INTRODUCTION

TOWARDS A RE-THINKING OF THE QUANTIFICATION OF COSTS AND BENEFITS IN HEALTH CARE DECISION MAKING

Economic evaluation methods in health care

The relationship between health and economic growth is one of the cornerstones of development economics. Apart from the obvious reductions in health care budgets as a result of “good health”, there are several other channels through which health influences economic growth. The most profound mechanisms with which “good health” may boost economic growth is through increased productivity and improved educational outcomes. Health is an important component of human capital. Healthy workers are physically and mentally more energetic, more productive, less absent from work and less likely to be employed part-time or to face disabilities whilst, healthy workers earn higher wages. Thus, “good health” is a determinant of productivity which can be shown to influence economic growth. Similarly, healthy childhood may result in better educational attainment which, in the long-term, yields significant productivity growth and higher earnings.

On one hand economic growth and public investments in health care infrastructure have led to the improvement of health status, on the other hand, pressures to finances have been put. Increasing longevity is one of the reasons often reported to contribute in the rise of costs. However, health expenditures are rising as a result of several other reasons including, higher incomes; new technologies and medical progress; inefficient organization and financing of health care systems; higher relative prices for health care inputs; increasing expectations of populations. Acknowledging the scarcity of resources, cost pressures mandate rationalization and attainment of economic efficiency.

In the past decades, economic evaluations in health care have been a valuable tool for identifying efficient allocations of resource and have informed resource allocation decision making. The rationale behind conducting economic evaluations is to aid decision making with the goal of maximizing economic efficiency from a given budget. Efficiency is a relative concept. It is an indicator of success and a comprehensive measure of the performance of a production unit. Efficiency is defined by comparing its input and output.
to those of the best performing of its peers e.g. a novel therapy versus the current standard of care. In other words, efficiency is defined by comparing observed to optimal productive performance.

Efficiency has different concepts. The commonest efficiency concept is technical efficiency. Traditional economic evaluations in health care address mainly the issue of technical efficiency. Technical efficiency refers to the conversion of inputs into outputs relative to best practice. Technical efficiency refers to the ability of a production unit to avoid waste of resources by producing as much output as input allows, or by using as little input as output production allows.

Allocation (or price) efficiency refers to whether inputs, for a given level of output and set of input prices, are chosen to minimise the cost of production, assuming that the producer, being examined, is already fully technically efficient. Thus, allocative (or price) inefficiency occurs when inputs are employed in wrong proportions, with respect to their prices. Overall (or cost) efficiency exists when a producer is simultaneously technically and allocatively efficient. Finally, scale efficiency relates to a state, at which production takes place in optimal size units. The decomposition of efficiency described above is summarised in Figure 1. Economic evaluation methods of health care technologies may partly or fully address the aforementioned economic concepts of efficiency depending on the metrics they use.

Figure 1 Economic evaluation methods and efficiency

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<th>Overall (Cost) Efficiency</th>
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<td>Technical Efficiency</td>
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<td>Allocative (price) Efficiency</td>
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<th>Pure Technical Efficiency</th>
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Economic evaluations of health technologies, traditionally quantify the cost-effectiveness or cost-utility of a new technology against a comparable intervention. Hence, economic evaluations tend to quantify the benefits and costs of therapeutic or preventative interventions from the narrow perspective of the health services. In several cases, a societal perspective is
considered after taking into account productivity losses, in terms of sickdays and costs that diseases incur to caregivers. Costs are typically expressed as the differential of a novel therapy or health intervention with the costs of the current standard of care or compared to no intervention. Notwithstanding the difficulties in expressing benefits in monetary terms, cost benefit analysis (CBA) is deemed as the most comprehensive method for addressing allocation efficiency. Moreover, the results of CBA enable comparisons with other publicly funded investments in the fields of health care or more widely.

Conventional economic evaluations mainly address the issue of technical efficiency from the perspective of the health care system. Hence, they may inform decision within a certain budget and do not facilitate cross-sectorial resource allocation. An important caveat of adopting a conventional economic evaluation framework (i.e. cost-effectiveness analysis) is the limited ability of the analysis to encompass and quantify wider consequences. Despite the magnitude of the broader benefits and their importance for the society and the governmental health care and social insurance budgets, such narrow analyses consider wider consequences as intangible and unquantifiable. For example, in children, a preventable or treatable disease may be linked to a neurological sequel, resulting in cognitive impairment and poor school performance. School performance and educational attainment, in turn, have been reported to have a well-established causal relationship with lifetime labour market outcomes i.e probability of employment and lifetime earnings\(^4\).

Furthermore, the improvement of health conditions or the prevention of diseases may have behavioural effects that, in turn, may alter economic decisions (i.e increased consuming, investment behaviour and capital formation through savings) that encourage long-term economic sustainability and growth\(^5\). Figure 2 illustrates a potential range of narrow and wider benefits arising from preventive health interventions such as immunizations that conventional economic evaluations may fail to capture.

The caveats of conventional economic evaluations are more prominent with immunizations against infectious diseases\(^6\). The benefits of immunizations may take years to materialize and in many cases are attributed to externalities. Apart from infectious diseases, several chronic diseases may not only negatively impact health care service budgets, but may also undermine governments' future expenses and revenues. Expenses would include a number of allowances (e.g. housing and disability benefits and special schooling) whereas reduced lifetime earnings would yield less governmental revenues in terms of future tax.
Approaching economic evaluations in health care from a broad perspective that accounts for a considerable proportion of both immediate and broader health benefits and externalities, requires a new conceptualization and quantification of benefits. By adapting a wider societal perspective, broader economic analyses have quantified the burden of several chronic and infectious diseases and subsequently the broader benefits of treatments and or preventive measures. These analyses suggest that the employment of additional methods to traditional economic evaluations are required in order to capture the economic consequences of diseases and therefore the benefits of therapeutic and preventive interventions.

The adoption of a societal perspective may inform the quantification of the burden of disease however, it may not capture the benefits for the governmental budget. Moreover, it is increasingly recognized that diseases resulting in individuals withdrawing from the workforce, working inefficiently (i.e. presenteeism), retiring or dying prematurely has, apart from societal, important fiscal consequences for governments.

Adopted from Barninghausen et al., 2011.
Furthermore, ageing poses two sets of fiscal pressures to publicly financed health care systems, namely, decreasing income, and increasing health care resource utilization. Fiscal loss associated with ill-health, disability, premature retirement and mortality pose a considerable burden on central and regional governmental budgets. The fiscal consequences of diseases and subsequently the fiscal benefits of health care interventions are largely ignored, despite their importance for the long-term sustainability of tax-funded health care and social protection systems.

The economic theory offers a range of methods for quantifying the fiscal consequences of health and health care interventions. These methods may quantify the government perspective or fiscal consequences of government funded health care interventions and inform resource allocation decisions, both within and outside the health care public budgets. In light of the above, this Thesis aims at identifying novel methodologies and analytic frameworks for quantifying the fiscal impact of diseases and of therapeutic and/or preventive health care interventions.

In what follows, a short review of infectious and chronic conditions with a broader impact is presented. In the subsequent sections of this Thesis case studies from immunizations and Attention-Deficit-Hyperactivity Disorder (ADHD) are presented wherein, the broader economic and fiscal consequences of health care interventions are quantified.

**Infectious diseases with broader consequences**

Several broader economic evaluations suggest that a proper accounting of the impact of immunizations against infectious disease require an understanding of the broad scope of immunization-mediated benefits. These studies suggest that ignoring the wider benefits of immunizations may lead to ill-informed decisions on vaccine adoption and thus, a broader perspective should be taken in the economic evaluations.

Bloom et al. quantified the broader economic impact of immunizations by linking the survival benefit resulting from several paediatric immunizations and the relationship between health status, adult height and wages in order to estimate the return on investment (ROI) of a GAVI childhood immunization program. The research projected that increasing childhood vaccinations’ coverage would result in the increase of adult life expectancy by half a year initially and by one and a half years by 2020. Using macroeconomic methods for population-based economic projections, Bloom and colleagues estimated that a paediatric vaccination program would have a return on investment (ROI) of 18% by 2020. The projection of the benefits employed a previous macroeconomic research showing the positive relationship between economic growth and social
infrastructure which, in turn, includes health care. In a similar analysis, in the Philippines it was found that vaccination significantly improved cognitive development as measured by language, mathematical, and non-verbal reasoning test scores. Translating cognitive gains due to childhood vaccination into adult income was expected to yield a positive rate of return.

Lucas (2010) assessed the impact of malaria eradication on educational attainment. Using data from Sri Lanka and Paraguay, malaria eradication increased the years of educational attainment and literacy. The study reported that eradicating malaria would yield gains in GDP per capita of $15 to $75 through the education channel alone. Based on the estimated cost of a long lasting insecticide treated bed net of $10, the results suggested that a highly positive benefit: cost ratio, attributable to the educational effect only, may be attained.

**Chronic diseases with broader consequences**

There is a plethora of evidence in the literature, across several therapeutic categories, demonstrating the broader societal and economic burden of chronic diseases. The burden of chronic diseases may be linked not only to the diseased individual but may extend to the caregiver i.e family members, parents and spouses.

Numerous studies have described the impact that ADHD can have on educational outcomes. For example, children with ADHD are regularly found to have lower educational attainment, increased likelihood of dropping out of school and grade retention compared to children without ADHD. Although reduced educational performance in ADHD children has some immediate societal cost implications, the costs of reduced educational achievement may impair lifetime opportunities for ADHD individuals because of education-linked wage effects that will persist over the course of life.

Rheumatoid arthritis is another potential source of considerable disability and reduced productivity in terms of sickdays and increased unemployment. A retrospective, cross-sectional study in the US quantified that the annual earnings losses of rheumatoid arthritis ranged between $2,319 and $3,407. Similar results were produced by another US study, which from the Medical Expenditures Panel Study (MEPS) estimated the loss of earnings among working-age adults with arthritis and other rheumatic conditions (ages 18–64 years).

Moreover, psychiatric disorders have been shown to result in negative economic and educational outcomes. A UK study reported that psychiatric disorders in adolescents were associated with reduced workforce participation, lower income and lower economic living standards at age
Moreover, the study projected a higher probability for adolescents with psychiatric disorders to be employed part-time, dependent on social security and benefits, to have lower incomes and living standards and to have less educational attainment. Several other studies reported a considerable loss of human capital for individuals with an early-onset chronic depression.

Furthermore, an important intergenerational component on the relationship between socioeconomic status and health exists. A recent US study reported that individuals, whose parents were relatively healthy during their early life, showed higher college completion rates. From a parent’s or caregiver’s perspective, children’s or spouses’ health may result in reduced employment rates and earnings. Mothers of children with autism spectrum disorders were reported to earn 35% less than the mothers of children with another health limitation and 56% less than the mothers of children with no health limitation.

In the present Thesis, a quantitative analytic methodological framework for assessing the broader economic and government perspective of health conditions and the broader benefits of therapeutic interventions and immunizations is presented. Case studies relating to paediatric conditions and adolescent and adult vaccinations are presented. In addition, a critical appraisal of the economic evaluation methods is conducted. The observed gap between microeconomic and macroeconomic methods is analysed with the aim to identify methods adequately reflecting the broader economic benefits of health interventions.

References
RESEARCH OBJECTIVES

In Part I of this Thesis a quantitative analytic methodological framework for assessing the government perspective or fiscal impact of health conditions and the fiscal benefits of therapeutic interventions and immunizations, is presented. The framework is discussed “vis a vis” the limitations of traditional economic evaluation approaches in considering how changes in health status change productivity and consequently future government tax revenue, tied to productive labour output. Case studies relating to paediatric conditions, with cognitive defects and negative impact on educational attainment are presented. The framework links differences in educational attainment to education-specific wages, and in this respect education also influences future government tax revenue.

Part II of this Thesis applies the method to paediatric, adolescent and adult vaccinations. The aim of the first case study is to estimate the fiscal impact of changes in morbidity and mortality attributed to rotavirus immunization in Ghana and Vietnam. The first case study aims to quantify the impact of rotavirus morbidity and mortality on lifetime productive capacity and related tax transfers, and demand for government transfers in relation to education and health care in immunized and non-immunized cohorts. The second case study presented quantifies the cost and benefits of HPV immunization of 12-year old males and females in Germany. This study conducts a societal and fiscal CBA to estimate the ROI of investing in immunization in order to prevent HPV-related cancers. The third case study of Part II aims to produce a CBA of adult immunizations, against 7 vaccine-preventable diseases in the Netherlands from a governmental perspective. Based on the assumption of the residual societal and fiscal value of working-aged adults the study aims to project the lifetime gross tax benefits from preventing mortality and morbidity from infections that adult populations are susceptible to.

Part III of this research aims to quantify the broader benefits of treating ADHD in Germany. The first study implements a government perspective framework to estimate the long-term fiscal consequences of ADHD on the German government and social insurance system based on differences in educational attainment and the resulting differences in lifetime earnings compared with non-ADHD cohorts. The second ADHD study’s objective is to project the long-term societal economic consequences of reduced educational attainment, as measured by total lifetime earnings and aims at conducting a CBA to
economically appraise the rate of return from investments in hypothetical health interventions targeting ADHD.

Finally, in the Discussion and Synthesis of this Thesis, a critical appraisal of the methods that the economic theory provides us with is conducted. The observed gap between micro and macro estimates attributed to health is analysed with the aim to suggest methods for bridging this void and for adequately reflecting the broader economic benefit in economic analyses.
Part I

A fiscal quantitative analytic framework of assessing health care interventions