ASSESSING THE ECONOMIC IMPACT OF NON-COMMUNICABLE DISEASES IN THAILAND AND ITS IMPLICATIONS FOR THE UNIVERSAL COVERAGE SCHEME: A HUMAN CAPITAL AUGMENTED SOLOW GROWTH MODEL

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ABSTRACT
This study investigates the economic impact of non-communicable diseases (NCDs) on Thailand's economy from 1995 to 2022, using the Solow growth model with human capital. The analysis focuses on two main arguments in production function: the adverse effect of NCDs through human capital (morbidity and mortality) and physical capital (public health expenditure). The extent of the impact is evaluated by comparing the transition path of the economy in two scenarios - a counterfactual one in which NCDs are eradicated and a business-as-usual alternative in which NCDs continue to affect the economy. The results are that average Real GDP growth reduced by 0.1201 percentage points compared to the counterfactual scenario. Specifically, in 2022, Real GDP declines from 1.8772 trillion United States dollars (USD; at constant 2017 prices) in the counterfactual scenario to 1.7649 trillion USD in the business-as-usual scenario. This represents a reduction of 9.1363 percentage points in Real GDP for 2019, equivalent to a decrement of 0.1123 trillion USD. This study also explores a universal coverage scheme (UCS) in the business-as-usual context by comparing two scenarios: one with, and another without, UCS implementation. These findings demonstrate a positive impact on the economy, with an observed increase in average Real GDP ranging from 0 to 2.3707 percentage points between 1995 and 2022, compared to the scenario without UCS.
Keywords: Non-Communicable Diseases, Universal Coverage Scheme, Solow Growth Model, Human Capital, Counterfactual Scenario

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INTRODUCTION

Noncommunicable diseases (NCDs), often referred to as chronic diseases, constitute a major contributor to global mortality. These diseases present a significant health challenge for the global population, primarily due to behavioral risk factors and the demographic shift toward an aging population. The prevalence of these diseases will increase dramatically in the forthcoming decades, and the shift in lifestyle patterns toward more sedentary occupations and less healthy diets is a prominent factor driving the rising prevalence of chronic diseases worldwide (Bloom et al., 2014a). In the year 2016, non-communicable diseases (NCDs) were accountable for 71% (41 million) of the fifty-seven million deaths that occurred globally (World Health Organization, 2018). The four predominant types of NCDs, responsible for over 80% of all premature NCD-related deaths are cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes (World Health Organization, 2023).

Moreover, NCDs disproportionately impact low- and middle-income countries, where an excess of three-quarters of global NCD-related deaths, totaling 31.4 million, occur annually, accounting for 77% of all NCD-related deaths and 86% of premature deaths in these nations (World Health Organization, 2023). In the case of Thailand, NCDs were estimated to constitute 74% (399,100) of all NCD-related deaths in 2016. Cardiovascular disease emerged as the leading cause, accounting for 23% of all deaths, followed by cancer (18%), chronic respiratory disease (6%), and diabetes (4%), respectively (World Health Organization, 2018).

Multiple perspectives within the research community (e.g., Abegunde & Stanciole, 2006; Mane et al., 2019; Bloom et at., 2014a) assert that non-communicable diseases (NCDs) have a significant impact on economic growth through various channels, including mortality, morbidity, healthcare expenditures, and foreign direct investment. For simplicity, this study assumes that the country is a closed economy, thus the model has only three main channels. The first two channels; mortality and morbidity, affect human capital in different age group populations through reduction of labor productivity and population size due to disability or illness and premature death, respectively. The last channel is healthcare expenditure, as the government must increase public health spending rather than directing investments towards infrastructure or other sectors. This, in turn, impedes physical capital accumulation.

These pathways are simulated through the model based on the Solow model with human capital. The model is constructed utilizing comprehensive demographic simulations for a hypothetical scenario in which NCDs are not present, as well as a scenario representing the current situation. Furthermore, the model is linked to a universal coverage scheme to assess the advantages of this policy. As a result, the outcomes derived from this study are anticipated to yield substantial advantages for social planners and government authorities in formulating policies that promote sustainable economic growth, both in the present and in the future.

This study aims to investigate and calculate the impact of non-communicable diseases (NCDs) on aggregate macroeconomic performance in Thailand between 1995 and 2022 through the human capital augmented Solow growth model and its implications for the Universal Coverage Scheme (UCS).

LITERATURE REVIEWS

Relationship between Health and Economic Growth

Most of the literature primarily focuses on health improvement, using life expectancy as a health measure to examine the effects on economic growth. The estimated results differ due to the specification of each literature, thus the impact of life expectancy on economic growth varies between positive (e.g., Bloom et al., 2014b; He & Li, 2020; Kalemli-Ozcan & Weil, 2000), negative (e.g., Acemoglu and Johnson, 2007; Minamimura & Yasui, 2019), and non-monotonic (e.g., Cervellati & Sunde, 2011). Latterly, health economists utilize communicable diseases as a health measure. The pioneering study extends the Solow growth model and employs acquired immunodeficiency syndrome (AIDS) disease as a health measure (Cuddington, 1993). However, the impact of AIDS has decreased dramatically in recent years, and the world encounters a new challenging disease, namely non-communicable diseases (NCDs).

Non-Communicable Diseases' Pathways and Economic Growth

In the closed economy, there are three pathways through which NCDs significantly affect economic growth. First, NCDs decrease the size of labor through mortality, absenteeism, early retirement, disability (Abegunde & Stanciole, 2006), and negative expectations regarding employment (Bloom et al., 2020). These factors encourage a lower labor supply, reduced labor productivity, and a higher dependency ratio (Bloom et al., 2014a; Cuddington, 1993). Second, the variation in the age groups that have a difference in education and experience is disproportionately affected by NCDs, which negatively affects human capital accumulation (Bloom et al., 2020). Third, the treatment and intervention for NCDs require enormous resources in increased public health expenditure, thus the government cannot properly allocate the resources for other activities, for example, NCDs reduce the government's ability that target poverty reduction because the ill people require an ever-growing share of resources (Bloom et al., 2014a), These obstructions reduce human capital and investment in physical capital, then lowering the aggregate output.

Primary Approaches to Quantify Economic Losses from Non-Communicable Diseases

Three primary approaches are commonly employed by health economists to quantify the economic losses from diseases. The initial and frequently employed approach for assessing the impact of these diseases is the Cost of Illness method (COI). This method, recognized for its simplicity in quantifying the disease's impact, encompasses two distinct components: direct costs (such as medical costs, non-medical costs, and research costs) and indirect costs (such as the loss of income due to absenteeism, early retirement, or premature death) (Bloom et al., 2020). In the context of Thailand, Bundhamcharoen et al., (2016) apply the COI method to evaluate the economic burden attributable to smoking in the year 2009 in which most of the burden is from indirect costs.

The second approach is the Value of a Statistical Life (VSL), where costs are inferred from the willingness to pay for the decreased risk or willingness to accept premia for risky situations (Bloom et al., 2020). Prominent literature implements this method to calculate the social value of progress against cancers and heart diseases (Murphy & Topel, 2006). This approach also yields a single number similar to the COI approach, but the VSL approach incorporates the costs of pain and suffering via the revealed preferences of the workers studied (Bloom et al., 2020).

Abegunde et al. (2007) conclude that the VSL approach estimates the highest effect, followed by the COI method, because both the COI and VSL approaches have two crucial problems: the economic adjustment mechanism and the neglect of physical and human capital accumulation. The mechanism of the first problem is the substitution of laborers, who are unable to perform their duties due to illness by capital or alternative workers. The health economist, therefore, recommends an alternative and more suitable approach, known as the examination of the disease's impact on Gross Domestic Product (GDP), often referred to as the economic growth approach.

The economic growth approach can be divided into two main classes: econometric and simulation models. The econometric model puts the prevalence of disease being the regressor in the growth regression. However, this approach is plagued by the fundamental issue that the occurrence of the disease is endogenous, or that the disease environment generates a correlation between disease and geographic factors that independently impact the outcome and are difficult to control. Two approaches can be employed to address these issues: using environmental instruments or changes in health as instruments and the simulation model (Weil, 2014).

Regarding environmental instruments, (Weil, 2014) proposes a malaria ecology that measures malaria prevalence as an instrument variable. The estimated result is that in high-prevalence regions, eliminating the disease increases output per capita by a factor of 2.7. In terms of the simulation model, it can broadly be defined as the Value of Lost Output (VLO) (Alkire et al., 2015).

Simulation Model of Non-Communicable Diseases

The primal model of the VLO method from the World Health Organization (WHO) simulates the economic impact of chronic diseases based on Solow (1956), namely the Economic Projections for Illness and Cost of Treatment (EPIC) model. The EPIC is a model to estimate the burden of ill health on economic performance. Abegunde et al. (2007) utilize this model to examine the economic losses in Thailand between 2006 and 2015 due to heart disease, stroke, and diabetes. The result of their analysis indicates that the cumulative GDP loss by 2015 is 1.49 billion US dollars. The EPIC approach acknowledges the reality that physical capital or substitute labor can compensate for the loss of labor, thereby facilitating economic adjustment mechanisms. Nevertheless, its limitation lies in its exclusive consideration of mortality, without incorporating the effects of morbidity. Subsequently, Bloom et al. (2020) develop and extend the EPIC model to incorporate heterogeneous human capital levels of workers in different age groups, morbidity, and the impact of treatment costs on physical capital into the new model, which relies on human capital augmented Solow growth model.

Universal Coverage Scheme (UCS)

Thailand has undertaken the comprehensive implementation of the Universal Coverage Scheme (UCS) intending to extend coverage across the entire nation, commencing from 2002 onwards.

McManus (2012) suggests that this policy improves health equity in Thailand and is assessed in three main dimensions of macroeconomic impact: consumption, savings, and government expenditure. Moreover, Kirdruang & Glewwe (2018) suggest that the UCS has no impact on savings and consumption in the short run. Hence, in the context of the Solow growth model, the primary emphasis regarding the Universal Coverage Scheme (UCS) lies in its impact on government spending.

RESEARCH METHODOLOGY

The analysis utilizes the human capital augmented Solow growth model as proposed by Hall and Jones (1999) to evaluate the impact of non-communicable diseases (NCDs) on Thailand's economy with aggregate output or real gross domestic product (Real GDP). The assessment compares the transition path of the economy between two distinct scenarios: a business-as-usual scenario, in which NCDs exert adverse effects on the economy through human and physical capital, and a counterfactual scenario that assumes the elimination of NCDs from the initial period of interest, incurring zero-intervention costs.

Aggregate Production Function

The aggregate production function follows the Cobb-Douglas form, represented as:

$$Y_t = \gamma K_t^{\alpha}(A_t H_t)^{1-\alpha}$$

where the constant scale factor (γ) is adjusted to align the Real GDP in the initial year, the human capital (H_t) is conceptualized in terms of time units through the process of educational attainment or years of schooling, the physical capital (K_t) follows the law of motion for the capital stock that the physical capital investment in the subsequent period is equivalent to the discrepancy between investment and the depreciation of the physical capital, and the labor-augmenting technology (A_t) is exogenous.

Business-as-usual Scenario

NCDs exert a detrimental influence on the economy through two primary channels. The first channel pertains to human capital, in which these diseases lead to a reduction in labor

productivity due to morbidity, represented as:
$H_t = \sum_{a=15}^{64}(hL_t^a - Z_t^a)\ and\ h = e^{\theta(YS)}$
where L_t^a denotes the working-age population belonging to age group a at time t, the average human capital (h) is constant, θ is the rate of returns to education from Mincer's equation, YS represents the average years of schooling within the age group of 15 to 64, and Z_t^a denotes the year lost due to disability of NCDs belonging to age group a at time t. The second channel involves physical capital. NCDs lead to an increase in public health expenditures allocated to NCD management, thus impacting the accumulation of physical capital, represented as:
$K_{t+1} = s(Y_t - (G_{t,wo} + HS_t)) + (1-\delta)K_t$
$K_{t+1} = s(Y_t - G_t) + (1-\delta)K_t$
$K_{t+1} = s((1-w)Y_t) + (1-\delta)K_t$
where $G_{t,wo}$ represents government expenditure without public health spending associated with NCDs (HS_t). Furthermore, the share of gross savings in output (s), the depreciation rate (δ), and the share of tax revenue in output (w) are constant and exogenous.

Counterfactual Scenario

In the scenario represented by the overbar, the total elimination of NCDs results in the complete cessation of mortality. This absence of mortality contributes to a significant increase in the labor force, subsequently leading to a notable augmentation of human capital, represented as:

$$\bar{H}_t = h \sum_{a=15}^{64} \bar{L}_t^a$$

where the working-age population in the counterfactual scenario is denoted by $\bar{L}_t^a$ follows the population evolution framework introduced by Bloom et al. (2020), which can be expressed as:

$$\bar{L}_t^a = \frac{L_t^a}{\prod_{\tau=0}^{min\{t,a\}-1}[1 - d_{t-1-\tau}^{a-1-\tau}]}$$

where $d_{t-1-\tau}^{a-1-\tau}$ denotes the mortality rate belonging to age group $a-1-\tau$ at time $t-1-\tau$. The effect on physical capital becomes evident, as demonstrated by a decrease in public health expenditures allocated to the management of NCDs, represented as:
$\bar{K}_{t+1} = s(\bar{Y}_t - (G_t - HS_t)) + (1-\delta)\bar{K}_t$
$\bar{K}_{t+1} = s(\bar{Y}_t - \bar{G}_t) + (1-\delta)\bar{K}_t$
$\bar{K}_{t+1} = s(1-\bar{w})\bar{Y}_t + (1-\delta)\bar{K}_t$
where $\bar{w}$ is the share of tax revenue in the counterfactual scenario and $\bar{G}_t$ denotes the government spending in the counterfactual scenario, excluding the public health spending on NCDs (HS_t).

Universal Coverage Scheme (UCS)

When evaluating the impact of the UCS, our analysis primarily centers on the business-as-usual scenario. In this scenario, the economic consequence of NCDs becomes evident. We assume that the absence of the UCS program proportionally affects the years of schooling, denoted by the parameter u. This effect can be formally expressed as follows:
$H_t = \sum_{a=15}^{64}(hL_t^a - Z_t^a)$ and $h = e^{\theta((u \times YS))}$
The parameter u is bounded within a numerical range between 0 and 1. Consequently, we compare two distinct cases within the business-as-usual scenario: one with full UCS implementation (where u equals one), signifying the scenario with complete UCS implementation, and the other with UCS absent where $u \in [0,1)$.

Data

The real GDP, labor-augmenting technology, the elasticity of output with respect to human capital, and depreciation rate were obtained from Penn World Table version 10.01. The initial physical capital was obtained from Ketsawa (2019). The average years of schooling relied on the latest updated version of the Barro-Lee dataset reported by Barro and Lee (2013). The rate of returns to education was obtained from Bils and Klenow (2000). The exchange rates used to convert USD to THB for each year were obtained from the Bank of Thailand. The public health spending of the Universal Coverage Scheme was acquired from the National Health Security Office (NHSO). The share of tax revenue and savings in aggregate output were obtained from the World Bank database. The working-age population was taken from the United Nations. The mortality rate and years lived with disability were taken from the 2019 Global Burden of Disease (GBD) study of the Institute for Health Metrics and Evaluation (IHME). The NCDs' public health expenditure was taken from the World Health Organization (2019).

RESEARCH RESULTS

Analysis of Non-Communicable Diseases (NCDs) from 1995 to 2022

The results indicate a notable reduction in average Real GDP growth between 1995 and 2022, amounting to 0.12 percentage points, as well as a cumulative decrease in the total Real GDP between 1995 and 2022 by 1.8518 trillion USD or 150.614 percentage points of Real GDP 2019, in comparison to the counterfactual scenario. In the year 2022, the Real GDP experiences a decrease of 0.1123 trillion USD business-as-usual scenario, declining from 1.8772 trillion USD in the counterfactual scenario to 1.7649 trillion USD. This represents a difference of 9.1363 percentage points in Real GDP compared to 2019.

Table 1 Impact of Non-Communicable Diseases (NCDs)

Macroeconomic Indicators	Counterfactual	Business-as-usual	Burden
Real GDP 2022 (trillion USD, constant 2017)	1.8772	1.7649	0.1123
Real GDP 1995-2022 (trillion USD, constant 2017)	35.2720	33.4202	1.8518
Average real GDP growth 1995-2022 (%)	4.4019	4.2819	0.1200

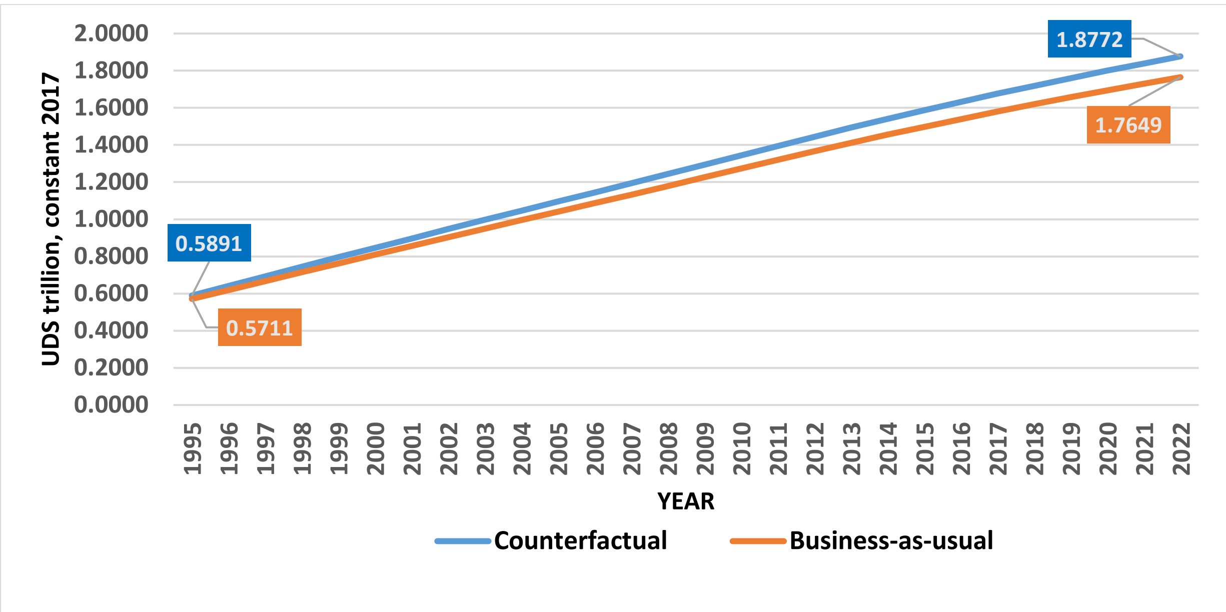

Figure 1 Transitional Dynamics of Real GDP in Both Scenarios from 1995 to 2022

Universal Coverage Scheme (UCS) Results
In the scenario without UCS implementation, further categorization is applied, with four cases distinguished by the different proportional effects on the years of schooling (u).

Table 2 Impact of Universal Coverage Scheme (UCS)

Macroeconomic Indicators	$u1$	$u0.75$	$u0.5$	$u0.25$	$u0$
Average Real GDP growth 1995-2022 (%)	4.2819	3.6434	3.0361	2.4605	1.9111

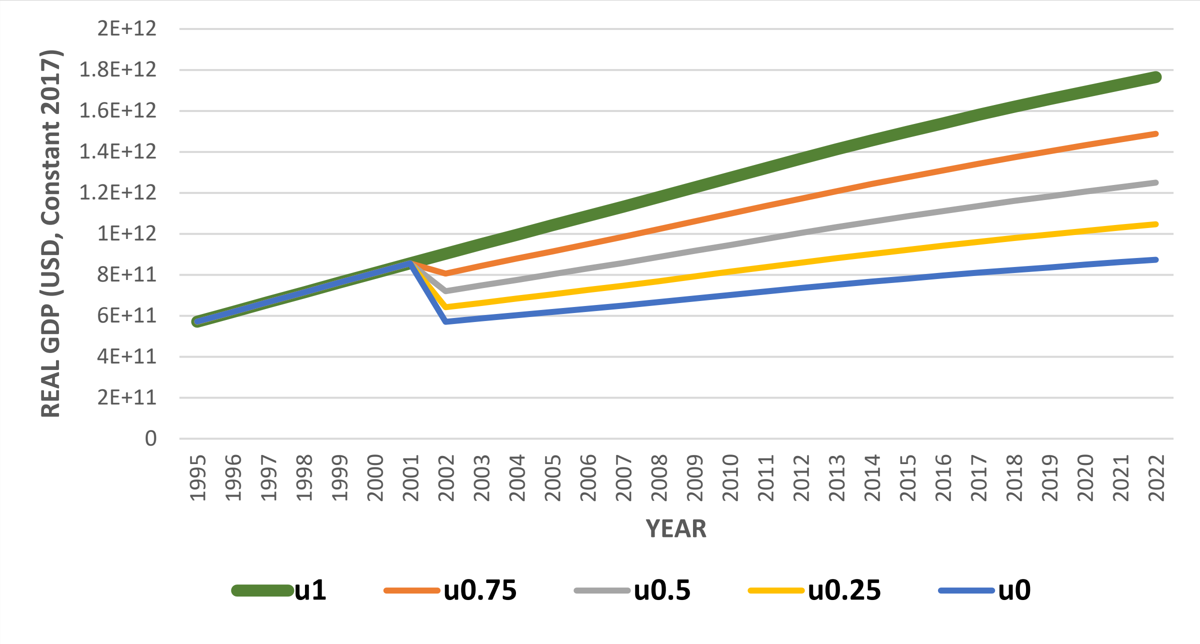

Figure 2 Transitional Dynamics of Real GDP in UCS Scenario and without UCS Scenario

The implementation of the Universal Coverage Scheme (UCS) policy in Thailand results in a noteworthy increase of 0 to 2.3707 percentage points in average real GDP between 1995 and 2022, relative to the scenario without UCS.

DISCUSSION & CONCLUSION

The reduction in the macroeconomic indicators attributable to NCDs occurs through three primary pathways. The most significant pathway through which NCDs exert a detrimental impact on the economy is morbidity, in which NCDs result in an increase in years lost due to disability (YLDs). Subsequently, mortality is affected as well, as NCDs reduce the size of labor through premature mortality. Lastly, physical capital accumulation is hindered, as government expenditures must be redirected towards public health spending on NCDs rather than investment in physical capital accumulation.
When comparing Thailand’s transition path under the business-as-usual and counterfactual scenario, it becomes evident that non-communicable diseases (NCDs) result in a decrease in the average growth rate of real GDP during the period from 1995-2022, amounting to a reduction of 0.1201 percentage points. By the year 2022, the aggregate output reduces from a real GDP of 1.8772 trillion USD (constant 2017) in the counterfactual scenario to 1.7649 trillion USD in the business-as-usual scenario, representing a difference of 9.1363 percentage points in real GDP for the year 2019. The results indicate that NCDs exert a detrimental influence on Thailand’s economy. Consequently, the government must increase public health expenditure targeted at addressing NCDs. This can be achieved through the implementation of

various policies, such as the Universal Coverage Scheme (UCS), aimed at assisting individuals facing the challenges posed by chronic disease.

To calculate the impact of the Universal Coverage Scheme (UCS), we undertake a comparative analysis involving two scenarios: one with the implementation of UCS and the other in the absence of UCS. In the scenario without UCS, the impact is observed through two primary factors: human capital and physical capital. In terms of human capital, we assume that the absence of UCS exerts a proportional influence on the years of schooling. Meanwhile, concerning physical capital, government expenditure was reduced in correspondence with the absence of UCS.

Consequently, the Universal Coverage Scheme (UCS) demonstrates a positive effect on Thailand's economy. There is an observed increase ranging from 0 to 2.3707 percentage points in average real GDP between the years 1995 and 2022, relative to the scenario lacking UCS.

In conclusion, investing in public health through policies like the Universal Coverage Scheme (UCS) not only improves the well-being of the population but also strengthens Thailand's economic resilience in the face of the growing burden of non-communicable diseases. These findings underscore the importance of proactive measures and strategic investments to address the challenges posed by NCDs and promote sustainable economic growth.

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