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ANALYSIS OF THE LINKAGE BETWEEN DOMESTIC REVENUE MOBILIZATION AND SOCIAL SECTOR SPENDING

Phase I Final Report

Leadership in Public Financial Management II (LPFM II)

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ANALYSIS OF THE LINKAGE BETWEEN DOMESTIC REVENUE MOBILIZATION AND SOCIAL SECTOR SPENDING

Phase I Final Report

Leadership in Public Financial Management II (LPFM II)

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CONTENTS

ACRONYMS

2SLS	Two-stage-least-squares (regression technique)
COR	Contracting Officer's Representative
CPI	Corruption Perceptions Index
DRM	Domestic Revenue Mobilization
ECO	Economic Cooperation Organization
GDP	Gross Domestic Product
GNI	Gross National Income
HIPC	Highly Indebted Poor Country
IDIQ	Indefinite Delivery Indefinite Quantity Contract
IMF	International Monetary Fund
LPFM II	Leadership in Public Financial Management II
ODA	Overseas Development Assistance
PFM	Public Financial Management
SDGs	Sustainable Development Goals (SDGs)
UHC	Universal Health Coverage
USAID	United States Agency for International Development
USAID/E3	United States Agency for International Development Bureau for Economic Growth, Education and Environment
USD	United States Dollar
USG	United States Government
WDI	World Development Indicators
WHO	World Health Organization

EXECUTIVE SUMMARY

The Sustainable Development Goals (SDGs) highlight "strengthening domestic resource mobilization, including through international support to developing countries, to improve capacity for tax and other revenue collection," as one of the targets to be achieved by 2030 in financing other development commitments. Presently, low income countries are able to mobilize only 13 percent of their Gross Domestic Product (GDP) on average, compared to the 20 percent of GDP that the United Nations estimates would be required to achieve the SDGs.[1] As populations increase and demand for public resources increase, developing countries face increasing pressures to increase public service delivery, particularly for priority sectors such as health and education.

Efforts to create fiscal space for specific sectors have typically focused on increasing sectoral expenditure efficiency, garnering external funding for the sector, or setting minimum budget targets in favor of particular sectors (as African countries have done for health, education, and agriculture during the MDG era). One reason for this sector-specific approach may be lack of clear evidence that increasing domestic resources ultimately leads to greater allocation or expenditure in priority sectors. This paper aims to investigate whether such a linkage actually exists. Specifically, we aim to:

a) quantify the relationship between domestic resources and public expenditure in health; and

b) identify possible reasons for why such observed differences exist across countries, including levels of external health financing, governance factors, and demographics.

We take government tax revenue as a proxy for domestic resources, and analyze how it influences government expenditure in the health sector. We investigate whether an increase in the government's tax revenues leads to higher budgetary expenditure on health. Using panel data from 74 countries for a period of 25 years, we use regression analysis to model the relationships between government expenditure in health and tax revenues, while accounting for factors such as GDP per capita, external assistance for health, population most in need of such services, and a country's international governance ratings. Our analysis is conducted for three income groups: low income, lower middle income, and higher middle income, based on the World Bank country classifications using GNI per capita.[2] The analysis uses country-level time series data publically available from sources such as the World Development Indicators (WDI), International Monetary Fund (IMF), World Health Organization (WHO), and other international sources.

Our analysis, described in detail in subsequent sections, finds that when normalized for GDP, increased tax revenues lead to greater public expenditure on health in countries for all income groups. We estimate that a 10 percent increase in national tax revenue leads to a 17 percent increase in public health expenditure in low income countries, compared to a 4 percent and a 3 percent increase in lower income and upper middle income countries, respectively.

1 Strengthening Tax Systems to Mobilize Domestic Resources in the Post-2015 Development Agenda. Element 11. Paper 2. OECD

2 http://data.worldbank.org/about/country-and-lending-groups

1. INTRODUCTION

The Addis Ababa Action Agenda has renewed global focus on domestic resource mobilization (DRM) as a cornerstone for attaining the Sustainable Development Goals (SDGs). Indeed, "strengthening domestic resource mobilization, including through international support to developing countries, to improve capacity for tax and other revenue collection," is a specific target under the SDGs. Presently, low income countries are able to mobilize only 13 percent of their Gross Domestic Product (GDP) on average, compared to the 20 percent of GDP that the United Nations estimates would be required to achieve the SDGs.[3] The SDGs imply that these increased resources should be put to use to achieve other SDGs, including the number one goal of eliminating poverty in all its forms. USAID's "Vision for Ending Extreme Poverty," makes the explicit linkage between poverty reduction and inclusive, sustainable economic growth, with the latter being dependent on, among other factors, strengthened human capacity through education and health care.

Efforts to create fiscal space for priority social sectors such as health and education, typically features prominently in public policy agendas as a means for strengthening the assets of individuals so they can participate in and benefit from inclusive economic development. Most interventions and studies on creating fiscal space for such sectors have focused on increasing sectoral expenditure efficiency, garnering external funding for the sector, or setting minimum budget targets in favor of particular sectors (as African countries have done for health, education, and agriculture during the MDG era). Such sector-specific focus is unsurprising since health or education officials and practitioners often consider overarching fiscal issues to be outside the purview of their particular Ministry or practice.

Another reason for such sector-specific approaches could be the of lack of empirical research that shows any linkage between overall domestic resources and budgetary allocation to social sectors, thereby limiting line ministries' focus on DRM to those issues that relate directly to their own sectors. The lack of any demonstrable relationship between revenue increases and higher spending on priority sectors such as education and health may be one of the reasons for the very modest amount of overseas development assistance (ODA) support for DRM. The OECD estimates that only 0.1 percent (USD 118.4 million) of total ODA in 2012 was allocated to tax related support.[4] If increased government revenues can be understood to result in greater budget allocations to the health sector, there could be motivation for health departments/ministries to actively support DRM initiatives as well as for increased ODA allocations to tax related support.

In this context, this study aims to answer the following question: *do public expenditures in the health sector in fact increase when overall domestic revenues increase?* The study presents an empirical analysis of relevant variables from 74 countries over a period of 25 years (1990-2015). The purpose of this analysis is to investigate any likely linkages between increased domestic revenues and increased public spending on health.

The rest of this report is organized as follows. Section 2 presents a summary of our literature review on factors influencing government spending on health and education. In Section 3, we

3 Strengthening Tax Systems to Mobilise Domestic Resources in the Post-2015 Development Agenda. Element 11. Paper 2. OECD

4 For more see: http://www.oecd.org/dac/Post%202015%20Domestic%20Resource%20Mobilisation.pdf

present our empirical framework and describe the model that we use to conduct the analysis. Section 4 details the variables and data used. In Section 5, we present our key findings from the analysis. Finally, Section 6 touches upon limitations of the study and areas for further research.

2. LITERATURE REVIEW

There are not many empirical studies that establish a linkage, or lack thereof, between increased DRM in developing countries and increases in public expenditure and service delivery for priority sectors. Much of the research done to date looks either at discrete country examples, and/or narrowly at individual sectors. One of the more comprehensive analyses is the IMF's study of poverty reducing public spending for countries that reached HIPC completion point[5], which assesses whether extra funds freed through debt relief were directed to poverty-reducing spending. This analysis, covering 35 countries, indicates that participating countries increased their poverty-reducing expenditure by an average of 2.5 percentage points of GDP over the period 2001to 2013. As most of these countries were experiencing strong GDP growth over this period, countries experienced an average increase of 12 percent in poverty-reducing public spending in absolute terms each year over the period. However, this analysis does not look at trends in spending for health specifically, and examines domestic resources mobilized specifically from the standpoint of debt relief rather than with respect to increases in tax revenues.

Given the research question at hand, our literature review focused on studies that discuss factors that influence government expenditure in the health sector and other priority sectors. It should be noted that empirical literature on the factors that influence prioritization of health expenditures is sparse and cross-country econometric analyses find that the determinants of public health expenditure are often not statistically robust and are sensitive to model specification (Tandon, et. al, 2014). Below, we summarize some of the key studies that look into determinants of increased public health expenditures.

a) Fans and Saurkar (2008)[6] studied the size, trends, causes and the composition of government expenditure, with specific focus on six sectors - agriculture, defense, education, health, social security, and transportation and communication. The study used panel data – data across countries and years - from 1980 to 2002 for 44 countries spread across Asia, Africa and Latin America. According to the study, the major factors influencing total government expenditure as a percentage of GDP are government revenue as a percentage of GDP, aid received as a percentage of GDP, macro adjustment[7] (dummy/indicator variable)[8] and other factors affecting government expenditure. According to the study, government expenditure as a percentage of GDP has increased over time, but on an average, governments in developed countries spent less than developing countries. Of the total government expenditure, allocation of government expenditure across the sectors is dependent on total government expenditure as a percentage of GDP, per capita GDP, and other factors that may affect spending in the sector. For instance, in Asia, Africa, and Latin America, government spending on education increased with an increase in per capita GDP. In Africa, structural adjustments led to an increase in government spending on education,

5 For more see: https://www.imf.org/external/np/hipc/2001/track/track.pdf

6 Fan, S., Yu, B., & Saurkar, A. (2008). Public spending in developing countries: trends, determination, and impact. *Public expenditures, growth, and poverty*, 20-55.

7 It is defined as the first year when the IMF implemented its structural adjustment program loans.

8 Indicator/Dummy variable are qualitative variables and takes on a finite number so that different categories of a nominal variable can be identified

but it decreased government spending on the sector in Latin America. Similar trends were observed in the case of health as well. The study also found that revenue allocation varies across the regions.

b) In a study by Xu and Saksena (2011),[9] panel data covering 143 countries over 14 years (1995 to 2008) is analyzed to identify the determinants of government expenditure on health in developing countries. The study applied both fixed effects[10] and dynamic models[11] to explore the relationship between government's health expenditure and the key determining factors viz. GDP per capita, overall government's physical capacity (measured by expenditure as a share of GDP), demographic structure, disease pattern, and health system characteristics (services provided, financing through social insurance or taxes, overseas health assistance and payment mechanism through patient based fee or fee-for-services). According to the study, government expenditure on health as a percentage of GDP varies across countries - it ranges from less than 5 percent to 15 percent. Further, according to the study, taking into account other factors, health expenditure generally grows slower than GDP. The study also indicates fungibility i.e., external aid for health reduces government's expenditure on healthcare using domestic resources.

c) The study by Reeves, Gourtsoyannis et al. (2015)[12] analyzed the relationship between the health system coverage[13] and tax revenues of the government. A strong relationship was observed between the two - increasing tax base especially in low income countries led to a greater coverage in healthcare expenditure. The results were based on data for 89 low-income and middle-income countries from 1995 to 2011.

d) A study by Samadi and Homaie (2013),[14] uses panel data from Economic Cooperation Organization (ECO) countries to assess whether health expenditure per capita is affected by GDP per capita, the proportion of population below 15 years and above 65 years old, number of physicians, and the level of urbanization (proportion of population residing in urban regions). The study observed a long-term relationship between government's health expenditure per capita and these factors. A short term relationship was also identified, except with the proportion of population above 65 years.

e) Education for Global Monitoring Report (2014)[15] shows that it is necessary to increase tax revenues in developing countries to bridge the education financing gap. The study also noted

9 Xu,K. , Saksena P. (2011) The determinants of health expenditure-A country level panel data analysis. World Health Organisation. Results for Development Institute. Retrieved from < http://www.who.int/health_financing/documents/report_en_11_deter-he.pdf>

10 Fixed effects models control for, or partial out, the effects of time invariant variables with time-invariant effects

11 Dynamic model does not control for, or partial out, the effects of time invariant variables with time-invariant effect

12 Reeves, A., Gourtsoyannis, Y., Basu, S., McCoy, D., McKee, M., & Stuckler, D. (2015). Financing universal health coverage -effects of alternative tax structures on public health systems: cross-national modelling in 89 low-income and middle-income countries. *The Lancet*, *386*(9990), 274-280

13 Reeves et al use a vector of seven indicators for health systems coverage. (a) government health expenditure; (b) private health expenditure; (c) child mortality per 1,000 livebirths including neonatal, post-neonatal, age 1–5 years, and under-5 mortality; and (d) maternal mortality per 1,00,000 livebirth. ((e) proportion of births with a skilled attendant; (f) proportion of women receiving at least four antenatal visits; and (g) proportion of the population who incur severe financial costs in accessing health care The first four are available on longitudinal basis and the next three are on cross-sectional basis

14 Samadi, A. H., & Homaie Rad, E. (2013). Determinants of Healthcare Expenditure in Economic Cooperation Organization (ECO) Countries: Evidence from Panel Cointegration Tests. Available at SSRN 2286987.

15 UNESCO, EFA. "Global Monitoring Report 2008: Education for All by 2015. Will We Make It." *United Nations Education, Science and Cultural Organization, Paris* (2007).http://unesdoc.unesco.org/images/0022/002270/227092E.pdf

that governments in these countries should allocate at least 6 percent of their GDP and 20 percent of their budget to education.

Our review of the studies mentioned above indicates that government expenditure on priority sectors such as health is dependent on various factors, including tax revenue, GDP per capita, and official aid, among other things.[16] We draw on these studies and economic theory to identify variables for our analysis that influence government expenditure on health.

While there is a general recognition that increased tax base and revenues facilitate the provision of funds for key services including health, education, social safety nets—which are often characterized as poverty-reducing public expenditures—this paper focus is particularly on public spending on health and its relation to available domestic resources. While understanding the relationship between domestic resource mobilization and poverty-reducing public expenditures would be important from a policy perspective, we do not examine this relationship for several reasons. First, time-series and spatial data for poverty-reducing public expenditures spanning 25 years for more than 200 countries would be difficult to obtain for a meaningful analysis. Second, not all—and particularly not developing countries—will have successfully adapted their domestic budgeting and financial management systems to the needs of their poverty reduction strategies. Indeed, many countries have not consistently had poverty reduction strategies spanning back a decade or longer. This makes the determination of what accounts for a poverty-reducing expenditure subjective and inconsistent across a number of different countries. Even where poverty reduction strategies exist, expenditures are often not reported in a uniform manner comparable across counties (such as the Classification of the Functions of Government (COFOG)). Third, of the most common sectors that account for a significant chunk of poverty-reducing expenditures—namely, health, education, infrastructure, etc.—data for the health sector is generally more robust across countries than the others.

3. EMPIRICAL FRAMEWORK

Government's expenditure decisions and the sectoral allocation of these expenditures are made based on its needs and priorities. However, such spending is constrained by resources that government has at its disposal. Governments do have control - although limited – over the resources it can raise to fund its expenditures. This is especially true in the case of tax revenues, as governments can mobilize more tax revenues by becoming more efficient in tax collection, and by widening the tax net. Therefore, the government's decision on expenditures, the sectoral allocation of expenditures, and tax revenue collections are made simultaneously. In that sense tax revenues are endogenous to total government expenditure of which public health expenditure is a sub-set. In our empirical approach we hypothesize that there is a two-way relationship, between total government expenditures (including public health expenditure) and tax revenues.

To take these inter-relationships into account, we specify the structural relationships between total government expenditure, tax revenue, and public health expenditure. We specify total government expenditure as a function of tax revenues, non-tax revenues, GDP, total population, and official aid. Tax revenue is a function of total government expenditure, GDP, size of the formal sector, size of external trade, and governance. Public health expenditure is a function of GDP, tax and non-tax revenues, lagged value of private health expenditures, lagged value of external health assistance, governance, and health indicators – including lagged value of sanitation, lagged value of prevalence of

16 Annex B discusses previous studies on factors influencing a country's tax revenue.

TB, and percent of population who might need health care. The specification of the structural equations and the variables used are presented in Table 1 below.

Table 1. Structural Relationships

Relationship between Total Expenditure, Tax Revenues & Public Spending on Health	
Total Expenditure (Equation 1)	Total Expenditure as a % of GDP = fn (Tax Revenue as a % of GDP, Total other revenues as a % of GDP, GDP per capita (PPP), Total Population, Official Aid)
Tax Revenue (Equation 2)	Tax Revenue as a % of GDP = fn (Total Expenditure as a % of GDP, GDP per capita (PPP), Formal Sector as a % of GDP, Trade as a % of GDP, Governance Index)
Public Health Expenditure (Equation 3)	Public Health Exp (% of GDP) = fn (Tax Revenue (% of GDP), GDP per capita (PPP), Lag Private Health Exp (% of GDP), Lag External Health Assistance (% of GDP), Needy Population, Lag Improved Sanitation, Other Total Revenue (% of GDP), Lag No. of prevalence TB cases,)

Given that our primary interest is to understand the relationship between tax revenues and public expenditures on health, we collapse the total government expenditure and tax revenue equations into one single equation (reduced form equation of tax revenues), by substituting for total government expenditures (with factors influencing it) in the tax revenue equation. As a result we have a reduced form specification where tax revenue is expressed as a function of total government expenditure, GDP per capita, total non-tax revenues, population, official aid, formal sector, trade, governance index. That is, the three structural equations are now reduced to two equations, a reduced form equation of tax revenues, and a structural equation for public health expenditures. The specific equations and variables used are presented in Table 2 below.

Table 2. Empirical Model

Relationship between Tax Revenues and Public Spending on Health[17]	
Tax Revenue (Equation 1)	Tax Revenue as a % of GDP = fn (GDP per capita (PPP), Total other revenues as a % of GDP, Total Population, Official Aid as a % of GDP, Formal Sector as a % of GDP, Trade as a % of GDP, Governance Index (Polity), Country Dummy, Year Dummy)
Public Health Expenditure (Equation 2)	Public Health Exp (% of GDP) = fn (Tax Revenue (% of GDP), GDP per capita (PPP), Lag Private Health Exp (% of GDP), Lag External Health Assistance (% of GDP), Needy Population, Lag Improved Sanitation, Other Total Revenue (% of GDP), Lag No. of prevalence TB cases, Governance Index (Polity), Country Dummy, Year Dummy)

If tax revenue and public health expenditure are endogenous, then in Equation 2, the error term will be correlated with tax revenue and as a result the coefficient estimate of tax revenue will not be consistent. In order to obtain a consistent estimate, it is important to use variables – known as

17 Variables and data sources will be detailed in the next section. In an earlier version of this report, we had not used governance index (polity), TB prevalence and fixed effects for countries and variables in our model.

instruments – that are correlated to tax revenues but not correlated to public health expenditures. In the tax revenue equation, the size of the formal sector and trade as a percent of GDP are conceivably related only to tax revenue, and not related directly to public health expenditures.

Further, when there is endogeniety, the appropriate estimation technique would be two-stage-least-squares (2SLS). The 2SLS estimation involves two steps. First, tax revenue is estimated as a function of all exogenous independent variables in the system (that comprises the tax revenue and the public health expenditure equations) including the two instruments, size of trade as a percent of GDP, and the size of the formal sector as a percent of GDP. Then, the public health expenditure equation (Equation 2) is estimated using the predicted value of tax revenue (obtained from the first step) in place of the tax revenue variable. The 2SLS estimation – unlike the Ordinary Least Squares (OLS) estimation - allows us to estimate consistent estimates as the predicted tax revenue variable is by construction unrelated to the error in the public health equation.

As a first step in our estimation process, we test to see if tax revenues and public health expenditures are in fact endogenous as hypothesized. The Hausman test confirmed that the variables are endogenous in the case of low income countries, while it was inconclusive for lower middle and upper middle income countries. It must be noted here that the Hausman test is an asymptotic test, best suited for datasets with a large number of observations. For this reason, we also present the results using the OLS estimation for the sake of completeness and to facilitate comparison in Section 5.

Other studies, notably Tandon et al (2014), have noted that empirical findings related to the prioritization of health spending are sensitive to model specification. To respond to concerns related to model specification, and to test the robustness of our findings, we have explored a number of alternative specifications. Annexes E-J contain results of alternate specifications of the model in order to test the stability of the relationships between public health expenditure and tax revenues. Annexes E and F present regression results when all countries are considered together; Annex G presents results when total population is included as an explanatory variable for public health expenditure; Annex H reports results when all countries are considered together and the first difference of the variables are used; and Annexes I and J present results when all the variables in the model are made to be stationary.

4. DATA

We use panel data covering 74[18] countries over a period from 1990 to 2015. Since the focus of this study is on developing countries, we undertake our analysis for three groups of countries based on gross national income (GNI) - low income (per capita GNI of $1,045 or less), lower middle income (per capita GNI between $1,046 and $4,125) and upper middle income (per capita GNI between $4,126 and $12,735) countries – as classified by the World Bank in 2014. High income countries are not included in our analysis because the characteristics of these countries are very different and we are particularly interested in the relationship between tax revenue and public expenditure on health in the case of developing countries.

Regressions were estimated for each income group separately, and for all income groups combined. The results of the regressions estimated by income categories are presented in Section 5. With the

18 We have considered data of 74 countries, whereas in the regression model the number of countries differs based on the number of observations (i.e., continuous time series data) for respective variables.

exception of income level variables, all variables are transformed into natural logarithms to smooth the data or remove volatility and to facilitate interpreting the effects in percentage terms.

Data on public health expenditure as a percentage of GDP, per capita GDP (PPP in current US$), tax revenue as a percentage of GDP, other total revenue as a percentage of GDP, private health expenditure as a percentage of GDP, population below 14 years of age and 65 and above (needy population), and improved sanitation facilities has been collated from the World Development Indicators database of the World Bank. Data on external health financing and number of tuberculosis (TB) cases were collected from the WHO Database.

The variables used in our analysis are enlisted in the bullets below. Please refer Annex C and Annex D for a detailed description, source and descriptive statistics of the variables. The choice of these variables is informed by literature review as well as the availability of a time-series data for the indicators for the time span being considered. For this reason, we rely on indicators that strike a balance between both a sound rationale as well as data availability.

- **GDP per Capita:** GDP per capita (measured using constant 2011 PPP terms) is an indicator of a country's income and a major factor influencing public expenditure on health. A rich country with a high GDP per capita tends to spend more on health (Fans and Saurkar (2008), and Samadi and Homaie (2013)). The strength of this positive relationship between public expenditure on health GDP per capita is highest in low income countries where governments tend to spend a higher share of their budget on these sectors when income increases (Xu and Saksena (2011).

- **Tax Revenue as a percentage of GDP**: Tax revenue—the revenue generated by the central government through taxation—is our primary factor of concern. Controlling for all other factors, a government's ability to spend is strongly influenced by the revenues it generates. While tax revenue is a subset of the total resources available to the government, we use tax revenue as a separate explanatory variable in our model in addition to using non-tax revenues. Budget planners and decision makers may respond differently to changes in tax revenues as compared with non-tax revenues. Certain non-tax revenues may be retained as source in some countries, for instance, as is the case with many fees. Non-tax revenues may also include funds like social contributions over which the government may not have the same discretion for their use. While resources are fungible, the government does not necessarily have the ability to redirect funds included in non-tax revenues to health or other priority areas as readily as it might with tax funding.

  Increase in tax revenue contributes positively to the funds available with the government which enables the government to increase its expenditure, including on health. This positive relationship between government expenditure and revenue has been recognized by previous studies as well. Reeves, Gourtsoyannis et al. (2015) and Education for Global Monitoring Report (2014)[19] noted that tax revenue positively affects government spending on health. Similarly, Fans and Saurkar (2008) found that government revenue as a percentage of GDP results in higher government expenditure.

19 UNESCO, EFA. "Global Monitoring Report 2008: Education for All by 2015. Will We Make It." *United Nations Education, Science and Cultural Organization, Paris* (2007). http://unesdoc.unesco.org/images/0022/002270/227092E.pdf

- **Other (Non-tax) Revenue as a percentage of GDP**:[20] The revenue generated by the central government other than through taxation also influences public expenditure in health. Government's revenue from sources other than tax also impacts its expenditure on health since more revenue implies more funds with the government enabling it to increase budgetary allocation on sectors including health.

- **External Health Assistance, as a percentage of GDP:** This indicator measures external resources for health expressed as a percentage of GDP. The effect of external financing for health on public health expenditures can be either positive or negative. Increase in external health financing could crowd out government spending on health, since the money received through external sources is an alternative source of funds that can be used to fund investment in the health sector. Xu and Saksena's (2011) study showed that external aid has a negative effect on government expenditure on health from domestic sources.

  However, on the other hand, external health financing could take the form of funds provided to the government for expenditure in these sectors, which will lead to increased public spending on health and education (as highlighted by Fans and Saurkar, 2008). External financing can crowd in government expenditure, for instance by funding construction of new health or education facilities, which may require increased recurrent spending by the government in the following years. In either case, it is unlikely that the effect of external financing on public health expenditure can be seen in the same time period. We therefore use the lagged value of external health financing to explain the current year's public spending on health because public health expenditure in the current year is less likely to be affected by external health financing this year than that received in the previous year.

- **Private Health Expenditure as a percentage of GDP**: While determining the extent of resources to allocate towards public health, the government would take private expenditure on health into consideration. If spending by the private sector on health is high, there would be lesser need for public expenditure on the same. Samadi and Homaie (2013) observed that private expenditure on health relative to total healthcare expenditure has a negative impact on total healthcare spending. Given that private health expenditures are also determined by public spending on health, private and public health spending are both endogenous. However, given that current year public spending on health is likely to be determined by the level of private spending in the previous year, we use the lagged value of private health expenditure as a percentage of GDP as the factor that determines current public health spending.

- **Needy population as a percentage of total population**: Needy population refers to demographic groups in a country that have a greater need for health services. The higher the proportion of needy population in a country, the greater the need for increased government expenditure on health and education. For the purpose of our analysis, we categorize population aged less than 14 years and more than 64 years as 'needy population' with the assumption that this population group requires most frequent health services. Previous

20 We consider tax revenue and other total revenue separately in our model because budget planners and decision makers may respond differently to changes in "other total revenue" as compared to tax revenue because certain categories of "other total revenue" may be retained at source in some countries (as is the case with many fees). "Other total revenue" may also include funds like social contributions over which the government may not have the same discretion for their use. While money is fungible, the government would not necessarily be able to re-direct the funds included in "other total revenue" to health or other priority areas as readily as it might with tax funding.

studies including Xu and Saksena (2011) and Samadi and Homaie (2013) have also considered similar factor in their analyses.

- **Improved Sanitation Facilities:** Improved sanitation facilities are likely to reduce the incidence of diseases and hence result in lower health expenditures. On the other hand improved sanitation facilities can also be the result of increased expenditures on health. However, the lagged value of improved sanitation facilities may give us a better sense of the relationship between sanitation facilities and public health expenditures, as it is with a lag that improved sanitation facilities will result in better health outcomes. Due to data constraints, we only use a year of lag for this variable.

- **Number of TB cases:** Xu and Saksena (2011) considered disease prevalence as one of the factors influencing government health spending. They used incidence of tuberculosis per 100,000 people as an indicator of prevalence of diseases. Countries with higher disease prevalence tend to require greater public expenditure on health. We used the lagged value of number of TB cases since the government would budget its expenditure on health based on the history of disease prevalence in the country. While many other variables may be well-suited to serve as a proxy for disease prevalence, we have chosen this variable because of the availability of time-series data for the period considered in our analysis.

- **Polity Index:** Polity index, published by the Center for Systemic Peace, provides a composite score for each country over the years on a scale of autocracy (-10) to full democracy (10). The underlying assumption for this variable is that countries with good governance (as indicated by the score of democracy) are under increased pressure from their citizens to allocate a greater budget for priority sectors, including health.

In addition, to account for any secular trends or time-dependent shocks (such as, recessions), our model also includes fixed effects for year and country.[21] This captures any time dependent or secular trends that might have changed across time or countries. For instance, tax effort across time and countries might have changed in the 25 years of our analysis due to introduction of computers, increased capacity for tax collection, and other factors. Country and time dummies therefore address the issue of any serial correlation in our panel data.

5. RESULTS

The model presented in Section 3 was estimated using both the 2SLS and OLS techniques. In Table 3 and 4 below we present the results of the 2SLS estimation of the Public Health Expenditures and Tax Revenue regressions, respectively.

21 For country variable, we provided numeric values from 1 to 74 based on the alphabetic letter of the countries.

Table 3. 2SLS regression results for public health expenditure

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP), Log(Lag No. of prevalence TB cases), Governance Index (Polity), Country Dummy, Year Dummy)[22]								
	Low Income		**Lower Middle Income**		**Upper Middle Income**		**Overall**	
Intercept	(3.49)		2.59		7.18	**	5.83	**
Log Tax Revenue (% of GDP)	1.70	***	0.40	**	0.27	**	1.00	***
Log GDP per capita, (PPP constant 2011 USD)	(1.74)	***	(0.28)	*	(0.37)	**	(0.84)	***
Log Needy Population (% of total population)	4.90	*	(0.16)		(0.43)		(0.01)	
Lag of log Private Health Expenditure (% of GDP)	0.10		0.16	***	(0.18)	***	(0.11)	*
Lag of Log Improved sanitation (% of pop access)	0.08		(0.06)		(0.08)		(0.04)	
Lag of log External Health Assistance (% of GDP)	0.06		0.03	*	0.01		0.03	**
Log Other Total Revenue (% of GDP)	0.01		0.12	***	0.21	***	0.18	***
Lag of log Number of TB cases	(0.57)		0.04		(0.19)	***	0.04	
Governance Index (Polity)	0.02		0.01	*	0.00		0.01	*
R Square	89%		95%		93%		90%	
Adjusted R Square	84%		94%		90%		88%	
No of Observations	147		252		158		557	
Wu-Hausman F (p-value) [1]	0.00		0.17		0.25		0.00	
Minimum eigenvalue statistic (Weak Instruments) [2]	15.63		15.72		8.64		34.44	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.
[1] Based on the Wu-Hausman F test, the null hypothesis that the Tax Revenue and Public Health Expenditures variables are exogenous is rejected for Low Income Countries and all income categories combined, and is accepted in the case of Middle Income and Upper Middle Income countries.
[2] Based on the test proposed by Stock and Yogo, we find that the null hypothesis that the instruments used in the model are weak is rejected for all country groupings except the Upper Middle Income group at the 10% relative bias level. The null hypothesis is rejected for the Upper Middle Income group at the 20% relative bias level.[23]

The regression results presented above rely on robust standard errors. The most prominent results in the above table show that, keeping all other factors considered in the equation as constant:

- When normalized for GDP, a 10 percent increase in tax revenue leads to a 17 percent increase in the public health expenditure in the low income countries and 4 percent and 3 percent increases in lower middle income countries and upper middle income countries, respectively. When the income categories are removed and all countries grouped as one, we see that after normalizing for GDP, a10 percent increase in tax revenue leads to a 10 percent increase in the public health expenditure. Tax revenue is therefore a significant explanatory variable, at least at the 95 percent confidence level, for public health expenditure for low income, lower middle income, and upper middle income countries.

- Across all country groups, a negative relationship is observed between per capita GDP and public health expenditure as a percentage of GDP. This can be explained by the fact that

22 In the earlier draft of this report, the empirical model did not include the following explanatory variables - the number of TB cases, governance index (polity) and fixed effects for countries and years. The results for this model were similar to the results with the revised model presented in this report. In the earlier model, when normalized for GDP, a 10 percent increase in tax revenue leads to a 10 percent increase in the public health expenditure in the low income countries and a 7 percent and 3 percent increase in the case of lower middle income and upper middle income countries respectively.

23 2SLS relative bias values are as follows: 16.85(5%), 10.27 (10%), 6.71 (20%), 5.34 (30%). The null hypothesis is rejected if the minimum eigenvalue statistic exceeds this critical value. James H. Stock and Motohiro Yogo, Chapter 5, Testing for Weak Instruments in Linear IV Regression

public health is a basic human necessity that the government spends on. However, as the income of a country increases and basic necessities of its citizens are being met, the government's priorities shift to other matters that are important to the country's growth and development, such as telecommunications, or IT infrastructure.

- We also observe that an increase in other (non-tax) government revenue as a percentage of GDP positively impacts public health expenditure. After normalizing for GDP, a 10 percent increase in other government revenue, increases public health expense by 1 percent in the case of lower middle income countries, and by 2 percent each in the case of upper middle income countries and the overall model. The effect is statistically insignificant for low income countries.

- In line with expectations, it is observed that in the case of low income countries, a higher proportion of needy population is associated with higher public health expenditure (at 10 percent confidence level). In the case of the other income groups, the proportion of needy population does not impact public health expenditure.

- When normalized for GDP, a 10 percent increase in private health expenditure in the previous year increases public health expenditure in the current year by 2 percent in lower middle income countries and by 1 percent in the overall model, but decreases public health expenditure by 2 percent in the upper middle income countries. In the case of low income countries, private health expenditure in the previous year does not impact public health expenditure.

- A 10 percent increase in external health assistance in the previous year increases current public health expenditures by 0.3 percent in the case of both the lower middle income countries and the overall model. It, however, does not impact public health expenditure in the case of low income countries and upper middle income countries.

- The prevalence of TB—a proxy for disease prevalence in our model—does not influence public health expenditure in the case of low income countries, lower middle income countries and the overall model. In the case of upper middle income group, contrary to expectation, a negative relationship is observed between the number of TB cases in the previous year and public health expenditure in the current year. One explanation for this relationship could be that the number of TB cases is unable to adequately capture the prevalence of disease in a country.

- In the lower middle income countries and the overall model, governance index (polity) has a positive impact on public health expenditure implying that better governance results in more public expenditure on health. In the case of low income and upper middle income countries, governance does not seem to have an impact on public health expenditure.

Table 4. 2SLS regression results for tax revenue

Log (Tax Revenue (% of GDP)) = fn (Log (GDP per capita (PPP constant 2011 USD)), Log (Formal Sector (% of GDP)), Log (Trade (% of GDP)), Log (Other Total Revenue (% of GDP)), Log (Total Population), Log (Official Aid (% of GDP), Governance Index (Polity), Country Dummy, Year Dummy)								
	Low Income		Lower Middle Income		Upper Middle Income		Overall	
Intercept	40.69	***	28.86	***	15.37		13.81	***
Log GDP per capita, (PPP constant 2011 USD)	0.25		0.29	**	(0.60)	**	0.13	
Log Formal Sector (% of GDP)	(0.19)		0.08		2.52	***	0.53	***
Log Trade (% to GDP)	0.44	***	0.35	***	0.03		0.33	***
Log Other Total Revenue (% of GDP)	0.08	***	(0.08)	***	(0.34)	***	0.05	***
Log Total Population	(2.36)	***	(1.84)	***	(1.08)	**	(0.97)	***
Log Official Aid (% of GDP)	0.17	***	0.00		(0.01)		0.06	***
Governance Index (Polity)	0.00		0.01		0.00		0.00	
R Square	92%		91%		92%		89%	
No of Observations	147		252		158		557	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above regression results indicate that, on an average, across all countries, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in trade leads to a 4 percent increase in tax revenue in low income countries and 3 percent in lower middle and overall group. Trade has no impact on tax revenue in case of upper middle income group.
- Formal sector's contribution to GDP has a positive impact on tax revenue, a 10 percent increase in the size of the formal sector leads to a 25 percent increase in tax revenue in upper middle income and 5 percent in overall group. Formal sector has no impact on tax revenue in case of low and lower middle income countries.
- When normalized for GDP, a 10 percent increase in official aid leads to 2 percent increase in tax revenue in low income and 0.6 percent in overall group. Whereas there is no impact in lower middle and upper middle income countries.
- A 10 percent increase in the total population results in a 24 percent decline in tax revenue in low income, 18 percent in lower middle, 11 percent in upper middle and 10 percent in overall group.
- Per capita GDP has a positive effect in case of lower middle income and negative effect in upper middle income countries. There is no impact in case of low income and overall group.
- A 10 percent increase in other total revenue leads to increase in 0.8 percent and 0.5 percent in low income and overall group respectively. In case of lower middle and upper middle income countries, other total revenue has a negative impact.
- Governance index (polity) does not impact tax revenue.

As highlighted in in Section 3, the results of the Wu-Hausman test indicated that the explanatory variables are exogenous in the case of lower and upper middle income countries, but that they were endogenous for the case of low income countries. The results presented above utilize the 2SLS method to deal with this endogeneity, particularly for low income countries. In Table 3 below, we

also present the OLS results for the second equation for all income groups as well as for the overall model without the income groups. As shown in Table 5 below, the OLS regression result highlights a positive and significant relationship between tax revenue and public health expenditure.

Table 5. OLS regression results for public health expenditure

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP), Log(Lag No. of prevalence TB cases), Governance Index (Polity), Country Dummy, Year Dummy)								
	Low Income		Lower Middle Income		Upper Middle Income		Overall	
Intercept	(4.23)		4.80	**	7.67	**	4.15	**
Log Tax Revenue (% of GDP)	0.97	***	0.25	***	0.15	**	0.54	***
Log GDP per capita, (PPP constant 2011 USD)	(1.39)	***	(0.21)		(0.38)	**	(0.65)	***
Log Needy Population (% of total population)	4.51	*	(0.56)	*	(0.40)		0.12	
Lag of log Private Health Exp (% of GDP)	(0.10)		0.13	**	(0.15)	**	(0.08)	
Lag of Log Improved sanitation (% of pop access)	0.73	***	(0.21)		(0.09)		0.35	***
Lag of log External Health Assistance (% of GDP)	0.15	**	0.03	**	0.01		0.05	***
Log Other Total Revenue (% of GDP)	0.13	**	0.09	***	0.17	***	0.18	***
Lag of log Number of TB cases	(0.54)		(0.01)		(0.21)	***	(0.06)	
Governance Index (Polity)	0.02	**	0.01	**	0.00		0.01	**
R Square	89%		95%		93%		90%	
Adjusted R Square	85%		94%		91%		89%	
No of Observations	163		259		159		581	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

- When normalized for GDP, a 10 percent increase in tax revenue leads to a 3 percent and 2 percent increases in the lower and upper middle income countries, respectively. In the overall model, a 10 percent increase in tax revenue leads to a 5 percent increase in the public health expenditure.

- In all groups, except lower middle income countries, a negative relationship is observed between GDP per capita and public health expenditure as a percentage of GDP. In the case of lower middle income countries, GDP per capita does not impact public health expenditure.

- In the case of upper middle income countries and the overall model, the proportion of needy population does not have an impact on public health expenditure. Contrary to expectation, in lower middle income countries, a negative relationship is observed between the proportion of needy population and lower public health expenditure.

- When normalized for GDP, a 10 percent increase in private health expenditure in the previous year increases public health expenditure in the current year by 1 percent in lower middle income countries. However, in the upper middle income countries, private health expenditure in the previous year negatively influences public health expenditure. In the case of low income group countries and the overall model, private health expenditure does not impact public health expenditure.

- Contrary to expectation, it is observed that in low income countries and in the overall model, a 10 percent increase in the improved sanitation access in the previous year increases public health expenditure by 7 percent and 4 percent respectively in the current

year. In the case of all other groups, improved sanitation does not have any impact on public health expenditure.

- A 10 percent increase in external health assistance in the previous year increases current public health expenditures by 2 percent in low income countries, 0.3 percent in lower middle income countries and 0.5 in the overall model. In the case of upper middle income countries, external health assistance does not impact public health expenditure.
- When normalized for GDP, a 10 percent increase in other government revenue leads to increase in public health expenditure by 1 percent each in low income and lower middle income countries, and 2 percent increase in the case of both upper middle income countries and the overall model.
- Contrary to expectation, it is observed that in upper middle income countries, there is a negative relationship between number of TB cases in the previous year and public health expenditure in the current year. In the case of all other groups, TB prevalence does not impact public health expenditure.
- In all income groups, governance index (polity) has a positive impact on public health expenditure, except in the case of upper middle income countries where governance does not impact public health expenditure.

In either model, tax revenue is a statistically significant explanatory variable for public health expenditures. In general, we also observe that tax revenue has a proportionately higher impact on public health expenditure the lower the income group of the country. This suggests that mobilizing tax revenues in low income countries is more likely to see increases in public expenditure in priority sectors, such as health. It must be noted though that while positive, the elasticity of the relationship between tax revenue as a percentage of GDP and public health expenditure is less than 1 in all but the case of low income countries. That is, a 10 percent increase in tax revenue as a percentage of GDP results in less than a 10 percent increase in public health expenditures. This implies (but does not necessarily prove) that other unknown sectors are capturing more than their proportional share of tax revenue. The results in the alternative specifications included in Annexes E-J support this conclusion. Assessing whether health is getting a proportional share of the increased tax revenue was however not the stated research question of the study and the results obtained are indicative as much as they do suggest that increased domestic resource mobilization (particularly tax revenue) will likely result in increased public health expenditure.

6. LIMITATIONS OF STUDY AND AREAS FOR FURTHER RESEARCH

Our analysis on whether domestic tax revenues influence government spending on health establishes, albeit preliminarily, that tax revenues indeed have a positive impact on public health expenditures although the extent of impact varies across income groups. In particular, we observe that tax revenues impact public health spending the most in low income countries. This can have programmatic implications for USAID as it indicates that programs to support tax revenue collection or compliance could in theory be linked to benefit other sectors such as health and education. However, the cross-country and time-series nature of our analysis may mask the nuances that underlie this relationship. A next step therefore may be to explore this relationship more deeply for low income countries, perhaps through specific case studies or focused data analysis to understand

the reasons behind this relationship and the composition of increased public expenditure in health as a result of increased domestic resources.

To strengthen our econometric models and results, additional robustness checks and modifications may be useful. For instance, a number of variables could be explored to give a nuanced flavor to the current analysis. An example is using an indicator for fiscal decentralization to see whether increased aggregate DRM at the national level has any relationship with public spending in priority sectors where sub-national governments are responsible for revenue collection and budget allocation. The current model does not explore tax administration reforms and how it affects tax revenue collections, nor do we utilize a country's tax effort and tax capacity indicators to make statements about tax revenue collections and its relationship to public health expenditures. Tax effort and capacity indicators for 25 years may be unavailable across all country groups. However, a narrower time period with these indicators may offer additional insights into revenue collection and public health expenditure.

In addition, better data availability for the specified time period and countries will improve the accuracy of the results. For instance, the data that this study uses for public health expenditure comes from the World Health Organization's Global Health database. This indicator includes recurrent and capital spending from government (central and local) budgets as well as external borrowings and grants (including donations from international agencies and nongovernmental organizations). It therefore does not isolate on-budget donor support for health from domestic spending alone. As a result, the observed relationship that the current study finds between external financing on health and public health expenditure must be taken with caution. In order to determine accurately any crowding in or crowding out effect of external financing on public health expenditure, we would have to use data that isolates on-budget donor support from public health spending.

A number of other variables can be explored in lieu of or in addition to the explanatory variables in our model. For instance, a better proxy for disease prevalence could be examined, (i.e. malaria prevalence, tropical countries, etc.) which do not compromise the number of observations in the model. The definition of 'needy population' could be tightened to include female of fertility age, restrict children to only those under 5 years of age, and all population over 65. Should data availability permit, a better indicator for the formal sector will also improve the model specification. Finally, an expansion of this study could look at a shorter time period but focus on broader social spending priorities, such as education, welfare programs etc., to understand how poverty-reducing expenditures may be affected by increased domestic resources.

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8. ANNEXES

Annex A: Literature on factors influencing a country's tax revenue

Budgetary allocation by a government is strongly influenced by its revenue, particularly taxes which are a major source of revenue for the government. Hence, we undertake a detailed review of previous work studying the factors influencing government's tax revenue. The following are some key studies in this area:

a) Bird, Matinez-Vazquez and Torgler (2004),[24] using a sample of 110 developing countries over the period 1990-1999, observed that government's tax revenues were determined by supply side variables such as GDP per capita, rate of population growth, ratio of exports plus imports to GDP, and non-agricultural share of GDP. In addition to these, demand side factors such as societal institutions (political stability, political rights, civil liberties, corruption index, rule of law etc.), size of the shadow economy[25], fiscal decentralization and income inequality also play a critical role in determining tax revenue of a government. The study opined that developing countries with stable and responsive governments and strong regulatory regime and societal institutions can increase their tax revenue. The study also undertakes regional comparisons and indicates that the lower level of tax revenue in Latin America as compared to other developing countries is mainly due to the low quality of institutions, high rates of corruption, presence of shadow economy and lower tax rates in the region.

b) Sen Gupta (2007)[26], based on an analysis of panel data of 105 developing countries from 1980-2004 (25 years), concluded that structural factors such as GDP per capita, share of agriculture in GDP, trade openness, and foreign aid significantly affect tax revenues in developing countries. According to the study, the tax revenue of Sub Saharan countries is well above their potential, but in the case of few Latin American countries, the revenue is below potential.

c) In a study by Atiqul Haque,[27] panel data of 50 developing countries from 1995 to 2009 was analyzed to identify the factors influencing government's tax revenue. According to the study, the share of agriculture in GDP and the size of the shadow economy have a statistically significant negative influence on tax revenue, while purchasing power parity (PPP), adjusted per capita GDP, and international trade as a percentile of GDP positively impact the tax revenue potential of developing countries. The study also found that efforts of tax revenue mobilization (tax to GDP ratio) by the government in Asia are relatively poorer than those in Africa and Latin and Central America.

d) In a study by Bhushan and Samy (2010)[28] focusing on Burundi, Cameroon, Ethiopia, Tanzania and Uganda, an econometric model was designed to assess the key determinants of revenue from taxation in a country. The study considered GDP per capita, aid as a percentage of the

24 Bird, R. M., Martinez-Vazquez, J., & Torgler, B. (2006). Societal institutions and tax effort in developing countries. *The Challenges of Tax Reform in a Global Economy*, *283*.
25 the part of an economy involving goods and services which are paid for in cash, and therefore not declared for tax
26 Sen Gupta, A. (2007). Determinants of tax revenue efforts in developing countries. *IMF Working Papers*, 1-39.
27 A.K.M. Atiqul Haque. Determinants of Low Tax Efforts of Developing Countries
28 Bhushan, A., & Samy, Y. (2010). Enhancing Domestic Resource Mobilization for Effective Development: The Role of Donors. *North-South Institute, Ottawa, Canada*.

Gross National income (GNI)[29], agricultural income as a percentage of the GDP, trade openness, inflation levels, debt and form of government (democracy) as the key determining factors. A significant conclusion from this study was that aid does not have a significant effect on taxes collected by the government.

29 Gross national income (GNI) is defined as the sum of value added by all producers who are residents in a nation, plus any product taxes (minus subsidies) not included in output, plus income received from abroad such as employee compensation and property income.

Annex B: Factors Influencing Tax Revenue

The following are the key factors influencing a country's tax revenue:

- **Formal sector's contribution to GDP**: Countries with lower share of formal sector (secondary and tertiary sector) in GDP, i.e., countries with heavy dependence on agriculture, tend to have lower tax revenue because a lot of the agricultural trade occurs in the informal sector and also because it is harder to tax agriculture compared to the formal sector (Bhushan and Samy (2010)). According to Atiqul Haque, formal sector's contribution to GDP is an indicator of the stage of development since higher share of non-agricultural activities in GDP implies smaller subsistence sector, more industrialization and higher opportunity to collect taxes. Thus, increase in formal sector activities within a country will result in higher tax revenue for the government.

  For our analysis, to account for the formal sector's contribution to GDP, we calculate the value added by the formal sector as a percentage of GDP. This value is computed by deducting from 100 percent the "Agriculture, value added (or Net output of the agricultural sector)" as a percentage of GDP.

- **Trade as a percentage of GDP**: Governments often tax the goods and service that the country trades in, especially given the ease of taxing trade compared to income tax since they take place at specified location (Bird, Matinez-Vazquez and Torgler (2004), Sen Gupta (2007) and Bhushan and Samy (2010)). As a result, the extent of trade that the country undertakes (sum of exports and imports) also influences its tax revenue. A positive relationship is expected between trade a country engages in and the tax revenue of the country (as observed by Atiqul Haque). Thus, we include trade (sum of import and export) as a percentage of GDP as a factor influencing government's tax revenue.

- **Other total revenue as a percentage of GDP**: Other revenue of the government also contributes to the funds available with the public sector. If the other sources of revenue are high, the government may not have to depend on taxation to meet the public expenditures. In other words, tax revenue and other revenues are substitutes implying that if other government revenue increases, tax revenue may fall. On the other hand, it is also possible that higher other revenues results in increased public expenditure on activities requiring further expenditure by the government. The government may therefore increase taxation and tax revenue in order to create funds to meet these expenditures.

- **Total Population:** Demographics characteristics of a country can also influence the tax revenue collected. As a country's population increases, the government may not be able to account for/capture all tax payers (Bird, Matinez-Vazquez and Torgler (2004)). This implies that higher population will result in lower tax revenue.

- **GDP Per Capita:** GDP per capita is an indicator of the extent of development in a country. Countries with higher level of development have a greater capacity to pay and collect taxes (Bird, Matinez-Vazquez and Torgler (2004) and Atiqul Haque). Thus, a positive relationship may be observed between GDP per capita and tax revenue.

- **Official aid as a percentage of GDP:** The effect of aid on tax revenue can be positive or negative (Sen Gupta (2007)). If the aid is perceived as an alternative source of funds to tax

revenue that can be relied on to meet public expenditures, tax revenue may decrease. This implies that there would be a negative relationship between aid and tax revenue (Bhushan and Samy (2010)). On the other hand, aid may require additional expenditure to be incurred by the government. In order to meet this spending requirement, the government may undertake measures to increase tax revenue.

Annex C: List of variables, definitions and source of data

Variable	Definition	Source	Original Source
Agriculture, value added (% of GDP)	Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.	World Development Indicators (WDI) Database, World Bank	World Bank national accounts data, and OECD National Accounts data files.
GDP per capita, PPP (constant 2011 international $)	GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2011 international dollars.	WDI Database, World Bank	World Bank, International Comparison Program database.
Health expenditure, private (% of GDP)	Private health expenditure includes direct household (out-of-pocket) spending, private insurance, charitable donations, and direct service payments by private corporations.	WDI Database, World Bank	World Health Organization Global Health Expenditure database
Health expenditure, public (% of GDP)	Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds.	WDI Database, World Bank	World Health Organization Global Health Expenditure database
External Health Assistance	The sum of resources channelled towards health by all non-resident institutional units that enter into transactions with resident units or have other economic links with resident units, explicitly labelled for health or not, to be used as mean of payments of health goods and services or as investment in capital goods by financing agents in the government or private sectors. They include donations and loans, in cash and in-kind resources.	WHO, Global Health Expenditure Database	OCED Data and respective Government departments
Net official aid received (current US$)	Net official aid refers to aid flows (net of repayments) from official donors to countries and territories in part II of the DAC list of recipients: more advanced countries of Central and Eastern Europe, the countries of the former Soviet Union, and certain advanced developing countries and territories. Official aid is provided under terms and	WDI Database, World Bank	Development Assistance Committee of the Organisation for Economic Co-operation and Development, Geographical Distribution of Financial Flows to Developing Countries, Development Co-operation Report, and International Development Statistics database. Data are available online at: www.oecd.org/dac/stats/idsonline.

Variable	Definition	Source	Original Source
Net official development assistance received (current US$)	conditions similar to those for ODA. Part II of the DAC List was abolished in 2005. The collection of data on official aid and other resource flows to Part II countries ended with 2004 data. Data are in current U.S. dollars. Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25 percent (calculated at a rate of discount of 10 percent). Data are in current U.S. dollars.		
Number of prevalent tuberculosis cases (estimated)	The number of cases of tuberculosis (all forms) in a population at a given point in time (the middle of the calendar year). It is sometimes referred to as "point prevalence". Estimates include cases of TB in people with HIV.	World Health Organization (WHO)	World Health Organization (WHO)
Polity2 Index	The Polity data series is a widely used data series in political science research. The latest version, Polity IV, contains coded annual information on the level of democracy for all independent states with greater than 500,000 total population and covers the years 1800–2015. For each year and country, a "Polity Score" is determined which ranges from -10 to +10, with -10 to -6 corresponding to autocracies, -5 to 5 corresponding to anocracies, and 6 to 10 to democracies.	Center for Systemic Peace (CSP): Polity IV Annual Report	Center for Systemic Peace (CSP): Polity IV Annual Report
Population (Total)	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. The values shown are midyear estimates.	WDI Database, World Bank	(1) United Nations Population Division. World Population Prospects, (2) United Nations Statistical Division. Population and Vital Statistics Report (various years), (3) Census reports and other statistical publications from national statistical offices, (4) Eurostat: Demographic Statistics, (5) Secretariat of the Pacific Community: Statistics and Demography Programme, and (6) U.S. Census Bureau: International Database.
Population ages 65 and above (% of total)	Population ages 65 and above as a percentage of the total population. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin.	WDI Database, World Bank	The United Nations Population Division's World Population Prospects.
Population, ages 0-14 (% of total)	Population between the ages 0 to 14 as a percentage of the total population. Population is based on the de facto definition of population.	WDI Database, World Bank	The United Nations Population Division's World Population Prospects.

Variable	Definition	Source	Original Source
Tax revenue (% of GDP)	Tax revenue refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue.	WDI Database, World Bank	International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates.
Revenue, excluding grants (% of GDP)	Revenue is cash receipts from taxes, social contributions, and other revenues such as fines, fees, rent, and income from property or sales. Grants are also considered as revenue but are excluded here.	WDI Database, World Bank	International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates.
Trade (% of GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	WDI Database, World Bank	World Bank national accounts data, and OECD National Accounts data files.

Annex D: Descriptive Statistics

Variable	No. of Obs	Mean	Std Dev.	Min	Max	Median
Low Income						
External Health Assistance (% of GDP)	315	0.01	0.01	0.00	0.06	0.01
GDP per capita, (PPP constant 2011 USD)	420	1,186	468	351	2,681	1,167
Improved sanitation (% of pop access)	420	19.62	12.90	2.60	60.80	15.15
Needy Population (% of total population)	420	48.19	2.31	38.90	52.98	48.41
Non-Agricultural Sector (% of GDP)	420	62.45	10.57	34.03	92.59	62.82
Official Aid (% of GDP)	398	14.04	9.04	0.01	62.47	12.73
Other Total Revenue (% of GDP)	203	1.53	1.11	0.06	6.22	1.28
Polity	420	0.91	4.75	(8.00)	9.00	-
Private Health Exp (% of GDP)	304	3.64	1.88	1.40	10.54	3.18
Public Health Exp (% of GDP)	304	2.46	1.09	0.04	6.60	2.27
Tax revenue (% of GDP)	203	11.12	4.10	0.78	26.05	10.70
Total Population (Millions)	420	19.80	18.80	2.94	97.00	12.73
Trade (% of GDP)	395	52.21	18.61	19.68	151.18	47.52
Lower Middle Income						
External Health Assistance (% of GDP)	355	0.01	0.01	-	0.05	0.00
GDP per capita, (PPP constant 2011 USD)	450	4,197	2,165	1,301	10,667	3,626
Improved sanitation (% of pop access)	440	54.11	27.51	7.00	97.80	51.90
Needy Population (% of total population)	450	40.34	5.93	25.68	51.67	41.28
Non-Agricultural Sector (% of GDP)	423	78.11	9.81	34.14	94.58	80.59
Official Aid (% of GDP)	414	6.37	7.00	(0.08)	53.34	4.42
Other Total Revenue (% of GDP)	349	4.65	4.72	0.08	19.18	2.64
Polity	446	3.94	5.38	(10.00)	9.00	6.00
Private Health Exp (% of GDP)	342	2.85	1.53	0.48	11.35	2.65
Public Health Exp (% of GDP)	342	2.58	1.51	0.27	9.55	2.18
Tax revenue (% of GDP)	349	15.37	8.20	4.41	61.02	13.82
Total Population (Millions)	450	98.60	249.00	0.51	1,300.00	15.58
Trade (% of GDP)	435	77.80	34.86	15.24	209.89	71.26
Upper Middle Income						
External Health Assistance (% of GDP)	279	0.00	0.00	-	0.02	0.00
GDP per capita, (PPP constant 2011 USD)	425	10,036	3,436	3,966	24,460	9,782
Improved sanitation (% of pop access)	396	74.58	18.84	24.00	98.60	80.70
Needy Population (% of total population)	400	38.20	4.88	28.29	49.51	38.16
Non-Agricultural Sector (% of GDP)	417	90.46	6.04	59.02	97.97	91.75
Official Aid (% of GDP)	395	3.04	3.91	(2.39)	22.88	1.77
Other Total Revenue (% of GDP)	317	6.89	5.56	(0.00)	29.90	5.04
Polity	285	4.56	5.13	(7.00)	10.00	6.00
Private Health Exp (% of GDP)	323	2.82	1.51	0.51	10.24	2.55
Public Health Exp (% of GDP)	323	3.38	0.88	1.50	6.70	3.26
Tax revenue (% of GDP)	322	18.57	5.32	3.86	30.27	19.08
Total Population (Millions)	425	22.10	43.70	0.07	206.00	3.36
Trade (% of GDP)	424	91.64	38.86	15.16	220.41	94.05

Annex E: Result of Regression Analysis using Overall data across all countries (without Income Categories)

Equation One

The results of the analysis for the tax revenue equation are presented in the table below:

Log (Tax Revenue (% of GDP)) = fn (Log (GDP per capita (PPP constant 2011 USD)), Log (Formal Sector (% of GDP)), Log (Trade (% of GDP)), Log (Other Total Revenue (% of GDP)), Log (Total Population), Log (Official Aid (% of GDP))		
Intercept	(1.62)	***
Log GDP per capita, (PPP constant 2011 USD)	0.04	
Log Formal Sector (% of GDP)	0.74	***
Log Trade (% to GDP)	0.28	***
Log Other Total Revenue (% of GDP)	(0.00)	
Log Total Population	(0.03)	**
Log Official Aid (% of GDP)	0.03	*
R Square	39%	
No of Observations	588	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above regression results indicate that, on an average, across all countries, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in trade leads to a 3 percent increase in tax revenue.
- Formal sector's contribution to GDP has a positive impact on tax revenue, a 10 percent increase in the size of the formal sector leads to a 7 percent increase in tax revenue.
- When normalized for GDP, a 10 percent increase in official aid leads to around 0.3 percent increase in tax revenue.
- A 10% increase in the total population results in a 0.3% decline in tax revenue.
- GDP per capita and other total revenue do not impact tax revenue.

Equation Two

The results of the analysis for the public health expenditure equation are presented in the table below:

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Equator Dummy, Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP))		
Intercept	(0.68)	
Log Tax Revenue (% of GDP)	0.50	***
Log GDP per capita, (PPP constant 2011 USD)	0.29	***
Log Needy Population (% of total population)	(0.21)	
Lag of log Private Health Exp (% of GDP)	0.15	***
Equator Dummy	(0.28)	***
Lag of Log Improved sanitation (% of pop access)	(0.13)	***
Lag of log External Health Assistance (% of GDP)	0.18	***
Log Other Total Revenue (% of GDP)	0.12	***
R Square	53%	
No of Observations	588	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above regression results indicate that using data for all countries together, on an average, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in tax revenue leads to a 5 percent increase in the public health expenditure.
- When normalized for GDP, a 10 percent increase in other total revenue leads to a 1 percent increase in public health expenditure.
- As expected, a 10% increase in GDP per capita leads to a 3 percent increase in public health expenditure as a percentage of GDP.
- When normalized for GDP, a 10 percent increase in external health assistance in the previous year increases public health expenditure by 2 percent.
- Contrary to expectation, governments of countries located closer to the equator spend less on health than those located away from the equator.
- A 10 percent increase in private health expenditure in the previous year increases public expenditure on health in the current year by 2 percent.
- Improved sanitation access as percentage of population in the previous year decreases public health expenditure in the current year.
- The proportion of needy population does not impact public health expenditure.

Annex F: Overall Regression Results (including Income Categories)

Equation One

The results of the analysis for the tax revenue equation for the overall model with income categories (income dummies) are presented in the table below:

Log (Tax Revenue (% of GDP)) = fn (Log (GDP per capita (PPP constant 2011 USD)), Log (Formal Sector (% of GDP)), Log (Trade (% of GDP)), Log (Other Total Revenue (% of GDP)), Log (Total Population), Log (Official Aid (% of GDP)), Income Dummy		
Intercept	(1.07)	*
Log GDP per capita, (PPP constant 2011 USD)	(0.05)	
Log Formal Sector (% of GDP)	0.66	***
Log Trade (% to GDP)	0.30	***
Log Other Total Revenue (% of GDP)	(0.01)	
Log Total Population	(0.01)	
Log Official Aid (% of GDP)	0.03	**
Lower Middle Income Dummy	0.13	**
Upper Middle Income Dummy	0.31	***
R Square	40%	
No of Observations	588	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above regression results indicate that using data for all countries together with dummy indicators for each group, on an average, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in trade leads to a 3 percent increase in tax revenue.
- Formal sector's contribution to GDP has a positive impact on tax revenue, a 10 percent increase in the size of the formal sector leads to a 7 percent increase in tax revenue.
- When normalized for GDP, a 10 percent increase in official aid leads to around 0.3 percent increase in tax revenue.
- As expected, compared to low income countries, lower middle income countries and upper middle income countries have a higher tax revenue as a percentage to GDP.
- GDP per capita, other government revenue and total population does not impact tax revenue.

Equation Two

The results of the analysis for the public health expenditure equation across all countries with income categories are presented in the table below:

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Equator Dummy, Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP)), Income Dummy		
Intercept	0.48	
Log Tax Revenue (% of GDP)	0.50	***
Log GDP per capita, (PPP constant 2011 USD)	0.24	***
Log Needy Population (% of total population)	(0.42)	**

Lag of log Private Health Exp (% of GDP)	0.10	***
Equator Dummy	(0.28)	***
Lag of Log Improved sanitation (% of pop access)	(0.06)	
Lag of log External Health Assistance (% of GDP)	0.18	***
Log Other Total Revenue (% of GDP)	0.11	***
Lower Middle Income Dummy	(0.25)	***
Upper Middle Income Dummy	(0.05)	
R Square	56%	
No of Observations	588	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above regression results indicate that using data for all countries together (with dummy variables for country groups), on an average, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in tax revenue leads to a 5 percent increase in the public health expenditure.
- As expected, a 10 percent increase in GDP per capita leads to a 2 percent increase in public health expenditure as a percentage of GDP.
- When normalized for GDP, a 10 percent increase in external health assistance in the previous year increases public health expenditure by 2 percent in the current year.
- Contrary to expectation, governments of countries located closer to the equator spend less on health than those located away from the equator.
- When the proportion of needy population is higher, the public expenditure on health as a proportion of GDP is lower, which is not in line with expectations.
- A 10 percent increase in the previous year private health expenditure increases public expenditure on healthcare by 1 percent in the current year.
- Improved sanitation access as percentage of population in the previous year has no relationship with public health expenditure.
- When normalized for GDP, a 10 percent increase in other total revenue increases public health expenditure by 1 percent.
- Lower middle income countries spend less on public health expenditure compared to low income countries. In the case of upper middle income countries, public health expenditure is not significantly different from low income countries.

Annex G: 2SLS model with fixed effects and total population

The results of the 2SLS fixed effect regression analysis for the public health expenditure equation with total population are presented in the table below:

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP), Log(Lag No. of prevalence TB cases), Governance Index (Polity), Log Total Population, Country Dummy, Year Dummy)						
	Low Income		**Lower Middle Income**		**Upper Middle Income**	
Intercept	30.20		23.23	***	23.25	***
Log Tax Revenue (% of GDP)	1.58	***	0.07		0.11	
Log GDP per capita, (PPP constant 2011 USD)	(1.66)	***	(0.34)	**	(0.40)	**
Log Needy Population (% of total population)	7.88	**	(0.36)		(0.30)	
Lag of log Private Health Exp (% of GDP)	0.06		0.09		(0.15)	***
Lag of Log Improved sanitation (% of pop access)	(0.36)		(0.12)		(0.15)	
Lag of log External Health Assistance (% of GDP)	0.08		0.02	*	0.00	
Log Other Total Revenue (% of GDP)	0.03		0.09	**	0.14	**
Lag of log Number of TB cases	(0.62)		(0.04)		(0.19)	***
Governance Index (Polity)	0.02		0.01	***	0.00	
Log Total Population	(2.51)		(1.05)	***	(0.95)	**
R Square	89%		95%		93%	
Adjusted R Square	85%		94%		91%	
No of Observations	147		252		158	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above 2SLS regression results indicate that using data by income group, on an average, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in tax revenue leads to 16 percent increase in the public health expenditure in the low income countries. In the case of lower middle and upper middle income countries, tax revenue does not impact public health expenditure.
- Increase in the proportion of needy population increases public expenditure on health as a proportion of GDP in low income countries. In the case of lower and upper middle income groups, the proportion of needy population does not have any impact on public health expenditure.
- A 10 percent increase in private health expenditure in the previous year decreases the public health expenditure by 2 percent in the current year in upper middle income group. In the case of low and lower middle income groups; there is no relationship between these two variables.
- When normalized for GDP, a 10 percent increase in previous year's external health assistance increases public health expenditure in the current year by 0.2 percent in lower middle income countries. It has no impact on public health expenditure in low income and upper middle income countries.

- A 10 percent increase in the other total revenue leads to a 1 percent increase in public health expenditure in the current year in both lower middle income and middle income countries. In the case of low income countries, other government revenue does not have any impact on public health expenditure.

- It is observed that an increase in the number of TB cases in the previous year leads to a decrease in public health expenditure in the current year in the upper middle income group. In the low income and lower middle income groups, TB prevalence does not impact public health expenditure.

- In the lower middle income group, countries' governance index (polity) has a positive impact on public health expenditure; but it does not have any impact on public health expenditure in the low income and upper middle income countries.

- Increase in the total population leads to a decrease in the public health expenditure as a proportion of GDP in lower and upper middle income countries. In the case of low income countries, total population does not have any impact on public health expenditure.

- In the case of all groups, a negative relationship is observed between GDP per capita and public health expenditure.

- For all income groups, improved sanitation access in the previous year has no impact on current year's public health expenditures.

Annex H: First difference model with fixed effects

The results of the analysis for the public health expenditure equation are presented in the table below. The first difference of all the variables has been taken in this fixed effects model to ensure that there is no issue of serial correlation[30]:

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP), Log(Lag No. of prevalence TB cases), Governance Index (Polity), Country Dummy, Year Dummy)				
	2SLS		**OLS**	
Intercept	0.09		0.00	
FD Log Tax Revenue (% of GDP)	0.92	**	0.41	**
FD Log GDP per capita, (PPP constant 2011 USD)	(0.52)	*	(0.35)	
FD Log Needy Population (% of total population)	1.13		0.61	
FD Lag of log Private Health Exp (% of GDP)	0.11		0.02	
FD Lag of Log Improved sanitation (% of pop access)	1.91		0.18	
FD Lag of log External Health Assistance (% of GDP)	(0.01)		(0.01)	
FD Log Other Total Revenue (% of GDP)	0.07	**	0.09	***
FD Log Number of TB cases	0.09		0.04	
FD Governance Index (Polity)	0.00		0.00	
R Square	13%		26%	
Adjusted R Square	-1%		14%	
No of Observations	503		531	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.

The above 2SLS and OLS first difference regression results indicate that using data for all countries together, on an average, holding all other factors in the model constant:

- When normalized for GDP, an increase in change in tax revenue leads to increase in change in the public health expenditure with both the approaches.
- Contrary to expectation, increase in change in GDP per capita leads decrease in change in public health expenditure as a percentage of GDP when we use 2SLS (in the case of OLS, there is no relationship between the two).
- An increase in change in the other total revenue leads to an increase in change in public health expenditure in the current year in the case of both the approaches.
- External health assistance, proportion of needy population, private health expenditure, improved sanitation, number of TB cases, governance index (polity) do not have an impact on public health expenditure (with both approaches).

30 Jeffrey M. Wooldridge, 2009, *Introductory Econometrics (Forth Edition)*, Chapter 12 - Serial Correlation and Heteroskedasticity in Time Series Regressions, P.427

Annex I: 2SLS model considering all stationary variables (with fixed effects)

The results of the fixed effect analysis for the public health expenditure equation when the variables are stationary are presented in the table below:

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP), Log(Lag No. of prevalence TB cases), Governance Index (Polity), Country Dummy, Year Dummy)							
	Low Income			**Lower Middle Income**		**Upper Middle Income**	
Intercept	15.02	**		(4.89)		(2.21)	
Log Tax Revenue (% of GDP)	1.06	**		0.81	***	0.01	
Log GDP per capita, (PPP constant 2011 USD)	(1.57)	***		0.20		(0.43)	*
Log Needy Population (% of total population)	(7.83)			0.03		0.31	
Lag of log Private Health Exp (% of GDP)	0.02			0.17	*	0.09	
Lag of Log Improved sanitation (% of pop access)	(0.00)			0.22		0.24	
Lag of log External Health Assistance (% of GDP)	0.16			0.02		0.01	
Log Other Total Revenue (% of GDP)	0.14			0.18	***	0.00	
Lag of log Number of TB cases	(0.40)			0.26	**	0.02	
Governance Index (Polity)	0.02	*		0.01		(0.00)	
R Square	90%			93%		34%	
Adjusted R Square	86%			92%		14%	
No of Observations	146			240		149	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.
The first differences of the following variables are considered:
Low Income Countries: Needy Population (% of total population), Trade (% to GDP), Official Aid (% of GDP)
Lower Middle Income Countries: GDP per capita (PPP constant 2011 USD), Private Health Exp (% of GDP), Formal Sector (% of GDP), Trade (% to GDP)
Upper Middle Income Countries: GDP per capita (PPP constant 2011 USD), Private Health Exp (% of GDP), Official Aid (% of GDP), Public Health Exp (% of GDP)

The above 2SLS results indicate that using data by income group, on an average, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in tax revenue leads to 11 percent increase in the public health expenditure in the low income countries, 8 percent in the lower middle income countries, and 0.1 percent increase in the case of upper middle income countries.

- When normalized for GDP, an increase in private health expenditure in the previous year positively relates with public health expenditure in the current year in lower middle income countries. In the case of other income groups, private health expenditure does not impact public health expenditure.

- A 10 percent increase in the other total revenue leads to a 2 percent increase in public health expenditure in the current year in lower middle income countries. In the case of the other groups, other government revenue does not have any impact on public health expenditure.

- As expected, it is observed that a 10 percent increase in the number of TB cases in the previous year leads to a 3 percent increase in the health expenditure in the current year in the lower middle income countries. In the low income and upper middle income countries, TB prevalence does not impact public health expenditure.
- In the low income group, government polity index has a positive impact on public health expenditure. Whereas in the lower and upper middle income groups, it does not have any impact.
- For all income groups, external health assistance in the previous year, proportion of needy population and improved sanitation population to access do not impact public health expenditures.

Annex J: OLS model considering all stationary variables (with fixed effect)

The results of the OLS regression analysis for the public health expenditure equation, when all variables are stationary, are presented in the table below:

Log (Public Health Exp (% of GDP)) = fn (Log (Tax Revenue (% of GDP)), Log (GDP per capita (PPP constant 2011 USD)), Log (Lag Private Health Exp (% of GDP)), Log (Lag External Health Assistance (% of GDP)), Log (Needy Population), Log(Lag Improved Sanitation), Log (Other Total Revenue (% of GDP), Log(Lag No. of prevalence TB cases), Governance Index (Polity), Country Dummy, Year Dummy)							
	Low Income			**Lower Middle Income**		**Upper Middle Income**	
Intercept	14.46	**		4.33	**	(2.21)	
Log Tax Revenue (% of GDP)	0.91	***		0.25	***	0.05	
Log GDP per capita, (PPP constant 2011 USD)	(1.55)	***		(0.17)		(0.41)	**
Log Needy Population (% of total population)	(9.59)			(0.91)	***	0.32	
Lag of log Private Health Exp (% of GDP)	(0.01)			0.11		0.09	
Lag of Log Improved sanitation (% of pop access)	0.61	***		(0.32)	*	0.16	
Lag of log External Health Assistance (% of GDP)	0.22	***		0.03	**	0.01	
Log Other Total Revenue (% of GDP)	0.14	***		0.12	***	0.02	
Lag of log Number of TB cases	(0.47)			0.06		0.04	
Governance Index (Polity)	0.02			0.01	*	(0.01)	
R Square	89%			95%		35%	
Adjusted R Square	85%			94%		15%	
No of Observations	163			248		154	

Note: Levels of significance at 1% (***), 5% (**) and 10% (*) percent.
The first differences of the following variables are considered:
Low Income Countries: Needy Population (% of total population), Trade (% to GDP), Official Aid (% of GDP)
Lower Middle Income Countries: GDP per capita (PPP constant 2011 USD), Private Health Exp (% of GDP), Formal Sector (% of GDP), Trade (% to GDP)
Upper Middle Income Countries: GDP per capita (PPP constant 2011 USD), Private Health Exp (% of GDP), Official Aid (% of GDP), Public Health Exp (% of GDP)

The above OLS regression results indicate that using data by income group, on an average, holding all other factors in the model constant:

- When normalized for GDP, a 10 percent increase in tax revenue leads to 9 percent increase in the public health expenditure in the low income countries, 3 percent in the lower middle income countries, and 0.5 percent increase in the case of upper middle income countries.
- When normalized for GDP, a 10 percent increase in previous year's external health assistance increases public health expenditure in the current year by 2 percent in low income countries and 0.3 percent in lower middle income countries. In the case of upper middle income countries, external health assistance does not impact public health expenditure.
- A 10 percent increase in the other total revenue leads to a 1 percent increase in public health expenditure in the current year in both low income and lower middle income groups. In the case of the upper middle income group, other government revenue does not have any impact on public health expenditure.
- Contrary to expectation, when the proportion of needy population is higher, the public expenditure on health as a proportion of GDP is lower in the lower middle income group.

However, in the low income and upper middle income groups it does not have any impact on public health expenditure.

- Improved sanitation access as percentage of population in the previous year increases the public health expenditure in the current year in low income group and decreases public health expenditure in lower middle income group. In the case of the upper middle income group, improved sanitation does not impact public health expenditure.
- A negative relationship is observed between GDP per capita and public health expenditure in the low income and upper middle income groups. The two are unrelated in case of the lower middle income countries.
- In the case of the lower middle income group, governance index (polity) has a positive impact on public health expenditure. In low and upper middle income groups, it does not have any impact on public health expenditure.
- For all income groups, previous year's private health expenditure and number of TB cases have no impact on current year's public health expenditures.