRIENDLY HOSPITAL INITIATIVE " " BREASTMILK " " BREAST MILK " " IODINE " " IODIZED " " IODIZATION " " VAD " " LACTAT" " FOLIC ACID " " FOLAT" " VACCINE" " VACCINATION" " IMMUNIZ" " DIPHTHERIA " " TETANUS " " PERTUSSIS " " DTP " " HIB " " ROTAVIRUS " " MEASLES " " IMMUNIS" " HEPB MONO " " HIB MONO " " INJECTION SAFETY " " RUBELLA " " MENINGITIS " " PENTA " " PNEUMO " " TETRA " " GAVI " " CHILDHEALTH " " CHILD HEALTH " " INFANT HEALTH " " NEWBORN HEALTH " " CHILD MORTALITY " " INFANT

Health focus area level I	Health focus area level II	Keywords
		MORTALITY " " UNDER FIVE MORTALITY " " CHILD SURVIVAL " " INFANT SURVIVAL " " CHILDHOOD ILLNESS" " LRI " " RESPIRATORY INFECTION" " DIARRHEA" " DIARRHOEA" " ORAL REHYDRATION " " ORT " " ORS " " UNICEF " " MNCH" " RNCH " " RCH " " RNH " " MNH " " MCH " " EMAS " " MCNH "
	Maternal health, family planning	" FERTILITY " " FAMILY PLANNING " " FP " " BIRTH SPACING " " CONTRACEPT" " FAMILY SIZE" " IPPF " " INTERNATIONAL PLANNED PARENTHOOD FOUNDATION " " ABORTION" " REDUCED FERTILITY " " UNFPA " " REDUCE FERTILITY " " BIRTH CONTROL "
	Maternal health, unspecified	" POSTPARTUM " " POST PARTUM " " MATERNAL HEALTH " " MATERNAL MORTALITY " " MATERNAL DEATH " " SAFE MOTHERHOOD " " BIRTH ATTENDANT" " SBA " " MATERNAL AND INFANT HEALTH " " ANTENATAL " " PRENATAL " " NEONATAL " " PERINATAL " " POSTNATAL " " FETUS" " FETAL" " IPTP " " REPRODUCTIVE HEALTH " " MATERNITY " " OBSTETRIC" " PREGNANCY " " RH " " REPRODUCTIVE HEALTH " " REPROD " " RHCS " " STD " " STI " " SEXUAL HEALTH " " SEXUALLY TRANSMITTED " " SYPHILIS " " FISTULA " " WOMEN S HEALTH " " WOMENS HEALTH " " SEPSIS " " SEPTICEMIA " " ANEMI" " ANAEMI" " FOETUS" " FOETAL " " FGM " " FEMALE GENITAL MUTILATION " " FEMALE GENITAL CUTTING " " FEMALE CIRCUMCISION " " SBAS "
	Child/newborn nutrition	" NUTRITION " " BIRTH WEIGHT " " BIRTHWEIGHT " " VITAMIN A " " BREAST FE" " BREASTFE" " FEEDING " " MICRONUTRIENT" " ZINC " " FORTIFICATION " " STUNT" " WASTING " " UNDERWEIGHT " " BABY FRIENDLY HOSPITAL INITIATIVE " " BREASTMILK " " BREAST MILK " " IODINE " " IODIZED " " IODIZATION " " VAD " " LACTAT" " FOLIC ACID " " FOLAT" " IRON "
	Child/newborn vaccines	" POLIO " " VACCINE" " VACCINATION" " IMMUNIZ" " DIPHTHERIA " " TETANUS " " PERTUSSIS " " DTP " " HIB " " ROTAVIRUS " " MEASLES " " IMMUNIS" " HEPB MONO " " HIB MONO " " INJECTION SAFETY " " RUBELLA " " MENINGITIS " " PENTA " " PNEUMO " " TETRA " " GAVI "
	Child/newborn other	" CHILDHEALTH " " CHILD HEALTH " " INFANT HEALTH " " NEWBORN HEALTH " " CHILD MORTALITY " " INFANT MORTALITY " " UNDER FIVE MORTALITY " " CHILD SURVIVAL " " INFANT SURVIVAL " " CHILDHOOD ILLNESS" " LRI " " RESPIRATORY INFECTION" " DIARRHEA" " DIARRHOEA" " ORAL REHYDRATION " " ORT " " ORS " " UNICEF "
Non-communicable diseases	Tobacco	" TOBACCO" " SMOK"

Health focus area level I	Health focus area level II	Keywords
	Mental health	" SCHIZOPHRENIA " " MENTAL HEALTH " " NEUROTIC " " NEUROS " " PSYCHOLOG" " PSYCHIATRIC" " EMOTIONAL " " PTSD " " POST TRAUMATIC " " POSTTRAUMATIC " " ALCOHOL " " ADDICTION " " DOWN SYNDROME " " DOWN S SYNDROME " " DOWNS SYNDROME " " BEHAVIORAL " " DEPENDANCE " " DRUG ABUSE " " SUBSTANCE ABUSE " " OPIOID " " COCAINE " " AMPHETAMIN " " CANNABIS " " DEPRESSIVE DISORDER " " DEPRESSION " " DYSTHYMIA " " BIPOLAR " " ANXIETY " " EATING DISORDER " " AUTISM " " ASPERGER " " DEVELOPMENTAL DISORDER " " CONDUCT DISORDER " " INTELLECTUAL DISABILITY " " PHOBIA " " MENTAL DISABILITY " " MENTAL RETARDATION " " DEPENDENCE "
	Non-communicable diseases, unspecified	" CANCER" " CHEMOTHERAPY " " RADIATION " " NEOPLAS " " TUMOR " " DIABET" " INSULIN " " ENDOCRINE " " RHEUMATI" " ISCHAEMIC " " ISCHEMIC " " CIRCULATORY " " CEREBROVASCULAR " " CIRRHOSIS " " DIGESTIVE DISEASE" " OTHER DIGESTIVE " " GENITOURINARY " " UROGENITAL " " MUSCULOSKELETAL " " CONGENITAL " " OBESITY " " OVERWEIGHT " " GLAUCOMA " " HYPERTENSI" " HERNIA " " ARTHRITIS " " CLEFT LIP" " CLEFT PALATE" " PHENYLKETONURIA " " PKU " " SICKLE CELL" " DREPANOCYTOSIS " " HEMOPHILIA " " HAEMOPHILIA " " THALASSEMIA " " GENETIC" " HEART DISEASE" " CARDIOVASCULAR " " CHRONIC RESPIRATORY " " NONCOMMUNICABLE " " NON COMMUNICABLE " " COPD " " STROKE " " CATARACT " " CHRONIC OBSTRUCTIVE PULMONARY DISEASE" " ASTHMA " " SKIN DISEASE" " PHYSICAL DISABILITY " " DENTAL " " ORAL HEALTH " " CVD " " IHD " " CKD " " KIDNEY DISEASE" " MSK "
Health system strengthening/SWAps		" SWAP" " TRAINING " " CAPACITY " " DATA SYSTEM" " SECTOR WIDE APPROACH" " HEALTH SYSTEM " " SECTOR WIDE APPROACH" " SECTOR PROGRAM" " BUDGET SUPPORT" " SECTOR SUPPORT " " HSS " " TRACKING PROGRESS " " SKILLED HEALTH WORKERS " " SKILLED STAFF " " ADEQUATE FACILITIES " " ESSENTIAL MEDICINES " " HEALTH INFORMATION SYSTEM" " POLICY DEVELOPMENT" " EARLY WARNING ALERT AND RESPONSE SYSTEM" " MEDICAL EQUIPMENT " " SURGICAL EQUIPMENT " " HEALTH SECTOR PROGRAM" " HEALTH SECTOR SUPPORT " " SECTOR SUPPORT PROGRAM" " HEALTH INFRASTRUCTURE " " HEALTH INSTITUTIONAL STRENGTHENING " " HSPSP " " M&E "" MONITORING" " SURVEILLANCE " " GOVERNANCE " " HUMAN RESOURCE" " HUMAN CAPITAL " " IMPROVED CAPACITIES " " SCALING UP " " REALLOCATE RESOURCES " " STRATEGIES AND PROGRAME" " HIV STRATEGIES " " PROGRAM IN COUNTRY ACTIVITIES " " STRATEGIC INFORMATION " " PROCUREMENT " " EVIDENCE BASED " " CASE REPORTING " " OUTBREAK

Health focus area level I	Health focus area level II	Keywords
		PREPAREDNESS " " RAPID RESPONSE STRATEGY " " MEDICAL WORKERS " " HEALTH CARE PERSONNEL " " OPERATIONAL RESEARCH " " SUPPORTIVE ENVIRONMENT " " INFORMATION SYSTEM" " INSECT " " WORKFORCE " " INFRASTRUCTUR " " ADMINISTRATIVE "
Other infectious diseases		" INFECTIOUS " " TRICHURIASIS " " YELLOW FEVER " " WHIPWORM " " TRACHOMA " " SCHISTOSOMIASIS " " SNAIL FEVER " " KAYAYAMA FEVER " " RABIES " " ONCHOCERCIASIS " " RIVER BLINDNESS " " ROBLES DISEASE" " LYMPHATIC FILARIASIS " " ELEPHANTIASIS " " LEISHMANIASIS " " LEISHMANIOSIS " " HOOKWORM " " FOOD BORNE TREMATOD " " FOODBORNE TREMATOD " " FOOD BORNE TREMATOD " " ECHINOCOCCOSIS " " HYDATID DISEASE" " HYDATIDOSIS " " DENGUE " " CYSTICERCOSIS " " CHAGAS " " TRYPANOSOMIASIS " " ASCARIASIS " " TROPICAL DISEASE" " AVIAN " " CHOLERA " " DYSENTERY " " PARASITE DISEASE" " INFLUENZA " " PANDEMIC" " EPIDEMIC" " COMMUNICABLE " " AVIAN INFLUENZA " " AVIAN FLU " " FAO " " NEGLECTED TROPICAL DISEASE "

eTable 6. Additional health focus area categorizations

Channel	Allocation criteria	Health focus area
Bilaterals and the EC	CRS purpose code 13030, family planning	Family planning
	CRS purpose code 13020, reproductive health care	Maternal health, non-family planning
	CRS purpose code 12240, basic nutrition	Child and newborn nutrition
	CRS purpose code 12250, infectious disease control and the keywords “child” or “vaccine” present in descriptive variables	Child and newborn vaccines
	CRS purpose code 13040, STD control including HIV/AIDS	HIV/AIDS
	CRS purpose code 12262, malaria control	Malaria, unspecified
	CRS purpose code 12250, infectious disease control and no other keywords present in the descriptive variables	Other infectious diseases
	CRS purpose code 12263, tuberculosis control	Tuberculosis
World Bank IDA and IBRD	Theme code population and reproductive health	Maternal, newborn, and child health, unspecified
	Theme code tuberculosis	Tuberculosis
	Theme code child health	Child and newborn health, unspecified
	Theme code HIV/AIDS	HIV/AIDS
	Theme code malaria	Malaria, unspecified
	Theme code injuries and non-communicable diseases	Non-communicable diseases, unspecified
	Theme code nutrition and food security	Child and newborn nutrition
	Theme code other communicable diseases	Other infectious diseases
	Theme code health system performance	SWAPs/health system strengthening

Channel	Allocation criteria	Health focus area
	Theme code social analysis and monitoring	SWAPs/health system strengthening
UNFPA	Family planning, gender equality, population and development	Family planning
	Reproductive health, sexual health, maternal and newborn health, STI prevention	Maternal health, unspecified
	Data analysis, mobilization, program coordination, monitoring and evaluation, advocacy	Family planning and Maternal health, unspecified, according to proportions between the two.
UNICEF	All DAH	Child and newborn health, unspecified
UNAIDS	The keyword search was run on budget information for years 2008–2015 Program components in budget documents from 1998 to 2007	All health focus area level-two categories under HIV/AIDS
Gavi	All DAH	Child and newborn vaccines
Global Fund	Disease components for Malaria, HIV/AIDS, TB, TB/HIV, and Other (health system strengthening) Keyword search on program service delivery areas	All health focus area level-two categories under Malaria and HIV and health focus area level one categories for TB and HSS/SWAps
WHO	Reproductive, maternal, newborn, child, and adolescent health (divided by 2); Research in human reproduction	Maternal health, unspecified
	Nutrition	Child and newborn nutrition
	Vaccine-preventable diseases	Child and newborn vaccines
	Reproductive, maternal, newborn, child and adolescent health (divided by 2)	Child and newborn health, unspecified
	Aging and health; gender, equity and human rights mainstreaming	Maternal, newborn, and child health, unspecified
	HIV/AIDS	HIV/AIDS
	Malaria	Malaria
	Tuberculosis	Tuberculosis
	Mental health and substance abuse	Non-communicable diseases, mental health
	Disabilities and rehabilitation; Non-communicable diseases; Violence and injuries	Non-communicable diseases, unspecified
	Neglected tropical diseases; Tropical disease research; Epidemic- and pandemic-prone diseases	Other infectious diseases
	Health system information and evidence; Integrated people-centered health services; National health policies, strategies and plans; Access to medicines and health technologies and strengthening regulatory capacity; Alert and response capacities	SWAps/health system strengthening

Disaggregating preliminary estimates by health focus area

Estimates by health focus area for years in which descriptive data were not available (usually 2016 and in many cases 2015 as well) were obtained by modeling channel-specific DAH per health focus area as a function of time. Out-of-sample validation was used to test the predictive accuracy of a large suite of models, estimating the models using 1990–2010 data and predicting 2011 and 2012. The potential models included fractional multinomial logit regression, OLS regression, autoregressive integrated moving average (ARIMA) models, Epanechnikov kernel-weighted local polynomial smoothing, and multivariable fractional polynomial models. For each model, time was

modeled linearly, with splines, and by including lag-dependent variables. Other methodologies considered included modeling health-focus-area-specific DAH as a dollar amount and as a fraction of the channel-specific total DAH. Lastly, models that involved transforming the dependent variable in natural log and logit transformed space were considered. In order to accommodate zero values in the logit transformation, the transformation described in Smithson and Verkuilen was applied.[66] Over 40 models and specifications were evaluated in total.

Each of the potential models and specifications described above was estimated using data from 1990 through 2010, and then the estimated model was used to predict DAH by health focus area for 2011 and 2012. Since we have DAH estimates for 2011 and 2012, we compared the modeled estimates and the observed estimates and calculated average percent deviation and average total absolute deviation for each model and specification across all the channels and health focus areas. A variant of the Epanechnikov kernel-weighted local polynomial smoothing had the smallest average percent deviations and average total absolute error. In this model and specification, health focus area-specific DAH fractions were independently estimated at the channel level after they were logit transformed. Time was the only independent variable included in the model. The health focus area-specific DAH estimates were adjusted so the sum of the channel's health focus area disbursements totaled the channel-specific DAH envelope. Our preferred model, the Epanechnikov kernel-weighted local polynomial smoothing, minimized both the average percent deviation and the total absolute error out of sample, predicting two years ahead. See Dieleman et al. for a table that demonstrates the performance of four models, each with their optimal specification (as determined by the out-of-sample average percent deviation and total absolute error).[1]

Tracking development assistance for health from bilateral aid agencies and the European Commission

OECD-DAC maintains two databases on aid flows: 1) the DAC annual aggregates database, which provides summaries of the total volume of flows from different donor countries and institutions, and 2) the CRS, which contains project- or activity-level data.[3]

These two DAC databases track the following types of resource flows:

> Official development assistance (ODA), defined as "flows of official financing administered with the promotion of the economic development and welfare of developing countries as the main objective"[69] from its 24 members (Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, South Korea, Spain, Sweden, Switzerland, the United Kingdom, the United States, and the EC). The CRS also now includes some private ODA, such as that funded by the Gates Foundation and the Global Fund, as well as assistance from the United Arab Emirates, Kuwait, the Czech Republic, and Iceland.

ODA includes:

• Bilateral ODA, which is given directly by DAC members as aid to recipient governments, core contributions to NGOs and public-private partnerships, and earmarked funding to international organizations.

• Multilateral ODA, which includes core contributions to multilateral agencies such as WHO, UNFPA, the Global Fund, Gavi, UNAIDS, UNICEF, PAHO, the World Bank, and other regional development banks. Only regular budgetary contributions to these institutions can be reported to the OECD-DAC; hence, extrabudgetary funds, including earmarked contributions that donors can report as bilateral ODA, are not included as multilateral ODA. Only 70% of core contributions to WHO can be counted as multilateral ODA.

a. Official development finance (ODF), which includes grants and loans made by multilateral agencies.

b. Other official flows (OOF), which refers to transactions that "do not meet the conditions for eligibility as Official Development Assistance or Official Aid, either because they are not primarily aimed at development, or because they have a Grant Element of less than 25 percent."

The DAC aggregate tables include all multilateral development banks, the Global Fund, operational activities of UN agencies and funds, and a few other multilateral agencies. The project-level data in the CRS cover a smaller subset

of multilateral institutions, including UNAIDS, UNFPA, UNICEF, public-private partnerships including Gavi and the Global Fund, some development banks, and the Gates Foundation, but do not reflect the core-funded operational activities of WHO prior to 2009, disbursements by Gavi prior to 2007 and the Gates Foundation prior to 2009, or all loans from the World Bank.

This research utilized the CRS as the principal source for tracking bilateral DAH. This is because the DAC aggregate tables do not report detailed project-level information about the recipient country and health focus area. The OECD sector codes for general health (121), basic health (122), and population programs (130) were used to identify health flows in the CRS.

To avoid double-counting, all identifiable earmarked commitments and disbursements made by DAC members via Gavi, International Finance Facility for Immunisation (IFFIm), the Global Fund, WHO, UNICEF, UNAIDS, UNFPA, and PAHO were subtracted from bilateral ODA. The channel of delivery fields as well as keyword searches in the descriptive project fields (project title, short description, and long description) were used to identify 17 potential sources of double-counting. Research funds for HIV/AIDS channeled by the US government through the National Institutes for Health (NIH) were also removed from the total since they do not meet the definition of DAH as contributions from institutions whose primary purpose is development assistance. Official development finance (ODF) from the CRS was not counted because these expenditures were included elsewhere, either in the analysis of multilateral institutions relevant to the study or in the assessment of health spending by the Gates Foundation, the data for which were obtained via correspondence and from their annual reports, audited financial statements, and project databases. To avoid double-counting, only health assistance flows from multilateral institutions to low- and middle-income countries were counted, and not transfers to multilateral institutions.

Estimating disbursements for the 23 bilateral channels and the EC

Both the DAC tables and the CRS rely on information reported by DAC members and other institutions to the OECD-DAC. Hence, the quality of the data varies considerably over time and across donors. Three variables were used to estimate yearly donor disbursements: CRS commitments, CRS disbursements, and DAC commitments. There were two main challenges in using the data from the CRS for this research:

1. underreporting of aid activity to the CRS compared to what is reported to the DAC, and

2. underreporting of disbursement data to the CRS compared to commitment data reported to the CRS.

These issues are highlighted in eFigure 1. Methods developed to account for both these challenges are discussed below. Details on how we estimated the cost of providing technical assistance and program support for these institutions are highlighted below in the section titled “Calculating the technical assistance and program support component of development assistance for health from loan- and grant-making channels of assistance.”

To address these two challenges, we determined a cutoff point for each channel. We defined this channel-specific cutoff year as when the ratio of total CRS disbursements to commitments was greater than 50% and did not drop subsequently below 30%. eFigure 2 below shows each donor’s CRS disbursement to commitment ratio in green, and the estimated cutoff year is marked with a vertical red line. For years after the cutoff year, DAH is measured using the unadjusted disbursement data. For the time prior to the cutoff year, it was determined that the disbursement data are not of high enough quality, and adjusted commitments were used instead.

Two adjustments were made to commitments to estimate disbursements before each donor-specific cutoff point:

I. The first adjustment addressed underreporting of aid activity to the CRS (relative to the DAC). To address this challenge, all CRS commitments for the health sector were adjusted upward using the DAC commitment to CRS commitment coverage ratio. The coverage ratio of the CRS was well below 10% before 1996 but has improved steadily over time.

II. The second adjustment addressed underreporting of disbursements data to the CRS (relative to commitments reported to the CRS). To address this challenge, we pooled completed projects in the CRS that have disbursement data for each channel and computed yearly project disbursement rates (the fraction

of total commitments disbursed for each year of a project) and overall project disbursement rates (the fraction of total commitments disbursed over the life of each project) by project length. Yearly disbursement schedules were calculated for projects with lengths of one, two, three, four, five, and six years. When an observed project length was more than six years, all expenditure after the sixth year was aggregated and assumed to be expended in the sixth year. This does not happen often. Yearly disbursement rates were the median of these shares, averaged across projects for every donor in each project year. The sum of these averages equals one, so that all the disbursements were expended over the lifetime of a project. The product of these donor-specific yearly disbursement rates and the donor-specific overall disbursement rates yielded the donor-specific disbursement schedules. The donor-specific disbursement schedules were applied to project-level DAC-adjusted commitments reported in the CRS. eFigure 3 shows the yearly disbursement rates and overall disbursement rates for projects with one- to six-year lifespans for each of the 23 member countries and the EC.

Lastly, to address the challenge of underreporting of aid activity to the CRS compared to the DAC for all years, the difference between each donor's aggregate DAC health commitments and CRS health disbursements was added to each donor's yearly DAH. Since only aggregate commitments are reported to the DAC, several adjustments were made, based on more detailed CRS data:

I. First, each donor's yearly average project length was calculated by applying the donor-specific disbursement schedules described above to CRS projects that had disbursement in order to get adjusted DAC commitments.
II. Commitments for projects that have not opened yet were then subtracted, based on the open date reporting in the CRS. This ensured that future disbursements were not captured.
III. Lastly, these DAC-adjusted commitments were compared to CRS disbursements, inclusive of transfers that were later dropped as double-counting.

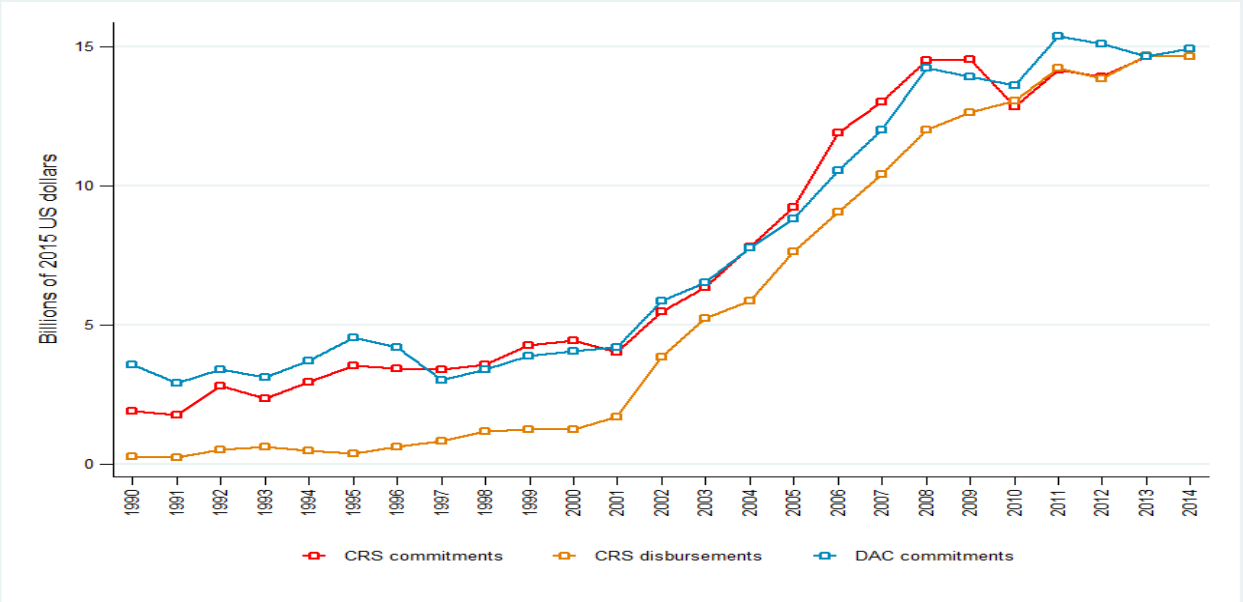
Transfers from donors to other global health channels that we already track were removed, including NGOs, the Global Fund, Gavi, PAHO, UNAIDS, UNFPA, UNICEF, WHO, the EC, and the regional development banks. The names of NGOs that were captured in IHME's NGO data were searched for in the CRS descriptive variables and tagged as double-counting. Transfers from the United States to the NIH were also excluded.

Channel codes in the CRS data were used to track DAH to international and donor-country-based non-governmental organizations.

In addition to tracking disbursements from the EC, gross disbursements from the DAC were used to compile data on the sources of funding for the EC.

eFigure 1 Comparing CRS commitments, CRS disbursements, and DAC commitments

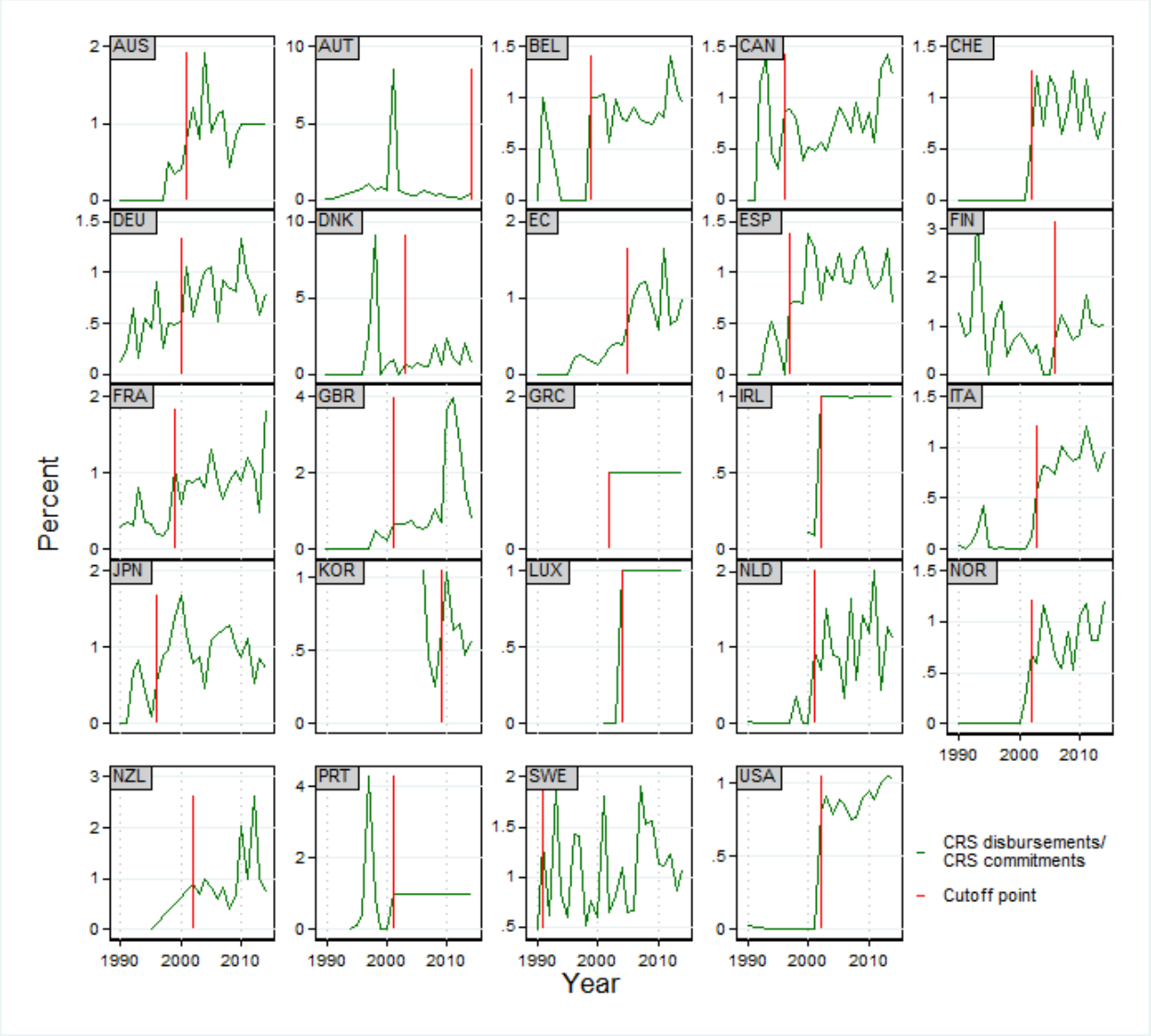
This figure compares commitments and disbursements from the Creditor Reporting System (CRS) and Development Assistance Committee (DAC) databases of the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD-DAC) from 1990 to 2014. CRS disbursements are usually underreported when compared to both CRS and DAC commitments data, especially in earlier years. Because of this gap between CRS and DAC, CRS disbursements data were adjusted to fit DAC commitments data.



Source: OECD-DAC and OECD Creditor Reporting System

eFigure 2 CRS disbursement to commitment ratio and cutoff points by donor agency

This figure shows the channel-specific cutoff year. Before this year, we adjust CRS commitments using disbursement schedules. After this cutoff we rely on CRS-reported disbursements. The total CRS disbursements to commitments ratio is in green, and the cutoff year is marked with a vertical red line. The cutoff year is determined to be when the ratio goes above 50% and does not fall back below 30%. The vertical axis represents the CRS disbursement to commitment ratio as a percentage. AUS = Australia, AUT = Austria, BEL = Belgium, CAN = Canada, CHE = Switzerland, DEU = Germany, DNK = Denmark, EC = European Commission, ESP = Spain, FIN = Finland, FRA = France, GBR = Great Britain, GRC = Greece, IRL = Ireland, ITA = Italy, JPN = Japan, KOR = South Korea, LUX = Luxembourg, NLD = the Netherlands, NOR = Norway, NZL = New Zealand, PRT = Portugal, SWE = Sweden, USA = United States of America.

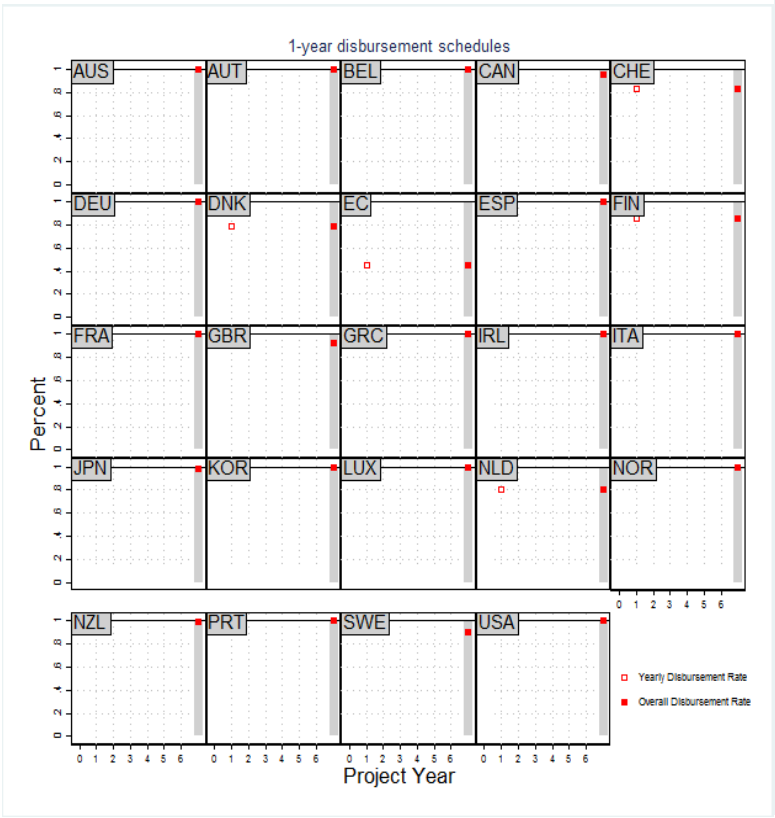


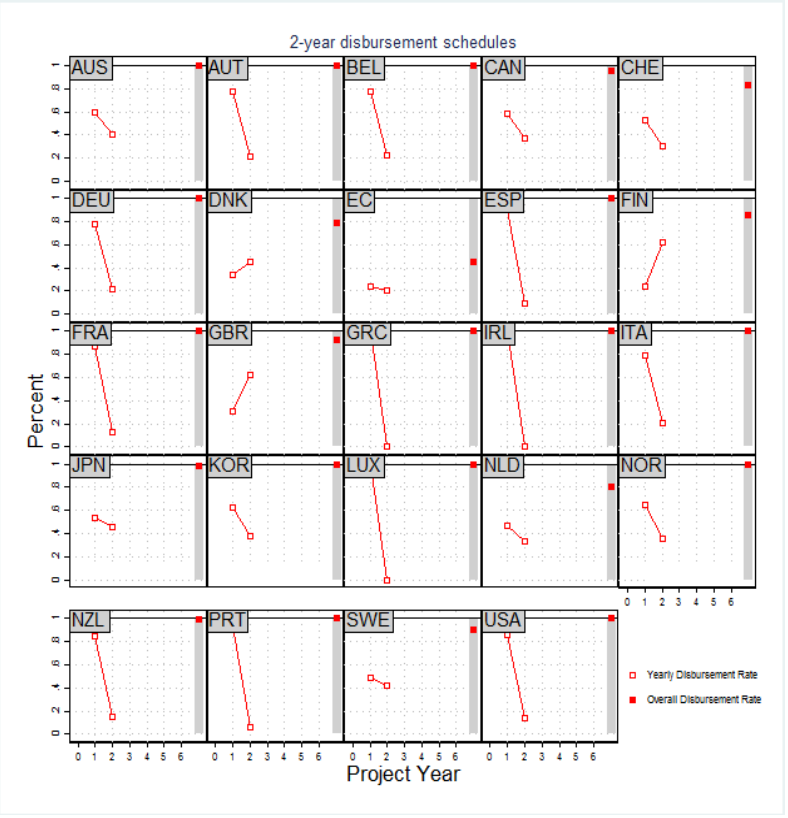
Source: OECD Creditor Reporting System

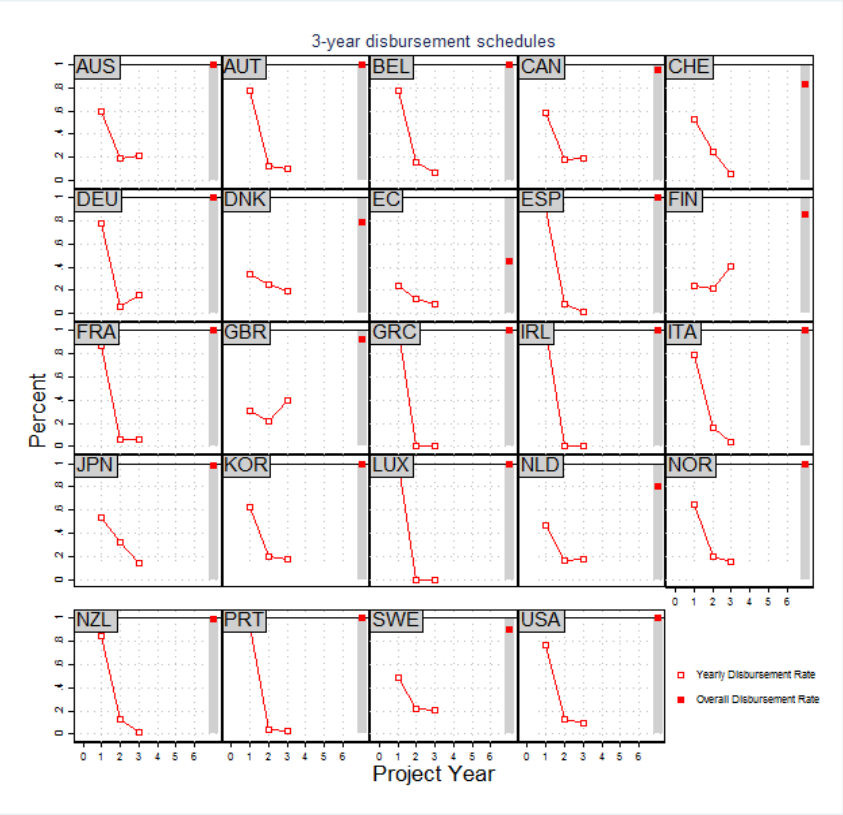
EXAMPLE. Australia's CRS disbursement to commitment ratio and cutoff year
The green line shows the ratio of Australia's disbursements to commitments, as reported in the CRS. Prior to 2001, the ratio was always below 50%. In 2001, the ratio rose above 50%; it did not fall below 30% in subsequent years, thereby defining 2001 as the cutoff year. Thus, for Australia, before 2001 DAH is based on adjusted CRS commitment data. These data are adjusted using disbursements schedules (eFigure 3) and data from the DAC. After 2001, Australia's DAH is based on the disbursements reported in the DAC.

eFigure 3 One- to six-year disbursement schedules for bilateral channels

This figure shows the estimated disbursement schedules for bilateral channels. Before the channel-specific cutoff year, we rely on commitment data to inform our estimates of DAH. Commitment data are adjusted to reflect disbursements over time using schedules estimated from projects in the CRS that have both commitment and disbursement data. The vertical axis represents the percentage of the commitment disbursed. AUS = Australia, AUT = Austria, BEL = Belgium, CAN = Canada, CHE = Switzerland, DEU = Germany, DNK = Denmark, EC = European Commission, ESP = Spain, FIN = Finland, FRA = France, GBR = Great Britain, GRC = Greece, IRL = Ireland, ITA = Italy, JPN = Japan, KOR = South Korea, LUX = Luxembourg, NLD = the Netherlands, NOR = Norway, NZL = New Zealand, PRT = Portugal, SWE = Sweden, USA = United States of America.


1-year disbursement schedules
AUS
AUT
BEL
CAN
CHE
DEU
DNK
EC
ESP
FIN
FRA
GBR
GRC
IRL
ITA
JPN
KOR
LUX
NLD
NOR
NZL
PRT
SWE
USA
Percent
Project Year
Yearly Disbursement Rate
Overall Disbursement Rate


2-year disbursement schedules
AUS
AUT
BEL
CAN
CHE
DEU
DNK
EC
ESP
FIN
FRA
GBR
GRC
IRL
ITA
JPN
KOR
LUX
NLD
NOR
NZL
PRT
SWE
USA
Percent
Project Year
Yearly Disbursement Rate
Overall Disbursement Rate


3-year disbursement schedules
AUS
AUT
BEL
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KOR
LUX
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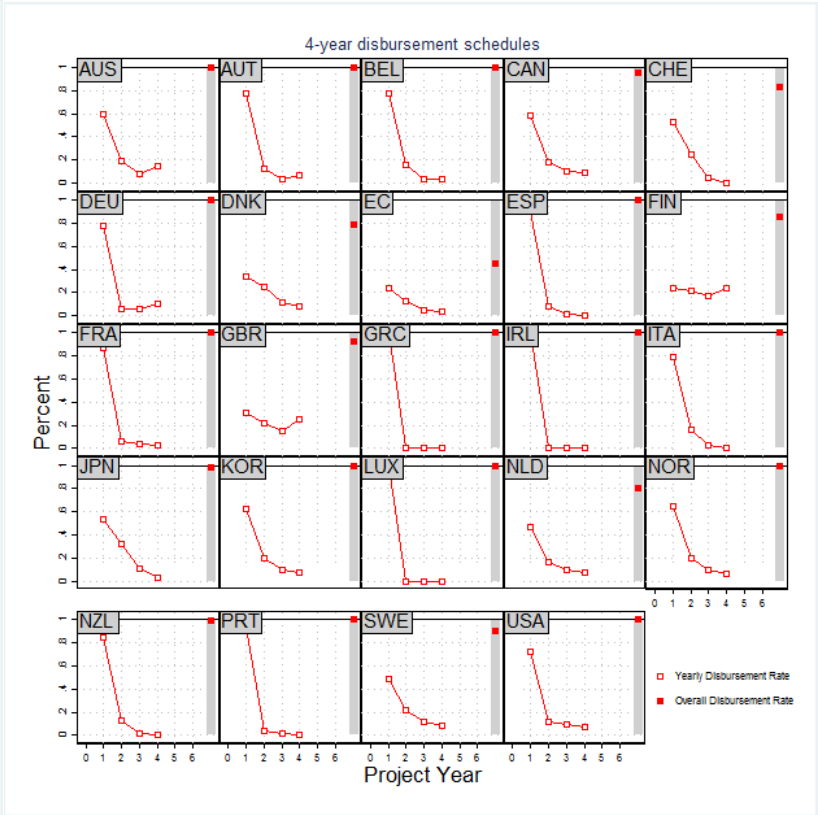
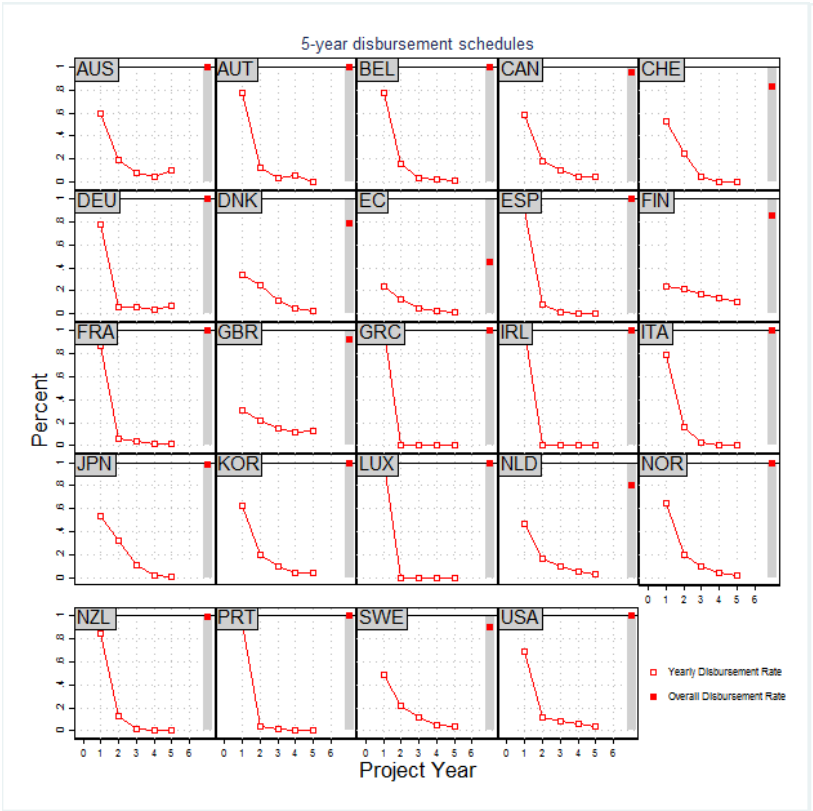
NOR
NZL
PRT
SWE
USA
Percent
Project Year
Yearly Disbursement Rate
Overall Disbursement Rate


4-year disbursement schedules
AUS
AUT
BEL
CAN
CHE
DEU
DNK
EC
ESP
FIN
FRA
GBR
GRC
IRL
ITA
JPN
KOR
LUX
NLD
NOR
NZL
PRT
SWE
USA
Percent
Project Year
Yearly Disbursement Rate
Overall Disbursement Rate


5-year disbursement schedules
AUS
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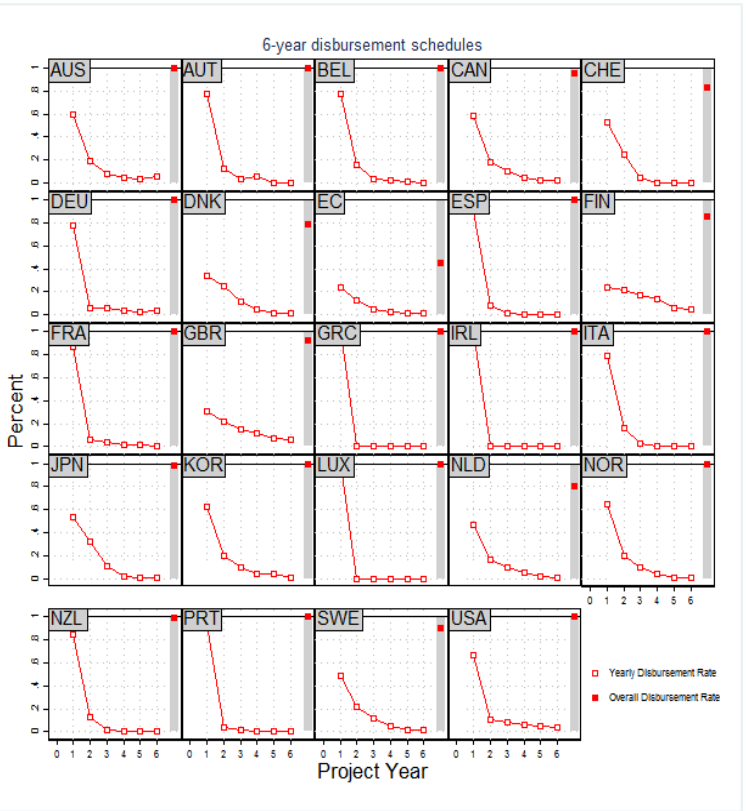
FRA
GBR
GRC
IRL
ITA
JPN
KOR
LUX
NLD
NOR
NZL
PRT
SWE
USA
Percent
Project Year
Yearly Disbursement Rate
Overall Disbursement Rate


6-year disbursement schedules
AUS
AUT
BEL
CAN
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DEU
DNK
EC
ESP
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FRA
GBR
GRC
IRL
ITA
JPN
KOR
LUX
NLD
NOR
NZL
PRT
SWE
USA
Percent
Project Year
Yearly Disbursement Rate
Overall Disbursement Rate

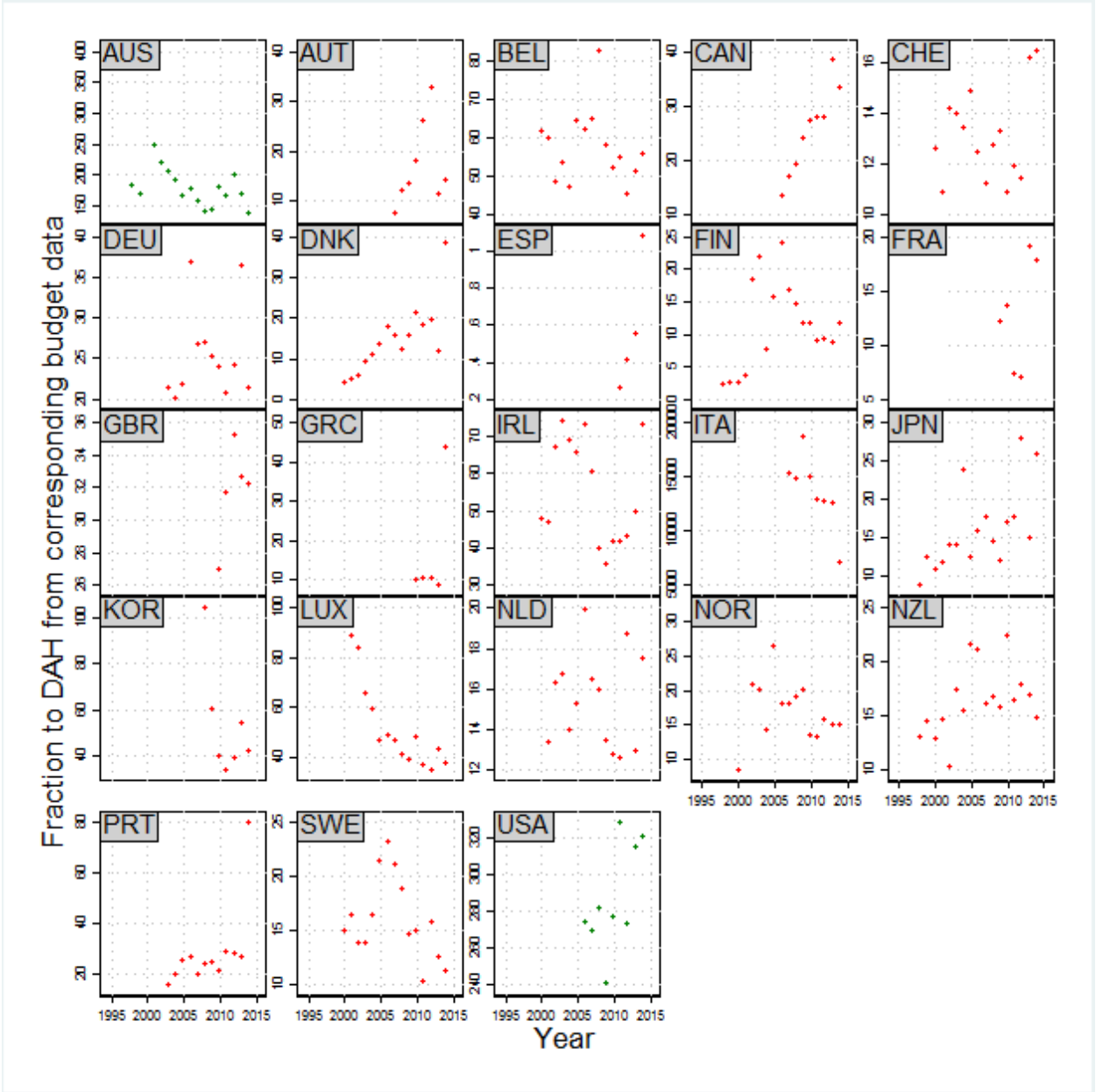
EXAMPLE. Australia's one- to six-year disbursement schedules

To estimate disbursements using commitment data, we rely on disbursement schedules derived from CRS data that include both commitments and disbursements. Disbursement schedules are specific for each channel and the length of a project. These schedules also take into consideration the average amount of commitments for each channel that lead to disbursements. Across all Australian projects in the CRS with complete disbursements data, Australia disbursed 100% of the funds that it committed, as shown by the solid red dot on the right-hand side of the Australia panel (upper left corner of the first panel of eFigure 3). In projects with a length of one year, Australia disbursed 100% of the funds that it committed in that year. For two-year projects, Australia disbursed 59% of total disbursements in year one and 41% of total disbursements in year two. In projects with lengths of three years, Australia disbursed about 59% of total disbursements in year one and 19% and 22% of total disbursements in years two and three, respectively. This is estimated for projects ranging from one to six years. The disbursement schedules were applied to commitment data from the CRS to estimate disbursements for years prior to the cutoff year, which is 2001 for Australia.

To predict DAH for the recent years not reported in the CRS, budget data were extracted from a variety of sources. These data are listed in eTable 4. Global health budgetary data were utilized whenever possible, but these detailed data were available as a complete time series only for Australia and the United States. For all other bilateral channels, general ODA budgets were used. In order to predict DAH for 2015 and 2016 for 23 bilateral agencies, the budget ratio for each donor was calculated by dividing DAH estimates by the corresponding budget data (ODA or global health). Budget ratios for 2015 and 2016 were projected using a weighted average of the previous three years (placing one-half weight on the one-year lagged ratio, one-third weight on the two-year lagged ratio, and one-sixth weight on the three-year lagged ratio), and this ratio was multiplied by the observed budgeted DAH for those same years. eFigure 4 plots the budget ratio for each bilateral channel. Budget data for the EC were inconsistent and did not match the disbursement series. Instead, DAH for 2015 and 2016 was estimated based on trends in DAH for EC member countries. A weighted average was applied to the percent change in DAH from 2014–2015 and 2015–2016 for all EC member countries. The weighting was based on each country's total national contributions to the EC. These data were collected from the EC's 2014 financial statement.[67] The weighted average was then applied to the EC's 2014 DAH to forecast 2015, and 2015 to forecast 2016.

eFigure 4 DAH as a percentage of corresponding budget data by bilateral agency

This figure shows the trend of the ratio of DAH measured as a share of budget data. Green dots indicate that a donor provided global-health-specific budget data, so in these cases the denominator is all global-health-specific budgeted data. The numerator is estimated DAH. Red dots indicate that a donor did not have global-health-specific budget data, so overall ODA budget data were used in calculating the DAH to budget ratios. The vertical axis represents estimated DAH as a fraction of corresponding budget data. Green dots are out of 100. Red dots are out of 100,000,000. AUS = Australia, AUT = Austria, BEL = Belgium, CAN = Canada, CHE = Switzerland, DEU = Germany, DNK = Denmark, ESP = Spain, FIN = Finland, FRA = France, GBR = Great Britain, GRC = Greece, IRL = Ireland, ITA = Italy, JPN = Japan, KOR = South Korea, LUX = Luxembourg, NLD = the Netherlands, NOR = Norway, NZL = New Zealand, PRT = Portugal, SWE = Sweden, USA = United States of America.



Source: IHME DAH Database (2016) and corresponding bilateral ODA/DAH budget documents outlined in eTable 2 and 4.

EXAMPLE. Australia's DAH as a percentage of corresponding budget data

Australia provided global-health-specific budget data for 1998–2016 through its International Development Assistance and Overseas Aid Program budgets. For 1998–2014, health ODA and observed DAH were used to create DAH to budget ratios. These budget ratios were then used with 2015 and 2016 health ODA budget data to project DAH in 2015 and 2016, using a weighted average:

$$(Total\ DAH_t) = \left(\frac{1}{2}\right)(Budget\ ratio_{t-1})\,(Budgeted\ GHE_t) + \left(\frac{1}{3}\right)(Budget\ ratio_{t-2})(Budgeted\ GHE_t) + \left(\frac{1}{6}\right)(Budget\ ratio_{t-3})(Budgeted\ GHE_t)$$

where t = year to be modeled (2015 or 2016).

Tracking development assistance for health from the development banks

The World Bank Project-level health disbursement data for 1990–2016 were obtained from the World Bank through correspondence with Miyuki Parris, Operations Analyst.[68] Health disbursements included all health projects as well as other sector projects with a health sector code. In addition to these data, data were collected from the World Bank online loans database in order to fill in descriptive information for loans from the two arms of the World Bank: the International Development Association (IDA) and the International Bank for Reconstruction and Development (IBRD).[68] Along with keyword searches, health theme codes were used to allocate disbursements by health focus area. The online database contains up to five sector codes and five theme codes that can be assigned to each project. Sector codes represent economic, political, and social subdivisions, while theme codes represent the goals or objectives of World Bank activities. The codes are summarized in eTable 7. Emergency recovery loans were excluded since they do not fit the definition of DAH.

eTable 7 World Bank's health sector and theme codes

Health sector codes Sector codes represent economic, political, or social subdivisions within society. World Bank projects are classified by up to five sectors.	**Health theme codes** Theme codes represent the goals or objectives of World Bank activities. World Bank projects are classified by up to five themes.
Historic (prior to 2001): (1) Basic health (2) Other population health and nutrition (3) Targeted health (4) Primary health, including reproductive health, child health, and health promotion Current (as of 2001): (1) Health (2) Compulsory health finance (3) Public administration – health (4) Noncompulsory health finance	Current: (1) HIV/AIDS (2) Malaria (3) Tuberculosis (4) Other communicable diseases (5) Population and reproductive health (6) Child health (7) Nutrition and food security (8) Injuries and non-communicable diseases (9) Health system performance (10) Social analysis and monitoring

Data on yearly government contributions were obtained from the DAC statistics in order to disaggregate IDA flows by source. Details on how we estimated the cost of providing technical assistance and program support for these institutions are highlighted below in the section titled calculating the technical assistance and program support component of development assistance for health from loan- and grant-making channels of assistance. The data received from the World Bank captured disbursements for only the first few months of 2016, so budget data from 2012 through 2016 and historic disbursement data were used to predict 2016 health disbursements for IDA and IBRD separately.[69] The 2016 estimate was based on a three-year weighted average of previous years (placing one-half weight on the one-year lagged ratio, one-third weight on the two-year lagged ratio, and one-sixth weight on the three-year lagged ratio). The predicted ratio was then multiplied by the observed program budget for 2016 to get the estimates of DAH.

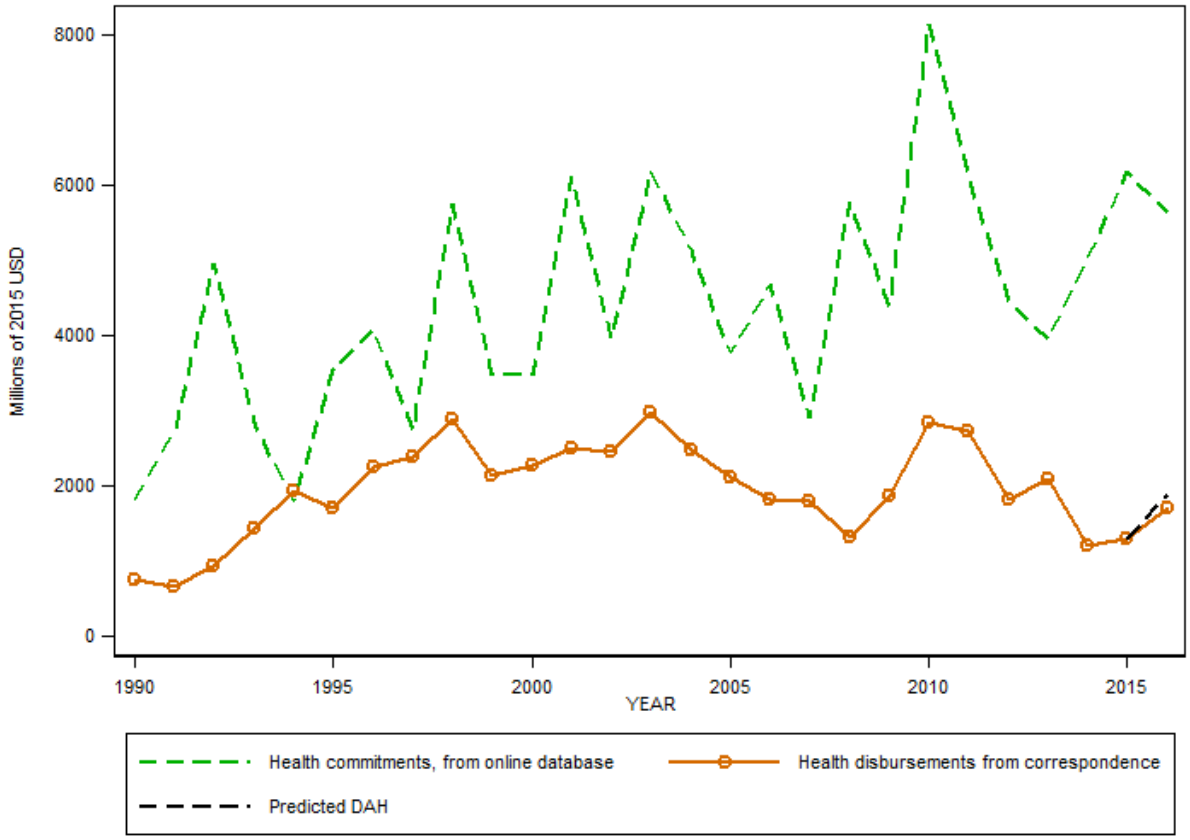
$$(Predicted\ Ratio) = \left(\frac{1}{2}\right)(Observed\ DAH_{t-1})\,(Budgeted\ DAH_{t-1}) + \left(\frac{1}{3}\right)(Observed\ DAH_{t-2})(Budgeted\ DAH_{t-2}) + \left(\frac{1}{6}\right)(Observed\ DAH_{t-3})(Budgeted\ DAH_{t-3})$$

$$(Total\ DAH_t) = (Predicted\ Ratio)(Budgeted\ HE_t)$$

eFigure 5 shows (a) total health commitments from the online loans database (green dashed line), (b) total health disbursements received from correspondence (orange line), and (c) predicted full-year disbursements (black dashed line). The database distinguishes between loans from IDA and IBRD, but the aggregates are shown in the figure.

eFigure 5 World Bank's annual health sector commitments and disbursements

This figure shows health sector commitments from the online database in green. The orange line shows annual health disbursements data received from the World Bank through 2016. The line for 2016 disbursements is lower because the 2016 data are incomplete due to reporting lag. The dashed black line shows predicted full-year disbursements based on the estimation method described above.



Source: IHME DAH Database (2016) and correspondence with World Bank

Regional development banks

The African Development Bank (AfDB), Asian Development Bank (ADB), and Inter-American Development Bank (IDB) all maintain their own loan databases, which were used to estimate disbursements.[13,15,16] eTable 8 provides a summary of the data sources used across the regional banks. Furthermore, eFigures 6, 7, and 8 display commitments and disbursements from 1990 to 2016 for each organization.

In 2010, the AfDB began providing an online project-level database with cumulative commitment data for all projects and cumulative disbursement data for closed projects. Cumulative disbursements were divided by the project length to estimate annual disbursements for closed projects. For ongoing and approved projects, commitments were adjusted by the average fraction of commitments that were disbursed for closed projects, and then the adjusted commitments were divided by the average project length. Disbursement levels prior to 2007 did not match previously gathered data from AfDB's Compendium of Statistics, so data from the Compendium of Statistics were used for pre-2007 estimates of DAH.

The ADB reported commitments and disbursements for all projects. Many of these projects were tagged as belonging to multiple sectors. For example, a project can be tagged for health, for education, and for public sector management. For projects with multiple sectors, disbursements and commitments were divided by the number of sectors a project was tagged for. If a project had multiple sectors, if it did not have the word "health" in its title or in its description, and if it also did not include any words associated with the health focus areas tracked in the *Financing Global Health* report in its title or in its description, it was excluded from the study. Once disbursements and commitments were adjusted for the presence of multiple sectors, annual disbursements were estimated by dividing the project length by total disbursements. For projects without a closing date, estimates were based on the average project length by project type. When no disbursement data were available, adjusted commitments were used, based on the average fraction of commitments that were disbursed by project type for projects with both commitments and disbursements data.

The IDB's project database also provided commitments and disbursements for all projects. The same methods were used for estimating annual disbursements from the IDB as were used for the ADB. Through correspondence, 2016 health loan disbursements were obtained. These numbers were used for the 2016 estimates. All datasets used to estimate disbursements for the regional development banks were updated in November 2016. Due to lags in reporting, preliminary estimates of DAH in 2016 may be incomplete. However, since these channels have so few new projects each year, it was assumed that smoothing disbursements over time for reported projects captured the majority of total disbursements for 2016.

eTable 8 Summary of data sources for the regional development banks

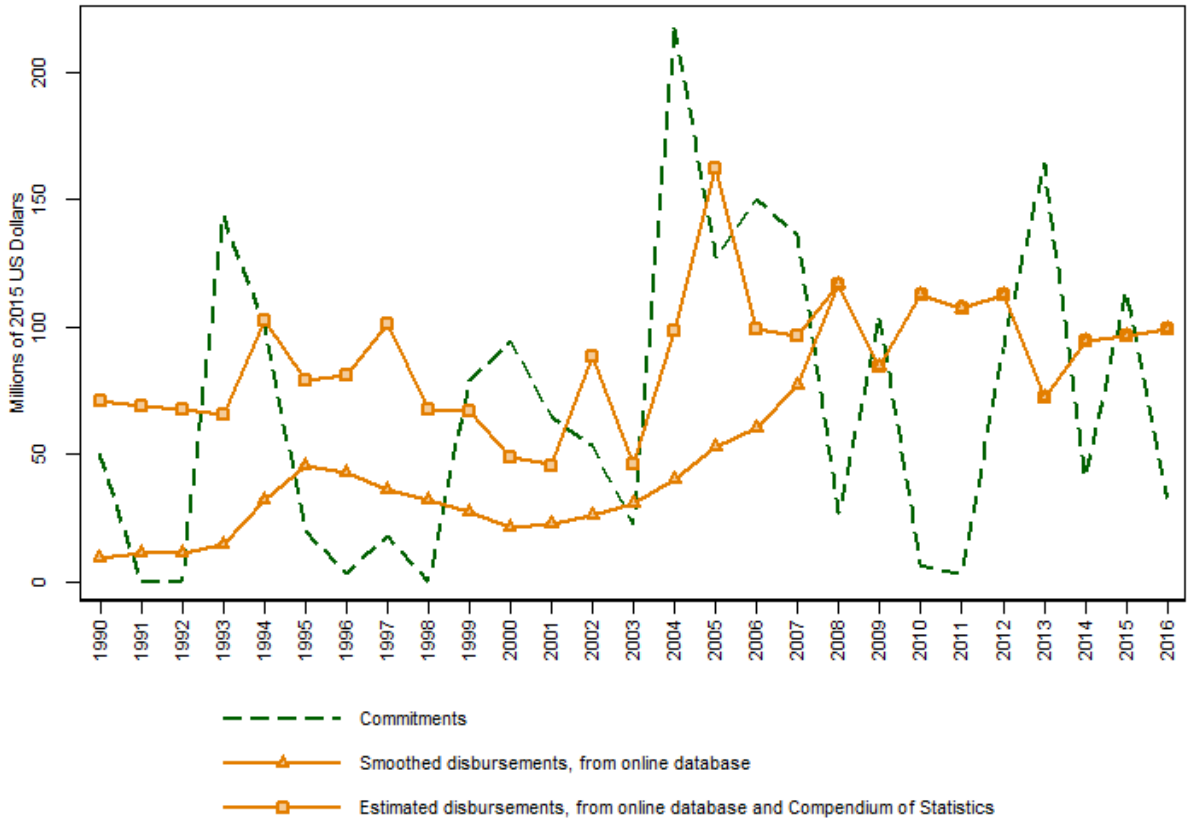
This figure indicates the data available and used to estimate DAH. (X) indicates that project-level data are present in the dataset. (-) indicates that project-level data are not present in the dataset.

Institution	Data source	Commitments	Cumulative disbursements	Yearly disbursement	Notes
African Development Bank (AfDB)	Compendium of Statistics	X		(Aggregate – not at the project level)	The Compendium of Statistics was not available for 1990–1993, 1995, and 1998–1999; we estimated yearly disbursements using the average of neighboring disbursements
	Online Projects Database	X	X		As yearly disbursement amounts are not provided in the online database, we

Institution	Data source	Commitments	Cumulative disbursements	Yearly disbursement	Notes
					estimated yearly disbursements by allocating cumulative disbursements over each year of the project.
	OECD-Creditor Reporting System	X		X	To maintain continuity with previous estimate, yearly disbursement amounts from the CRS were not used.
Asian Development Bank	Online Projects Database	X	X		As yearly disbursement amounts are not provided in the online database, we estimated yearly disbursements by allocating cumulative disbursements over each year of the project.
	OECD-Creditor Reporting System	X			To maintain continuity with previous estimate, yearly disbursement amounts from the CRS were not used.
Inter-American Development Bank	Online projects database	X	X		As yearly disbursement amounts are not provided in the online database, we estimated yearly disbursements by allocating cumulative disbursements over each year of the project.
	Correspondence			X	Loan disbursements from January through November 2016 were provided, along with projected disbursements for December 2016.

eFigure 6 Commitments and disbursements by the African Development Bank

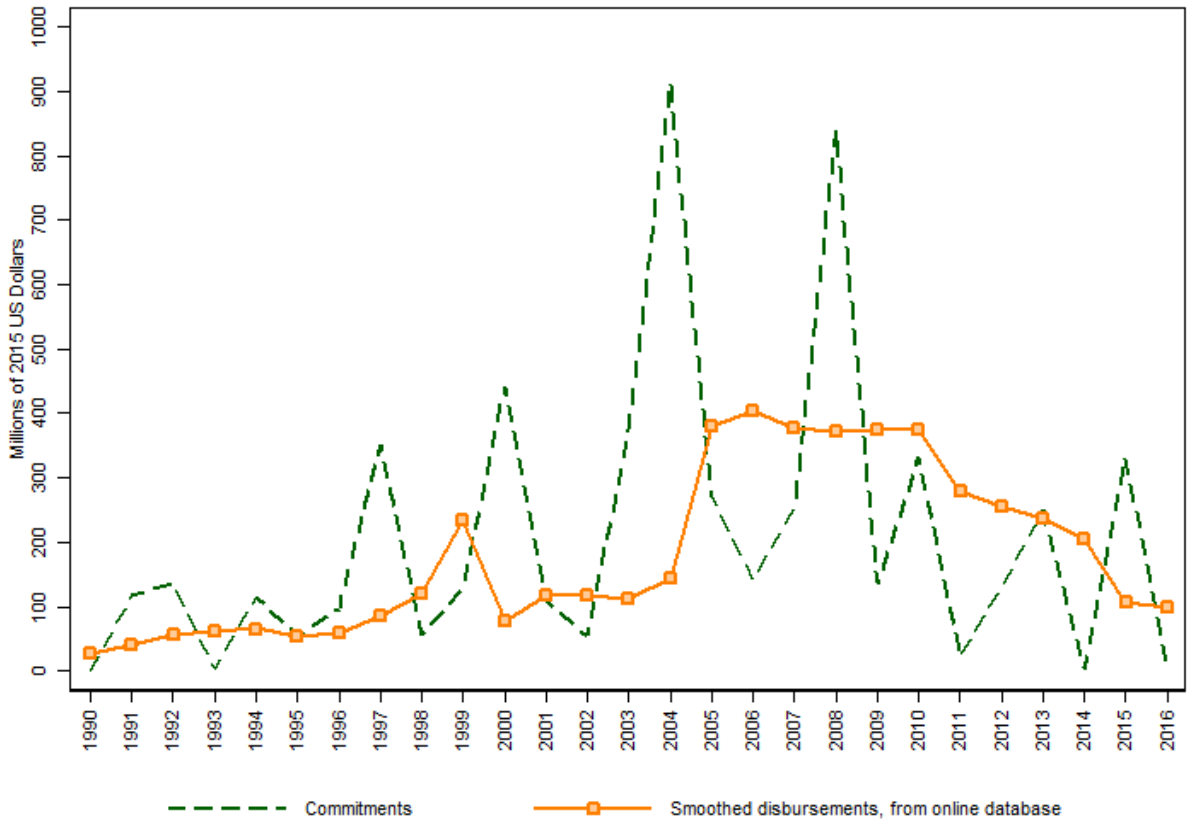
The dashed green line shows commitments from the African Development Bank's (AfDB) online project database. The orange line with triangles shows smoothed disbursements from the online project database. A combination of the Compendium of Statistics and online project database was used in the DAH estimates, shown by the orange line with squares.



Source: IHME DAH Database (2016) and African Development Bank Compendium of Statistics.

eFigure 7 Commitments and disbursements by Asian Development Bank

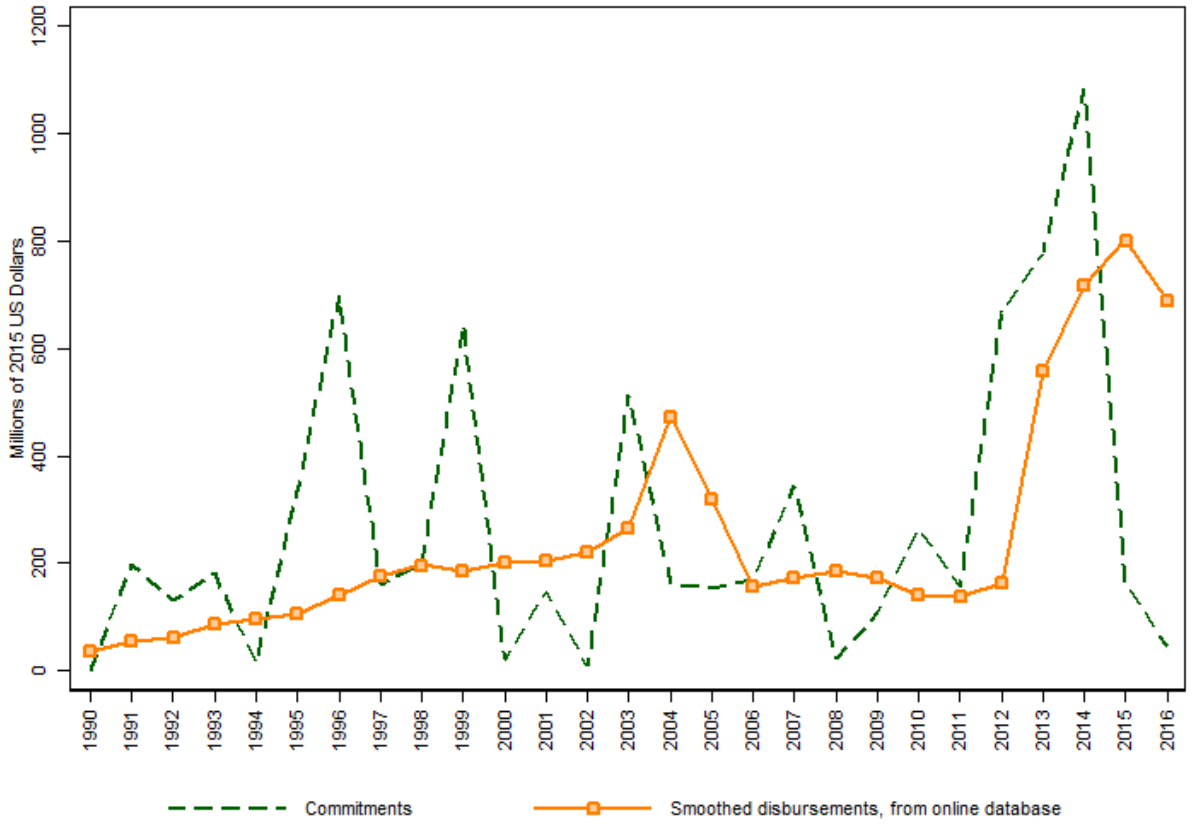
The dashed green line shows commitments from the Asian Development Bank's (ADB) online projects database. The orange line shows smoothed disbursements from the online projects database.



Source: IHME DAH Database (2016)

eFigure 8 Commitments and disbursements by Inter-American Development Bank

The dashed green line shows commitments from the Inter-American Development Bank's (IDB) online projects database. The orange line shows smoothed disbursements from the online projects database, and from correspondence for 2016.



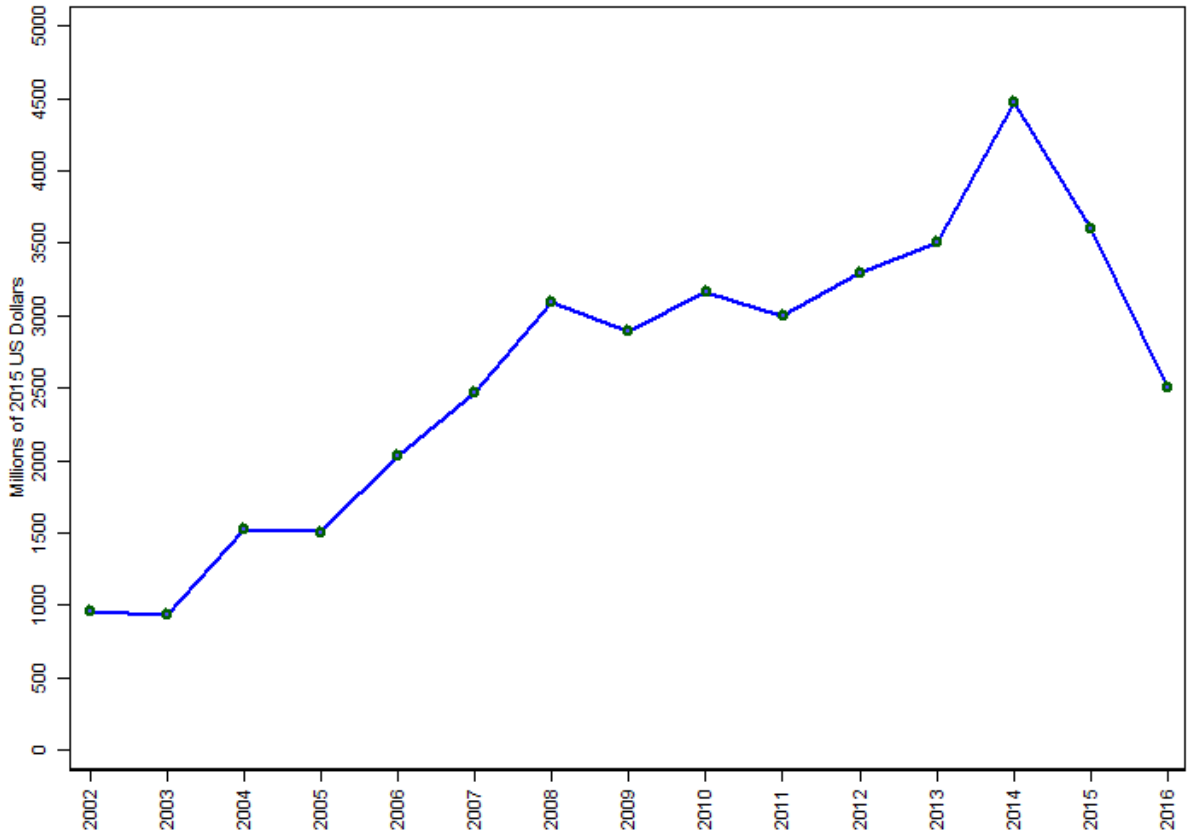
Source: IHME DAH Database (2016) and correspondence

Tracking contributions from the Global Fund and Gavi

The Global Fund to Fight AIDS, Tuberculosis and Malaria

The grants database made available online by the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) provides grant-level commitments and annual disbursements.[22] In addition, sources of funding were compiled from the Global Fund's contributions dataset and annual reports, all downloaded from the Global Fund website.[23,24] eFigure 9 shows The Global Fund's annual contributions received from public and private sources. eFigure 10 shows the Global Fund's annual commitments and disbursements from its project database from 2002 through 2016.

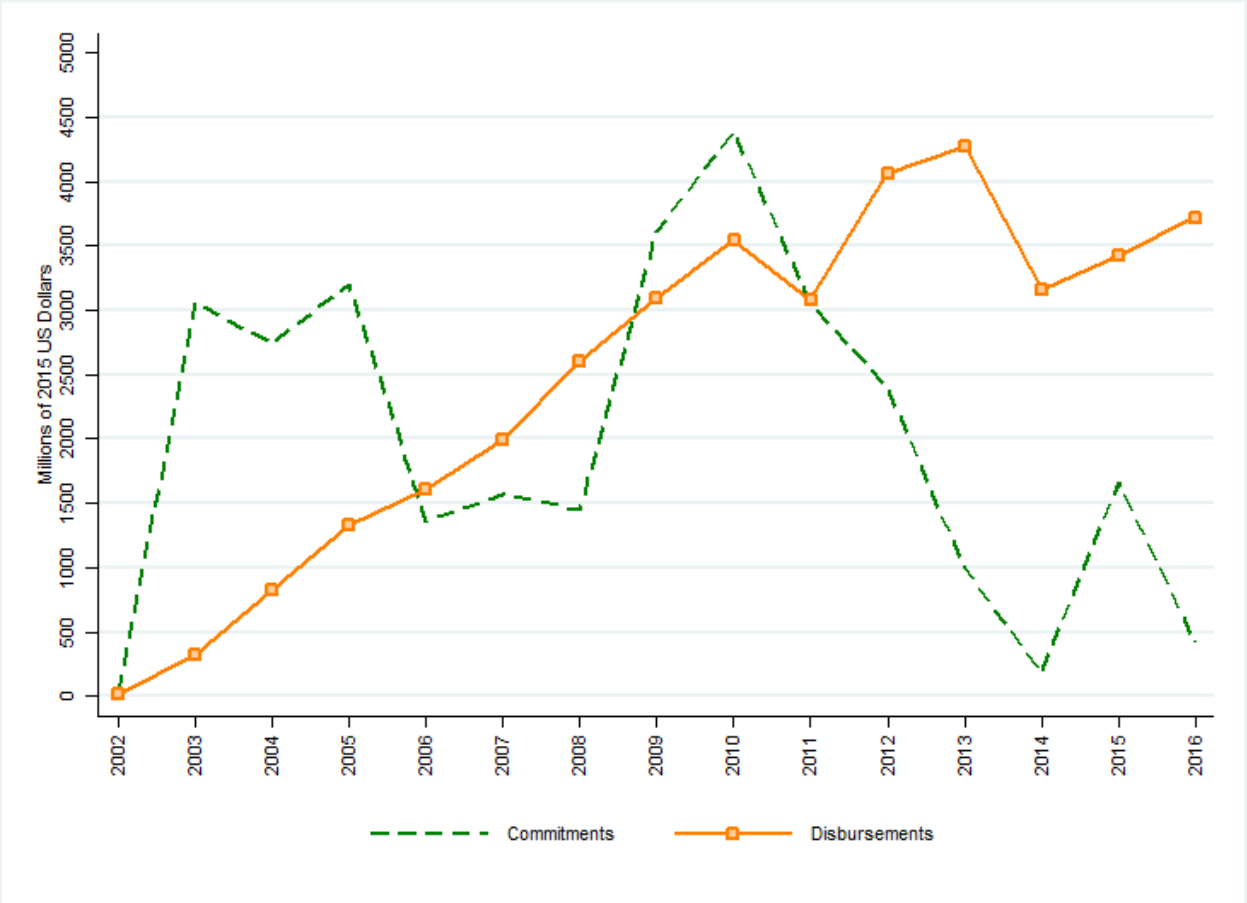
eFigure 9 Contributions received by the Global Fund to Fight AIDS, Tuberculosis and Malaria



Source: Global Fund pledges and contributions 2016

eFigure 10 The Global Fund to Fight AIDS, Tuberculosis and Malaria's commitments and disbursements

The dashed green line shows commitments from the Global Fund to Fight AIDS, Tuberculosis and Malaria's online grants database. The orange line shows disbursements from the online grants database.



Source: IHME DAH Database (2016)

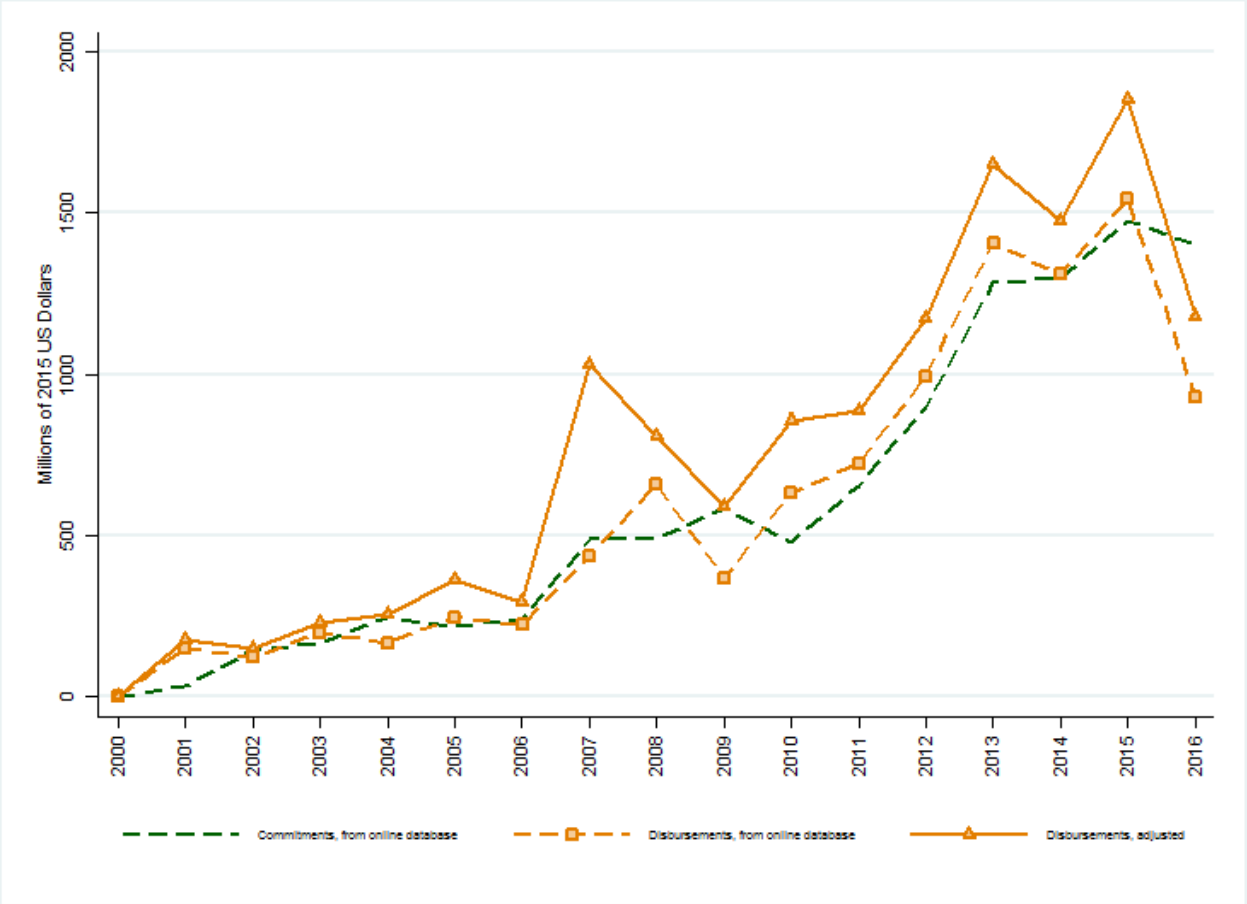
Gavi, the Vaccine Alliance

Gavi provided publicly available project-level data on commitments, disbursements, and investment cases from 2000 through the present.[18,21] Gavi's annual DAH was defined as the sum of (1) project-level disbursements by year paid; (2) investment cases (one-time investments in disease prevention and control); and (3) administrative and work plan costs. Data from Gavi's online databases include expenditure for (1) and (2), but not (3). However, project-level data from the CRS for 2007–2012 did include administrative and work plan costs, so disbursements data from the online database were adjusted to match the CRS in those years. The average fraction of administrative and work plan costs was added to total disbursements in 2000–2006 and 2013–2014, the years in which the CRS did not include these data. Total DAH before (dashed orange line) and after (blue line) are shown in eFigure 11. Contributions data from Gavi's website as well as annual reports from the International Finance Facility for Immunisation (IFFIm) and Advance Market Commitment for Pneumococcal Vaccines were used to determine Gavi's annual income.[19,20,70]

All of the data sources used for Gavi estimates were complete through 2015. Donor contributions received and outstanding pledges data were available on Gavi's website. The unadjusted total pledges were used as total disbursements for 2016.

eFigure 11 Gavi's income and disbursements

The dashed green line shows commitments from Gavi's online database. The dashed orange line shows the disbursements from Gavi's online database, which are the sum of project-level disbursements and investment cases. These data are adjusted using Gavi expenditure data reported to the Creditor Reporting System (CRS) to add administrative and work plan costs to the total. Adjusted disbursements are shown by the solid orange line.



Source: IHME DAH Database (2016)

Tracking expenditure by United Nations Agencies active in the health domain

Data on income and expenditures were collected for five UN agencies: WHO, UNICEF, UNFPA, UNAIDS, and PAHO. The data sources and calculations for each are described in detail below. Similar to the bilateral channels, we extracted budget data for the UN agencies to predict DAH for years for which we did not have health expenditure data. Model choices and budget measures for UN agencies are presented in eTable 4.

World Health Organization

Data on WHO's budgetary and extrabudgetary income and expenditure were compiled from annual reports and audited financial statements released by WHO.[71] Income data were extracted from WHO's assessed and voluntary contributions, while expenditure data were extracted from both budgetary and extrabudgetary spending reports. As the financial statements represent activities over a two-year period, both income and expenditure data were divided by two, in order to approximate yearly amounts, and dollars were deflated using the US GDP deflator specific to the

reporting year. Expenditures from trust funds, regional offices tracked separately, and associated entities not part of WHO's program of activities, such as UNAIDS and Global Fund trust funds were excluded. Expenditures from supply services funds were also excluded, as these expenditures pertain to services provided by WHO but paid for by recipient countries.

Disbursement data were not available for WHO in 2016. Much like the bilateral agencies, the ratio of DAH to the total program budget was estimated for 1990–2015 and then predicted for 2016 using the three-year weighted average of previous years (placing one-half weight on the one-year lagged ratio, one-third weight on the two-year lagged ratio, and one-sixth weight on the three-year lagged ratio). The predicted ratio was then multiplied by the observed program budget for 2016 to get the estimates of DAH (see "EXAMPLE. Australia's data sources" box on page 15 and "EXAMPLE. Australia's DAH as a percentage of corresponding budget data on page 25 for an example of this methodology).

United Nations Population Fund

Data on income and expenditure were extracted for UNFPA from its audited financial statements.[65] As these statements represent activities over a two-year period, income and expenditure data were divided by two in order to approximate yearly amounts. Dollars were deflated using the US GDP deflator specific to the reporting year. The only exceptions to this rule were years 2006 through 2009, for which annual data were available.

Income and expenditures associated with procurement and cost-sharing activities were excluded from estimates of health assistance because UNFPA uses cost-sharing accounts when a donor contributes to UNFPA for a project to be conducted in the donor's own country. Since this money can be considered domestic spending that goes through UNFPA before being returned to the country in the form of a UNFPA program, it is not included in calculations of total DAH. UNFPA's additional expenditures for these projects come from trust funds or regular resources and are therefore captured in our estimates.

The disbursement data for UNFPA were available through 2015. For year 2016, much like the bilateral agencies, the ratio of DAH and income was estimated for 1990–2015 and then predicted for 2016 using the three-year weighted average of previous years. The predicted ratio was multiplied by observed income to estimate DAH for 2016.

United Nations Children's Fund

Data on income and expenditure for UNICEF were extracted from its audited financial statements.[62] As these statements represent activities over a two-year period for all years from 1990 through 2011, income and expenditure data were divided by two in order to approximate yearly amounts. Dollars were deflated using the US GDP deflator specific to the reporting year.

Since UNICEF's activities are not limited to the health sector, the fraction of UNICEF's expenditure that was for health was estimated using a combination of annual reports. UNICEF's annual reports in the 1990s reported this number, but reporting categories changed over time, making it difficult to arrive at consistent estimates of health expenditure.

The product of observed program budget and the weighted average of the DAH to budget ratio (placing one-half weight on the one-year lagged ratio, one-third weight on the two-year lagged ratio, and one-sixth weight on the three-year lagged ratio) was used to predict DAH in 2015 and in 2016, using the same methodology that was utilized in predicting DAH for WHO.

Joint United Nations Programme on HIV/AIDS

UNAIDS income and expenditure data for both its core and noncore budgets were extracted from its audited financial statements.[60] As financial data are provided on a biennial basis from 1998 through 2011, the quantities were divided by two to obtain yearly amounts for all biennium data. Dollars were deflated using the US

GDP deflator specific to the reporting year.

For UNAIDS, budget measures were available only for a subset of reported total disbursements. UNAIDS reported total expenditure, which combined Unified Budget and Workplan (UBW) and non-UWB components, but only UBW budget data were available.[61] To predict DAH for UNAIDS in 2015 and 2016, disbursements in those years were calculated by multiplying the observed UBW budget by the three-year weighted average of the ratio of DAH to the UWB budget (placing one-half weight on the one-year lagged ratio, one-third weight on the two-year lagged ratio, and one-sixth weight on the three-year lagged ratio).

Pan American Health Organization

The Pan American Regional Office for WHO, or PAHO, reports its income and expenditure in its biennial financial report.[9,72] The funds transferred through the "Rotating Fund" were excluded because developing countries fund this procurement of health commodities, and it therefore does not fit the definition of DAH.

As the financial data are provided on a biennial basis (with the exception of 2010 through 2014, where single-year financial reports were available), the quantities were divided by two to obtain yearly amounts. Dollars were deflated using the US GDP deflator specific to the reporting year.

Correspondence with PAHO revealed that data from the financial statements include both Program and non-Program funds. The latter include funds that countries provide PAHO, so that PAHO can reinvest these funds into the countries' national health systems. These funds should not be included as development assistance for health, and PAHO provided corrected disbursement numbers for 2008 to 2013. These funds were provided as biennial disbursements, so they were divided by two to obtain yearly disbursements. The ratio of Program disbursements numbers provided by PAHO and the sum of Program and non-Program funds collected from financial statements was taken for the years 2008 to 2013. The average ratio was calculated, and this ratio was multiplied through disbursement numbers collected from financial statements from earlier years. In this way, Program and non-Program funds collected from audited statements from earlier years were adjusted to estimate DAH.

For PAHO, disbursement data were not available for 2014 and 2016. PAHO provided budget information along with disbursements for 2008 to 2013. PAHO provided budget information for 2014 to 2017 as well. The average ratio between spending and budget was calculated over the years 2008 to 2013, and this ratio was used to estimate 2014, 2015, and 2016 disbursements.

Tracking development assistance for health from private foundations

Previous studies on foundations outside the US have documented the severe paucity of reliable time series data and lack of comparability across countries.[73] Hence, this research focused efforts on tracking only US foundations. The Wellcome Trust, a foundation based in the United Kingdom, is reputed to be the single largest non-US foundation active in the area of health. However, since the Wellcome Trust is principally a source of funding for technology, including drugs and vaccine research and development, its contributions do not meet the definition of DAH.

US Foundations

The Foundation Center maintains a database of all grants of $10,000 or more awarded by over 1,000 US foundations. The Foundation Center has coded each grant by sector and international focus and therefore is able to identify global health grants. IHME purchased a customized dataset with cross-border health grants and health grants to US-based international programs from 1992 to 2013 from the Foundation Center.[31] Grants from the Gates Foundation, which were tracked separately, were excluded. Additionally, grants to channels that this research already tracks were excluded.

The Foundation Center adopted a new classification methodology as of FGH 2016. The Foundation Center was able to provide historical data based on the new classification system from 2002 to 2012. In order to obtain the series from 1990 to 2001, we multiplied a weighted fraction calculated based on both old and new classification data values from 2002 through 2004 by the old data series (1990–2001) we had previously obtained.

$$
\begin{aligned}
&(Weighted\ fraction) \\
&\quad = \left(\frac{1}{2}\right)\left(DAH_{new\ classification}\right)/\left(DAH_{old\ classification}\right)2002 \\
&\quad + \left(\frac{1}{3}\right)\left(DAH_{new\ classification}\right)/\left(DAH_{old\ classification}\right)2003 \\
&\quad + \left(\frac{1}{6}\right)\left(DAH_{new\ classification}\right)/\left(DAH_{old\ classification}\right)2004
\end{aligned}
$$

$$(DAH\ Estimate_t) = (Weighted\ fraction)(DAH\ Observed_t)$$

where DAH Observed is the old data values for the series 1990 through 2001

To estimate total health grants in 1990–1991 and 2014–2016, the natural log of US foundation DAH was regressed on the natural log of US GDP per capita and year using ordinary least squares estimation. The missing years of data were predicted based on estimated regression coefficients from the equation. Exponents of the predicted values were used as final estimates

$$(ln\ Foundation_t) = \alpha + \beta_1(\ln US\ GDP\ per\ capita_t) + \beta_2(year_t) + \varepsilon$$

Details on how we estimated the cost of providing technical assistance and program support for these US foundations are highlighted below in the section titled "Calculating the technical assistance and program support component of development assistance for health from loan- and grant-making channels of assistance."

Bill & Melinda Gates Foundation

The Gates Foundation has been the single largest grant-making institution in the health domain since 2000; hence, additional research was undertaken to accurately capture its annual disbursements. The Gates Foundation's IRS 990PF filings for years 1990–2007, which report all global health grants disbursed per year, were downloaded from the Foundation's website. Additionally, disbursement data for years 2008–2015 were collected from the Gates Foundation online grants database, the OECD CRS, and personal correspondence.

An ordinary least squares linear regression model was used to predict the disbursement for the Gates Foundation for 2016. Since there is a strong correlation between market trends and Gates Foundation annual disbursements, market data including lagged US GDP, lagged yearly average of Berkshire stock returns, lagged yearly average of the Russell Index, and lagged total assets of the Gates Foundation Trust were utilized to predict the total disbursement for year 2016.

$$
\begin{aligned}
&(BMGF\ total\ disbursement_t) \\
&\quad = \alpha + \beta_1(US\ GDP\ per\ capita_{t-1}) + \beta_2(Berkshire\ stock\ returns_{t-1}) \\
&\quad + \beta_3(Russell\ Index_{t-1}) + \beta_4(BMGF\ total\ asset_{t-1}) + \varepsilon
\end{aligned}
$$

The Gates Foundation's predicted DAH was adjusted to account for in-kind DAH and double-counting. The difference between the Gates Foundation's final DAH and DAH without in-kind added and double-counting removed from 2003–2015 was regressed using ordinary least squares on DAH without in-kind added and double-counting removed and year. The predicted difference was then subtracted from the predicted DAH from the previous regression for 2016.

Tracking non-governmental organizations

Currently, there are no centralized, easily accessible databases for tracking program expenses of the thousands of NGOs based in high-income countries that are active in providing development assistance and humanitarian relief worldwide. This study relied on CRS data and the only comprehensive data source identified for a large subset of these NGOs, namely the United States Agency for International Development's Report of Voluntary Agencies (USAID's VolAg report).[26] The report, which includes both US-based and international NGOs that received funding from the US government, provides data on domestic and overseas expenditures for these NGOs as well as their revenue from US and other public sources, private contributions, and in-kind. Total revenue and expenditure data obtained from the NGOs' IRS tax forms, accessed through the GuideStar online database, were also used in tracking NGOs incorporated in the US.[25]

First, in order to track disbursements from OECD donor countries to NGOs, we utilized channel codes present in the CRS database. The code 21000 identified international NGOs and the code 22000 identified donor-country-based NGOs. In order to remove double-counting, we conducted a keyword search on channels where the donor country was the United States to exclude NGOs present in the USAID VolAg report.

In order to use the USAID VolAg data, several challenges were overcome. We outline these challenges here and discuss below the methods employed to estimate a consistent series of DAH channeled through NGOs despite these challenges. First, with the exception of BMGF, it was impossible to track the amount of funding from US foundations routed through US NGOs, which may have led to double-counting in estimates of total health assistance. The second challenge relates to the incompleteness of the universe of NGOs captured through the USAID report. The report provides data on NGOs that received funding from the US government. While this covers many of the largest NGOs, it is not a comprehensive list. A related problem is that the VolAg report only includes NGOs that received funds in a given year. While many of the largest NGOs are consistently funded by the US government and are therefore in the report every year, not all NGOs are reported across all years. Third, health sector-specific expenditure is not reported in the VolAg or systematically reported in IRS tax forms. The VolAg does report overseas expenditure but does not disaggregate this expenditure by sector. Fourth, complete data are lacking in several time periods. At the time of analysis, the 2015 VolAg, which provided data for 2013, was the most recent report available. For NGOs incorporated in the US, IRS tax forms were obtained. Furthermore, prior to 1998 the VolAg report did not include international NGOs. Attempts were made to compile other data on the health expenditures of the top international NGOs, in terms of overseas expenditure, by searching other websites for financial documents and contacting these organizations directly. Getting reliable time series data before 2000 proved to be extremely difficult for even this small sample of international NGOs.

Estimates of the share of overseas expenditure spent on health-related projects drew upon a sample of NGOs for which such data were available. Collecting financial data on health expenditures for each NGO would have been prohibitively time-consuming. Therefore, a sample of NGOs was drawn from the list for each year; the sample included the top 30 NGOs in terms of overseas expenditure and 20 randomly selected US-based NGOs from the remaining pool, with the probability of being selected set proportional to overseas expenditure. Next, health expenditure data were collected for each NGO in this sample by seeking out annual reports, audited financial statements, 990 tax forms, and data from NGO websites. Health expenditure was carefully reviewed to ensure that expenditures on food aid, food security, disaster relief, and water and sanitation projects were not included. eTable 9 summarizes the number of NGOs included each year in the USAID report, the number of NGOs in the sample by year, and the number of NGOs for which health expenditure data were successfully compiled.

eTable 9 Summary of US non-governmental organizations in the study

Year	Number of US NGOs in VolAG report	Number of international NGOs in VolAG report	Number of US NGOs in IHME sample	Number of US NGOs from sample for which data on health expenditure were found
1990	267	-	9	-
1991	334	-	14	-
1992	385	-	15	-
1993	411	-	12	-
1994	424	-	10	-
1995	416	-	12	-
1996	423	-	14	-
1997	425	-	18	-
1998	435	42	22	31
1999	438	-	28	-
2000	433	50	28	38
2001	442	51	25	38
2002	486	58	26	43
2003	507	54	31	39
2004	508	55	32	40
2005	494	59	34	44
2006	536	67	38	51
2007	556	68	35	52
2008	565	78	44	60
2009	580	90	39	67
2010	579	94	55	66
2011	595	112	63	74
2012	579	94	49	63
2013	519	113	50	71

A random effects regression model was fit to predict health expenditure as a fraction of total expenditure using the data for the sampled NGOs. This model was used to predict the fraction of expenditure spent on health for the remaining NGOs. To ensure that the predicted health fractions were bounded between zero and one, the regression utilized the logit-transformed health fraction as the dependent variable. Since several NGOs in the sample were observed for multiple years, the regression included a random effect that varied by NGO. Five of the nine variables used to predict the health fraction were drawn from the VolAg reports. They were (1) fraction of revenue from in-kind donations, (2) fraction of revenue from the US government, (3) fraction of revenue from private financial contributions, (4) overseas expenditure as a fraction of total expenditure, and (5) calendar year. The remaining four variables used to predict the health fraction were binary indicators that were constructed based on keyword searches on the NGO name and NGO description found in the VolAg. For both the NGO name and description, a keyword search was conducted to indicate whether the name or description was sufficiently health-related. Another keyword search was conducted independently on the NGO names and descriptions for keywords that indicated if the NGOs might focus on something other than health. These four indicators proved excellent predictors of health fractions.

$$
\begin{aligned}
&logit(\ NGO - specific\ DAH_{it}) \\
&\quad = \alpha + \beta_1(Inkind\ contributions\ fraction_{it}) \\
&\quad + \beta_2(US\ government\ contributions\ fraction_{\ it}) \\
&\quad + \beta_3(Private\ financial\ contributions\ fractions_{it}) \\
&\quad + \beta_4(Overseas\ expenditure\ as\ a\ fraction\ of\ total\ expenditure_{it}) \\
&\quad + \beta_5(Health - related\ name_{it}) + \beta_6(Non - health - related\ name_{it}) \\
&\quad + \beta_7(Health - related\ description_{it}) + \beta_8(Non - health - related\ desciption_{it}) + U_i + \varepsilon
\end{aligned}
$$

Overseas health expenditure was calculated for individual NGOs in each year by multiplying the estimated health fraction and total overseas expenditure. For the NGOs that were sampled, the observed health fraction acquired through data collection was used. For the unsampled NGOs, the fitted fraction from the previously described random effects regression was used. Total overseas expenditure, reported in the VolAg, was not available for 2014–2016. For 2014 US-based NGOs, the 2014 NGO overseas fraction was calculated by regressing the logit transformed observed overseas fraction on a linear time trend using ordinary least squares, for each NGO independently. For these cases, the overseas health fraction was calculated as the product of estimated overseas fraction, estimated health fraction, and total expenditure found in the IRS 990 forms.

$$
logit(Observed\ overseas\ health\ expenditure_i) = \alpha + \beta_i(year_t) + U_i + \varepsilon
$$

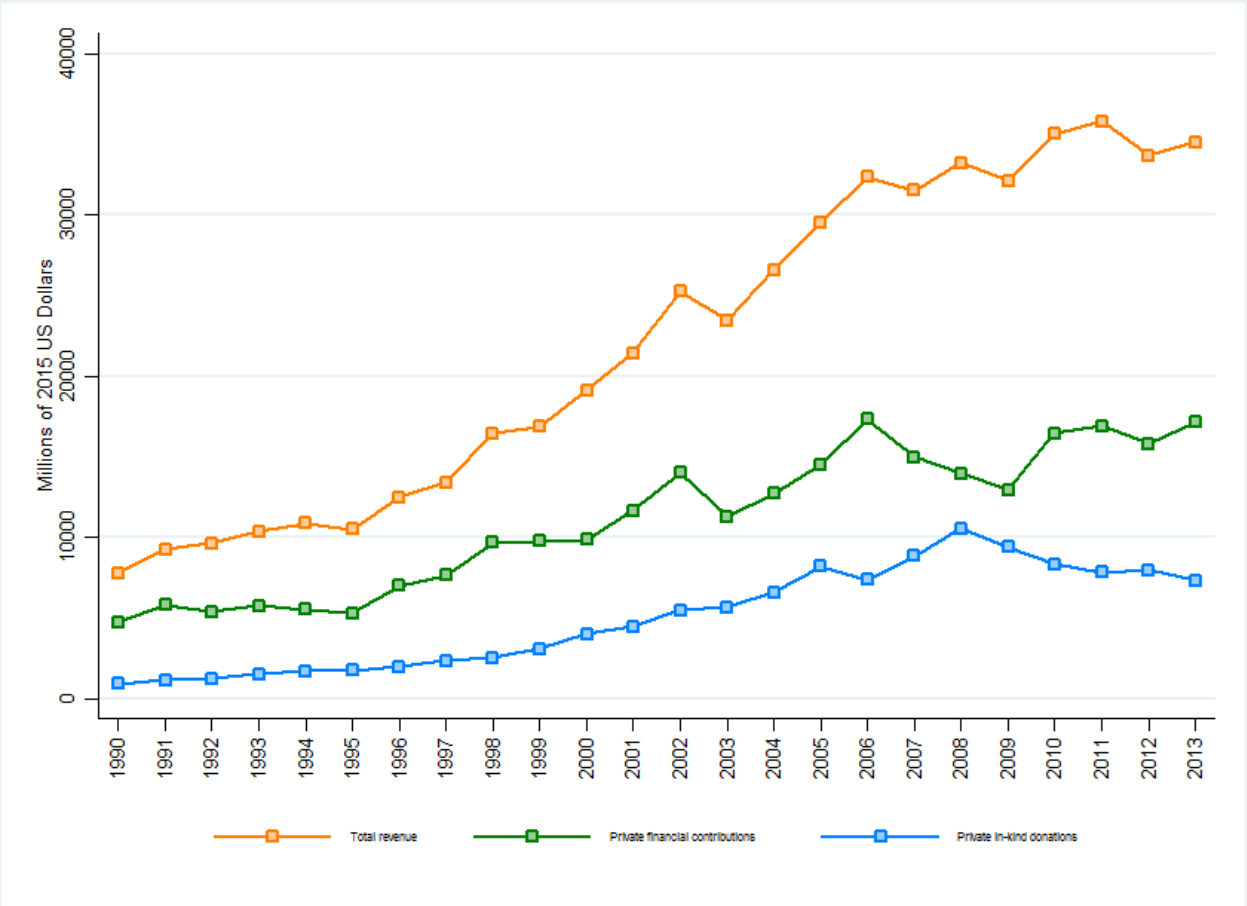
At this point three reasons remained why the overseas health expenditure for some NGOs remained unknown. First, if an observation was non-US-based for 2014, then IRS tax forms were not available and total overseas expenditure could not be calculated. Second, for 2015 or 2016, no data were available. Finally, if an NGO was reported in the VolAg in multiple years but not for an intermittent year, no NGO-specific data were available for the gap year. This would be the case if an NGO received support from the US government one year and then again in a nonconsecutive year. For all three of these scenarios, a panel-based hierarchical linear regression model was used to fill in the overseas health expenditure gaps. Total overseas health expenditure (measured at the NGO-year level) was regressed on US GDP per capita and US bilateral DAH disbursed. Because the US government funds many of these NGOs, US bilateral DAH was an excellent predictor of NGO DAH. A flexible model was employed to allow both the GDP and US government DAH coefficients to vary randomly across NGOs, such that each NGO employed a unique (but not independent) relationship between overseas health expenditure, GDP, and US government DAH. A random intercept was also included to capture the significant unobserved heterogeneity present in our set of NGOs. Once fit, this model was used to predict overseas health expenditure for all remaining gaps.

$$
(\ NGO\ DAH_{it}) = \alpha + \beta_{1i}(US\ GDP\ per\ capita_t) + \beta_{2i}(US\ bilateral\ DAH\ per\ capita_t) + U_i + \varepsilon
$$

Expenditures financed from each revenue source were then calculated by multiplying overseas health expenditure by NGO-specific revenue fractions. Expenditures from in-kind sources were deflated by a constant fraction. This was determined by comparing the federal upper limit and average wholesale price valuations of drugs on the WHO's Model List of Essential Medicines from the RED BOOK Expanded Database.[27,28] eFigure 12 and eFigure 13 show the income and estimated overseas health expenditure, respectively, of the NGOs in the universe of US- and non-US-based NGOs that were tracked in this study from 1990 to 2013 in constant 2015 US dollars.

eFigure 12 Total revenue received by non-governmental organizations

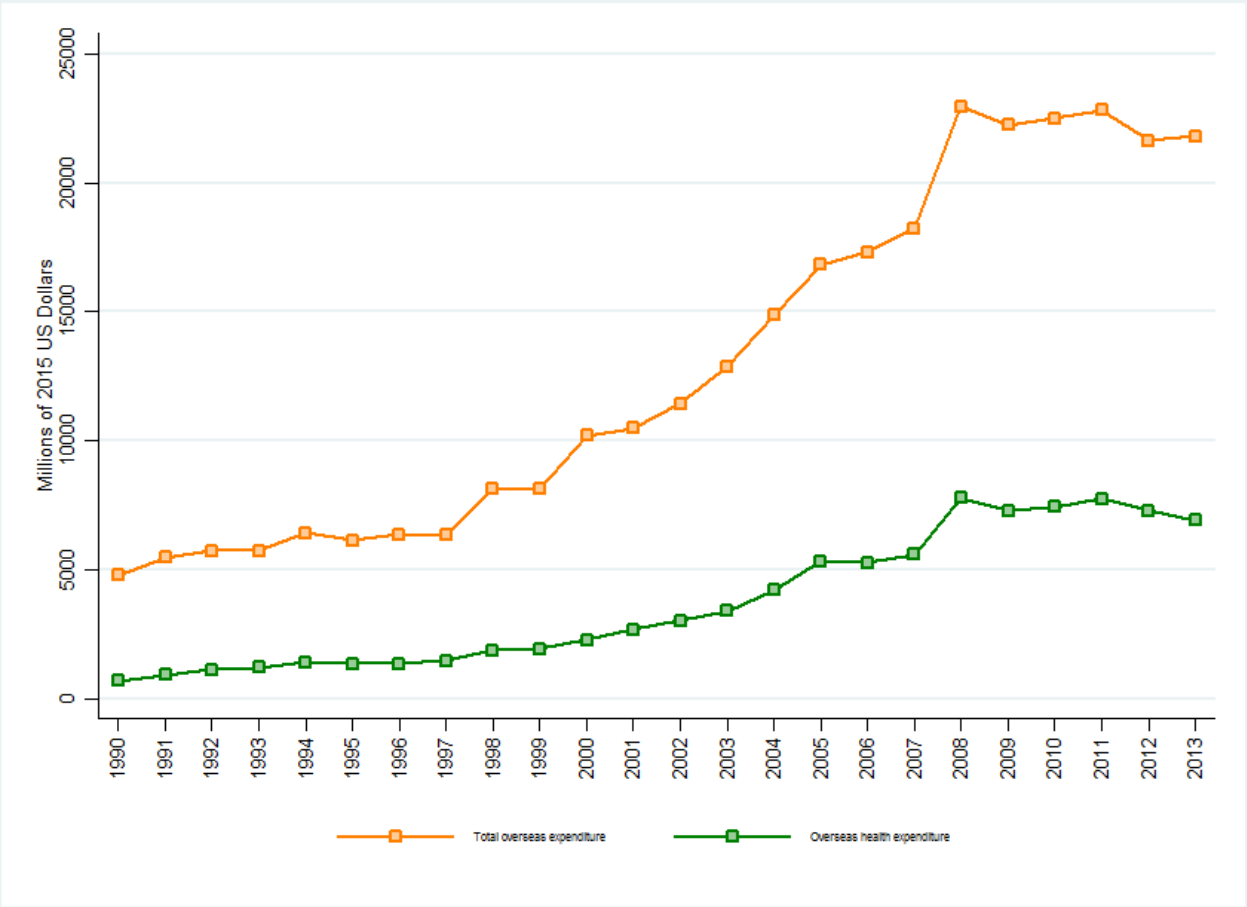
The orange line shows total revenue for all sources, both public and private, received by NGOs. The green line shows estimates of private financial contributions to NGOs, while the blue line shows private in-kind donations to NGOs.



Source: IHME DAH Database (2016)

eFigure 13 Expenditure by non-governmental organizations

The orange line illustrates total overseas expenditure by NGOs, regardless of sector. The green line shows overseas expenditure by NGOs to health-specific recipients, or DAH.



Source: IHME DAH Database (2016)

Calculating the technical assistance and program support component of development assistance for health from loan- and grant-making channels of assistance

The following methods were used to estimate the costs incurred by loan- and grant-making institutions for administering and supporting health sector loans and grants, which includes costs related to staffing and program management.

Data on the total administrative costs were compiled for a subset of institutions in our universe for which these data were readily available: IDA, IBRD, the Gates Foundation, the Global Fund, Gavi, USAID, and the UK Department for International Development (DFID). The sources of data for the institutions in this sample are summarized in eTable 10. The ratio of total administrative costs to total grants and loans was calculated for each source by year. It was assumed that the percentage of operating and administrative costs devoted to health would be equal to the percentage of grants and loans that were for health. In other words, if 20% of a foundation's grants were for health, the model assumed that 20% of administrative costs of the foundation were spent on facilitating these health grants.

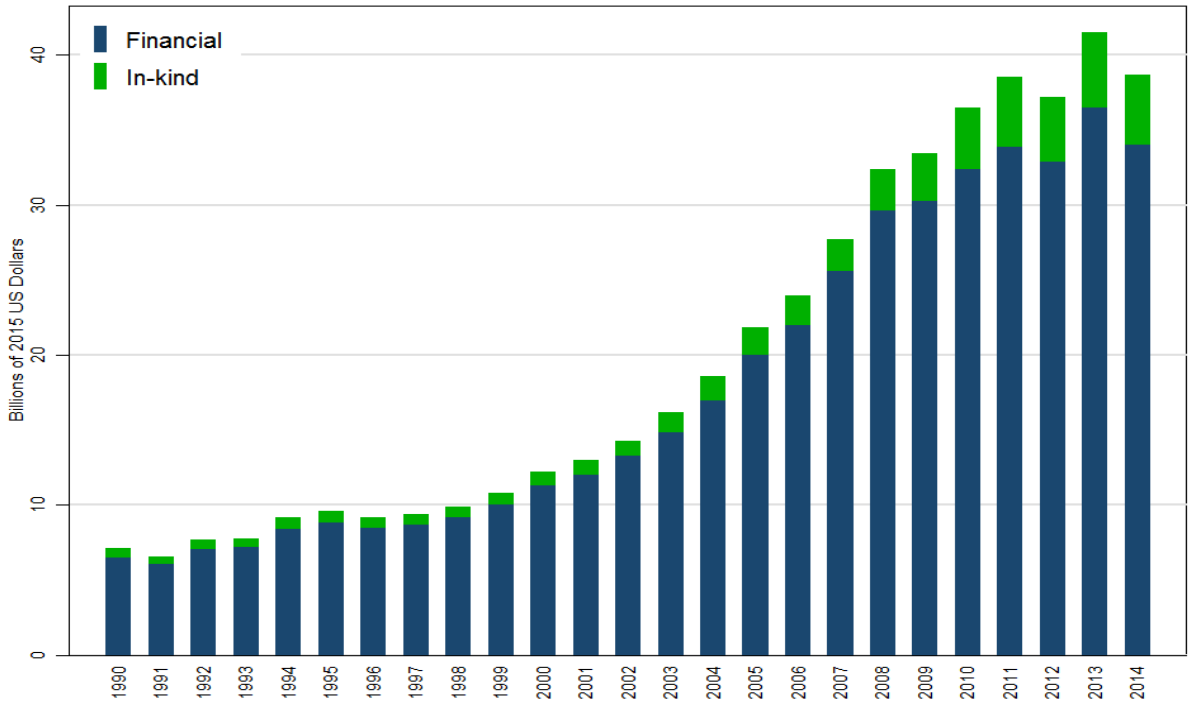
Given this assumption, the ratios of the observed administrative costs to grants/loans were used to estimate the in-kind contribution made by each of these organizations toward maintaining their health grants and loans. For the institutions not in this sample, the ratio from the institution most similar to it was used to arrive at an estimate of in-kind contributions. For example, the average ratio observed for IDA and IBRD was used for all other development banks, the average of the ratios for the Gates Foundation for all other US foundations. Total in-kind contributions from all grant- and loan-making global health institutions are shown in eFigure 14. There was also considerable variation across channels in the ratio of in-kind contributions to financial contributions.

eTable 10 Summary of data sources for calculating in-kind contributions

Organization	Source	Notes
Gates Foundation	990 tax returns	Used "cash basis" column to calculate ratio of total operating and administrative expenses to grants paid.
Global Fund	Annual report financial statements	Calculated ratio of operating expenses to grants disbursed.
Gavi	Annual report financial statements	Calculated ratio of management, general, and fundraising expenses to program expenses.
USAID	US government budget database	Used outlays spreadsheet to calculate ratio of total outlays for USAID operating account to sum of outlays for bilateral accounts.
DFID	Annual report expense summary	Calculated ratio of DfID's administration expenses to DfID's bilateral program expenses from 2002 onward.
IDA	World Bank audited financial statements	Calculated ratio of management fee charged by IBRD to development credit disbursements.
IBRD	World Bank audited financial statements	Calculated ratio of administrative expenses to loan disbursements.

eFigure 14 In-kind contributions by loan- and grant-making DAH channels of assistance

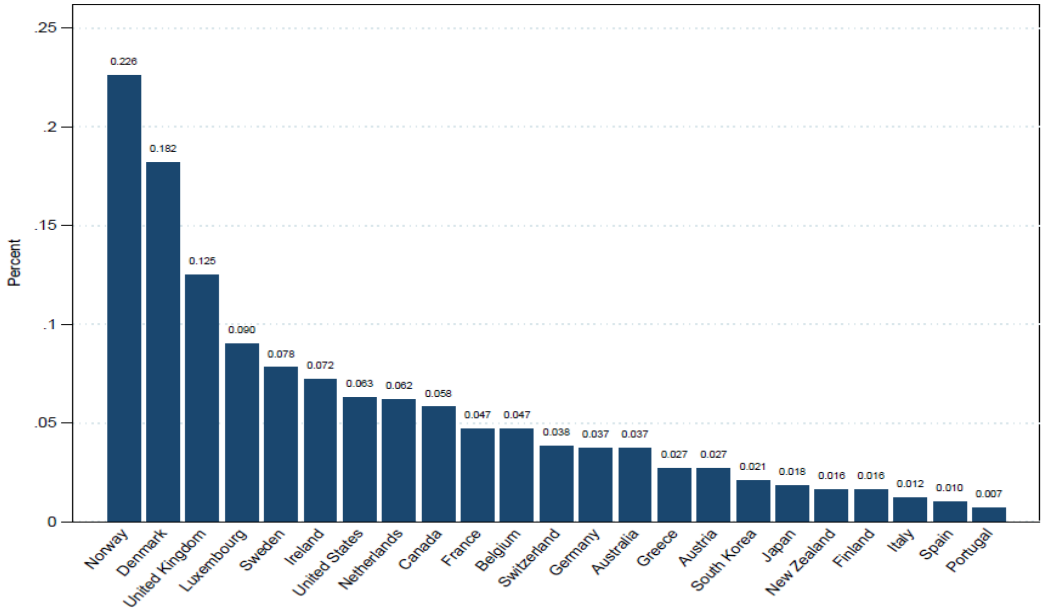
This figure illustrates the proportions of financial and in-kind DAH disbursed by loan- and grant-making institutions. The proportion of in-kind DAH varies, based on the channel. The overall proportion of in-kind DAH received across all channels has grown over time.



Source: IHME DAH Database (2016)

Comparing DAH by source and GDP

eFigure 15 DAH by source as a percentage of GDP, 2016



This figure illustrates DAH as percentage of GDP for each country as a source, across all channels. GDP data are constructed using methods developed by Spencer James and colleagues.[74]

SECTION 3. AGGREGATING TOTAL HEALTH SPENDING AND ITS COMPONENTS

Aggregation by source

The WHO estimates health spending by source for 184 countries from 1995 to 2014. This database is updated annually and draws on publicly available documents from countries and international organizations such as National Health Accounts (NHAs), Ministry reports, and estimates from the World Bank and International Monetary Fund.

Data on government health spending as agent (GGHE/GHEA), prepaid private health spending (PPP), out-of-pocket (OOP), and gross domestic product (GDP) series were downloaded from the WHO database in current national currency units (NCUs) for all years and countries for which it was available. These datasets were formatted and merged with the IHME development assistance for health (DAH) data, extracted from the IHME *Financing Global Health* report and reported in 2015 USD, and IHME GDP per capita data, reported in 2015 purchasing-power parity and also 2015 US dollars. In addition, we extracted IMF deflator and exchange rate series whose imputation is described below. Each of the WHO health expenditure variables were divided by the WHO GDP series, and multiplied by the IHME GDP data reported in 2015 purchasing power parity dollars. The IHME DAH series was converted into 2015 purchasing power parity dollars and then split into four variables – all DAH, DAH to governments, DAH to non-government entities, and unallocable DAH. The sum of DAH to governments, DAH to non-governments, and DAH unallocable is all DAH.

In order to isolate domestically financed government health spending (GHES), DAH to governments that could be traced to a specific country was subtracted from the estimates of GHEA, and DAH to non-governments was subtracted from the estimates of PPP. The DAH estimates include general health system strengthening but do not capture un-earmarked all-sector development assistance that may have been spent to benefit the health sector. Data available from Open Aid show that between 2000 and 2013, less than 5% (4.57%) of official development assistance went toward general budget support.[75] Given that general budget support funds are further split across the various government sectors, it is unlikely that this gap in the DAH data has a substantive impact on our final health estimates.

Finally, lead and lag versions of each variable were generated and all the health expenditure variables were logit transformed. Prior to imputation, missingness in the health expenditure variables was approximately 2.3%. We use the Amelia package in R to impute missing values, which improves on mean imputation and single imputation and is specifically designed for cross-section longitudinal data such as our own.[76,77] The imputation was run for 100 iterations and included eight variables – country, year, OOP per GDP, all DAH per GDP, GHES per GDP, PPP per GDP, the natural log of GDP per capita, and logit transformed GGE per GDP – along with their lags and leads.

After imputation the data were once again aggregated, cleaned, transformed back to linear space, and multiplied by GDP. There was no missingness in this final dataset.

IMF, UN, PWT, and World Bank Data

We extracted deflator time-series data for 191 countries from the years 1980–2016 from the IMF World Economic Outlook database. For the years and countries of interest, the percent missingness from this dataset was 2.4%. From the World Bank, deflator time-series data for 217 countries from the years 1960–2016 were extracted from the World Development Indicators database. The percent missingness for the years and countries of interest was 7.1%. From the UN National Accounts Main Aggregates database (UN), the IMF exchange rate series was extracted for the years 1970–2014 for 221 countries. Missingness among the years and countries of interest was 0.5%. From the PWT database, exchange rate series was extracted for 182 countries and 65 years – from 1950 through 2014. For the years and countries of interest, missingness was approximately 10.2%.

Deflator & exchange rate series

We downloaded deflator and exchange rate series from the WHO, World Bank, and IMF for all years and countries that was available. These data were formatted and combined with an IHME-generated GDP per capita series for 225 countries. Missingness in the data prior to imputation was approximately 14.7%. Leads and lags were generated for each of the variables before all the data were transformed into logit space. These 16 transformed variables – country, year, exchange rate from the World Bank in USD, exchange rate from the IMF in USD, exchange rate from the IMF in adjusted USD, exchange rate from PWT in USD, exchange rate from WHO in USD, exchange rate from the World Bank in purchasing-power parity dollars, exchange rate from the IMF in purchasing-power parity dollars, exchange rate from WHO in purchasing-power parity dollars, WHO price index, UN deflator, IMF deflator, World Bank deflator, GDP in 2010 purchasing-power parity dollars, GDP in 2010 USD – along with their leads and lags were imputed using the R package Amelia. We converted the fractions to be imputed in logit space in order to ensure that the reverse transformation is between 0 and 1, and included them in three degrees of lags and leads each. The imputation was run for 50 iterations after which the data were merged, cleaned, and transformed back into linear space. There was no missingness in the final series. The imputed IMF series for both the deflator and exchange rate were selected to be used exclusively in the rest of our analysis.

Aggregation by type of care

National Health Accounts

We used National Health Account (NHA) reports to track health spending by source (HF) and type (HC). The NHA data are reported in a standardized format, the System of Health Accounts (SHA) framework, created by the Organisation for Economic Co-operation and Development (OECD), World Health Organization (WHO), and Eurostat. Two iterations of the SHA framework have been developed, the first in 2001 and a second, updated version in 2011, referred to respectively as SHA 1.0 and SHA 2011. The transition between SHA 1.0 and SHA 2011 resulted in changed category classifications. eTable 11 illustrates how we mapped the two frameworks so that we could compare country-years across SHA formats.

eTable 11. SHA 1.0 to SHA 2011 mapping, for source (HF) and type (HC)

SHA 2011	Category	SHA 1.0
HF.1	GHES	HF.1
HF.2	PPP	HF.2.1 + HF.2.2 + HF.2.4 + HF.2.5
HF.3	OOP	HF.2.3
HF.4	DAH	HF.3
HC.1.1 + HC.2.1 + HC.3.1	Inpatient care, curative (HC.1.1), rehabilitative (HC.2.1) and long-term (HC.3.1)	HC.1.1 + HC.2.1 + HC.3.1
HC.1.2 + HC.1.3 + HC.2.2 + HC.2.3 + HC.3.2 + HC.3.3	Day and outpatient care, curative (HC.1.2, HC.1.3), rehabilitative (HC.2.2, HC.2.3), and long-term (HC.3.2, HC.3.3)	HC.1.2 + HC.1.3 + HC.2.2 + HC.2.3 + HC.3.2 + HC.3.3
HC.1.4 + HC.2.4 + HC.3.4	Home-based care, curative (HC.1.4), rehabilitative (HC.2.4), and long-term (HC.3.4)	HC.1.4 + HC.2.4 + HC.3.4
HC.4	Ancillary services	HC.4
HC.5	Medical goods	HC.5
HC.6.2 + HC.6.3	Immunization and early disease detection programs	HC.6.3 + HC.6.4
HC.7	Governance and health system and financing administration	HC.7

SHA 2011	Category	SHA 1.0
HC.9	Other	HC.nsk

We collected available NHA reports from WHO, OECD, Eurostat, and Global Health Data Exchange (GHDx) databases, as well as from a previous systematic review of NHA data by Bui et al. (2015).[78] Specifically, we extracted health spending reported by source and type of care. The source categories included government, prepaid private (PPP), out-of-pocket (OOP), and development assistance for health (DAH) spending. The type categories included inpatient care, day and outpatient care, ancillary services, medical goods, immunization and early disease detection programs, governance and health system and financing administration, and other care. Inpatient and day and outpatient categories were aggregated across curative, rehabilitative, and long-term care. Box 1 below provides definitions for each type of care.[79–81]

Box 3. Definitions of type of care from SHA 1.0 and SHA 2011

Inpatient care, curative & rehabilitative: The treatment and/or care provided in a health care facility to patients formally admitted and requiring an overnight stay.
SHA 1.0: An in-patient is a patient who is formally admitted to an institution for treatment and/or care and stays for a minimum of one night in the hospital or other institution providing in-patient care. In-patient care is mainly delivered in hospitals, but partially also in nursing and residential care facilities or in establishments that are classified according to their focus of care under the ambulatory-care industry but perform in-patient care as a secondary activity.
SHA 2011: An inpatient contact comprises a formal admission into a health care facility for treatment and/or care that is expected to constitute an overnight stay. The classification as inpatient care is irrespective of the type of provider. Emergency cases and urgent admissions should be included only when they result in an overnight stay and formal admission to an inpatient facility, but are otherwise considered as outpatient cases.
Outpatient care, curative & rehabilitative: The medical and ancillary services delivered in a health care facility to a patient who is not formally admitted and does not stay overnight.
SHA 1.0: Out-patient care comprises medical and paramedical services delivered to out-patients. An out-patient is not formally admitted to the facility and does not stay overnight. An out-patient is thus a person who goes to a health care facility for a consultation/treatment, and who leaves the facility within several hours of the start of the consultation without being "admitted" to the facility as a patient. All visitors to ambulatory care facilities that are not day cases or over-the-night cases are considered out-patients.
SHA 2011: Outpatient care comprises medical and ancillary services delivered to a patient who is not formally admitted to a facility and does not stay overnight. An outpatient is thus a person who goes to a health care facility for a consultation or treatment, and who leaves the facility within hours of the start of the consultation without being "admitted" to the facility as a patient.
Long-term care: A range of medical and personal care services that are consumed with the primary goal of alleviating pain and suffering and reducing or managing the deterioration in health status in patients with a degree of long-term dependency.
SHA 1.0: Long-term health care comprises ongoing health and nursing care given to in-patients who need assistance on a continuing basis due to chronic impairments and a reduced degree of independence and activities of daily living. In-patient long-term care is provided in institutions or community facilities. Long-term care is typically a mix of medical (including nursing care) and social services. Only the former is recorded in the SHA under health expenditure.
SHA 2011: Long-term care consists of a range of medical and personal care services that are consumed with the primary goal of alleviating pain and suffering and reducing or managing the deterioration in health status in patients with a degree of long-term dependency. Long-term care includes medical or nursing care and personal care services. Social care services are excluded.
Ancillary services: The healthcare or long-term care related services non-specified by function and non-specified by mode of provision, which the patient consumes directly, in particular during an independent contact with the health system and that are not an integral part of a care service package, such as laboratory or imaging services or patient transportation and emergency rescue.

SHA 1.0: This item comprises a variety of services, mainly performed by paramedical or medical technical personnel with or without the direction supervision of a medical doctor, such as laboratory, diagnosis imaging, and patient transport.
SHA 2011: Ancillary services to health encompass a variety of services, mainly performed by paramedical or medical technical personnel with or without the direct supervision of a medical doctor. The only ancillary services to be reported separately are those that are directly requested by patients and not intermediate services. Diagnostic services within outpatient departments are usually part of the bundle of activities of treatment and are therefore not to be excluded.
Medical goods: Pharmaceutical products and non-durable medical goods intended for use in the diagnosis, cure, mitigation or treatment of disease, including prescribed medicines and over-the-counter drugs, where the function and mode of provision are not specified.
SHA 1.0: Only the consumption of pharmaceuticals received from pharmacies or dispensing providers (including general retailers or mail-order) should be reported under the medical goods function; pharmaceuticals consumed in the course of a treatment, like surgery performed in an institutional or ambulatory setting, would not be included under medical goods.
SHA 2011: Includes medical goods acquired by the beneficiary either as a result of prescription following a health system contact or as a result of self-prescription; excludes medical goods consumed or delivered during a health care contact that are prescribed by a health care professional.
Immunization and early disease detection (EDD): Immunization includes both compulsory and voluntary immunizations/vaccinations, and can involve consumption by specific individuals in a campaign or in continued program operations; EDD can involve screening, diagnostic tests, and medical examinations to diagnose any communicable and non-communicable diseases.
SHA 1.0: No further definitions provided.
SHA 2011: For immunization, the expenditure involved in the consultation, both for the time and skills of the personnel and the purchase of the vaccine itself, should be accounted for; only disease detection before a diagnosis is made will be included in EDD, and self-examinations are not accounted for.
Governance, health system, and financing administration: Services that focus on the health system rather than direct health care, direct and support health system functioning, and are considered to be collective, as they are not allocated to specific individuals but benefit all health system users.
SHA 1.0: Health administration and health insurance are activities performed by private insurers and by central, regional, and local authorities including social security funds. They include the planning, management, regulation, and collection of funds and handling of claims of the delivery system. This excludes the administration of health care providers which is included in the valuation of the service functions.
SHA 2011: These expenditures direct and support health system functioning, and are incurred mostly but not exclusively by governments. Included are the formulation and administration of government policy; the setting of standards; the regulation, licensing or supervision of producers; management of the fund collection; and the administration, monitoring and evaluation of such resources, etc. However, some of these services are also provided by private entities, including by civil society (NGOs) and private medical insurance.
Other: Any other health care services not classified in the above function categories.

We identified 1,050 NHAs, both individually and from larger datasets. Of these 1,050 NHAs, health spending data by function and source was extracted from 964 across 112 countries and 26 years (1990–2015) (eTable 12). The remaining 86 NHAs did not have data for any category but were included as country-years in the larger datasets. If we had selectively picked every country-year that had any health spending data by function and source, these 86 would not have been included. The reason they did end up being included was because we imported large datasets rather than importing each specific country-year.

Not all NHAs were used for the THE or GHES analyses due to missingness. For example, if an NHA only reported spending for one health care function, the result would be that health spending for that country-year appears to be made up entirely of spending on that one category. So, if a country only reported medical goods spending, it would appear in our analysis that that country spent all of its health spending on medical goods for that year. Because of this limitation, we decided that at least inpatient and outpatient spending data had to be present for a country-year to

be included in the analysis. We chose inpatient and outpatient as they make up a significant portion of health spending.

We also made restrictions on country-years included in the total health spending analysis. We decided that only country-years that reported GHES, PPP, OOP, and DAH (unless the country was high-income, in which case we assumed DAH to be zero) would be included for total health spending calculations. As such, a country-year may be represented in the GHES analysis but not the THE analysis if they reported GHES spending but not spending by the other sources.

eTable 12. Country-years of NHA data available, by source

ISO3	Year(s)	Source	ISO3	Year(s)	Source	ISO3	Year(s)	Source
AFG	2008, 2011	Bui et al.	FJI	2011–2014	WHO/GHDx	MNG	2002	Bui et al.
AFG	2012	WHO/GHDx	FRA	1995–2010	Bui et al.	MOZ	2004–2006	Bui et al.
ALB	2003	Bui et al.	FRA	2011–2015	OECD	MWI	2002, 2005–2008	Bui et al.
ARM	2011, 2012	WHO/GHDx	FSM	2005–2008	Bui et al.	MWI	2011	WHO/GHDx
AUS	1995–2010	Bui et al.	GAB	2011	WHO/GHDx	MYS	2013	WHO/GHDx
AUS	2011–2015	OECD	GBR	1995–2010	Bui et al.	NAM	1999–2006	Bui et al.
AUT	1995–2010	Bui et al.	GBR	2011–2015	OECD	NER	2011–2013	WHO/GHDx
AUT	2011–2015	OECD	GEO	2001–2009	Bui et al.	NGA	1998–2005	Bui et al.
BDI	2007	Bui et al.	GEO	2011	WHO/GHDx	NIC	1995–1999	Bui et al.
BDI	2012	WHO/GHDx	GHA	2012	WHO/GHDx	NLD	1995–2010	Bui et al.
BEL	1995–2010	Bui et al.	GRC	1995–2010	Bui et al.	NLD	2011–2015	OECD
BEL	2011–2015	OECD	GRC	2011–2015	OECD	NOR	1995–2010	Bui et al.
BEN	2012	WHO/GHDx	GTM	1995–1997	Bui et al.	NOR	2011–2015	OECD
BFA	2005	Bui et al.	HND	1998	Bui et al.	NPL	2006–2008	Bui et al.
BFA	2011, 2012	WHO/GHDx	HRV	2008–2014	Eurostat	NZL	1995–2010	Bui et al.
BGD	2007	Bui et al.	HTI	2010–2012	WHO/GHDx	NZL	2011–2015	OECD
BGD	2011, 2012	WHO/GHDx	HUN	1995, 1996, 1998–2010	Bui et al.	PER	1996	Bui et al.
BGR	2013	Eurostat	HUN	2011–2015	OECD	PLW	2007	Bui et al.
BOL	1995, 1996	Bui et al.	IDN	2009	Bui et al.	POL	1995–2010	Bui et al.
BRB	2012	WHO/GHDx	IND	2001, 2004	Bui et al.	POL	2011–2015	OECD
BTN	2009	Bui et al.	IND	2013	WHO/GHDx	PRT	1995–2010	Bui et al.
BWA	2007–2009	Bui et al.	IRL	1995–2010	Bui et al.	PRT	2011–2015	OECD
CAN	1995–2010	Bui et al.	IRL	2011–2015	OECD	PSE	2000–2010	Bui et al.
CAN	2011–2015	OECD	IRN	2002–2008	Bui et al.	QAT	2009, 2010	Bui et al.
CHE	1995–2010	Bui et al.	ISL	1995–2010	Bui et al.	QAT	2011–2013	WHO/GHDx
CHE	2011–2015	OECD	ISL	2011–2015	OECD	ROU	2013	Eurostat
CHL	2003–2010	Bui et al.	ISR	1995–2010	Bui et al.	RWA	2002, 2003, 2006	Bui et al.
CHL	2012–2015	OECD	ISR	2011–2015	OECD	SEN	2005	Bui et al.
CIV	2007, 2008	Bui et al.	ITA	1995–2010	Bui et al.	SLE	2007–2010	Bui et al.
CMR	2011, 2012	WHO/GHDx	ITA	2011–2015	OECD	SLE	2013	WHO/GHDx
COD	2008	Bui et al.	JPN	1995–2010	Bui et al.	SLV	1995	Bui et al.

ISO3	Year(s)	Source	ISO3	Year(s)	Source	ISO3	Year(s)	Source
COD	2011–2013	WHO/GHDx	JPN	2011–2015	OECD	SUR	2006	Bui et al.
COL	2000–2003	Bui et al.	KEN	2001, 2005, 2009	Bui et al.	SVK	1999–2010	Bui et al.
CPV	2008, 2009	Bui et al.	KGZ	2004, 2006–2009	Bui et al.	SVK	2011–2015	OECD
CPV	2011	WHO/GHDx	KHM	2012–2014	WHO/GHDx	SVN	1997–2010	Bui et al.
CYP	2000–2014	Eurostat	KIR	2007–2009	Bui et al.	SVN	2011–2015	OECD
CZE	1995–2010	Bui et al.	KOR	1990–2010	Bui et al.	SWE	1995–2010	Bui et al.
CZE	2011–2015	OECD	KOR	2011–2015	OECD	SWE	2011–2015	OECD
DEU	1995–2010	Bui et al.	LAO	2009	Bui et al.	SYC	2009	Bui et al.
DEU	2011–2015	OECD	LBR	2009	Bui et al.	SYC	2013	WHO/GHDx
DNK	1995–2010	Bui et al.	LIE	2000–2014	Eurostat	TGO	2008	Bui et al.
DNK	2011–2015	OECD	LKA	1990–2006	Bui et al.	THA	2002–2008	Bui et al.
DOM	1996	Bui et al.	LKA	2013	WHO/GHDx	TJK	2013	WHO/GHDx
ECU	1995	Bui et al.	LTU	2011–2014	Eurostat	TUR	1995–2005	Bui et al.
EGY	1995, 2001	Bui et al.	LUX	1995–2010	Bui et al.	TWN	2009	Bui et al.
ESP	1995–2010	Bui et al.	LUX	2011–2015	OECD	TZA	2009	Bui et al.
ESP	2011–2015	OECD	LVA	2004–2015	OECD	TZA	2012	WHO/GHDx
EST	1999–2010	Bui et al.	MDA	2012	WHO/GHDx	UGA	1997	Bui et al.
EST	2011–2015	OECD	MDG	2003, 2007	Bui et al.	USA	1995–2010	Bui et al.
ETH	2004, 2007	Bui et al.	MEX	1999–2009	Bui et al.	USA	2011–2015	OECD
ETH	2010	WHO/GHDx	MEX	2011–2014	OECD	VUT	2005, 2007	Bui et al.
FIN	1995–2010	Bui et al.	MLI	1999–2004	Bui et al.	WSM	2002, 2004, 2006	Bui et al.
FIN	2011–2015	OECD	MMR	2002–2007	Bui et al.	ZMB	2002	Bui et al.
FJI	2007–2010	Bui et al.	MNE	2004–2006	Bui et al.			

Spending data were missing for at least one source by type of spending category for every country-year (eTable 13). Additionally, some countries reported only high-level categories of spending while others reported only sub-categories of spending. Countries also sometimes provided spending estimates for categories without reporting the breakdown of spending for the sub-categories adding up to the larger category, e.g., a value for HC.4 (ancillary services) was reported but HC4.1 (laboratory services) was not. To ensure that we were including dollars reported in total amounts that were not elsewhere specified while also maximizing data in cases where only sub-categories were reported, we prioritized reported total amounts over sums of subtotal amounts. We did so by using the reported totals where available and only substituting reported totals for a sum of reported subtotals when a reported total was missing.

eTable 13. Country-years of data used in analysis, by spending source and by type category.

	GHES	PPP	OOP	DAH	Total spending
Inpatient care, curative & rehabilitative	643	476	495	751	631
Outpatient care, curative & rehabilitative	643	476	495	751	631
Long-term care	418	229	277	664	429
Ancillary services	555	372	420	712	559

	GHES	PPP	OOP	DAH	Total spending
Medical goods	593	429	474	726	605
Immunization & early disease detection programs	483	323	253	742	472
Governance, health system, & financing admin.	618	432	258	741	617
Other	400	218	245	678	431

We included only country-years reporting at minimum inpatient and outpatient values when calculating fractions of each spending type by spending source. We did so to ensure a baseline denominator value. As a result, we excluded country-years that only reported one spending type and therefore would have had an inflated fraction value of 100% for that spending type over a given spending source.

Five country-years reported negative values for "Other" spending in the government health spending category. We replaced these five observations with zero, given the small size of the negative values compared to other categories.

We replaced missing values with zeroes in cases where a high-income country, as defined by the World Bank, reported missing for a DAH spending category. We did so under the assumption that high-income countries do not receive health assistance from abroad. When high-income countries did not report an overall spending total but did report GHES, PPP, and OOP spending, we substituted the total with the sum of GHES, PPP, and OOP values, again under the assumption that DAH was zero rather than missing. We left missing data for non-DAH values in high-income countries or for non-high-income countries as missing in our final dataset.

Institute for Health Metrics and Evaluation's GDP series

The Gross Domestic Product (GDP) series used in our analysis has been constructed from five different data sources. These sources include the Penn World Tables (PWT), the WB World Development Indicators, the United Nations Statistics Division (UNSTAT), the IMF World Economic Outlook report, and Angus Maddison's research homepage at the University of Groningen Department of Economics. Applying several stages of least-squares and mixed-effects regressions, these five series were filled out for 195 countries across 1950–2015, thereby removing any discontinuity or missingness. Following that, the IHME GDP series was constructed by taking an unweighted average of the filled series. Detailed explanation of this methodology can be found in James et al.[74]

Descriptive statistics

eTable 14 presents descriptive statistics for variables used in the analyses.

Variable	Mean	Median	Standard deviation	Minimum	Maximum
THE per capita	1,028.78	471.40	1,376.05	8.75	9,237.13
GDP per capita	15,582.54	8,515.59	18,778.95	317.23	129,207.40
By source					
GHES/THE	0.52	0.54	0.22	0.00	0.97
PPP/THE	0.06	0.04	0.08	0.00	0.65
OOP/THE	0.34	0.31	0.19	0.02	0.95
DAH/THE	0.08	0.01	0.14	0.00	0.97
By type					
Inpatient care, curative & rehabilitative/THE	0.29	0.29	0.08	0.03	0.60

Variable	Mean	Median	Standard deviation	Minimum	Maximum
Outpatient care, curative & rehabilitative/THE	0.30	0.29	0.10	0.02	0.72
Long-term care/THE	0.09	0.08	0.07	0.00	0.29
Ancillary services/THE	0.05	0.05	0.04	0.00	0.42
Medical goods/THE	0.22	0.20	0.11	0.00	0.60
Immunization & early disease detection programs/THE	0.04	0.03	0.04	0.00	0.38
Governance, health system, & financing admin./THE	0.05	0.04	0.05	0.00	0.54
Other/THE	0.02	0.01	0.06	0.00	0.48
Inpatient care, curative & rehabilitative/GHES	0.36	0.36	0.12	0.00	0.85
Outpatient care, curative & rehabilitative/GHES	0.27	0.26	0.10	0.00	0.72
Long-term care/GHES	0.10	0.10	0.08	0.00	0.30
Ancillary services/GHES	0.05	0.04	0.04	0.00	0.19
Medical goods/GHES	0.13	0.12	0.08	0.00	0.44
Immunization & early disease detection programs/GHES	0.08	0.04	0.11	0.00	0.75
Governance, health system, & financing admin./GHES	0.07	0.04	0.10	0.00	0.85
Other/GHES	0.03	0.01	0.07	0.00	0.60

Statistical model

Using the data on health financing by source and by type, merged with the gross domestic product per capita (GDP per capita), described in the previous sections, two primary analyses were conducted. These analyses, described below, use penalized spline (P-spline) smoothing estimation to estimate total health spending and its components across all years and countries. This methodological decision was based on the desire to describe the relationship between development (as measured by logged gross domestic product per capita) and health spending across countries and years. Thus, although country fixed effects and panel analyses were conducted in the exploratory analyses, these were not used in the final analysis presented in this study as they would ultimately remove the cross-country-year trends we attempt to describe. Penalized splines are flexible, nonlinear multivariate regressions that allow us to capture the cross-country-year trends of interest in this study.

Furthermore, our analysis excludes four countries from the Global Burden of Disease list of 188 countries (North Korea, Palestine, Taiwan, and Zimbabwe) due to missingness of data from either WHO (regarding health expenditures) and/or the IMF (regarding the government expenditure, deflator and exchange rates). Palestine and Taiwan were excluded due to lack of health expenditure data, while Zimbabwe did not have complete and reliable deflators or exchange rate series. North Korea was excluded for not having either all-sector government expenditure, health expenditure, or any of the conversion rates. Analyses were conducted in the following programs: Stata (version 13.1), Amelia (version 1.7), and R (version 3.3.2).

By source

Total health spending (THE) by source was broken down into four components:

1. Government health spending as source (GHES)
2. Out-of-pocket household health spending (OOP)

3. Prepaid private health schemes (PPP)
4. Development assistance for health (DAH)

These data span 1995 to 2014 and are complete panel datasets for 184 countries providing 3,680 country-years. To estimate the value of THE and the proportion that each of its four components made up at every potential level of development observed in our panel, controlling for year, we modelled each separately using a generalized additive model with an integrated penalized spline (P-spline) smoothing estimation analysis with logged GDP per capita and year as independent continuous variables. Our dataset contains 881 country-years where DAH equaled zero; 96% of these zero values were in high-income countries. It was determined that a log-transformation allowed for a better data fit, but to not lose country-years in our analysis, we first "lemon-squeezed" each component and then constrained the sum of the proportions to equal 1 using a center log-ratio transformation (CLR).[82–84] To estimate confidence intervals, we took 1,000 bootstrapped samples (clustering over countries), then analyzed each sample and predicted each outcome variable for every value of logged GDP per capita (rounded to a tenth). The following equations walk through an example of how one component, DAH, is transformed and modeled.

Lemon-squeeze transformation (LS)

$$LS\left(DAH_{c,t}\right) = \frac{\left(\left(DAH_{c,t}\right) * \left(N_{DAH_{c,t}} - 1\right) + 0.5\right)}{N_{DAH_{c,t}}})$$

Center log-ratio transformation (CLR)

$$CLR\left(LS\left(DAH_{c,t}\right)\right) = natural - \log(\frac{LS\left(DAH_{c,t}\right)}{\left(LS\left(DAH_{c,t}\right) * LS\left(OOP_{c,t}\right) * \ LS\left(PPP_{c,t}\right) * \ LS\left(GHE - S_{c,t}\right)\right)^{1/4}})$$

Generalized additive model with integrated penalized spline smoothing estimation

$$E(CLR\left(LS\left(DAH_{c,t}\right)\right) = \ \alpha + f\left(\ln GDP\ pc_{c,t}\right) + f(year)$$

Where *f*() represents the penalized spline smoothing function, *N* represents the number of observations for the particular spending component (DAH in this example), *c* indicates country, and *t* represents time. The P-spline analysis was conducted in R using the gam function within the mgcv library.[85]

To reiterate, once the P-spline models were estimated, we predicted for every observed value of logged GDP per capita in 2014 (rounded to the tenth) while holding year constant for each 1,000 bootstrapped sample. We then collated these predictions and took the mean at each estimate of logged GDP per capita. To generate 95% uncertainty intervals, we also took the 2.5 and 97.5 percentiles of the predictions at each respective value of logged GDP per capita.

By type

The by-type analysis nearly mirrors the by-source analysis outlined above except instead of four components, the analysis is conducted for eight components of total health spending:

1. Inpatient care, curative and rehabilitative
2. Day & outpatient care, curative and rehabilitative
3. Long-term care
4. Ancillary services
5. Medical goods
6. Immunization & early disease detection
7. Governance, health system, & financing administration
8. Other

Missingness of the health spending by type data is described in eTable 13 above. To estimate the value of the proportion that each of these eight components made up at every potential level of development observed in our

panel, we modeled each separately using a generalized additive model with an integrated penalized spline (P-spline) smoothing estimation analysis with logged GDP per capita and year as independent variables. It was determined that a log-transformation allowed for a better data fit, but to not lose country-years in our analysis, we first "lemon-squeezed" each component and then constrained the sum of the proportions to equal 1 using a center log-ratio transformation (CLR).[82–84] We then predicted each of our eight outcome variables for every value of logged GDP per capita (rounded to a tenth). The following equations walk through an example of how one component, Ancillary services, is transformed and modeled.

Lemon-squeeze transformation (LS)

$$LS\left(Ancillary_{c,t}\right) = \frac{\left(Ancillary_{c,t}\right) * \left(N_{Ancillary_{c,t}} - 1\right) + 0.5}{N_{Ancillary_{c,t}}})$$

Center log-ratio transformation (CLR)

$$CLR\left(LS\left(Ancillary_{c,t}\right)\right) = natural - \log(LS\left(Ancillary_{c,t}\right)/\ [LS\left(Ancillary_{c,t}\right) * LS\left(Inpatient_{c,t}\right) * LS\left(Outpatient_{c,t}\right) * LS\left(Longterm_{c,t}\right) * LS\left(Medial\ Goods_{c,t}\right) * LS\left(Immunization_{c,t}\right) * LS\left(Governance_{c,t}\right) * LS\left(Other_{c,t}\right)]^{1/8})$$

Generalized additive model with integrated penalized spline smoothing estimation

$$E(CLR\left(LS\left(Ancillary_{c,t}\right)\right) = \alpha + f\left(\ln GDP\ pc_{c,t}\right) + f(year)$$

Where *f*() represents the penalized spline smoothing function, *N* represents the number of observations for the particular spending component (Ancillary care in this example), *c* indicates country and *t* represents time.

To reiterate, once the P-spline models were estimated, we predicted for every observed value of logged GDP per capita (rounded to the tenth) while holding year constant.

Additional robustness analyses conducted can be found in the annex for the paper titled "Evolution and patterns of global health financing 1995–2014: development assistance for health, and government, prepaid private, out-of-pocket, and donor financing for 184 countries."[86]

SECTION 4. FORECASTING TOTAL HEALTH SPENDING AND ITS COMPONENTS

Ensemble modeling

We capitalize on past trends and relationships in health financing to forecast health expenditure by source for 184 countries, from 2014 through 2040, utilizing an advanced ensemble modeling approach.[87] The strength of ensemble modeling is that our forecasts draw on multiple predictions derived from different specifications in order to create a stronger overall prediction, eliminating the need for a researcher to select one preferred model.[88–91]

We assessed 10,800 model variants, out of which a total of 2,833 models passed our inclusion criteria to be included in the ensembles. To begin with, we forecast the gross domestic product (GDP) of 188 countries and the general government expenditure (GGE) of 187 countries from 2016 to 2040. After that, we forecast each of the components of total health expenditure (GHE, PPP, OOP, DAH) and then aggregated each country's forecasts to generate total health expenditure from 2015 to 2040 for 184 countries. Four countries (Taiwan, Palestine, North Korea, and Zimbabwe) had to be excluded from the analyses due to inadequate data. Analyses were conducted in the following programs: Stata (version 13.1), Amelia (version 1.7), and R (version 3.3.2).

Universe of model specifications and ensembles

After assembling the data, we developed a diverse set of plausible forecasting models. We assessed 10,800 model variants. These models included autoregressive terms, population, total fertility rate, other health financing variables, share of the population below 20, convergence terms, auto-correlated residuals, and country-specific random intercepts. We converted all our data to use first differences in order to account for non-stationarity.

Dependent variables

We forecasted a sequence of dependent variables in this paper in the following order: GDP per capita, GGE per GDP, DAH per GDP, GHE-S per GGE, OOP per GDP, and PPP per GDP. The last four components in the list were aggregated to produce total health expenditures.

Frontier analysis

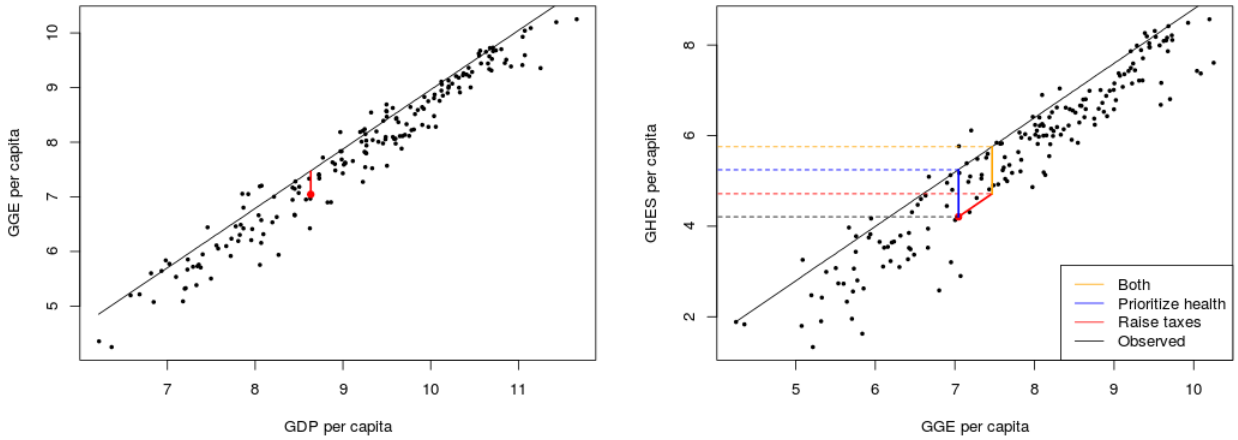
Frontier analysis is an econometric method for determining the efficiency with which a country (or other unit) produces an output. By benchmarking the country's performance against the observed performance of others, the frontier describes the maximum potential output that one could achieve. In the present study, we used frontier analysis in two ways: 1) to describe the potential total health spending a country could achieve given their level of GDP per capita, and 2) to describe the potential government health spending a country could achieve under different policy scenarios.

To estimate a country's potential increase in total health expenditure, we fit a frontier with log-scale gross domestic product per capita (GDP) as the input and log-scale total health expenditure per capita as the output. The potential increase in total health expenditure is defined as the difference between each point and the frontier (after exponentiating both values). By using this approach, we assert that a below-average country could spend as much as an average country at its level of GDP, even in the absence of inefficiency. The "frontier" package in R is used to estimate the frontier.[92]

To estimate a country's potential increase in government health expenditure under different policy scenarios, we fit two frontiers. eFigure 16 shows an example of these frontiers for India. First, we used GDP as the input and general government expenditure (GGE) as the output. The difference between each point and the frontier is the potential increase in GGE at the country's level of GDP (plot 1, red line). For the second frontier, we used GGE as the input and government health expenditure (GHE) as the output. The difference between each point and the frontier is the

potential increase in GHE at the country's level of general government expenditure (plot 2, blue line). All differences were taken after exponentiating the values.

eFigure 16. Potential government health expenditure: policy scenarios for India (illustrative example)



Plot 1 Plot 2

Together, these two frontiers can be used to model three policy scenarios and their effect on government health expenditure:

1) Potential increase due to prioritizing the health sector, calculated as the potential GHE at a country's current level of general government expenditure (plot 2, blue line).
2) Potential increase due to increasing general government expenditure, calculated as the expected level of GHE at a country's potential level of general government expenditure (plot 2, red line).
3) Potential increase due to both prioritizing the health sector and increasing general government expenditure, calculated as the potential GHE at a country's potential level of general government expenditure (plot 2, red line and orange line combined).

Additional robustness analyses can be found in the paper title "Future and potential spending on health 2015–2040 by government, prepaid private, out-of-pocket, and donor financing for 184 countries."[93]

Supplementary tables

eTable 15. Classifications of countries by World Bank income groups

High-income	Upper-middle-income	Lower-middle-income	Low-income
Andorra	Albania	Armenia	Afghanistan
Antigua and Barbuda	Algeria	Bhutan	Bangladesh
Australia	Angola	Bolivia	Benin
Austria	Argentina	Cameroon	Burkina Faso
Bahrain	Azerbaijan	Cape Verde	Burundi
Barbados	Belarus	Congo	Cambodia
Belgium	Belize	Côte d'Ivoire	Central African Republic
Brunei	Bosnia and Herzegovina	Djibouti	Chad
Canada	Botswana	Egypt	Comoros
Chile	Brazil	El Salvador	Democratic Republic of the Congo
Croatia	Bulgaria	Federated States of Micronesia	Eritrea
Cyprus	China	Georgia	Ethiopia
Czech Republic	Colombia	Ghana	Guinea
Denmark	Costa Rica	Guatemala	Guinea-Bissau
Equatorial Guinea	Cuba	Guyana	Haiti
Estonia	Dominica	Honduras	Kenya
Finland	Dominican Republic	India	Kyrgyzstan
France	Ecuador	Indonesia	Liberia
Germany	Fiji	Kiribati	Madagascar
Greece	Gabon	Laos	Malawi
Iceland	Grenada	Lesotho	Mali
Ireland	Hungary	Mauritania	Mozambique
Israel	Iran	Moldova	Myanmar
Italy	Iraq	Mongolia	Nepal
Japan	Jamaica	Morocco	Niger
Kuwait	Jordan	Nicaragua	Rwanda
Latvia	Kazakhstan	Nigeria	Sierra Leone
Lithuania	Lebanon	Pakistan	Somalia
Luxembourg	Libya	Papua New Guinea	South Sudan
Malta	Macedonia	Paraguay	Tajikistan
Netherlands	Malaysia	Philippines	Tanzania
New Zealand	Maldives	Samoa	The Gambia
Norway	Marshall Islands	Sao Tome and Principe	Togo
Oman	Mauritius	Senegal	Uganda

High-income	Upper-middle-income	Lower-middle-income	Low-income
Poland	Mexico	Solomon Islands	
Portugal	Montenegro	Sri Lanka	
Qatar	Namibia	Sudan	
Russia	Panama	Swaziland	
Saudi Arabia	Peru	Syria	
Singapore	Romania	Timor-Leste	
Slovakia	Saint Lucia	Ukraine	
Slovenia	Saint Vincent and the Grenadines	Uzbekistan	
South Korea	Serbia	Vanuatu	
Spain	Seychelles	Vietnam	
Sweden	South Africa	Yemen	
Switzerland	Suriname	Zambia	
The Bahamas	Thailand		
Trinidad and Tobago	Tonga		
United Arab Emirates	Tunisia		
United Kingdom	Turkey		
United States	Turkmenistan		
Uruguay	Venezuela		

eTable 16. Classifications of countries by Global Burden of Disease geographical regions

High-income	Central Europe, Eastern Europe, and Central Asia	Sub-Saharan Africa	North Africa and Middle East	South Asia	Southeast Asia, East Asia, and Oceania	Latin America and Caribbean
Andorra	Albania	Angola	Afghanistan	Bangladesh	Cambodia	Antigua and Barbuda
Argentina	Armenia	Benin	Algeria	Bhutan	China	Barbados
Australia	Azerbaijan	Botswana	Bahrain	India	Federated States of Micronesia	Belize
Austria	Belarus	Burkina Faso	Egypt	Nepal	Fiji	Bolivia
Belgium	Bosnia and Herzegovina	Burundi	Iran	Pakistan	Indonesia	Brazil
Brunei	Bulgaria	Cameroon	Iraq		Kiribati	Colombia
Canada	Croatia	Cape Verde	Jordan		Laos	Costa Rica
Chile	Czech Republic	Central African Republic	Kuwait		Malaysia	Cuba
Cyprus	Estonia	Chad	Lebanon		Maldives	Dominica
Denmark	Georgia	Comoros	Libya		Marshall Islands	Dominican Republic

High-income	Central Europe, Eastern Europe, and Central Asia	Sub-Saharan Africa	North Africa and Middle East	South Asia	Southeast Asia, East Asia, and Oceania	Latin America and Caribbean
Finland	Hungary	Congo	Morocco		Mauritius	Ecuador
France	Kazakhstan	Cote d'Ivoire	Oman		Myanmar	El Salvador
Germany	Kyrgyzstan	Democratic Republic of the Congo	Qatar		Papua New Guinea	Grenada
Greece	Latvia	Djibouti	Saudi Arabia		Philippines	Guatemala
Iceland	Lithuania	Equatorial Guinea	Sudan		Samoa	Guyana
Ireland	Macedonia	Eritrea	Syria		Seychelles	Haiti
Israel	Moldova	Ethiopia	Tunisia		Solomon Islands	Honduras
Italy	Mongolia	Gabon	Turkey		Sri Lanka	Jamaica
Japan	Montenegro	Ghana	United Arab Emirates		Thailand	Mexico
Luxembourg	Poland	Guinea	Yemen		Timor-Leste	Nicaragua
Malta	Romania	Guinea-Bissau			Tonga	Panama
Netherlands	Russia	Kenya			Vanuatu	Paraguay
New Zealand	Serbia	Lesotho			Vietnam	Peru
Norway	Slovakia	Liberia				Saint Lucia
Portugal	Slovenia	Madagascar				Saint Vincent and the Grenadines
Singapore	Tajikistan	Malawi				Suriname
South Korea	Turkmenistan	Mali				The Bahamas
Spain	Ukraine	Mauritania				Trinidad and Tobago
Sweden	Uzbekistan	Mozambique				Venezuela
Switzerland		Namibia				
United Kingdom		Niger				
United States		Nigeria				
Uruguay		Rwanda				
		Sao Tome and Principe				
		Senegal				
		Sierra Leone				
		Somalia				
		South Africa				
		South Sudan				
		Swaziland				

High-income	Central Europe, Eastern Europe, and Central Asia	Sub-Saharan Africa	North Africa and Middle East	South Asia	Southeast Asia, East Asia, and Oceania	Latin America and Caribbean
		Tanzania				
		The Gambia				
		Togo				
		Uganda				
		Zambia				

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