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Michael Simon, Daniel Tsegai and Steffen Fleßa

Intersectoral Health Action in Tanzania – Determinants and Policy Implications

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ABBREVIATIONS AND ACRONYMS

2SLS	Two-Stage-Least-Squares
3SLS	Three-Stage-Least-Squares
ARI	Acute Respiratory Infection
BEST	Basic Education Statistics Tanzania
D-by-D	Decentralization by Devolution
DALYs	Disability Adjusted Life Years
DISC	Diagnosis of Sustainable Collaboration
ESDP	Education Sector Development Programme
EWURA	Energy and Water Utilities Regulatory Authority
FBOs	Faith-Based-Organizations
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
HiAP	Health in All Policies
HMIS	HIV/AIDS and Malaria Indicator Survey
HSBF	Health Sector Basket Fund
IHA	Intersectoral Health Action
IFPRI	International Food Policy Research Institute
IHI	IFAKARA Health Institute
IPT	Intermittent Preventive Treatment
ITNs	Insecticide-Treated Bed Nets
LGAs	Local Government Authorities
MDG	Millennium Development Goals
MoEVT	Ministry of Education and Vocational Training
MOF	Ministry of Finance
MoHSW	Ministry of Health and Social Welfare
MoWI	Ministry of Water and Irrigation
MSPAS	Ministry of Public Health and Social Assistance, El Salvador
NBS	National Bureau of Statistics
NGO	Nongovernmental Organization
NIP	Nutrition Improvement Project

OLS	Ordinary Least Squares
PASHA	Prevention and Awareness in Schools of HIV/AIDS
PMO-RALG	Prime Minister's Office Regional Administration and Local Government
PHAC	Public Health Agency of Canada
PTR	Pupils-Teacher-Ratio
SDOH	Social Determinants of Health
SEM	Simultaneous Equation Model
SRH	Sexual and Reproductive Health
SWAP	Sector Wide Approach
TACAIDS	Tanzania Commission for AIDS
TDHS	Tanzania Demographic and Health Survey
TGPSH	Tanzanian German Programme to Support Health
URT	United Republic of Tanzania
WHO	World Health Organization
WSDP	Water Sector Development Program
ZEF	Zentrum für Entwicklungsforschung / Center for Development Research

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ABSTRACT

The tremendous human resource and economic burden of HIV/AIDS, malaria and diarrhoeal diseases is well acknowledged in many developing countries. Most of these diseases have multifaceted causes such as malnutrition, the consumption of contaminated water or poor education. Thus, cross-sectoral action is needed to lower the burden of disease in the long run.

However, little has been done to investigate the causal relationship between investments in 'health related' sectors and the reduction of disease prevalence. This paper aims at analysing the marginal health returns to cross-sectoral government spending for the case of Tanzania. For this, the normative assumption is to maximise the amount of Disability Adjusted Life Years (DALYs) averted per dollar invested. A Simultaneous Equation Model (SEM) is developed to estimate the required elasticities. The results of the quantitative analysis show that the highest returns on DALYs are obtained by improved nutrition and access to safe water sources, followed by sanitation. Looking at the impact of indirect factors, the health effect of investments in mother education exceeds the effect of additional short- and long-term public spending on water.

Key words: Health Promotion, Public Health Policy, Intersectoral Health Action, Disability Adjusted Life Years, Health Determinants, Cost-effectiveness, Tanzania

1. Introduction

Human capital investments are critical for the development and growth of nations. In addition to education and training, health care is the most crucial factor to increase the productive capacity of people (Hayami & Gōdo, 2005). The Millennium Development Goals (MDGs), defined in the year 2000, addressed this challenge by calling for a reduction of child mortality rates (MDG4), an improvement of maternal health (MDG5) and the combat of HIV/AIDS, malaria and other diseases (MDG6). Developing countries still face extreme health resource scarcity and an enormous burden of disease among the poor, due to the vicious circle of poverty and ill health. One example of a country facing these problems is the United Republic of Tanzania (Tanzania), said to have a highly inefficient health system (Makundi et al., 2007) with a very low physician/population ratio compared to other developing countries (Munga and Maestad, 2009).

Most of the common diseases in Tanzania have multifaceted causes, led by malnutrition and poor water supply. Thus, cross-sectoral action is needed to strengthen the health status of the population. According to the Government of Tanzania (2010), the “recognition of cross-sectoral contribution to outcomes and inter-sectoral linkages and synergies“ are one of the major prerequisites for the implementation of the Tanzanian poverty reduction strategy MKUKUTA. Each of the governments major sectors has it’s own prime objectives. Health is one of these major sectors, but improving health affects all other sectors in achieving their objectives. However, should the government spend more on health care, education, infrastructure or agricultural research to fight against the intolerable burden of disease? Tanzania faces a tight government budget that is already supported by the donor community to a large extent. Consequently, politicians need to know the health impact of additional investment in health related areas to use the given resources most efficiently and to use synergies in allocating preventive health resources.

So far, evidence regarding the relative size of the impact of cross-sectoral spending on health has been limited. This paper aims to provide the needed information for future policy making. For this, marginal health returns to cross-sectoral government expenditures are identified with the help of a quantitative budget analysis. The underlying normative concept to measure these elasticities is to calculate the amount of DALYs that can be saved per additional dollar invested.

The study benefits from secondary data on social indicators and public spending within a Simultaneous Equation Model (SEM).

The paper is organised as follows. In section 2, the groundwork of various authors regarding both, the need for IHA and the relative importance of certain sectors is presented. This is followed by a brief introduction to the Tanzanian health system, decentralisation processes and the current burden of disease in section 3.1. Moreover, the geographical distribution of health spending will be described in this section. The current situation of health related sectors such as the agriculture, water, sanitation and education sector will be described in section 3.2, supplemented by a budget analysis regarding the geographical distribution of public spending. In the following, the theoretical underpinnings of cross-sectoral collaboration for health are discussed with regards to the incentives and conditions to form coalitions aiming at the improvement of public health. The subsequent section 4.2 derives a SEM to model the outcomes of these coalitions. This is followed by the quantitative analysis including the description of data sources and a discussion of estimation methods and major results. Finally, conclusions, policy recommendations and limitations of the study are presented at the end of the paper.

2. Literature Review

The need for a comprehensive health care strategy including IHA was mentioned first at the Alma-Ata conference on Primary Health Care in 1978. Further initiatives such as the Ottawa Charter for Health Promotion (1980s), the WHO conference on IHA (1990s) and the Bangkok Charter for Health Promotion (2000) supported the idea to work across sectoral boundaries (PHAC, 2007). In the corresponding literature, a clear consensus does exist regarding the necessity of IHA to fight against the high burden of disease existing in many developing countries (O'Neill et al., 1997, Benson, 2007 etc.). Various concepts and efforts, such as the Social Determinants of Health (SDOH) project initiated by WHO or the Health in All Policies (HiAP) approach of the European Union have been developed to implement IHA in practice (Kickbusch and Buckett, 2010). Such collaboration efforts need to include the major sectors related to health, namely the agriculture, education, water and housing sector (World Health Assembly, 1986). The correlation of interventions in these sectors with the health status of the population will be discussed when developing the conceptual framework in section 4.1.

Various methodological approaches have been utilized to evaluate IHA. Case studies from Uganda (Mutambi et al., 2007), Ecuador (Vega C., 2007) and El Salvador (MSPAS, 2007) have used qualitative methods such as the analysis of key documents or direct interviews with government officials and local health workers to assess IHA in practice. In the case of South Australia, the effectiveness of the HiAP model was measured in three dimensions: process evaluation, impact evaluation and outcome evaluation (Kickbusch and Buckett, 2010). However, in most of these studies it was to early to draw conclusions about the effectiveness of IHA and the adequacy of the applied evaluation method because the initiatives just had started or the period of time considered was to short.

A method to assess cross-sectoral collaboration efforts in a quantitative manner is sectoral budget analysis. Fan has used this method to build a SEM aiming at the exploration of the relative impacts of cross-sectoral government expenditures such as education and health on poverty reduction in the case of India (2000), China (2002), Uganda (2004) and Tanzania (2005). For the case of Tanzania, he found that additional public investment in education, roads and agricultural research has favourable impacts on poverty reduction. Besides budget analysis, numerous authors have explored the socioeconomic underpinnings of health. For example, the results of Lee and Paxmann (1997) indicate that premature mortality in the United States is attributed to genetic factors (20%), environmental factors (20%), inadequacies in the health system (10%) and life-style (50%). Similar to this, a meta-analysis regarding the impact of various domains on the health of the population has been carried out by Mc Ginnis et al. (2002). The authors concluded that genetic predisposition (30 percent), social circumstances (15 percent), environmental exposure (5 percent), behavioural patterns (40 percent) and expenditures in medical care (10 percent) are responsible for early death in the United States.

Consequently, it is clear that IHA plays a large role in promoting public health. However, the relative size of the impact of cross-sectoral interventions on health differs among health related sectors. Thus, there is a need to measure these effects, as requested by various authors (e.g. Kindig et al., 2003). Due to the lack of quantitative monitoring instruments, this paper applies sectoral budget analysis as a new approach to evaluate the effect of IHA. To overcome the challenge of short periods of investigation mentioned by previous studies above, time-series data of almost 15 years is used in the analysis.

3. Public Health in Tanzania

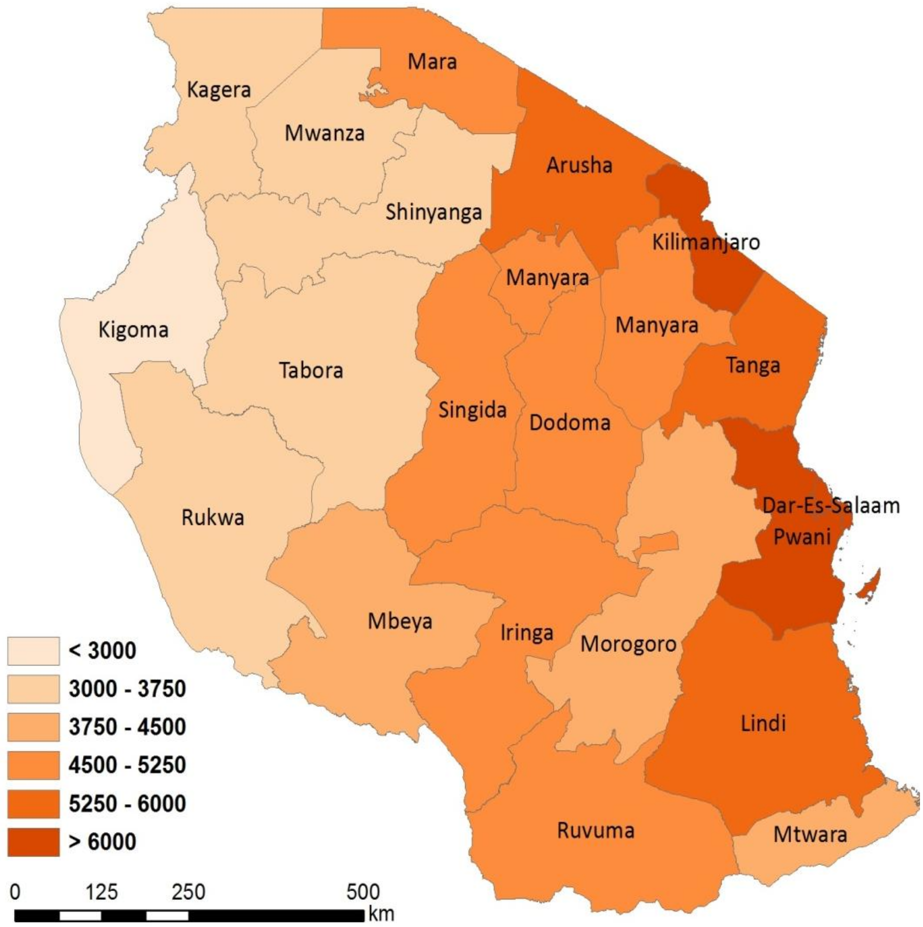
The following section discusses the current health system in Tanzania and reform movements, which have changed the health sector during the previous decades. In section 3.2, trends and public expenditure of health related sectors will be evaluated.

3.1 Health System Reforms and the Burden of Disease

With the beginning of the new millennium, Tanzania started to implement various health reforms planned during the 1990s. It was one of the leading countries that adopted a sector-wide approach (SWAP) for medium and long-term planning. This approach shifted the existence of many different vertical programmes of numerous actors to a joint initiative in which government and donor institutions finance the health sector within a coherent policy. The objective of a SWAP was to increase the coordination within the health sector and to strengthen national leadership, health management and service delivery (Hutton and Tanner, 2004). As requested in the poverty-reduction strategy MKUKUTA, interventions to improve child survival such as Integrated Management of Childhood Illness (IMCI), insecticide-treated nets, immunization or vitamin A supplementation were scaled up (Masanja et al., 2008). Difficulty remains in the evaluation of these reforms. After a decade of working with a health SWAP in Tanzania, its impact has received a mixed review (Zinnen & Robert, 2010). Programs of health related sectors such as Nutrition Improvement Projects (NIPs) have been implemented since the early 80s. However, the success of these programs was constraint by high transaction costs caused by great disharmony of the institutions involved (Msuya, 1999).

Today, funding sources used to finance the Tanzanian health sector include the governments' budget, the above noted Health Sector Basket Fund (HSBF) comprised of funds from development partners, collected user-fees and funds from health insurances and NGOs (Boex, 2008). All these resources compete with the financial needs of other sectors. Although nominal health resource allocation increased during the last few years, the government has failed to reach an annual growth rate of 24% intended in the Health Sector Strategy Plan (URT, 2009). Moreover, health spending as a percentage of total government spending declined from 14.1% in the financial year 2005/2006 to 11.2% in 2008/2009. Per capita health spending increased from US$ 11.29 in 2007/2008 to US$ 13.46 in 2008/2009, but remains far below the target of US$ 34 recommended by WHO to address health challenges (URT, 2009). Financial health resources channelled through the government sector are distributed to the regions and districts according to an allocation formula, which takes into account the population size (70%), poverty level (10%), the district medical vehicle route (10%) and under-five mortality (10%) (URT, 2007). However, actual regional per capita health spending (excluding the central level, map 1) strongly varies across the regions, reaching from 2.723 Tanzanian Shillings (US$ 1.68) in Kigoma region to 6.482 Tanzanian Shillings (US$ 4.00) in Kilimanjaro region. Neglected regions with low per capita Gross Domestic Product (GDP) such as Kagera, Shinyanga, Tabora or Kigoma (see section 3.2) also receive low per capita health investments. In contrast, more developed areas with higher per capita GDP receive more financial resources (e.g. Arusha, Kilimanjaro, Tanga). For a pro-poor policy, the investment strategy should be the reverse.

Map 1: Regional per Capita Health Investment at Current Prices, 2010 (in Tanz. Shillings)



Data source: Login Tanzania Database 2011 (mapped by the author)

The current burden of disease in Tanzania has been evaluated by the latest Tanzania Demographic Health Survey (DHS / URT, 2010), a nationally representative survey of 10,300 households selected from 475 sample points throughout Tanzania. According to the survey, the country was successful in reducing their under-5 child mortality rate from 147 deaths per 1000 live births in 1999 to 81 deaths per 1000 live births in 2010. Similarly, the infant mortality rate declined from 68 in 2005 to 51 in 2010 (deaths per 1000 live births, respectively). This is well on track to achieve MDG 4 (TGPSH, 2010).

HIV/AIDS still causes the highest amount of annual DALYs lost compared to other diseases, with 3,276,000 of 18,189,000 total annual DALYs (WHO, 2009). However, HIV prevalence slightly decreased from 7% in 2003/2004 to 6% in 2007/2008 according to HIV/AIDS and Malaria Indicator Surveys (HMIS, URT, 2005/2008). The level of HIV infection is higher for urban residents compared to rural residents (9 and 5 percent, respectively). Increased use of contraceptive methods also contributed these achievements. The use of contraceptives relies heavily upon cross-sectoral investments in education, as evidence by the increased usage from 22 percent of married women with no education to 52 percent of married women with at least secondary education (URT, 2011). The prevalence of Malaria is the second largest cause of annual DALYs lost in Tanzania (1,6440,000 DALYs). Efforts to reduce this burden of disease include the distribution of insecticide-treated bed nets (ITNs) and antimalaria drugs. In 2010, three in four Tanzanian households owned at least one mosquito net, but the percentage of households who owned an ITN was only 64. There is also an increasing distribution of intermittent preventive treatment (IPT) to prevent pregnant women from suffering malaria. The percentage of women who received the needed amount of IPTs (IPT-2) increased from 22% in 2004/2005 to 30% in 2007/2008.

Furthermore, acute respiratory infection (ARI) is one of the leading causes of morbidity and mortality in Tanzania (1,478,000 annual DALYs). Pneumonia is the most serious type of ARI for young children. Fortunately, the prevalence of ARI symptoms among children under the age of five declined from 8 percent in 2004/2005 to 4 percent in 2010 (URT, 2011). An additional, tremendous amount of 1,150,000 DALYs lost is caused by diarrhoeal diseases. Dehydration is a major health risk especially among young children. Cross-sectoral investments in water and sanitation are needed to prevent unhygienic practices and the use of polluted water, the two main causes of diarrhoeal diseases. According to the DHS, the prevalence of diarrhoea increased slightly from 12.6 percent in 2004/2005 to 14.6 % in 2010.

3.2 Health Related Sectors: Status Quo and Trends in Public Expenditure

Besides direct public investments in health, the expenditures on health related sectors such as education, water and agriculture highly influence the health status of the Tanzanian people through various channels. Total government expenditures including all sectors in 2010 constant Tanzanian shillings increased from 2,373 billion during the budget year 1999/2000 to 10,750 billion in 2010/2011 (Table 1)[1]. This corresponds to an annual growth rate of 14.7 percent. In relation to GDP at market prices, public expenditure steadily increased from 17 percent in 1999/2000 to 33 percent 2010/2011, which is consistent with the average in developing countries in Sub-Saharan Africa (World Bank, 2012).

Table 1: Government Expenditure on Major Sectors, 2010 constant billion Tanz. shillings[2]

Year	Education	Health	Water	Agriculture	Total Government Expenditure	GDP (market prices)
1999/00	443.17	165.07	29.48	43.91	2,373.39	13,927.26
2000/01	481.72	190.30	34.58	36.10	2,405.36	16,303.48
2001/02	618.93	255.00	58.32	57.25	2,625.04	17,536.16
2002/03	730.88	312.83	86.96	100.87	3,333.54	18,893.68
2003/04	661.88	334.03	94.25	181.23	3,888.64	20,145.42
2004/05	1,021.39	455.62	207.31	177.72	4,702.89	21,608.81
2005/06*	908.14	496.19	216.90	228.83	5,473.40	22,995.85
2006/07*	1,148.24	550.67	244.67	251.89	6,249.61	25,053.31
2007/08*	1,284.04	697.47	365.47	448.11	7,173.15	26,529.82
2008/09	1,517.28	798.48	250.52	318.60	7,807.71	27,434.52
2009/10	1,716.50	787.20	347.30	472.30	9,532.70	31,109.00
2010/11	2,062.31	1,116.57	350.28	836.85	10,749.63	32,175.93

* Budget Data available only

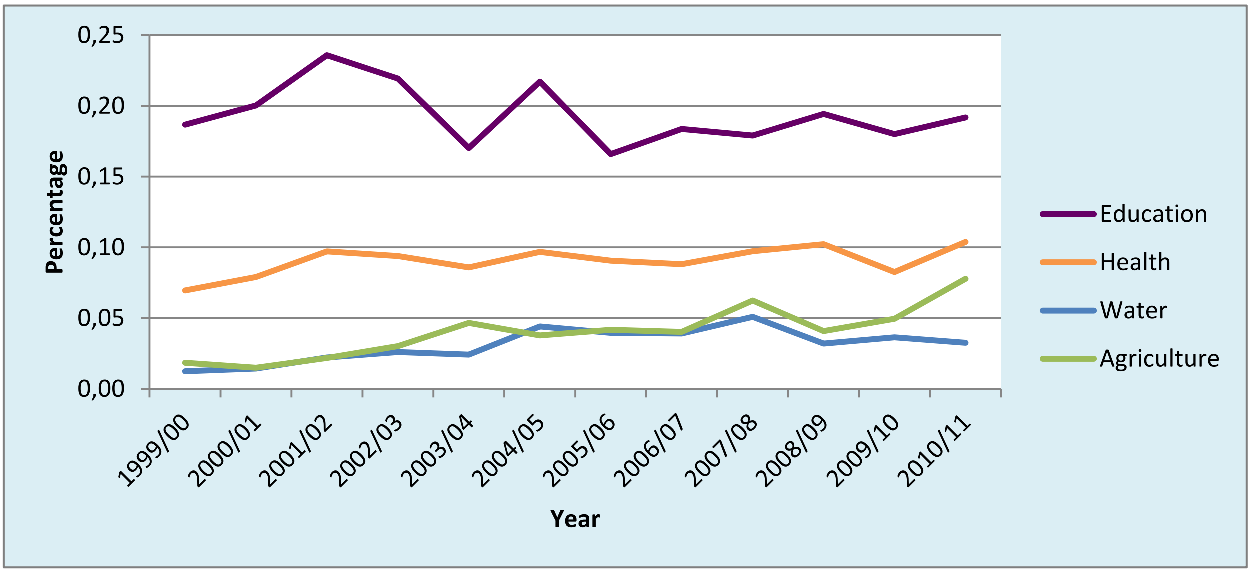
Source: Ministry of Finance

Within the government's discretionary budget, more than 60 percent is allocated to six key sectors including education, health, water, agriculture, roads and energy. This share increased by more than 10 percent during previous budget years (URT, 2011). On average, the education sector received most of the allocated funds (19 percent), followed by health (9 percent), agriculture (4 percent) and water (3 percent, see figure 1). Based on the normative assumption of maximizing the amount of DALYs saved, the optimal allocation of funds to these priority

[1] All government expenditures have been converted into 2010 constant prices using the GDP deflator.
[2] 1 USD = 1560 Tanzanian Shillings.

sectors will be examined in section 5.2.

Figure 1: Government Expenditure on Major Sectors (percentage)

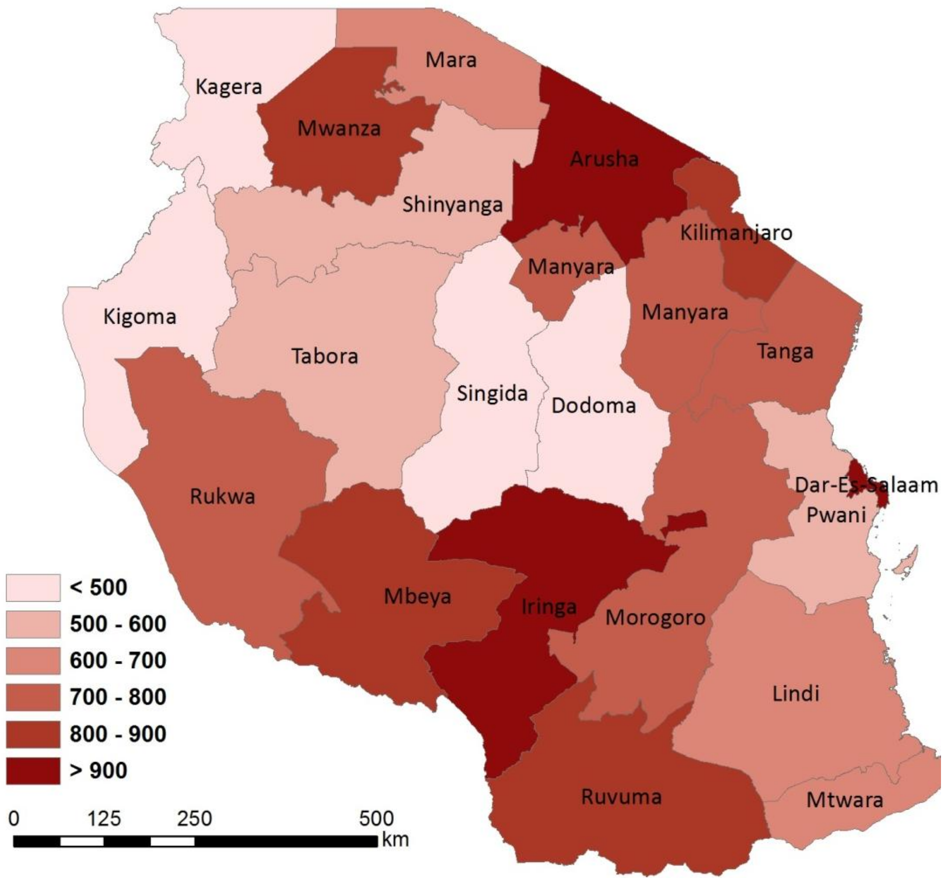


Source: Authors calculations / Ministry of Finance

The GDP per capita is a widely used indicator to assess the income and wealth situation of a certain geographical area. In turn, income and wealth influence public health through various channels (see section 4.2). Total GDP at market prices rose from about 14 billion Tanzanian shillings in 1999/2000 to about 32 billion Tanzanian shillings in 2010/2011 (table 1). This corresponds to an average annual growth rate of 7.9%, which is remarkably high compared to other developing countries in Sub-Saharan Africa (4.4%) and OECD countries (1.9%). However, the today's per capita GDP remains at a very low level of 824,000 current Tanzanian shillings (527 current US Dollars) with high differences across regions (map 2). The percentage of people living with less than 1.25 PPP-dollars a day was still 68 percent in 2007 (World Bank, 2012). As stated in section 3.1, poor regions do not receive higher amounts of public health investment as compared to richer regions.

About 85 percent of the local population in Tanzania work in the agricultural sector, providing food, medicines and raw material for domestic and foreign industries (URT, 2010). Since a large share of the food produced is consumed domestically, the developments in this sector directly influence the nutritional status of the people, which in turn affects productivity, susceptibility to infections and recovery time from illness. The allocation of funds to agriculture relative to the total budget increased from 2 percent during the budget year 1999/2000 to 8 percent in 2010/2011 (figure 1). In absolute figures, the agricultural budget rose from 43.91 to 836.85 billion Tanzanian shillings during the same time.

Map 2: Regional per Capita GDP at Current Prices, 2010 (in thousand of Tanzanian Shillings)



Source: National Bureau of Statistics / Ministry of Finance (2011)

There are large regional variations in per capita agricultural spending in favour of wealthier regions such as Arusha, Kilimanjaro or Ruvuma (Appendix 1). In general, these resources consist of subsidies for agricultural inputs such as fertilizer, improved seeds and agro chemicals as well as agricultural research and extension. As mentioned above, weaknesses in the agricultural production directly influence the food security in rural areas. The Tanzanian DHS 2010 shows that 42 percent of children under 5 are stunted or have low height-for-age, 5 percent have low weight-for-height or are wasted and 16 percent have low weight-for-age. These results show the prevalence of chronic and acute under nutrition in Tanzania. Cross-sectoral efforts are also needed in the field of nutrition, as children with mothers who have at least some secondary education were less likely to have micronutrient deficiencies (e.g. using inadequately iodised salt) than others (URT, 2011).

Public expenditure to improve access to safe water resources is critical to prevent unhygienic practices and the use of polluted water for food preparation, both of which can lead to water-borne diseases such as diarrhoea and cholera. For the period of 1999/2000 to 2010/2011, the budget of the water and sanitation sector increased from 29.48 to 350.28 billion Tanzanian shillings (table 1). This corresponds to an average increase of 25.2 percent per year. In relative terms, the budget share allocated to water and sanitation fluctuated between 1 and 5 percent with an average of 3 percent (figure 1). Landlocked and low-income areas receive comparably less than other regions (Appendix 2).

MDG 7 aims at halving the proportion of the population without sustainable access to safe drinking water and basic sanitation (United Nations, 2011). In the case of Tanzania, 68.3 percent of households have access to safe water sources, with a minimum of 45.0 percent in Shinyanga region and a maximum of 99.5 percent in Kagera region. This shows an increase of 28.1 percent compared to 2004, where 53.3 percent of the population had access to safe water (Energy and Water Utilities Regulatory Authority EWURA, 2009). In general, the probability of being connected to the water network is significantly higher in urban areas. Even if Tanzania is lagging behind to reach the global MDG drinking water target of 89 percent coverage by 2015, the country is developing well in contrast to other countries in Sub-Saharan Africa (60 percent coverage, United Nations, 2011). To be classified as using improved sanitation facilities, a household has to be connected to a public sewer or a septic system or has to use improved toilet facilities (UNICEF/WHO 2004). In 2010, only 13 percent of Tanzanian households used such improved facilities (URT, 2011).

Investment in education is positively correlated with the health of mothers, reproductive behaviour, healthy lifestyle and many other aspects of public health. The government of Tanzania has acknowledged the high importance of education and allocated an average of 19 percent of the total annual budget to this sector, which exceeds the allocation to other priority sectors significantly (figure 1). Total public expenditure on education increased from 443 billion Tanzanian shillings in 1999/2000 to 2,062 billion Tanzanian shillings in 2010/2011 (table 1). This corresponds to an average, annual growth rate of 15.0 percent. Regional per capita expenditure on education varies strongly across regions, with less than 10,000 Tanzanian shillings in Kigoma region and more than 20,000 shillings in Arusha, Kilimanjaro and Iringa region (Appendix 3). Literacy can help the Tanzanian people to understand the messages of health workers and to use drugs as prescribed. Results from the latest surveys indicate that 72 percent of women and 82 percent of men are literate, showing a small increase for both sexes since 2004/2005 (URT, 2011). These figures top the average literacy rates of the whole Sub-Saharan Africa region, with 54 percent of women and 71 percent of men being able to read and write properly (World Bank, 2012).

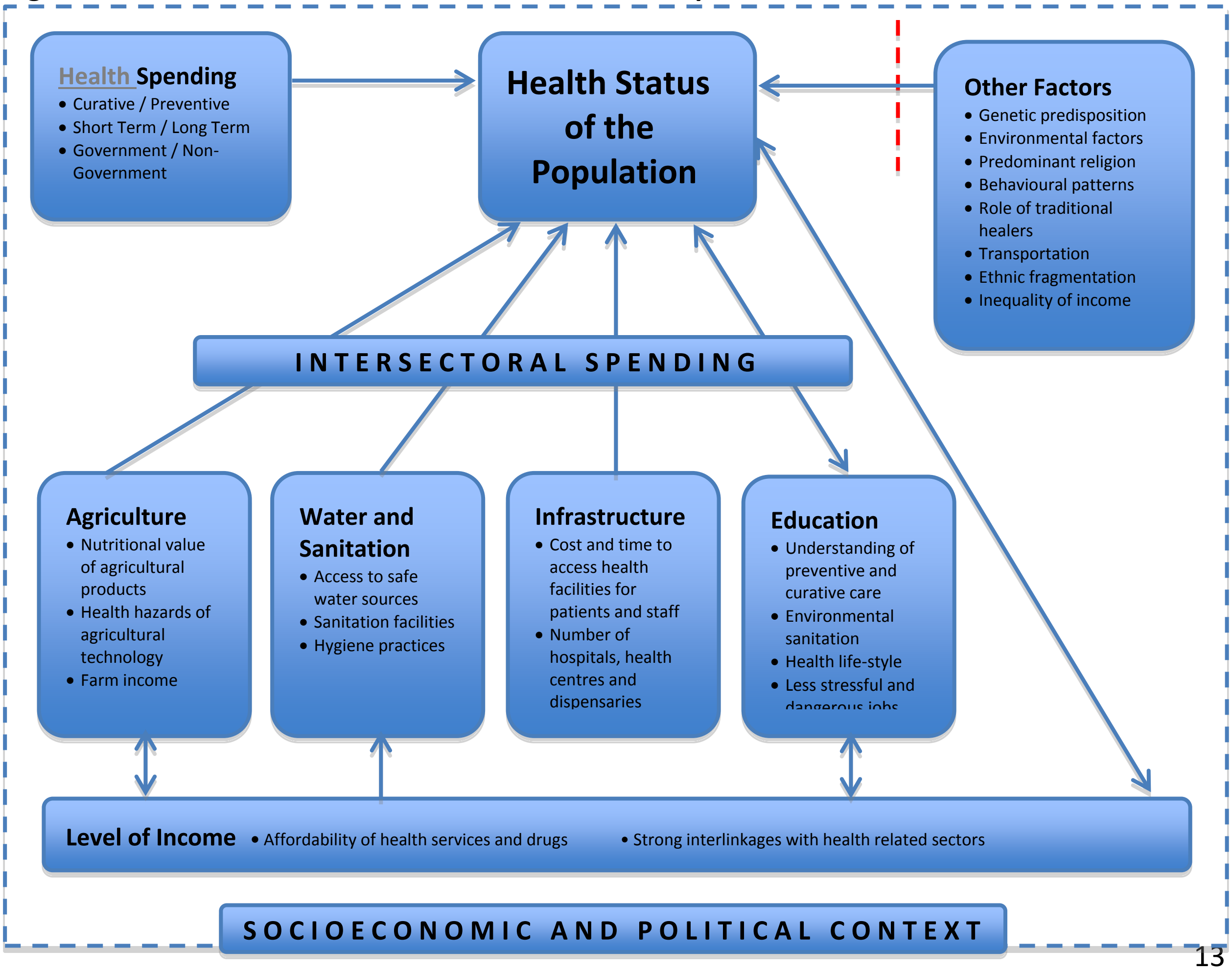
4. Theoretical Framework

In the following, a conceptual framework will be presented to explain the causal relationships between investments in health related sectors and the health status of the population. Furthermore, the relevant economic principals from economic theory will be discussed. The subsequent section 4.2 demonstrates an adequate approach to model IHA.

4.1 Conceptual Framework and Economic Theory of IHA

Most of the common diseases have multifaceted causes, led by malnutrition, poor water supply and inadequate sanitation (WHO & UN Water, 2012). Thus, public health is determined by a variety of factors within and outside the health sector. Figure 2 shows how all these factors are linked to health and other determinants of health. First, there is an assumed correlation between governmental and non-governmental health spending and the health status of the population, even if the actual impact might be small (Filmer & Pritchett, 1999). This includes expenditure on curative and preventive measures in the short and long run.

Figure 2: Determinants of the Health Status of the Population



As mentioned in section 3.2, public spending on agriculture mainly consists of subsidies for agricultural inputs such as fertilizer, improved seeds and agro chemicals as well as agricultural research and extension. This in turn influences agricultural production, which is predominantly used for own-consumption. Both, the nutritional value of the agricultural products and health hazards of agricultural technology determine the health status of the population (von Braun 2007, Arole, 1999). Farm income and the income from agricultural labour influences health in an indirect manner. Investments to improve access to drinking water, sanitation facilities and hygiene practices reduce the risk of diarrhoeal disease, which is still a leading cause of morbidity and mortality in developing countries. Moreover, access to safe water sources strengthens public health by reducing the risk of contamination during storage and transport of water (Fewtrell et al., 2005).

The links between infrastructure and health have been exhaustively reviewed by Brenneman and Kerf (2002). The found evidence reported in various studies that improved transport saves cost and time to reach health providers and strengthens the timely access to health care, especially for the poor. Moreover, it facilitates the staffing and operation of health institutions. The number of hospitals, health centres and dispensaries available in a certain region further determines access to health providers. The positive relationship between education and health has widely been verified in the literature. Educated people are more likely to afford health measures, their jobs are less stressful and dangerous, their social-psychological resources are larger and they have a more positive health lifestyle (Ross and Wu, 1995). Furthermore, education promotes the improvement of personal hygiene, environmental sanitation and the understanding of preventive and curative care (Arole, 1999).

Income enables people to afford health services, which go beyond the free services offered by the government. Further determinants of health, such as education, sanitation or nutrition are directly correlated with income, as shown in figure 2. Thus, using the words of Pritchett (1993), "wealthier is healthier". In a cross-country analysis he found that differences in income growth rates explain roughly 40% of the differences in infant and child mortality improvements. Further determinants of health, such as environmental conditions, the existence of traditional healers, genetic conditions and social determinants (e.g. social gradient or social exclusion, see Marmot, 2005) have not been included in the model due to poor data. The impact of cross-sectoral efforts on health is strongly influenced by the political and socioeconomic context of the country.

Coalition theory has widely been used as a framework for understanding and implementing cross-sectoral health interventions that lead to synergies in the allocation of scarce health resources (O'Neill et al., 1997). Gamson (1961) defined coalitions, which in the context of this paper are collaborations between the health sector and related sectors, as " […] temporary, means oriented, alliances among individuals or groups which differ in goals"(p. 374). According to the author, the collaboration of different sectors depends on four parameters. Firstly, the initial distribution of given resources among the participants have to be known. Secondly, the payoffs for each coalition have to be calculated, similar to game theoretical approaches. Thirdly, the so-called "Non-utilitarian strategy preferences" have to be identified. These strategy preferences can be described as inclinations to join with other groups determined by interpersonal attraction and independent of other players' resources. Fourthly, the "effective decision point" reveals the specified amount of resources that will enable the player to control the decision.

In general, the implementation of cross-sectoral coordination will contribute to an efficient use of scarce health resources. This coordination includes the health services provided by the private sector. According to Samuelson (1954), pareto-optimal provision of the public good "health services" is given when the sum of individuals' marginal rates of substitution equals the marginal rate of transformation between the health services offered by the public sector and health services provided by the private sector (Σ $MRS_i = MRT$). In reality, the government share of a developing country's total health budget is determined by the priorities of that country (e.g. Poverty Reduction Strategy Papers), the power relations between different government sectors, corruption and lobbyism.

Further preconditions for the successful use of intersectoral synergies are to ensure an adequate balance regarding the number of relevant stakeholders in each sector and their relative skills, the recognition of different cultures and incentives and the consensus on the benefits that could result from cross-sectoral cooperation. Furthermore, functional ways of communication between the stakeholders have to be ensured, tools for analysing common problems have to be developed and sufficient capacities and incentives have to be in place (von Braun et al., 2011).

4.2 The Model and the Marginal Impact on Health

The marginal health returns to cross-sectoral government expenditures have been determined using quantitative budget analysis. This information is needed by politicians as an incentive to form coalitions for health. Building on previous IFPRI studies in Asia and Africa (see Fan, 2000-2005), a SEM has been developed to estimate these effects. The formal structure of the system is represented by equation (1) to (5):

DISPREV = f (THINV, NUTR, SWATER, SANI, INFRA, GDP, EDU, URB) ***(1)***

NUTR = f (TAINV, GDP, BREASTF, IODINE, MEDU, VACC, URB, DISPREV) *(2)*
SWATER = f (TWINV, GDP, URB) *(3)*
EDU = f (TEINV, GDP, DISPREV, URB) *(4)*
GDP = f (LABOUR, LAND, EDU, RAIN, URB) *(5)*

The model can be grouped into two blocks of equations: The first block (equation 1) models the hypothesized major determinants of the dependent variable disease prevalence (DISPREV). Block two (equation 2-5) models the determinants of each endogenous variable used in block one. Each of these equations has a clear ceteris paribus interpretation, which makes it an appropriate SEM (Wooldrigde, 2009). The advantage of this method is that it allows measuring direct and indirect effects on health. To optimize the trade off between accuracy and complexity of the model, the Akaike Information Criterion (AIC) has been used. There is no reason to expect any non-linearities.

Equation (1) models the influence of various factors on the endogenous variable DISPREV, which is an index reflecting the most prevalent diseases among children under five in Tanzania. Disease prevalence has widely been used as a measure of need in the literature (e.g. Munga & Maestad, 2009). Children under the age of five have been chosen to reflect the age group most vulnerable to diseases influenced by cross-sectoral factors such as malnutrition or waterborne diseases. In addition, it accounts for the cohort-specific differences in the strength of the determinants of health. The index includes the percentage of children with fever (used as an indicator for malaria), diarrhoea or symptoms of acute respiratory infections (ARIs) in the two weeks preceding the DHS survey. These three diseases are weighted by annual DALYs lost according to the latest WHO-data, resulting in an index allocation of 38.2 percent to Malaria, 35.2 percent to Acute Respiratory Infections (ARI) and 26.7 percent to Diarrhoea (WHO, 2009). On the right hand side of the equation, the exogenous variable THINV measures the logarithm of deflated public per capita spending on health in the short- and long-term[3]. This includes the total expenditure of the current and the last five budget years. Thus, short-term spending for curative measures such as the provision of drugs or salaries for health personnel as well as long-term spending like preventive interventions or health research are considered. To account for the assumed correlation of nutrition and health, the endogenous variable NUTR has been included as an additional covariate. It captures the percentage of children under five years classified as malnourished according to weight-for-age[4], which is considered a general indicator for the nutritional status of children (Haddad et al., 2003).

The endogenous variable SWATER reflects the percentage of households with access to safe water sources, which is defined as living within a reach of an official water point. As an indicator for sanitation, the variable SANI captures the number of latrines per 100 pupils in Tanzanian schools. INFRA is a stock variable considering infrastructure, such as the number health facilities and the condition of roads needed to access them. Specifically, it is measured here as the percentage of women and men age 15-49 who reported serious problems in accessing health care due to the distance to the next health facility. Yearly, regional per capita GDP serves as an proxy for income. The nexus of health and education is reflected by the endogenous variable EDU, which captures the number of primary school pupils divided by the number of primary school teachers (Pupils-Teacher-Ratio, PTR). In each of the five equations, URB servers as a control variable for the degree of urbanization. The effect of urbanization on health remains unclear, since negative aspects of larger cities such as air pollution and industrial waste might outweigh the advantage of better health care and health infrastructure in urban areas (Moore et al., 2002).

Equation (2) models the factors that influence the endogenous nutritional status (NUTR) included in the first equation. As stated by von Braun et al. (2005), an increase of domestic budgetary allocations to agriculture strengthens agricultural growth, and, in turn, reduces malnutrition and hunger. The first covariate on the right hand side of equation 2 (TAINV) takes

[3] For comparison, all figures on sectoral government spending and GDP have been converted into 2010 constant prices using the GDP deflator. Moreover, the model uses logs of the per capita values.

[4] below -2 standard deviation units (SD) from the median of the WHO Child Growth Standards adopted in 2006.

this correlation into account reflecting the logarithm of deflated public per capita spending on agriculture at the regional level (total of current and previous year). Moreover, sustained income growth can lead to a reduction of malnutrition in the long run, as shown in a cross-country and household level study by Haddad et al. (2003). The log of regional per capita GDP has been included in the model as a proxy for household income.

In principle, malnutrition consists of protein-energy malnutrition and micronutrient deficiencies. One measure to prevent protein-energy malnutrition is to promote initial breast-feeding, reflected by the exogenous variable BREASTF. This variable indicates the percentage of mothers who started breastfeeding within one hour of birth among the last children born in the five years preceding the survey. Although not exclusively, micronutrient deficiencies are mainly due to deficiencies in iodine, iron, vitamin A and zinc (see Müller and Krawinkel, 2005). To cover at least one of these deficiencies, the percentage of households with adequate iodine content of salt (15+ ppm) is included by the variable IDODINE. Increasing education of mothers augments their skills at care giving and, in turn, improves the nutritional status of their children (Sahn & Alderman, 1997). To account for this correlation, the variable MEDU captures the percentage of women age 15-49 who completed at least grade 6 at the secondary level. Two further variables reflect the impact of health on nutrition. Besides the endogenous variable DISPREV, the covariate VACC represents the percentage of children age 12-23 months with a vaccination card. Ideally, regional differences in food prices, climate conditions and the existence of nutrition programmes should be included in the model. However, sufficient information about these variables was not available for the selected time period.

Determinants of access to safe water sources are modelled in equation (3). In the short term, public investments into the water sector extend the reach of water networks and improve the management of regional water sources. Long-term spending aims at capacity building of water personnel and structural changes, such as the privatisation of water suppliers. Both effects are captured in the right hand side variable TWINV, taking into account the logarithm of average, deflated public per capita spending on water in the current and the last five budget years. Whether consumers can afford to use safe water sources is also determined by income. Consequently, the log of the regional per capita GDP is included as a proxy for income. Information regarding the volatility of water prices, the gap between water demand and supply and the existence of certain interventions such as the installation of water kiosks has not been included in the model due to incomplete time series.

Equation (4) describes the relationship between education and its determinants. Since most of the Tanzanian schools are public, government spending on teachers' salaries and school supplies influences pupils' performance in the short run. Long-term investments include the construction and maintenance of classrooms or educational research. Both effects are reflected by the independent variable TEINV (same measurement procedure as for water spending). Health (DISPREV) affects cognitive functions of children and the school attendance of pupils and teachers, which in turn influences the level of education achieved (Jukes, 2005). Moreover, equation (4) includes per capita GDP as a proxy for income, necessary to cover education costs. Tuition for primary schools was eliminated in 2002, but families still have to pay for testing fees, uniforms and school supplies for primary education, as well as tuition for pupils in secondary schools. Information about additional variables, such as the educational status of the parents, cultural aspects, political factors and family background has been excluded from the model due to data constraints.

Widely used production functions such as Cobb-Douglas represent the relationship of an output (Y) to the inputs labour (L), capital (K) and total factor productivity (A) (Cobb & Douglas, 1928). In equation (5), a similar but more simplistic approach is used to model the determinants of regional per capita GDP. The variable LABOUR measures the percentage of women and men employed in the 12 months preceding the survey. Having in mind the high share of agricultural production, hectares of farmland (LAND) serve as a proxy for capital. This covariate includes the area under temporary mono or mixed crops, permanent mono or mixed crops and the area under pasture. Since agricultural output strongly correlates with rainfall variability, the variable RAIN has been included in equation (5). It measures yearly rainfall in millimetres. Due to increased skills and knowledge (EDU), the contribution of educated people to the GDP might be higher compared to others. Technological change and innovation are captured by total factor productivity in the Cobb-Douglas model. Reasons for omitting these variables in equation (5) are the short time period considered in this paper and the fact that technology might not be a local phenomenon.

Public spending on health, agriculture, water and education might have long lead times in affecting the prevalence of diseases. Consequently, current and past values of government expenditure have been included as lags in the model. Various econometric methods do exist to determine the adequate length of lag for each of the investment variables. Authors of similar works (e.g. Fan, 2000) used the adjusted R^2 criterion suggested by Greene (2008). This method was also applied in this study, resulting in a lag length that maximizes adjusted R^2 as defined by McElroy (1977). As mentioned above, the outcome was to include total spending of the current and the last five budget years. Furthermore, the choice of the appropriate length of lags was constrained by the length of the time series data available.

To measure the direct and indirect effects of cross-sectoral government spending and other variables on the prevalence of diseases, we have to totally differentiate equation (1) to (5). For that, we take the derivative of equation (1) with respect to the desired variable. Since most of the model variables are given as a percentage or included as logs, the result is the elasticity of the selected variables. As an example, the direct impact of agricultural investments (TAINV) on the prevalence of diseases through nutritional status (NUTR) can be derived as:

$$dDISPREV/dTAINV = (\partial DISPREV/\partial NUTR)\ (\partial NUTR/\partial TAINV) \qquad (6)$$

Similar, the effect of LAND on health is derived as:

$$\begin{aligned} dDISPREV/dLAND &= (\partial DISPREV/\partial GDP)\ (\partial GDP/\partial LAND) \\ &+ (\partial DISPREV/\partial SWATER)\ (\partial SWATER/\partial GDP)\ (\partial GDP/\partial LAND) \\ &+ (\partial DISPREV/\partial EDU)\ (\partial EDU/\partial GDP)\ (\partial GDP/\partial LAND) \\ &+ (\partial DISPREV/\partial NUTR)\ (\partial NUTR/\partial GDP)\ (\partial GDP/\partial LAND) \qquad (7) \end{aligned}$$

The first term on the right hand side of equation 7 shows the direct effect of LAND on the variance of regional per capita GDP, which in turn is a determinant of public health. Second, the change of GDP also leads to indirect effects on health through its influence on access to safe water, education and nutrition, as shown in the following terms. The direct and indirect effects of other variables on health can be derived in a similar way.

5. Quantitative Analysis: Model Estimation and Results

Section 5.1 explains the data sources and data transformations of all exogenous and endogenous variables used in the model. A discussion of adequate estimation methods and the corresponding results are presented in section 5.2.

5.1 Data

This study uses data at the regional level of Tanzania, excluding the five regions on the semi-autonomous state Zanzibar. Almost all of the 21 regions of Tanzania mainland include one regional capital classified as an urban district and several further districts all classified as rural. Since no systematic secondary data are available at the regional level, a panel dataset at the regional level was generated by aggregating survey data for the years 2004, 2005, 2009 and 2010. Thus, this study is based on a total of 84 observations. Data on public spending on health, education, agriculture and water were retrieved from various budget books for the years 1999/2000-2004/2005 and from the Local Government Information database (LOGIN Tanzania, see URT, 2012) for the years after 2005. This database is jointly provided by the Ministry of Finance (MOF) and the Prime Minister's Office Regional Administration and Local Government (PMORALG). The figures include recurrent and development spending of the government and, partly, donor funds allocated to the regions. For comparison, all data on government expenditures were deflated to the common base year 2010 using the GDP deflator retrieved from the World Bank's development indicators (World Bank, 2012). Population data used for computing per capita amounts were generated from the last population and housing census 2002 (URT, 2006). According to LOGIN Tanzania, population variables are inflated uniformly across all regions by 2.9% per annum.

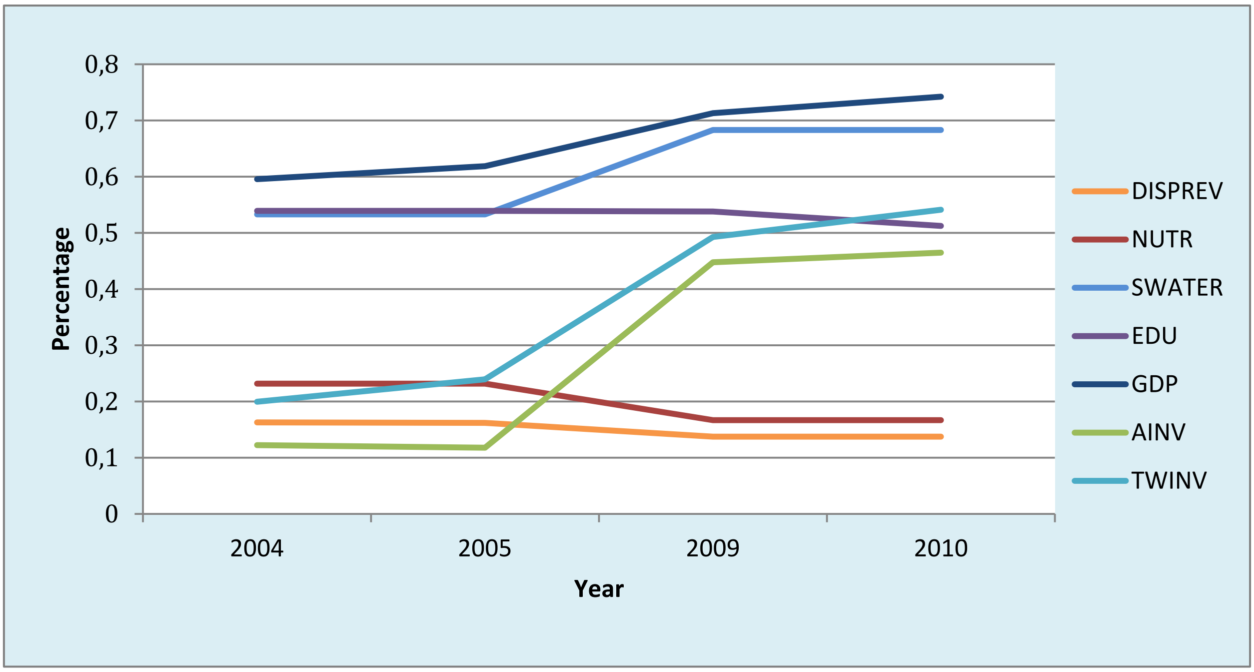
Information about per capita GDP was obtained from national accounts and deflated like public spending (URT, 2011). For the variable measuring the percentage of people with access to safe water sources, aggregated data from the Water Utilities Performance Report (EWURA, 2009) and Annual Health Statistical Abstracts (URT, 2006) was used. Data about agricultural farmland was retrieved from CountrySTAT, a database for food and agriculture statistics provided by the NBS (URT, 2012). For all other variables included in the model, data comes from the HIV/AIDS/STI surveillance report (URT, 2009), Basic Education Statistics Tanzania (BEST, URT, various years) and selected DHS and HMIS household surveys (URT, 2005-2011). The included data sources are the most comprehensive and reliable ones in Tanzania at present. Numerous studies, notably a paper published by Fan, Nyange & Rao (2005) have also used these data sources. Table 2 shows an overview of all variables. The behaviour of selected dependent and independent variables over time is reflected in figure 3.

Table 2: Descriptive Statistics

Variable	Mean	Standard Deviation	Min	Max	Unit of Measurement
DISPREV	0.150	0.061	0.043	0.351	Percentage
THINV	17811.07	7732.94	6179.00	38550.00	Tanzanian Shillings
NUTR	0.199	0.068	0.097	0.342	Percentage
SWATER	0.608	0.168	0.328	0.995	Percentage
SANI	1.706	0.601	0.462	3.238	No. of Latrines per 100 pupils
INFRA	0.305	0.137	0.073	0.559	Percentage
GDP	0.667	0.246	0.357	1.736	Million Tanzanian Shillings
EDU	53.214	9.188	34	74	Pupils-Teacher-Ratio (PTR)
URB	0.232	0.170	0.074	0.960	Percentage
TAINV	2881.00	2227.00	310.00	9210.00	Tanzanian Shillings
BREASTF	0.554	0.202	0.182	0.954	Percentage
IODINE	0.495	0.261	0.046	0.976	Percentage
MEDU	0.102	0.073	0.022	0.372	Percentage
VACC	0.823	0.080	0.666	0.978	Percentage
TWINV	3681.67	2190.66	995.00	9278.00	Tanzanian Shillings
TEINV	66382.08	23886.40	29458.00	141009.00	Tanzanian Shillings
LABOUR	0.813	0.090	0.518	0.968	Percentage
LAND	4.266	2.322	0.312	11.69	ha
RAIN	834.706	353.750	329.700	1989.600	Millimetres

Source: author’s calculations

Figure 3: Behaviour of Selected Dependent and Independent Variables Over Time



Source: author's calculations (PTR: divided by factor 100 / AINV, TWINV: divided by factor 10.000)

5.2 Model Estimation, Results and Marginal Returns to Public Investment

According to the model specification described in section 4.2, the four endogenous covariates are jointly determined with the dependent variable disease prevalence. Consequently, the problem of endogeneity of explanatory variables arises in the form of simultaneity. All endogenous, explanatory variables, which are determined simultaneously with disease prevalence, are generally correlated with the error term. Thus, the use of Ordinary Least Squares (OLS) to estimate the SEM would lead to biased and inconsistent estimates. Instead, similar to the solution of omitted variables and measurement error problems, the leading method to estimate SEMs is the method of instrumental variables. Exogenous variables appearing anywhere in the system serves as instruments for a particular equation. Three instrumental variable approaches are appropriate to estimate a SEM, namely Two-Stage-Least-Squares (2SLS), Three-Stage-Least-Squares (3SLS) and Generalized Method of Moments (GMM). Under the assumption that all equations are correctly specified, 3SLS produces asymptotically more efficient estimates compared to 2SLS and GMM (Wooldridge, 2010). Thus, 3SLS has been used to solve the model[5].

Table 2 presents the results of the estimated SEM. With some limitations, cross-sectoral investments seem to have enormous effect on the reduction of disease prevalence. The results

[5] See appendix 5 for 2SLS estimates.

of the estimated health equation (equation 1) show a significantly positive impact of nutrition, access to safe water sources and sanitation on health. For every one percent decrease in the number of malnourished children under five years, the disease index declines by 0.332 percentage points. This result complements previous research showing a highly significant correlation between nutrition and health in Tanzania (Alderman et al., 2005, Keding, 2010).

Slightly less effective are investments in water quality. The index declines by 0.167 percentage points for every one percent increase of people who have access to safe water sources. This confirms the results of a regional study on waterborne diseases on the Tanzanian side of Lake Victoria (Semili et al., 2005). Improved sanitation a has a smaller, but still significant potential to improve public health with a coefficient of 0.027. Unlike the theoretical assumption discussed in section 4.1, income seems to have no significant effect on the prevalence of under five diseases. The abolition of user fees for maternal and child health services in Tanzania might explain this result. However, out-of-pocket payments are still substantial in practice, especially for facility based deliveries (Kruk et al., 2008).

Furthermore, short- and long-term public spending on health are insignificant determinants of health. This unexpected weak effect of pure public health expenditure on the prevalence of diseases has widely been shown in the literature. Among others, the reason for this unexpected relationship could be the fact, that more public spending on health doesn't necessarily mean that more public health services are created. Some of these additional health services might have been consumed anyway. Thus, to see a measureable effect of public health spending on disease prevalence, the additional services have to change the total amount of health services consumed. Ultimately, services financed by the government have to be cost-effective in improving public health and consequently reduce the burden of disease (see Filmer & Pritchett, 1999). This can be questioned in the case of Tanzania, ranked 156 among 191 countries in overall health system performance (WHO, 2000).

Table 3: Relationship between Burden of Disease and IHA, 2004-2010

Dependent Variable	(1) DISPREV	(2) NUTR	(3) SWATER	(4) EDU	(5) GDP
THINV	0.102 (0.06)				
NUTR	0.332 (0.16)**				
SWATER	-0.167 (0.06)**				
SANI	-0.027 (0.01)**				
INFRA	0.053 (0.05)				
GDP	-0.127 (0.10)	-0.009 (0.064)	0.007 (0.19)	-34.927 (7.57)**	
EDU	-0.007 (0.00)**				-0.018 (0.00)**
URB	0.226 (0.46)	-0.137 (0.31)	1.974 (1.07)*	75.571 (41.3)*	2.633 (0.54)**
TAINV		-0.020 (0.01)			
BREASTF		0.075 (0.03)**			
IODINE		-0.040 (0.04)			
MEDU		-0.421 (0.13)**			
VACC		0.028 (0.07)			
DISPREV		0.507 (0.14)**		-35.250 (9.19)**	
TWINV			0.258 (0.09)**		
LTEINV				-3.774 (5.38)	
LABOUR					0.115 (0.13)
LAND					0.120 (0.02)**
RAIN					0.000 (0.00)
R-Squared	0.6512	0.8865	0.6965	0.8338	0.9069
Observations	84	84	84	84	84

Note: One/two asterisk indicate that coefficients are statistically significant at the 10/5 percent level, based on the statistics reported in respective parentheses. The coefficients of regional dummies are not reported.

For the evaluation of the "causes of the causes", estimates for equation (2) show that reaching grade 6 at the secondary level, as a proxy for mothers' education, significantly contributes to fight malnutrition with a coefficient of 0.421. Furthermore, the results suggest that decreasing prevalence of under five diseases reduces malnutrition, with a coefficient of 0.507 (significant at the 5 percent level). Estimates for equation (3) show that the sum of public spending on water during the current and the last five budget years and an increasing degree of urbanization are significant factors in determining access to safe water, with coefficients of 0.258 and 1.974, respectively. Growing income is highly correlated with improvements in education (equation 4). However, the relationship between education and urbanization shows an unexpected sign. An increasing degree of urbanization leads to a lower level of education. Reasons for that might be the fact that fast and unplanned urban growth often leads to increased poverty levels and population growth exceeding manageable education infrastructure (Moore et al., 2003). As expected, higher levels of education, urbanization and land are positive determinants of the regional GDP, with significant coefficients of 0.018, 2.633 and 0.120, respectively.

Having in mind the assumed policy objective of maximising the amount of DALYs saved, table 4 shows the returns of interventions in each of the sectors measured in DALYs. The highest returns on DALYs are obtained by improved nutrition and access to safe water sources, followed by sanitation. Looking at the impact of indirect factors, the health effect of investments in mother education exceeds the effect of additional short- and long-term public spending on water.

Table 4: Returns of Cross-sectoral Health Interventions (in thousands of DALYs saved)

Sector-Variable	Total DALYs	Sector-Variable	Total DALYs
NUTR	7464	MEDU	31
SWATER	3755	DISPREV	38
SANI	607	TWINV	10

Source: author's calculations

6. Conclusions

In section 6.1, the major findings of the quantitative analysis are summarized and future priorities for cross-sectoral government investment in health are discussed. This is followed by some limitations of the paper and suggestions for future research.

6.1 Major Findings and Priorities of Future Government Investment

Understanding how IHA contributes to the reduction of the burden of disease in Tanzania is crucial for future decisions on budget allocation. The results of the estimated SEM show a significantly positive impact of nutrition, access to safe water sources and sanitation on the reduction of disease prevalence for children under the age of five. By comparing these variables, the highest returns on DALYs are obtained by improved nutrition and access to safe water sources, followed by sanitation. However, short- and long-term public spending on health turned out not to have a significant positive impact on health. Further evaluation of the "causes of the causes" showed that the improved education of mothers and adequate levels of health significantly reduce the prevalence of malnutrition among children under the age of five. In the case of access to safe water sources, which is a further factor influencing the disease burden, the degree of urbanization and public spending on water in the short- and long run are significant positive determinants. In terms of DALYs saved for every additional percent of spending, the health effect of investments in mother education exceeds the effect of additional short- and long-term public spending on water.

Most of the expected and theoretically assumed correlations between investments of health related sectors and the health status of the population are supported by the results of the quantitative model. This encourages the use of budget analysis as a method for analysing IHA. However, some of the findings need to be further discussed. For example, the insignificant impact of public health spending, which is predominantly spending on curative measures, could be understood as a call for more preventive measures, including improvements in nutritional status and drinking water quality. This brings us back to the need of cross-sectoral investments.

According to the literature, IHA fails more often than it succeeds. One of the challenges might be the fact that the prestigious health sector often expects other sectors to consider health-related issues within their policies without regard to the question how the health sector can support the agendas of related sectors (O'Neill et al., 1997). Appointing particular government employees in each ministry to be in charge of intersectoral work could solve some of the challenges, such as the lack of taking over responsibility for cross-sectoral results. Increased training in multi-sectoral work and facilitating interaction among sectors instead of isolated approaches would provide impetus for effective IHA.

6.2 Limitations and Future Research Directions

There is much room for improvement regarding the available quality and quantity of data in Tanzania. This should be a priority of the relevant government institutions. Second, the considered investment variables do not include all kinds of donor funds spent in the regions. It is almost impossible to sum up total donor spending in a certain region due to the high number of vertical programs. Only some of the released funds are captured in the government budget. Third, the paper suffers from the common critique of DALYs regarding the assumptions and value judgements such as age-weighting and discounting (Anand and Hanson, 1997). However, yet no better option is readily available. Fourth, the policy relevance of budget allocation decisions can be questioned. Donors contribute to more than 40% of the annual budget in Tanzania (Wohlgemuth, 2006). Taking into account that most of these donor funds are earmarked, the scope for flexible budget allocation is limited.

More research is needed to identify cross-sectoral determinants of health. A similar analysis could be done to measure the impact of public spending on one specific disease such as HIV/AIDS, Malaria or Diarrhoea. Moreover, other age groups then children under the age of five should be considered. If data allows, other sectors such as roads and housing should be included in future studies.

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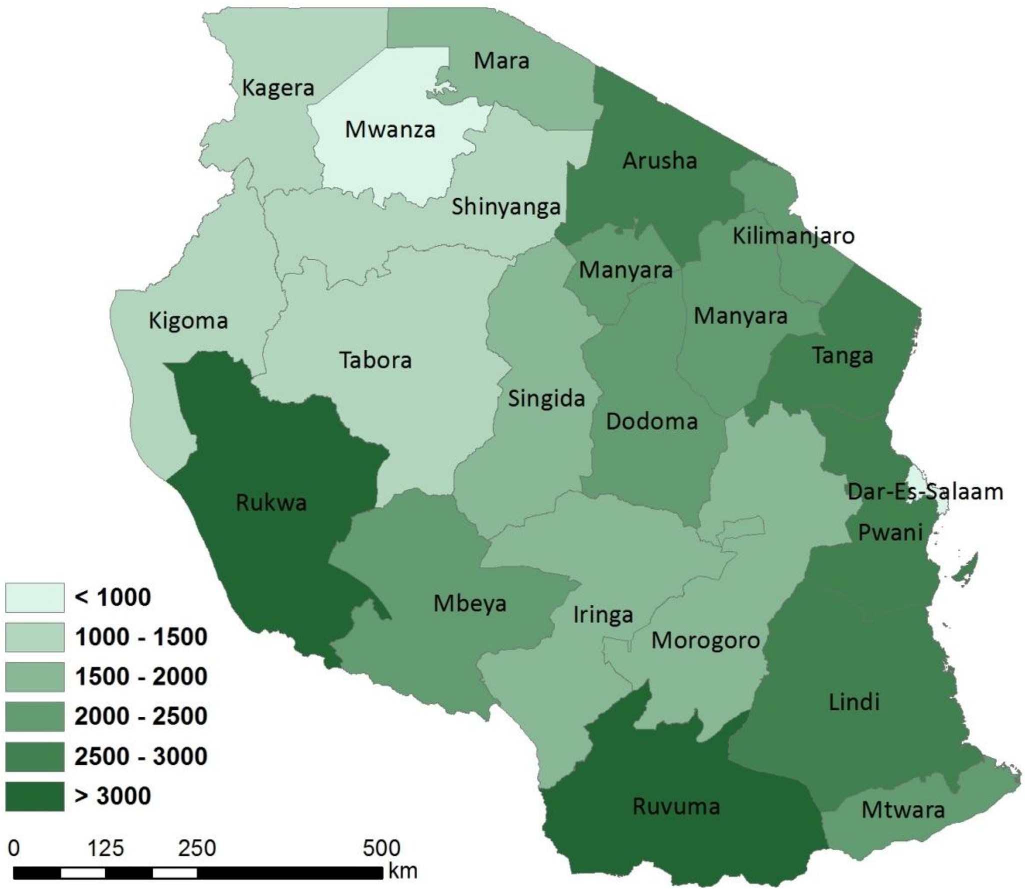
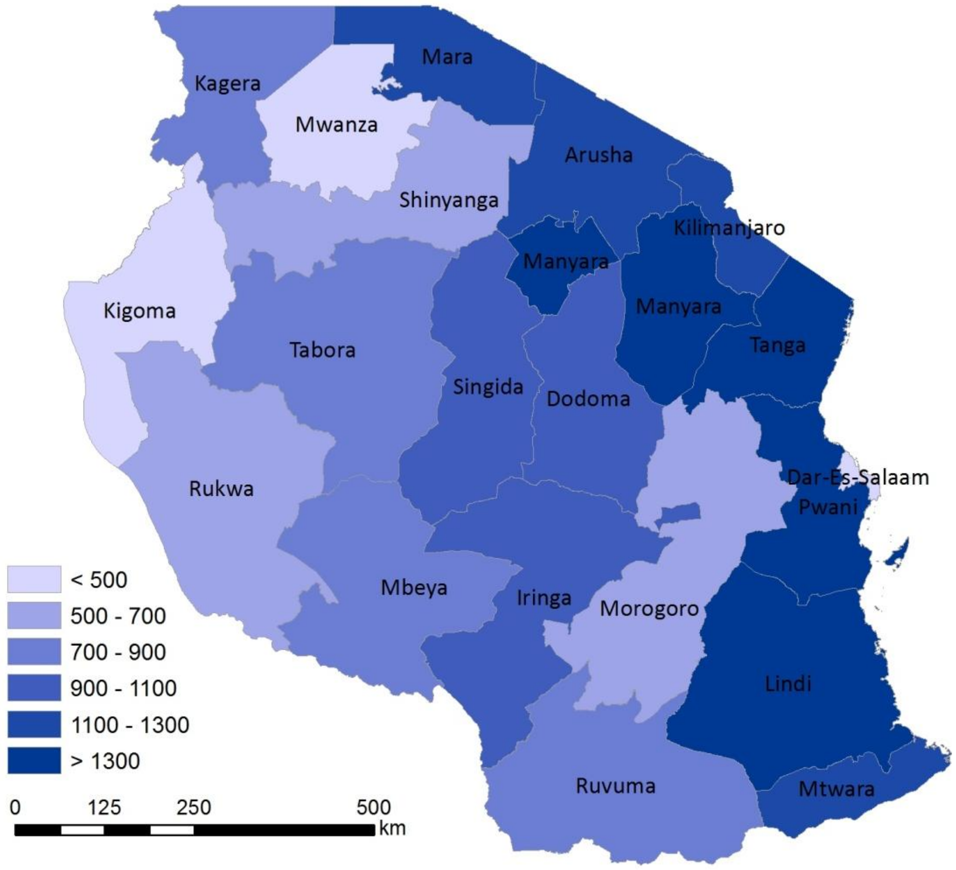
APPENDIX 1: MAP OF REGIONAL PER CAPITA AGRICULTURE INVESTMENT AT CURRENT PRICES 2010 (IN TANZANIAN SHILLINGS)



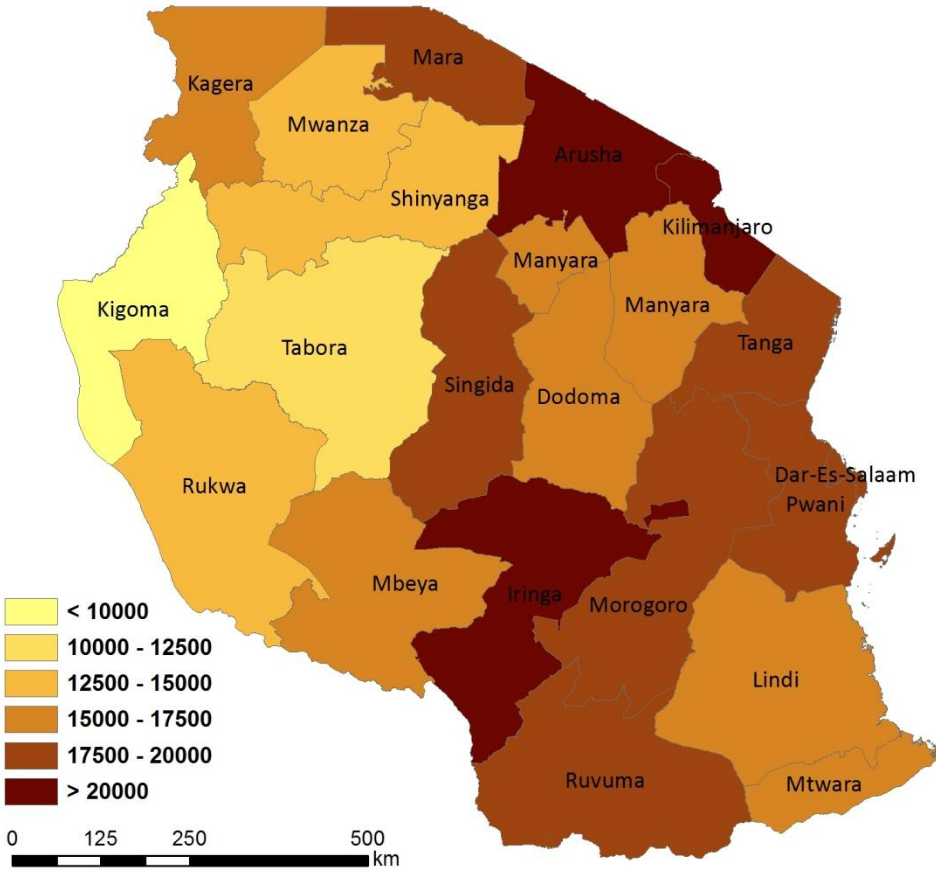
Data source: Login Tanzania Database 2011 (mapped by the author)

APPENDIX 2: MAP OF REGIONAL PER CAPITA WATER INVESTMENT AT CURRENT PRICES 2010 (IN TANZANIAN SHILLINGS)



Data source: Login Tanzania Database 2011 (mapped by the author)

APPENDIX 3: MAP OF REGIONAL PER CAPITA EDUCATION INVESTMENT AT CURRENT PRICES 2010 (IN TANZANIAN SHILLINGS)



Data source: Login Tanzania Database 2011 (mapped by the author)

APPENDIX 4: VARIABLE DEFINITIONS

Variable	Definition
Exogenous variable	
THINV	Logarithm of deflated public per capita spending on health in the short- and long term (total spending of the current and the last five budget years)*
SANI	Latrines per 100 pupils
INFRA	Percentage of women and men age 15-49 who reported serious problems in accessing health care due to the distance to the next health facility
URB	Percentage of people living in urban areas
TAINV	Logarithm of deflated public per capita spending on agriculture (current and previous budget year)*
BREASTF	Percentage who started breastfeeding within 1 hour of birth, among the last children born in the five years preceding the survey
IODINE	Percentage of households with adequate iodine content of salt (15+ ppm)
MEDU	Percentage of women age 15-49 who completed grade 6 at the secondary level
VACC	Percentage of children age 12-23 months with a vaccination card
TWINV	Logarithm of deflated public per capita spending on water in the short- and long term (total spending of the current and the last five budget years)*
TEINV	Logarithm of deflated public per capita spending on education in the short- and long term (total spending of the current and the last five budget years)*
LABOUR	Percentage of women and men employed in the 12 months preceding the survey
LAND	Per capita farmland in ha (including the area under temporary mono/mixed crops, permanent mono/mixed crops and the area under pasture)
RAIN	Yearly rainfall in mm
Endogenous variables	
DISPREV	Health-Index: prevalence of the following diseases, weighted by DALYs according to WHO, 2009: *Malaria:* Percentage of children under age 5 with fever in the two weeks preceding the survey

	Diarrhoea: Percentage of children under age 5 who had diarrhoea in the two weeks preceding the survey *Acute Respiratory Infection (ARI):* Among children under age 5, the percentage who had symptoms of acute respiratory infection (ARI) in the two weeks preceding the survey
NUTR	Percentage of children under five years classified as malnourished according to weight-for-age (below -2 standard deviation units (SD) from the median of the WHO Child Growth Standards adopted in 2006)
SWATER	Percentage of households with access to safe water sources
EDU	Number of primary school pupils divided by the number of primary school teachers (Pupils-Teacher-Ratio, PTR).
GDP	Deflated per capita GDP, in million Tanzanian Shillings*

* base year: 2010

APPENDIX 5: ESTIMATION VARIATIONS

Dependent Variable	(1) DISPREV	(2) NUTR	(3) SWATER	(4) EDU	(5) GDP
THINV	0.085 (0.08)				
NUTR	0.216 (0.24)				
SWATER	-0.123 (0.08)				
SANI	-0.038 (0.02)**				
INFRA	0.094 (0.08)				
GDP	0.010 (0.13)	0.095 (0.08)	0.010 (0.23)	-17.523 (11.74)	
EDU	-0.004 (0.00)**				-0.014 (0.00)**
URB	-0.118 (0.60)	-0.358 (0.40)	2.086 (1.28)	31.286 (59.29)	2.685 (0.66)**
TAINV		-0.026 (0.02)			
BREASTF		0.047 (0.04)			
IODINE		-0.023 (0.05)			
MEDU		-0.588 (0.17)**			
VACC		0.012 (0.09)			
DISPREV		0.369 (0.18)**		-22.60 (15.84)	
TWINV			0.247 (0.11)**		
LTEINV				-2.805 (8.50)	
LABOUR					0.255 (0.21)
LAND					0.081 (0.03)**
RAIN					0.000 (0.00)
R-Squared	0.7416	0.9003	0.6966	0.8643	0.9248
Observations	84	84	84	84	84