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Impacts of Direct and Indirect Tax Reforms in Vietnam: A CGE Analysis

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Abstract: The study applies a multi-sector multi-household static computable general equilibrium (CGE) tax model to assess the economy-wide impacts of taxes in Vietnam. It examines two tax reform scenarios based on the tax reform plan proposed by the Vietnam Ministry of Finance. The first scenario is increasing the value-added tax (VAT) rate to 12% from the current 10% rate. The second scenario relates to setting a competitive corporate income tax (CIT) rate to the lowest rate in ASEAN (Associations of South East Asian Nations) countries by reducing it from 20% to 17%. Correction of current tax distortions will have positive impacts on labour supply, utility, consumption, output, and welfare of households as they reallocate resources from more to less productive sectors of the economy. The CGE model allows for the finding of the macroeconomic and sectoral effects on prices and outputs, as well as on welfare of households. While this study contributes to the literature on the CGE model for the Vietnam economy, it is a small step for finding the optimal tax structure in Vietnam. It recommends that the Vietnam government should increase the standard VAT rate to 12% and reduce CIT rate to 17% to shift the tax burden from capitalists to consumers.

Keywords: tax reform; general equilibrium; tax analysis; Vietnam

JEL Classification: H3; E62; C68; D58

1. Introduction

The transition economy of Vietnam enjoyed prominent achievements in the first 30 years of economic reforms (*Doi Moi*) from 1986 to 2016 such as rapid growth, accelerated international integration, market liberalisation, and creation of more jobs in the private sector. Notably, the economy grew at an impressive average annual rate of 6.5% during the 1985–2017 period as possible with a remarkable increase in public expenditure. As the tax revenue accounts for only 80% of total revenue, there is still a high budget deficit resulting from an excess of spending over the tax revenue.

In detail, tax collection still excessively relies on few tax instruments such as value-added tax (VAT), corporation income tax (CIT), and tariff on trade of goods and services. The personal income tax (PIT) only contributes to an approximately modest portion of 6% of the total revenue. Tax and spending policies like this impact negatively on growth and equality of income redistribution. It has become essential to reform the tax system in order to, not only create more revenues, but also to stabilise the macro-economy and to enhance social welfare and to promote equality of income among households. More intensive research is also needed to address the more efficient allocation of resources in the economy.

CGE models have been used extensively for measuring the impacts of taxes in the last three decades (Ballard et al. 1985; Goulder and Summers 1989; Shoven and Whalley 1992; Baxter and King 1993; Elliott et al. 2010; Golosov et al. 2014; Bhattarai 2008, 2015; Bhattarai et al. 2017; Bhattarai et al. 2018b). These models allow to study the effectiveness of policy instruments that are more market-friendly and comprehensive and those that bring not only more efficiency in the allocation of scarce resources in production and consumption but also generate the optimal distribution of income with international competitiveness and social justice. A CGE model disaggregates and decentralises the economy with many types of households and production sectors while implementing tax measure such as consumption tax, capital income tax, household income tax, or in assessing impacts of public spending and transfers from rich to poor households to achieve a higher standard of living in a short span of time.

On the supply side, such a CGE model can be applied to measure the impacts of abovementioned changes in economic policy on gross domestic production (GDP) investment, employment, and capital formation by sectors. It also can demonstrate the effects of changes in the demand sides of the economy including changes in preferences for commodities consumed by households from various sectors. In addition, this model also can study changes in labour supplies or demand of households for leisure which forms an ingredient for analysis of income and welfare suitable to a socialist system of the economy in Vietnam. The relative price system is at the heart of the CGE analysis. The above effects emerge because of changes in the relative prices that emanate either from changes in technologies of production or from changes in policy instruments available to the policymakers.

To our knowledge, no study exists in the literature that is as comprehensive and consistent as our own to analyse the impacts of tax policy reforms of the Vietnamese economy, though there were few studies in the past that also tried to apply different versions of the CGE models for it including by (Chan et al. 1999; Martin and Fukase 1999; Chan and Dung 2002; Roland-Holst et al. 2002; Huong 2003; Dimaranan et al. 2005; Vanzetti and Huong 2006; Giesecke and Nhi 2010; Willenbockel 2011; Coxhead et al. 2013; Maliszewska et al. 2018; Dung 2018; Huong 2018). Most of these researchers focus on assessing impacts of Vietnam's international economic integration on growth, poverty, and income distribution.

In this study, in terms of methodology, we aim at building a multi-sector multi-household tax model to address the question of whether the Vietnam government should proceed with a tax reform in the form of increasing VAT rate and reducing the CIT rate. This research would contribute to past general equilibrium models of Vietnam using a standard dataset in the input–output table of Vietnam from the OECD (Organisation of Economic Cooperation and Development) that brings reliable results of model simulation for policy analysis. It is also expected to provide policy recommendations for policymakers to enhance the economy's performance. It will examine how rapid changes in preferences and technology of production will affect the relative prices of commodities and the allocation of resources among sectors. Moreover, it will address the question of how the burden of taxes is distributed across households.

The remainder of the paper is structured in five parts as follows. In Section 2, we discuss previous literature related to applying a CGE model for tax policy analysis, and then, we present a set of relevant stylized facts of the Vietnamese economy and main features of tax policy in Vietnam in Section 3. Section 4 provides an overview of this tax model and describes details of simulation settings. We present a general framework for modelling tax policy in the presence of 33 sectors and five groups of households for Vietnam. Section 5 discusses the results, and, the conclusion for this research is given in Section 6.

2. Literature Review

According to Borges (1986), the general equilibrium approach has various strengths on policy analysis so that this methodology was accepted widely by economists and policymakers shortly after it was introduced in the early 1980s. According to a review of Dixon and Rimmer (2016); Johansen (1960) initially contributed to the development of a major branch of economics, computable general

equilibrium (CGE) modelling. Subsequently, Shoven and Whalley (1984) are the first economists to apply CGE model in order to address policy issues in tax reform and international trade following the original algorithm derived by Scarf (1969) and corporate tax analysis of Harberger (1962).

Later on, Bhattarai and Whalley (2000) build up a CGE tax model for the UK investigating welfare impacts of eliminating tax distortions. Bhattarai (2011) employs an open-economy two-sector multi-household general equilibrium tax model with money for South Asia. In his research, the main finding is that a fiscal expansion policy has broadly positive impacts on household welfare and the upper-income household group gain much more than those in the bottom group in the flexible price system. In addition, the combination of fiscal and monetary policies can extensively affect efficiency and redistribution. His works on evaluating impacts of tax policies for other economies are also continuously developed in Bhattarai (2008); Bhattarai (2016); Bhattarai et al. (2017) and Bhattarai et al. (2018b).

The first academic researchers that computed a general equilibrium model for policy analysis in Vietnam are Chan et al. (1999) followed by Martin and Fukase (1999); Chan and Dung (2002); Roland-Holst (2004); Roland-Holst et al. (2002); Huong (2003); Dimaranan et al. (2005); Vanzetti and Huong (2006); Giesecke and Nhi (2010); Willenbockel (2011); Coxhead et al. (2013) and Minor et al. (2018). Most of these researchers focus on assessing impacts of Vietnam's international economic integration on growth, poverty, and income distribution.

Chan et al. (1999) use a CGE model for Vietnam in order to evaluate tax reform option with the main focus on VAT. As being a member of AFTA, Vietnam had to decrease tariff that would lead to a vast reduction in revenue. Therefore, they examined the effects of indirect tax reform covering the revenue gap caused by the tariff. They calibrated the model to a 1995 industry data set and 1992–1993 household living standard survey (VHLSS) to predict the effects and applied the Armington differentiation assumption between imports and domestic products. The model follows Shoven and Whalley (1992). As a result, they suggest that, though sale tax reform brings positive changes for Vietnam, it also leads to large redistributive effects that tend to swamp the aggregate impact. A few years later, a study carried by Chan and Dung (2002) also evaluated impacts of tariff reforms in Vietnam applying a CGE model. Their new contributions remain in finding that there are positive impacts on welfare when tariffs are eliminated. However, it also creates an increasing inequality between wealthy groups and poor groups and between people who live in rural and urban area. It is even worse in the scenario of removing all tariffs. They point out that people who owned fix factors in less liberalised sectors suffered most from tariffs reform.

Subsequently, Chan et al. (2005) continued the study of exploring impacts of trade liberalisation using a similar CGE model. However, they investigated the effects on labour market adjustment by comparing five different scenarios in order to provide policy analysis. With the same purpose of examining the impact of trade liberalisation, Toan (2005) constructed a SAM (Social Accounting Matrix) for the Vietnam economy from 2000 input-output (I-O) Table to apply in a recursive dynamic CGE model. He finds negative impacts on total welfare though with quite a bit of redistribution as the rural people lose whereas the urban habitats gain from the removal of such tariffs. This indicates a broader income gap as a consequence of integration.

Meanwhile, Martin and Fukase (1999) also apply CGE analysis, but they examine the impacts of most favoured nation (MFN) status that the United States granted to Vietnam. In general, the model provides a result of less trade than the author expected. They also find that it is not sufficient to explain expanding sectors and export achievement due to limits set by the Armington specification of the model.

In order to simulate potential impacts on macroeconomic variables of Vietnam in 2020 of the WTO (World Trade Organisation) accession, Roland-Holst et al. (2002) use the "1999 SAM" constructed by Tarp et al. (2002). The authors suggest that WTO integration can enhance Vietnam's comparative advantage as low-wage cost, but it would not continue in the long-run. They argue that the solution for this can be done by implementing complementary policies to diversify the economy and to promote external market access. With interest in evaluating impacts of WTO integration in Vietnam,

Roland-Holst (2004) continues his research with "2000 VSAM" constructed by Jensen et al. (2004), focusing on poverty incidence analysis. He also bases it on the CGE approach but combines it with micro-simulation parameters estimated from 2002 VHLSS. His study aims at seeking not only a higher level but also a sustainable level of income and saving for the poor. Assessing effects of WTO accession on the Vietnamese economy by using the CGE model, Vanzetti and Huong (2006) had found that a reduction in tariff would lead to an increase in imports. Meanwhile, Dimaranan et al. (2005) also analysed the liberalisation of tariffs and textile export quotas, though they paid much attention to industries rather than households. They note that the gains to Vietnam would be diminished in case of abolition of the quota.

Following a trend of combining CGE model and micro-simulation model for analysing fiscal policy, Jensen and Tarp (2005) use a micro-simulation model for Vietnam employing "2000 VSAM" and VHLSS98 data set. The CGE framework is used to measure the poverty impact of macro policies. They find that feedback effects significantly determine the poverty impact under the integration process. It is also noteworthy that the way household income distribution is considered as exogenously or endogenously would influence the results of the model.

Giesecke and Nhi (2009) build a dynamic computable general equilibrium for Vietnam called MONASH-VN model. Based on the general equilibrium approach, they explore the rapid growth and structural change of Vietnam's economy from 1996 to 2003 period. The key findings of their study are that improvement of technique and increase of foreign demand for goods and labour in Vietnam play an essential role in evaluating growth and structural changes. In 2010, they developed a model for analysis of impacts of VAT on Vietnam economy by simulating alternative complex policy reform through diversion of rates, exemptions, commodities, and enterprises assuming neutrality of the budget. Also, with attention to tax reform in Vietnam, Coxhead et al. (2013) use a CGE model to evaluate the effects of an environment tax introduced since 2012. They conclude that the tax might cause an increase in poverty and a fall in employment. In general, it can be seen as having a dispute with other development goals.

Recently, Dung (2018) develops a standard static CGE model originally from Dervis et al. (1981) and Lofgren et al. (2002). The study uses SAM 2011 data that was constructed by Central Institute of Economics Management (CIEM Vietnam) from two primary sources including 2007 input–output table and VHLSS 2010. He shows that if there is a 20% increase in the current VAT rate, government revenue will rise to 4.9%, whilst not only household income, but also household consumption, decreases. The negative impact, however, lessens for the poor group rather than the rich ones. He also carefully considers effects of policy changes with other factors related to households such as urban/rural, age, level of income, and education.

Huong (2018) employs a recursive dynamic CGE model to analyse and predict the impacts of tax policies on the sectoral structure of Vietnam economy in her doctoral thesis. She finds positive effects on industrialisation and modernisation of the economy if there is a reduction of tax rates in import tax, corporate income tax, and personal income tax. However, the closure rule assumed in her model is not consistent with the general equilibrium model as markets become weaker by fixing the inflows to Vietnam.

In very up-to-date research, Maliszewska et al. (2018) depict a picture about economic and distribution impacts of comprehensive and progressive agreement for trans-Pacific partnership (CPTPP) using a dynamic CGE model linked with a top-down microsimulation method. This approach is beneficial to provide economy-wide analysis in order to compare the impacts of change in tariffs and non-tariff measures in scenarios of CPTPP and TPP-12 and regional comprehensive economic partnership (RCEP).

Therefore, this study contributes to the literature of building a proper CGE model for Vietnam, aiming at finding the optimal tax structure to help to improve the economy's performance in the next century. In particular, it will focus more on investigating the macroeconomic and sectoral effects as well as welfare effects of the tax changes in order to address the question of whether Vietnam government

should increase the standard VAT rate and reduce CIT rate to shift the burden of tax from firms to consumers and from poor to rich households.

3. Vietnam Economy Stylised Fact and Tax Reform

The past three decades of reform since Doi Moi have witnessed remarkable achievements of Vietnam in terms of economic growth and in the improvement of people's living standards. The country has become one of the fastest growing countries in Asia as illustrated in Figure 1. According to the International Monetary Fund database the World Economic Outlook 2017, in 2011–2016, average GDP growth rate in Vietnam was 7.02%, which was much higher in the average growth rate of 6.2% of ASEAN-5 countries and 4.42% of the world respectively.

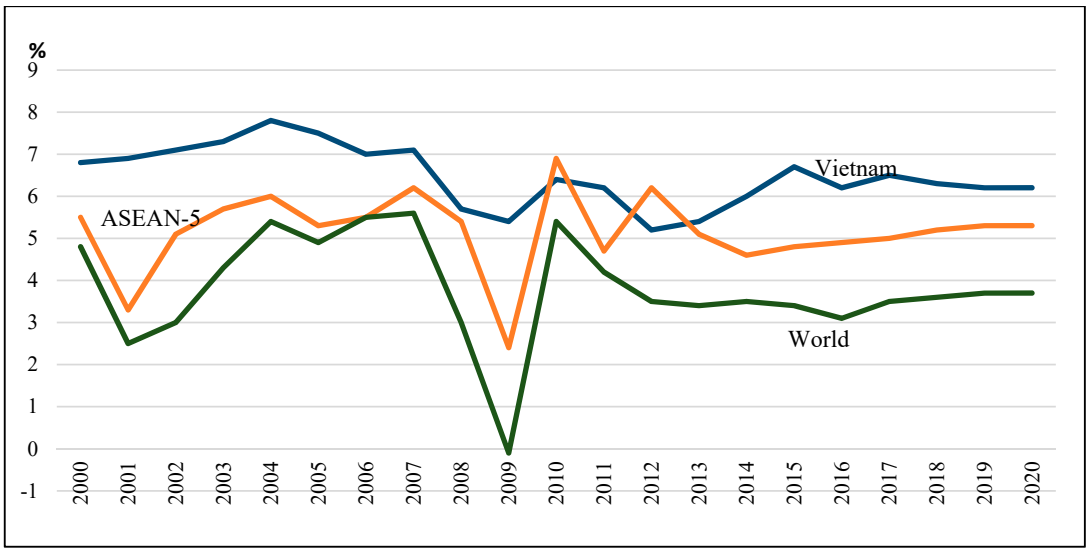

Figure 1. Real GDP Growth in Vietnam 2000–2020 (%). Source: World Economic Outlook, 2017.

As one can see in Figure 1, the negative impacts of the global financial crisis have resulted in the slowdown in GDP growth of Vietnam not only for period 2007–2009 but also later where the GDP rate was at the bottom of 5.25% in 2012 against 6.24% in 2011. However, it was recovered in 2013 (5.42%) and maintained at 5.98% in 2014, 6.68% in 2015, 6.21% in 2016, and 6.81% in 2017. The GDP growth in 2018 has attained, for the first time since 2010, a level higher than 7%—precisely 7.08% according to the Government Statistical Office (General Statistics Office of Vietnam GSO).

According to economists, the country could arrive at these achievements due to the government's decisive policies and actions (among which a series of tax reform measures we are going to study in this paper) with first priority focused to restrain the inflation (from 18.13% in 2011 to 9.21% in 2012, 6.04% in 2013 and under 4% since then until now—precisely 3.54% in 2018 (Do 2018)); to keep the macroeconomic stability; and to assure the social security and welfare. The country also has important advantages: Stable socio-economic conditions, great internal force and growth potential, expanded export markets, better reputations and relations in the international arena, improved investment environment, and national and international investors' belief in economic development prospects (Tan 2017).

In particular, in order to achieve that high growth rate for a long period, the government has taken actions to promote the consumption that accounts for a significant share of GDP. In 2016, the percentage of the final consumption expenditure to GDP was recorded with a considerable figure of 70.86%, of which 64.35% was contributed by households (see Appendix A.1).

In addition, rapid economic growth has created favourable conditions for Vietnam to improve people's living standards. Also, Vietnam has successfully transformed from one of the poorest countries among the world to the middle-income status (see Appendix A.2). GDP per capita increased from US$ 433 in 2000 to US$ 2171 in 2016, which is a clear indicator of such transformation (see Appendix A.3).

Poverty headcount ratio at national poverty lines has fallen dramatically, from 20.7% in 2010 to less than 13.5% in 2014 according to the World Bank Development Report 2017. However, the benefits of economic growth among different income groups are not equally shared (see Appendix A.4).

The wealthiest group earned income 6 to 8 times greater than the poorest people during the period 1992–2014. Moreover, among 63 provinces in Vietnam, the per capita income of the richest province, Ho Chi Minh City, is approximately 5 times greater than the average earning in the most impoverished province, Lai Chau. Similarly, the trend of increasing inequality can also be noticed by the extreme wealth gap between urban and rural areas (General Statistics Office of Vietnam 2015).

While there have been many achievements in economics and social fronts in Vietnam, efforts towards equality continue to face various challenges. Fiscal policy is always a valuable tool to achieve the government's goals. Thus, many tax reforms have been implemented over the past three decades. These reforms focus on expanding tax bases, reducing tariffs, and simplifying taxation, declaration, and payment methods.

Nonetheless, this tax system is still too complex with 10 different taxes that have implemented (see Figure 2). Also, as seen in Figure 3, the revenue is quite biased to indirect tax, as nearly 40% of total tax revenue comes from the VAT. This number is even higher than the overall contribution of direct tax (PIT and CIT) which accounts for 31% of total tax revenue. It is clearly seen that in Vietnam, indirect tax is a prominent source of revenue.

Tax on income	Tax on goods and services	Tax on property	Other Taxes
• Personal Income Tax • Corporate Income Tax	• Value Added Tax • Special Consumption Tax • Environment Protection Tax	• Agriculture Land Use Tax • Non-Agriculture Land Use Tax	• Export - Import Tax • Natural Resource Tax • Licence Tax

Figure 2. The tax system in Vietnam as of October 2018.

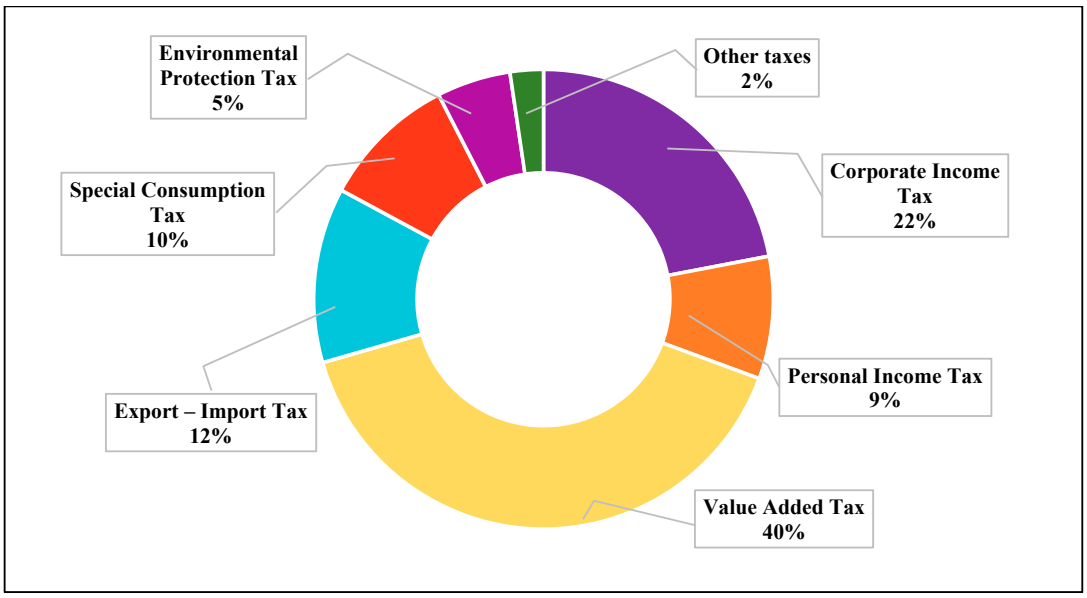

Figure 3. Breakdown of tax revenue by tax categories 2016 (% total). Source: 2016 Annual State Budget Report, Vietnam Ministry of Finance.

The sequence of tax reform in Vietnam over the past three decades can be summarised as follows:

In the early 1990s, the first reform had been put into practice, encouraging a market-friendly economy. A number of tax laws (as in Table 1) has been introduced focusing on establishing a tax system supporting the government's economic and social goals.

Table 1. Taxations introduced in the first reform.

No.	Tax Law	Year
1	Law on Turnover Tax	1990
2	Law on Special Consumption Tax (SCT)	1990
3	Law on Profit Tax (PT)	1990
4	Law on Export and Import Tariff (EIT)	1991
5	The Income Tax Ordinance on High-Income Earners	1990
6	Law on Agricultural Land Use Tax	1993

The second period of reform occurred in the late of the 1990s and early 2000s. This period of assessment changes was set apart with the presentation of different current tax laws. The tax laws incorporated the law on VAT (1997) and the law on CIT (1997). At this stage, the law on special consumption tax (SCT) and the law on export and import tariff (EIT) (1998) were likewise subjected to different amendments.

The third phase of the tax reform was implemented in the mid of the 2000s. During this period, Vietnam's main tax policies were redesigned to meet the conditions of international integration, especially the requirements by the World Trade Organization (WTO). Some tax laws have been changed such as the law on PIT (2007), the law on Natural Resource Tax (2009), the law on non-agricultural land use tax (2010), and the law on environmental protection tax (2010).

In addition, in the tax reform strategy of 2011–2020, the Prime Minister approved the objectives of the tax system: Comprehensive, equitable, and effective, consistent with the so-called socialist-oriented market economy; simple and transparent; promotes export and competitiveness; encourages investment, exceptionally high technology, and creates jobs and growth. Accordingly, the preeminent taxes that have been amended include the law on VAT, law on CIT, law on PIT, the law on SCT, and the law on EIT.

Most recently, on the 8th of August 2017, the Ministry of Finance of Vietnam (MoF) announced the proposal in which amendments and supplements are provided to existing tax laws on CIT, PIT, VAT, SCT, and natural resource tax. The proposal aims to develop a tax system which is consistent with international laws that simultaneously achieve budget goals. The plan also targets to clarify the tax system and reduce the tax burden on businesses. Considering these aims and also comparing with other economies (see Appendices A.5 and A.6), the MoF proposed an increase of VAT rate by 20% compared to the current tax rate, and a reduction of 3% in the CIT rate to 17% for small and medium enterprises.

Vietnam is facing a series of tax and tariff-related challenges and commitments under the regional and international cooperation mechanism under the CTTP agreements in recent years. These require Vietnam to be more efficient in designing the tax and tariff system appropriately. Our study with multi-sectoral and multi-household CGE model is very relevant to analyse impacts of policy reforms under considerations.

4. Methodology and Model Specification

This research aims to investigate the impacts of tax reform on macro-economy in Vietnam by applying an open multi-sector multi-household computable general equilibrium tax model for it. Therefore, this CGE model will be built in two components of households and economy, including the government sector and external sector, to evaluate the effects on household welfare and allocation of resources across sectors of the economy. The full impact of tax change occurs through several

rounds. First-round effects start with the incidence of difference in consumption. These have impacts on demand for products by households and foreigners and supply of goods and services by firms. Similarly, it affects government spending and investment spending. Second-round effects occur when the burden of taxes starts shifting gradually. It manifests itself as an increase or decrease in the prices of commodities, and a collection of revenues. Final impacts are settled when all burdens move throughout the economy. Applied general equilibrium models presented here are based on optimisation decisions of households and firms. Demand for goods and services is derived from preferences subject to budget constraints of households. The supply side is derived from the profit maximisation decisions of firms. The interaction of these economies into the global economy is through exports and imports in which balance of payments are maintained through adjustments in the exchange rates. The price system allocates resources efficiently. All economic agents do the best they can within their budget constraints (Bhattarai 2016). Computable general equilibrium models like this include most of the theoretical developments in economics over the last 200 years.

The model for each economy is benchmarked to the micro-consistent dataset for the economy. Producers supply goods and services for domestic and foreign markets. Public sectors use tax, transfer policies, and provide public services. The model assesses equilibrium that emerges from various policy instruments available to the policymakers. It is a fairly decentralised model aimed to replicate production and consumption activities of both the private and the public sectors. Each category of household is constrained by resources in optimising choices. Firms are constrained by available technology in supplying commodities that are in demand in their own markets. Revenue and expenditure accounts of governments and exports and imports are balanced over time.

This model of the Vietnamese economy considers five different quintiles of households ordered by income along with 33 production sectors. The revenue that the government gets is collected either from indirect taxes on goods consumed by households or from the direct tax on the income of labour and capital.

4.1. CGE Model and Tax Policy Scenarios

The model will be calibrated using the Vietnam input–output table 2011 dataset retrieved from OECD (2017) database (IOTs 2015 edition ISIC Rev.3) and 2012 VHLSS data (General Statistics Office of Vietnam GSO) to predict impacts on Vietnam economy through changes of different taxes in alternative tax reforms. The structure for the model based on Bhattarai and Whalley (2000) and Bhattarai (2008) is as follows:

4.2. Household Preferences, Demand Structure, and Technology

The utility of household h in Vietnam is assumed to be given by a nested constant-elasticity-of-substitution (CES) utility function. At the top level of this nest, the utility is a function of composite consumption. The consumption composite good is made up of 33 sub-composite products. The 33 goods reflect the products produced in the 33 sectors. Each sub-composite good is a nested function of domestic and imported products.

4.3. Demand Side of the Economy

A representative household maximises utility, which is described by a CES function of leisure and composite consumption. Households maximise their utility subject to a budget constraint including a composite price for the commodity and leisure. The composite commodity demand is derived from these for sub-composite goods (i = 1 . . . 33). Each of these sub-composites is obtained from domestic and imported sources. Details of model specifications of production, trade, public finance, and the redistribution mechanism are in Appendix B.

4.4. Evaluation of Welfare Change between Counterfactual and Benchmark Scenarios

The essence of tax policy analysis lies in comparing welfare changes between a benchmark and counterfactual economy. How much a typical consumer has gained or lost because of changes in policy

in money metric terms, or how much money is required to bring him/her back to the equivalent of original welfare, can be measured either in original or new prices. Hicksian equivalent variation (EV) is a measure of welfare change between the benchmark and counterfactual scenarios using benchmark (old) prices. Hicksian compensating variation (CV), on the other hand, measures welfare changes in terms of new prices. A general rule of thumb is that a positive Hicksian EV is a measure of welfare gain, and corresponds to a negative Hicksian CV, which gives the amount of money to be taken away from the consumer to keep her at the old utility level. In general, EV and CV are given by differences in money metric utility between old and new prices corresponding to benchmark and counterfactual solutions. If utility functions are linear and homogeneous, then the original and new equilibria can be thought of as radial expansion in the utility surface. Therefore, the change in welfare between the benchmark and counterfactual solutions of the model is proportional to the change in income or the percentage change along the radial projection between two consumption points. As in Shoven and Whalley (1992), for homothetic preferences, the values of EV and CV between a benchmark and counterfactual scenarios can be computed as:

$$EV^h = \left(\frac{U_C^h - U_B^h}{U_B^h}\right) I_C^h \text{ or } CV^h = \left(\frac{U_B^h - U_C^h}{U_C^h}\right) I_B^h \quad (1)$$

where superscripts C and B represent new (counterfactual) and old (benchmark) values of the variable on which they appear respectively, U is the money metric utility, and I denotes the income of the household. The values of both EV and CV are sensitive to elasticities of substitution in production and consumption. It is necessary to evaluate the sensitivity of the EV/GDP ratios to a set of relevant substitution elasticities for robustness of the tax reform analysis, Bhattarai and Whalley (2000).

4.5. Implementing the Structure in GAMS

The model outlined in this section is calibrated using the benchmark dataset for 2011. Rutherford (1995); Rutherford (1999) has developed a programming language MPSGE (mathematical programming system for general equilibrium analysis) which is a convenient software for solving a large-scale Arrow-Debreu model as specified in this paper. GAMS (general algebraic modelling system) serves as an interface for the MPSGE. The GAMS/MPSGE code for the Vietnam model used in this paper, that can be obtained upon request, uses the mixed complementarity conditions and path algorithm to solve the CGE model of Vietnam (see Rutherford (1995) for more details on MCP algorithm used in it). In the code, the general equilibrium model requires fulfilment of the following three conditions simultaneously:

1. Market clearance—at equilibrium prices, activity levels are choices where the supply of any commodity optimally balance demands by consumers and producers.
2. Zero profit—in equilibrium, no producer earns an excess profit, i.e., the value of inputs per unit activity must be equal to or greater than the value of outputs.
3. Income Balance—at equilibrium, the value of each agent's income must equal the value of factor endowments on the one hand and their total expenditure on the other.

In the model output (GDP), consumption, investment, exports, imports, and Armington supply are set as activities (quantities) and connected to the utility derived from consumption of these goods. Welfare analysis is conducted after alterations in consumption, income, or trade taxes. Similarly, the model constructs the aggregate supply and price indices based on weights assigned by calibrated shares of model commodities, real exchange rate index, index of a rental rate, the price for domestic sale, welfare price index, export price index, the rental price of capital, wage index, and the value of transfers. Firms, households, and government are the recipients of income and allocators of that for production, consumption, and public services in the model.

5. Calibration and Application of CGE Model of Vietnam for Tax Policy Analysis

The model specified in Section 4 (in Appendix B in greater details) now can be applied following two steps. The first step is to calibrate the computable general equilibrium (CGE) model for Vietnam with the micro-consistent dataset constructed from the latest input–output (IO) table of Vietnam. Decomposition of consumption by sector for each category of households was made using the quintile distribution of income from the VHLSS complemented by the income distribution data from the (UNU-WIDER 2017) database. The second step is to apply the calibrated CGE model to evaluate the impacts of alternative policies in Vietnam. This section covers these two aspects of analysis respectively.

5.1. Calibration of the CGE Model for Vietnam

Calibration of a CGE model requires preparation of a benchmark dataset that provides a consistent pattern in demand and supply by sectors and households in the private sector of the economy, and revenue and expenditure of the government in the public sector and inflows and outflows of goods and capital from the economy. Thus, benchmark data require three necessary conditions of a general equilibrium model to be satisfied: A zero-profit condition, market clearing, and income balance. The zero-profit condition for producers in the benchmark data is met for various sectors of the economy when aggregate output equals the gross of tax payments to labour and capital services and intermediate inputs. This essentially means that firms are just breaking even while producing goods and services and supplying them to markets. The market clearing condition for each sector implies that the total output or supply equals the aggregate demand—intermediate and final demands—for goods of those sectors. The total supply of goods in the market comprises domestic output and imports. The income balance condition implies that the expenditure of households and government is equal to their income or revenues gross of savings, the economy-wide trade balance condition holds, and the volume of savings equals the volume of investment in the economy. All of these three equilibrium conditions required for an empirical implementation of a GE tax model are satisfied in the dataset contained in the Vietnam input–output table obtained from the OECD input–output tables database for the year 2011 (to be updated for Asian Development Bank (2018)).

Data in Table 2 shows production tax rate is highest (41.9%) in refined petroleum products, followed by the agriculture sector (18.46%) and health and social work (14.59%) in the benchmark. Meanwhile, the highest consumption tax is recorded in the renting of machine and equipment sector (9.14%), and the lowest rate is applied in education (0.27%). There are three prominent sectors by capital assets in the Vietnamese economy including mining, wholesale, and financial intermediation (see Appendix C.1). In addition, agriculture and wholesale retail are labour-intensive industries in Vietnam. Agriculture, hunting, forestry and fishing, chemicals and chemical products, food products, beverages, and tobacco, and wholesale and retail trade and repairs are major sectors by the size of gross output.

Welfare gains are from the consumption of commodities as illustrated by sector for each quintile in Appendix C.3 and leisure per quintile in Appendix C.2 Changes in tax rates as discussed above distort allocations and the composition such consumption. Affluent people tend to spend more on leisure, however, the middle-income group (H3) spends even less than the poorest (H1) (see Appendix C.2). Despite this fact, poorest quintile experiences more welfare gains relative to other groups because they receive more substantial portion of transfer income and can consume most of their time at leisure as their supply of labour is very minimal. The middle income group works hard, gets less leisure, and pays taxes, and thus gets squeezed in the economic system in Vietnam.

For more details of capital share, labour share, and consumption share see Appendices C.3 and C.4. Based on the literature, the elasticity of substitution between goods and leisure is set equal to 3, and the elasticity of substitution among composite goods is set to 1.2.

Table 2. Sectoral calibrated corporation income tax (CIT) Rate and value-added tax (VAT) rate (%).

	CIT Rate	VAT Rate
Agriculture, hunting, forestry and fishing	18.46	1.7
Mining and quarrying	3.41	1.8
Food products, beverages and tobacco	3.48	2.02
Textiles, textile products, leather and footwear	7.92	1.63
Wood and products of wood and cork	3.6	1.32
Pulp, paper, paper products, printing and publishing	6.14	1.06
Coke, refined petroleum products and nuclear fuel	41.93	0.55
Chemicals and chemical products	11.71	0.58
Rubber and plastics products	6.65	0.58
Other non-metallic mineral products	4.98	2.21
Basic metals	8.84	1.44
Fabricated metal products	5.96	0.83
Machinery and equipment, nec	7.41	0.68
Computer, Electronic and optical equipment	6.21	0.6
Electrical machinery and apparatus, nec	7.02	0.84
Motor vehicles, trailers and semi-trailers	18.6	1.37
Other transport equipment	3.86	0.92
Manufacturing nec; recycling	4.35	0.64
Electricity, gas and water supply	5.12	1.79
Construction	10.79	1.09
Wholesale and retail trade; repairs	4.44	3.48
Hotels and restaurants	12.32	2.96
Transport and storage	11.76	2.39
Post and telecommunications	2.62	1.74
Financial intermediation	6.18	0.93
Real estate activities	6.2	5.09
Renting of machinery and equipment	6.05	9.14
Computer and related activities	2.18	3.84
R&D and other business activities	7.16	5.36
Public administration and defence; compulsory social security	23.5	0.15
Education	7.28	0.27
Health and social work	14.59	0.93
Other community, social and personal services	12.3	2.66

5.2. Application of CGE Model for Policy Analysis

After the replication of the benchmark economy, this model was applied to perform types of counterfactual policy experiments.

First set of scenarios consisted of increasing rates of VAT by 20% above the existing rates to raise revenue required for the expansion of public spending on infrastructure, social securities, and other public services. We study impacts of such an increase in tax rates on output, employment, investment, prices, labour supply, leisure, and consumption of households for various sectors of the economy. The impacts were studied computing percentage change in these variables that follow from our policy experiments. Results were intuitively appealing, relevant, and reasonable for all sectors of the Vietnamese economy. For instance, increase in taxes had adverse impacts on the welfare of affluent households but had a positive effect up to 0.75% of the base year income for the households in the poorest category of income quintiles. The mechanism for such impact remains in lower tax rates on transfer income of the low-income households in comparison to higher tax rates on transfer income of high-income households.

Our second experiment involved reducing the rates of CIT by 3%. Again, we studied impacts on output, employment, investment, prices, labour supply, leisure, and consumption of households. They were very intuitive, as the tax rate reduction in this way benefited the households in wealthier quintiles but had a negative impact on consumption income and welfare of households in the poorest category. This makes intuitive sense as these poor households get less transfer income after reduction

in taxes, so their overall income decreases when the corporate tax is reduced by 3%. On the other hand, the income of the rich households increases as they are liable to pay less tax after such reforms.

Thirdly we also find out the marginal cost of the public fund when taxes increased by piecemeal basis across each sector or when they are reduced in combinations. Finally, we measure the economy-wide deadweight loss due to the tax system.

These four categories of results have significant implications on the options available to policymakers. When the tax rate rises, it does lead to an increase in the amount of revenue collected that compatibly finances for a rise of 1.07% in government expenditure. On the other hand, when tax rates are reduced, it does not reduce the revenue collected by the government of Vietnam proportionately because the lower the tax rates less are the efforts for tax evasion and avoidance. It broadens the tax base and so compensates for the revenue lost due to lower tax rates. Thus, our CGE based analysis, in general, is supportive of applicability of the Laffer-curve hypothesis on taxes for the Vietnamese economy.

We focus on reporting four different types of results for our policy experiment for VAT and CIT: (a) Impact of reforms on output and investment by sectors, (b) change in consumption bundles by categories of households, (c) impacts on welfare of households, and (d) impacts on public finance including the marginal excess burden of taxes. We check the robustness of the model by a series of sensitivity analysis and assess the marginal excess burden of public funds.

5.2.1. Impacts of an Increase in VAT on Output, Capital Stock, Welfare, and Revenue

We remove the production taxes underlying the benchmark economy and make each sector subject to benchmark VAT of 10%. Then, we increase the VAT by 20%. The impacts of these are measured and reported in Figures 4–6 and Table 3, below. Rich structure of production with 33 sectors contained in our model can measure backwards and forward linkages very nicely. This model is helpful in measuring the changes in the sectoral GDP and capital stock as shown in Figure 6. Vietnam is growing continuously at the annual rate of 6–7% in more than 20 years. This expansion is led by transformation away from the agriculture to the manufacturing and service sectors because of the FDI export-led strategy of economic growth. Textiles, footwear, electronics, and processed agricultural product sectors are expanding spectacularly along with construction, finance, real estate, and transport sectors of the Vietnamese economy. Uniformity in the tax system removes the underlying distortions in production. Impacts of new taxes also differ due to variation in preferences of consumers for types of goods.

An increase in VAT raises prices of commodities to consumers. This reduces demand for products in the production sectors. This further results in lower demand for labour and capital inputs. Thus, an increase in VAT is often contractionary. Outputs of 15 out of 33 sectors are decreased when VAT rate is increased by 20% of the actual rate. It is expected that household consumption declined in most of industries when the consumption tax climbs up. The government collects more revenue to finance an increase of public expenditure which leads to a growth in welfare of lower income groups but lessen welfare of the richer (the shock hits hard to the H3 group which decreases their welfare by nearly 3%).

Increase in VAT from 10% to 12% leads to increase in revenue but will have quite significant re-allocation impacts across sectors for distributing scarce resources ranging from real estate, wholesale, and property sectors to education, public services, and chemical sectors. It also changes the composition of commodities in the consumption baskets of households as shown in Figure 5. Meanwhile households in the poorest quintile gain 0.8% in welfare and middle-income household loses almost by 3%. Similarly, government revenue increases faster than government expenditure.

Rich structure of production with 33 sectors can measure backwards and forward linkages very nicely. Thus, the model is useful in measuring the changes in the sectoral GDP, gross output, investments, exports and imports, as well as the relative prices of commodities in these sectors. We constructed aggregate or sector-wise scenarios for changes in private or public sector policies in the economy. Also, it is well suited to study challenges faced by the households as there are five categories of households classified by income levels. Generally, this model is thus fit for analysis of the industrial structure and distribution of income simultaneously according to the emerging nature of the Vietnamese economy.

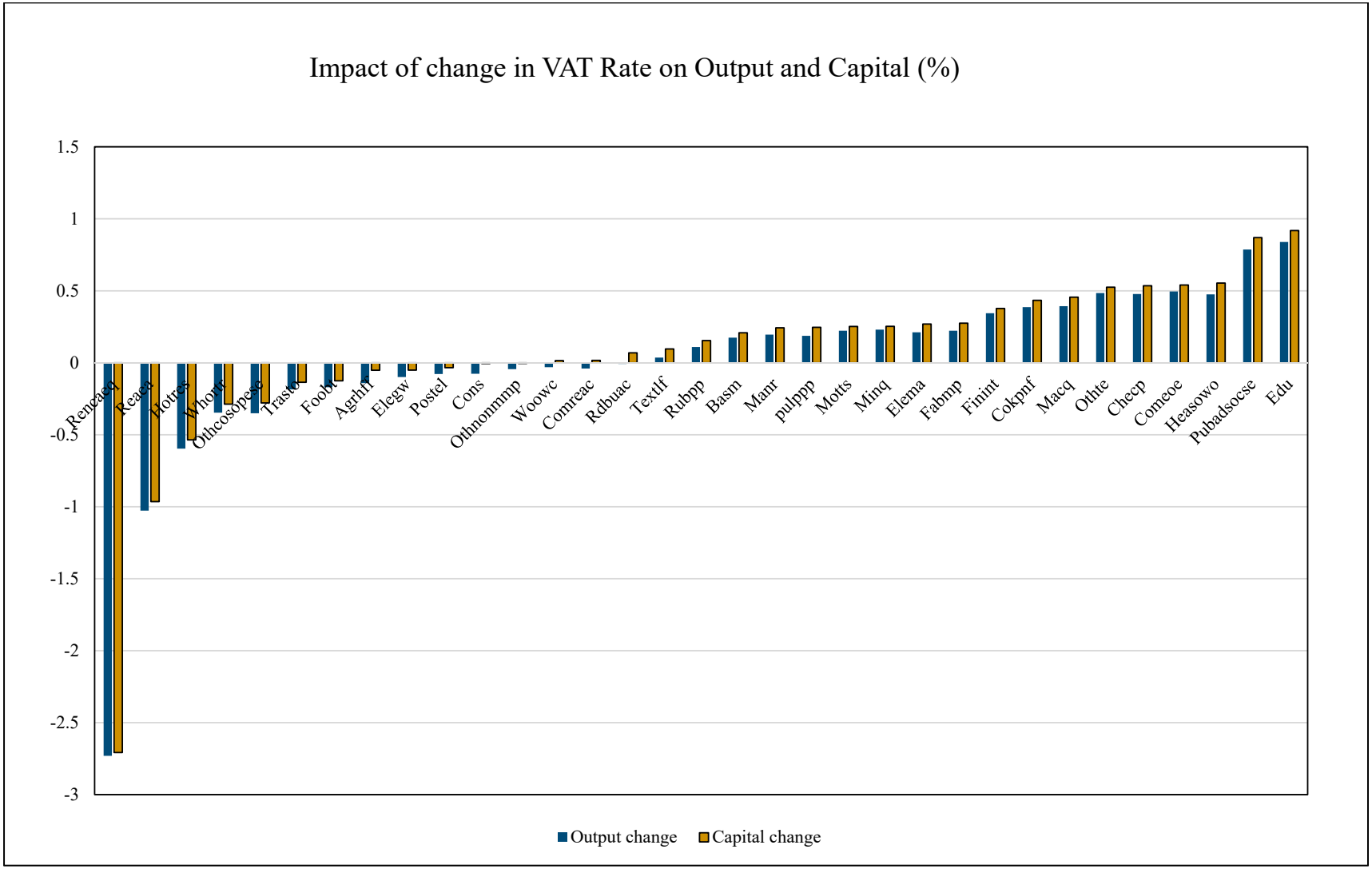

Figure 4. Impacts of VAT reform on output and capital.

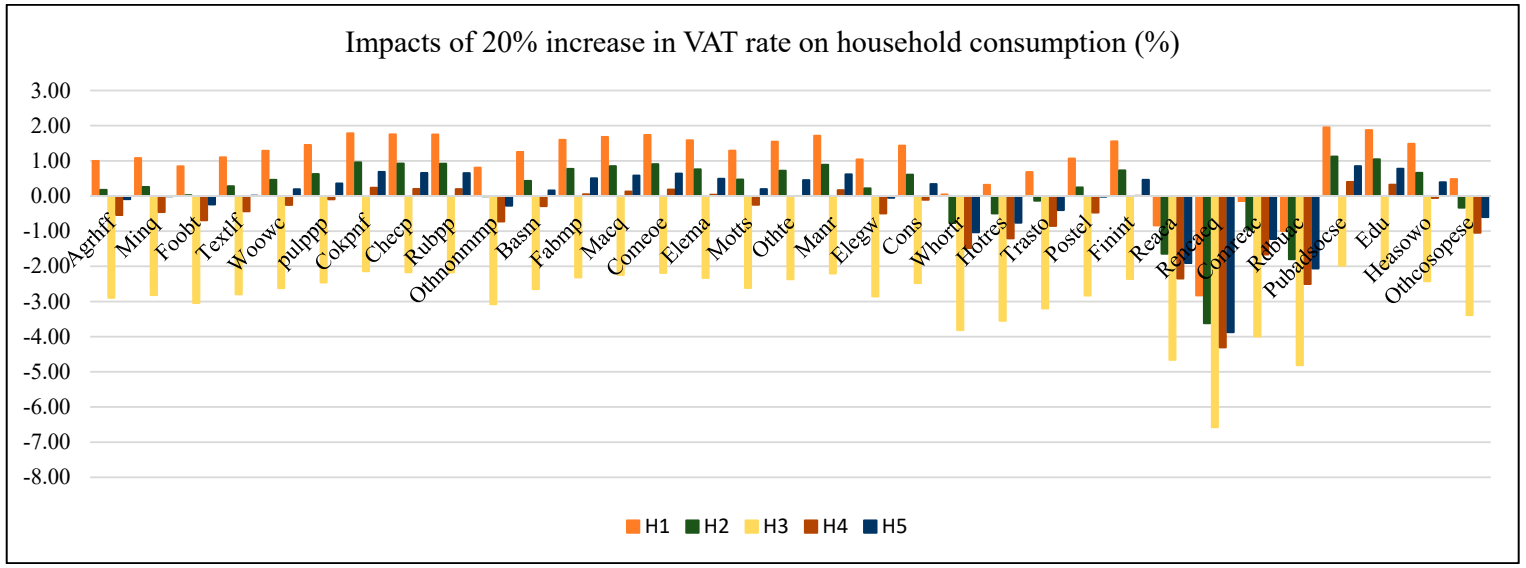

Figure 5. Impacts of VAT reform on household consumption.

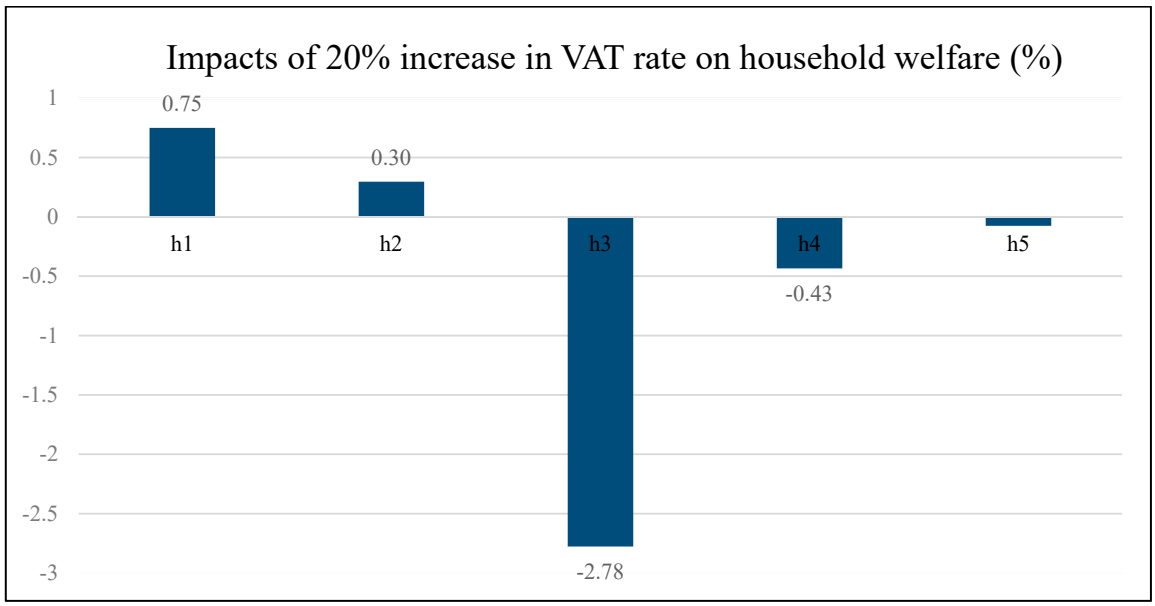

Figure 6. Impacts of VAT reform on household welfare.

Table 3. Impacts of VAT reform on revenue and government spending (US$, millions).

Total Tax Revenue	2355.406
Change in Revenue	1288.523
Government Expenditure	7114.482
Change in Government Expenditure	75.6184

5.2.2. Impacts of a Reduction in CIT on Output, Capital Stock, Welfare, and Revenue

Output in most sectors are increased after a reduction of corporate income (or production) tax. It also has positive impacts on household consumption of wealthier group. The poorer groups consume less because they have less money due to a decrease in transfer as tax revenue has been reduced. The government also has to tighten its public expenditure that makes the lower income groups lose their welfare. In the meantime, the wealthier groups gain more welfare as they can pay less tax than before.

A decrease in the CIT rate from 20% to 17% leads to expansion of most of the industries that are organised in corporations with a small decline in agriculture, education, and public services sectors (see Figure 7). Some of these increases are due to more investment in more productive sectors dominated by medium and large corporations or multinational corporations (MNCs) and others due to a reduction in the use cost of capital. Revenue does not decrease despite a reduction in the CIT rate because of higher growth of industries. Thus, such corporate tax reform is generating not only extra output, but also revenue for the government. Only one adverse effect is a slight increase in income inequality as the welfare of the poorest two quintiles decrease compared to the benchmark while welfares increase for richer three quintiles. It also changes the composition of commodities in the consumption baskets of households as shown in Figure 8. While households in the poorest two quintiles lose up to 7% of their commodity bundles, gains for wealthy households are much higher as the richest quintile gains up to 18% more of commodities for consumption. Adverse impact on distribution is also evident in aggregate welfare of households as illustrated in Figure 9. The middle-income household gains 9.5% compared to the benchmark 2.7% and 1.1% loss of welfare of 1st and 2nd quintile respectively. Government revenue increases faster than government expenditure with this experiment in the CIT (Table 4).

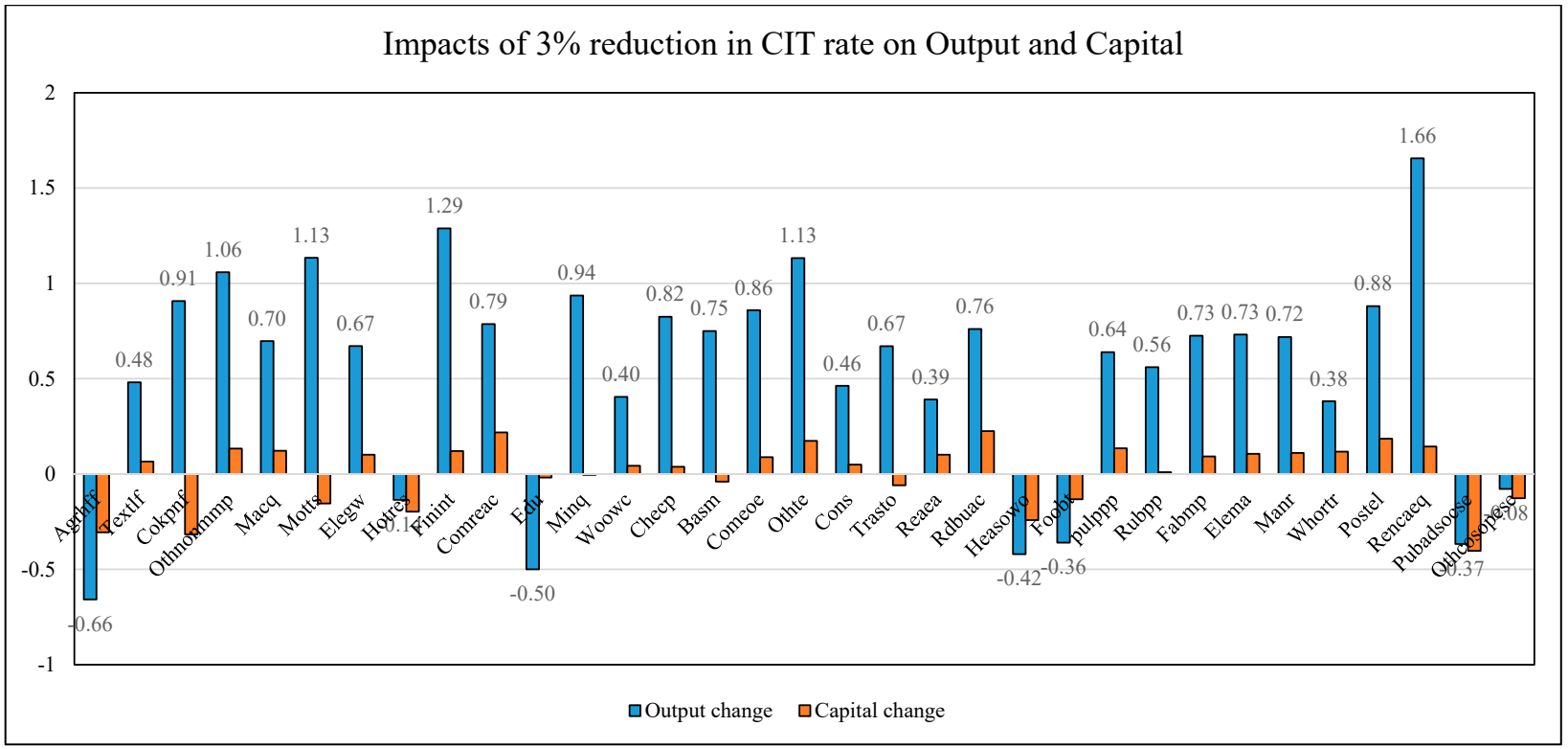

Figure 7. Impacts of CIT reform on output and capital.

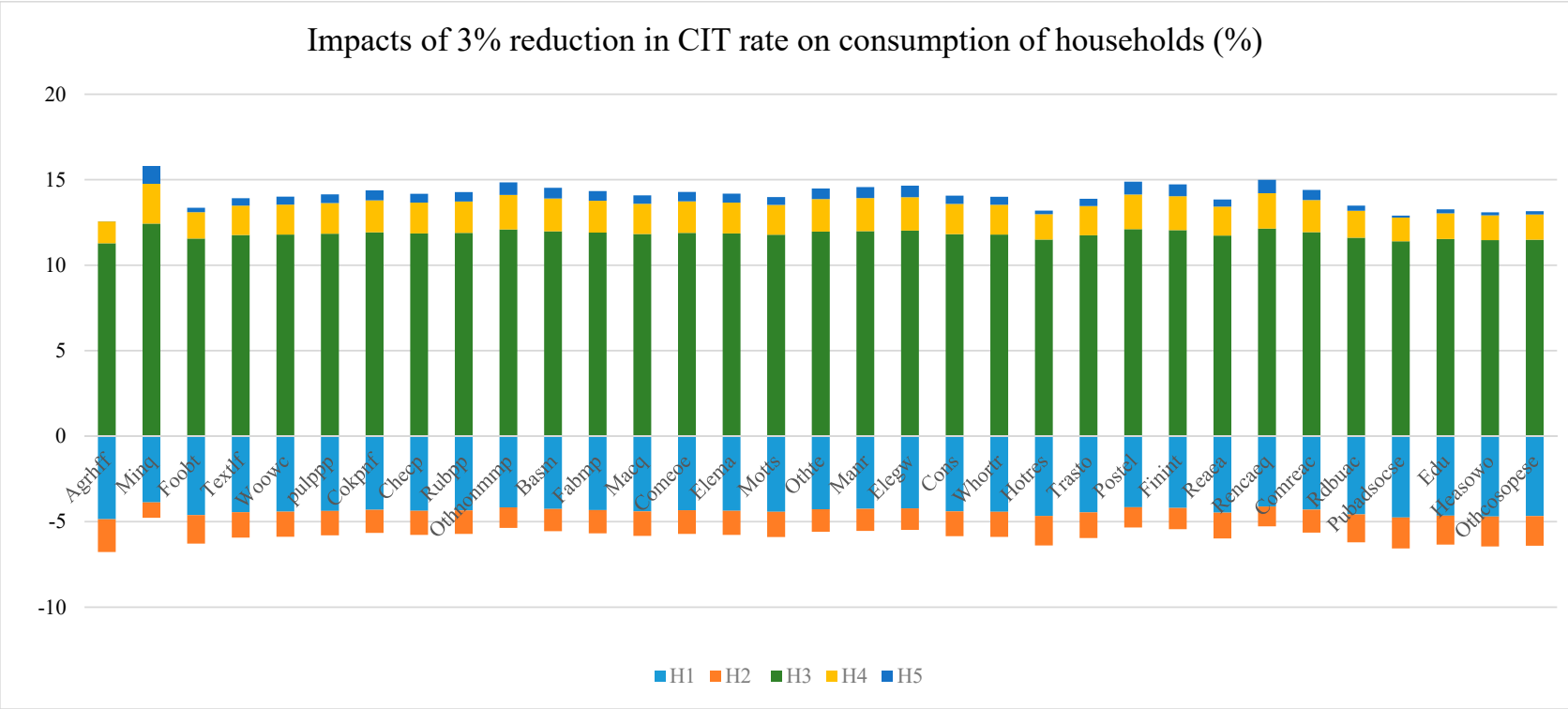

Figure 8. Impacts of CIT reform on consumption.

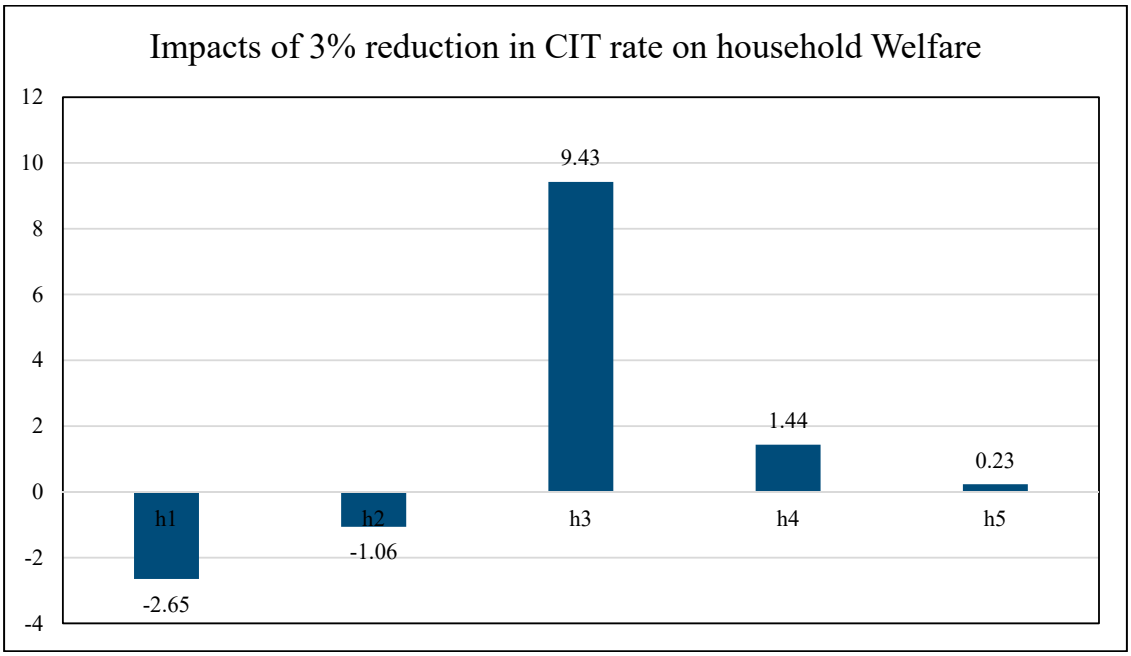

Figure 9. Impacts of CIT reform on household welfare.

Table 4. Impacts of CIT reform on revenue and government spending ($US, millions).

Total Tax Revenue	1849.5
Change in Revenue	782.6
Government Expenditure	6765.1
Change in Government Expenditure	−273.7

For the moment we focus on the comparative static analysis of these sectors, but the dynamic version of this model also is under construction to deal more with the issues of intertemporal optimisation by households and firms and by the policymakers. Study of dynamic adjustments from the current benchmark to a new steady state then can be conducted to analyse options available to Vietnam in various planning horizons of 5, 10, 20, or 50 years, by which Vietnam is expected to transform itself from a lower middle-income economy to a very advanced economy. A fully dynamic model will allow analysis of capital formation over time by producers, skill formation by households, balancing of trade among production sectors, and balancing of debt and deficit to sustainable levels by the public sector by altering options on revenue and spending over time. Such a dynamic model will be suitable to analyse changes in the production technology, structure of preferences of households, and the structure of tax, transfer, and subsidy policies in the Vietnamese economy.

5.2.3. The Marginal Excess Burden of Public Funds

The marginal excess burden (MEB) of taxes measures the extra cost to society, in terms of money metric welfare, of each dollar of revenue raised by means of a certain tax instrument. We have computed the MEB for each tax instrument included in the Vietnam model by dividing the change in welfare (ΔW_t) by the net change in the government revenue (ΔR_t).

First, we illustrate the total cost of the tax system in terms of the utility of households in Table 5. Lower-income households, who benefit more from transfer while tax in place, lose their income from transfers when taxes are eliminated. Richer households gain when taxes are eliminated as they do not need to pay taxes, and these are shown by NoVAT, NoCIT, NoPIT, and NoTax cases. The loss for the poorest households is from 4% in case of NoVAT goes up to 65% in NoPIT and up to 84% in NoTax case. Middle-income households gain most welfare proportionately from the elimination of taxes than by households in the highest income decile.

Table 5. Welfare change of tax elimination (%).

	H1	H2	H3	H4	H5
NoVAT	−4.01	−1.58	14.56	2.26	0.37
No CIT	−6.69	−2.62	24.16	3.75	0.61
No PIT	−65.15	−27.53	198.55	32.71	9.72
Notax	−84.18	−34.09	252.16	41.11	11.35

We also calculate the marginal cost of public funds (MCF) which measures the value of resource transfers between private and public sectors. Taxes are distortionary and result in the loss of welfare. Thus, the value of one-unit taxes transferred by public sector is actually worth only 0.93 in case of VAT and 0.92 in case of the CIT as shown in Table 6.

Table 6. Marginal cost of public funds.

	VAT	CIT
MCF	0.9267	0.9182

These results are comparable to those reported in Bhattarai (2008) in the case of the UK economy.

5.2.4. Robustness of Analysis by Sensitivity Tests

We check the robustness of the welfare impact results outlined above using sensitivity analysis of the results to four different sets of substitution elasticities between capital and labour (σ_v), substitution between consumption and leisure by households (σ_c). We consider 10 different sets of elasticities holding tax structure fixed as in the benchmark.

We change the elasticity from low e1 to the highest e10 to see the output changes, as presented in Appendix C.6. The robustness of our model is illustrated as the variation in output across sectors. It is as expected well within a small range. Robustness of results was confirmed with all other computations; the model is robust as we carry a sensitivity analysis of the result.

6. Conclusions

Comparative static analyses of increase in VAT rate from 10% to 12% and reduction in corporate income tax rate (CIT) rate from 20% to 17%, considered by the government in recent years, have contrasting effects in the Vietnamese economy.

- While an increase in VAT raises prices of commodities to consumers, it reduces demand for products in production sectors. This further results in lower demand for labour and capital inputs. Thus, the increase in VAT tends to be contractionary. Outputs of 15 out of 33 sectors decrease when VAT rate is increased by 20% of the actual rate of 10% in the benchmark. Such an increase in VAT from 10% to 12% leads to an increase in revenue but will have quite significant re-allocation impacts across sectors as it seems to reallocate scarce resources from real estates and wholesale and property sectors to education, public services, and chemical sectors. It also changes the composition of commodities in the consumption baskets of households significantly. While households in the poorest quintile gain 0.8% in welfare who proportionately get a larger share of public transfer, middle-income household loses almost by 3% of their welfare in the benchmark. VAT increase is good for the public sector as the government revenue increases faster than the government expenditure.
- Reduction in the CIT rate from 20% to 17% leads to expansion of most of the industries that are organised under corporations with a small decline in output of sectors that are less under the corporate structure such as agriculture, education, and other services. Some of these increases are due to expansion in the capital stock with more investment in those sectors and others due to a

reduction in the use cost of capital input. Revenue does not decrease, despite a reduction in the CIT rate, because of higher growth of industries. Corporate tax reform is generating, not only extra output, but also revenue for the government. Only one adverse effect is a slight increase in income inequality as the welfare of the poorest two quintile decreases compared to the benchmark while that increases for richer three quintiles. It also changes the composition of commodities in the consumption baskets of households. While households in the poorest two quintiles lose up to 7% of their commodity bundles, gains for wealthy households are much higher, as the richest quintiles gain up to 18% more of commodities for consumption. Adverse impact on distribution is also evident in the aggregate welfare of households, as the middle-income group gains 9.5% compared to the benchmark, compared to 2.7% and 1.1% losses in welfare of households in the first and the second quintile, respectively. Government revenue does not decrease but increases faster than government expenditure when the CIT rate is reduced to 17% from 20%.

- Lower-income households benefit more from transfer tax but lose more when taxes are eliminated. Richer households gain when taxes are eliminated as is shown by NoVAT, NoCIT, NoPIT, and NoTax cases. The loss for the poorest households ranges from 4% in the case of NoVAT to 65% in NoPIT to 84% in NoTax case. Middle-income households gain most welfare proportionately from the elimination of taxes than by households in the highest income decile as they squeezed less when taxes are eliminated.
- Model is robust to the sensitivity analysis. We consider 10 different sets of elasticities holding tax structure fixed as in the benchmark. The robustness of our model as the variation in output across sectors is, as expected, well within a small range. Robustness of results was confirmed with all other computations; the model is robust as we carry a sensitivity analysis of the result.

Thus, in terms of policy implications for Vietnam, our model results are rather supportive of the increase of VAT rate and the reduction of CIT rate, as proposed by the Ministry of Finance as part of a larger tax reform aiming to make the tax system consistent with international laws, to reduce the tax burden on business and at the same time to achieve budget goals. However, in order to compensate the negative impacts on some preponderant sectors of the national economy and to avoid unexpected distortions in income/welfare distribution amongst household groups as shown in our model scenarios analysis, it is worth recommending that the government applies relevant corrective measures. In fact, we are currently studying some simulations of these measures by running the corresponding counterfactual scenarios in our CGE model. In further research, we are working on a dynamic CGE model of the decentralised economy of Vietnam not only to measure the differentiated effects on rural and urban areas and to the Northern and the Southern regions of Vietnam, but also to measure the gains from regional interlinkages and integration in the process of economic development.

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Conflicts of Interest: We have no conflict of interest to publish things written here in this format in this journal.

Appendix A Stylised Fact and Tax Structure in Vietnam

Appendix A.1 Consumption Expenditure in Vietnam 1997–2016

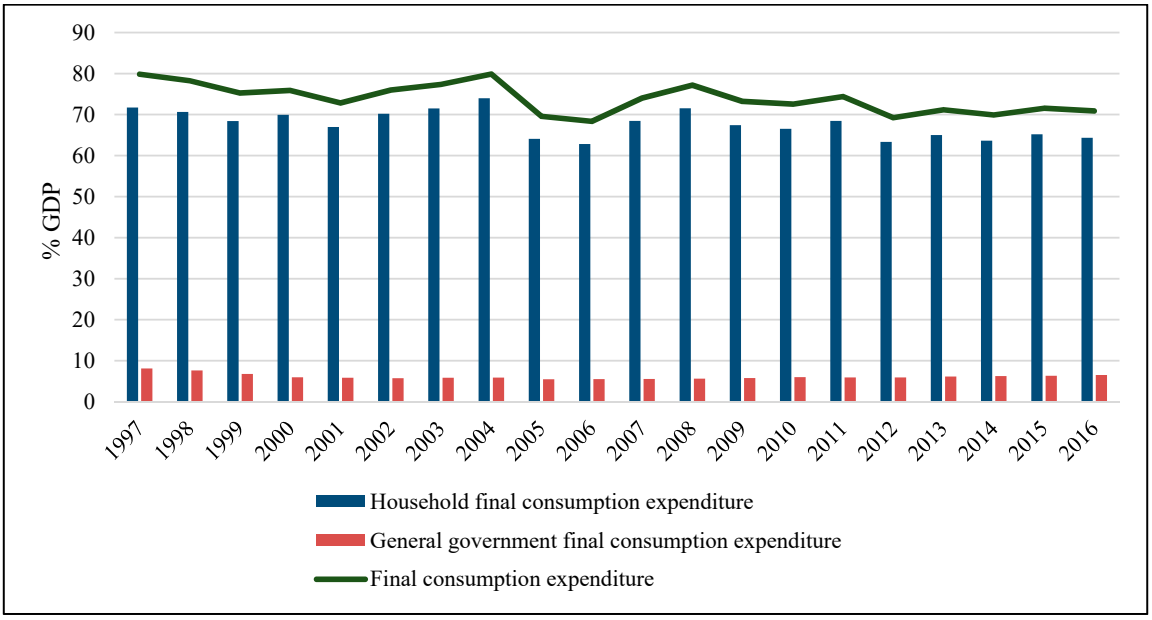

Figure A1. Consumption Expenditure in Vietnam 1997–2016; World Development Indicator, 2017.

Appendix A.2 GDP per Capita by Income Group in 2016 (US$)

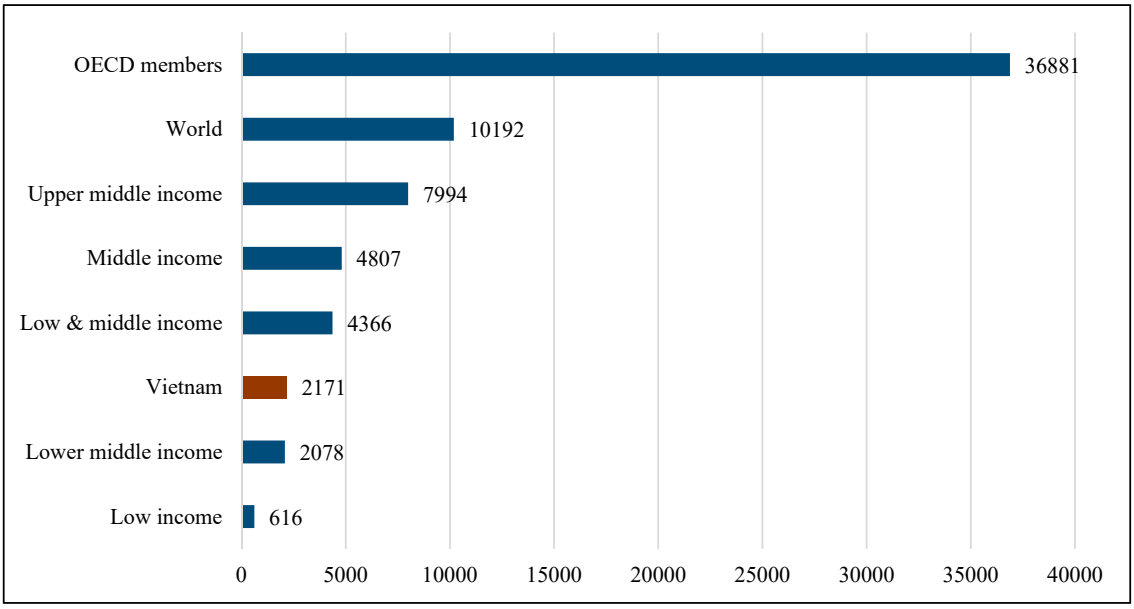

Figure A2. GDP per Capita by Income Group in 2016 (US$); World Development Indicator, 2018.

Appendix A.3 GDP per Capita in Vietnam 2000–2016 (Current US$)

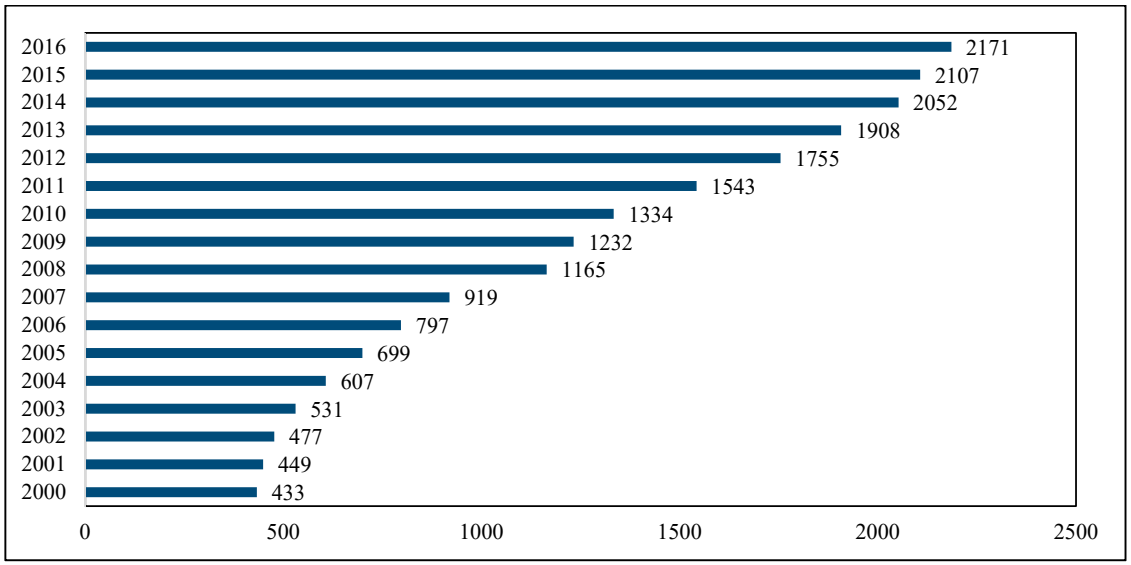

Figure A3. GDP per Capita in Vietnam 2000–2016 (Current US$). Source: World Development Indicator, 2017.

Appendix A.4 Distribution of Income Share in Vietnam

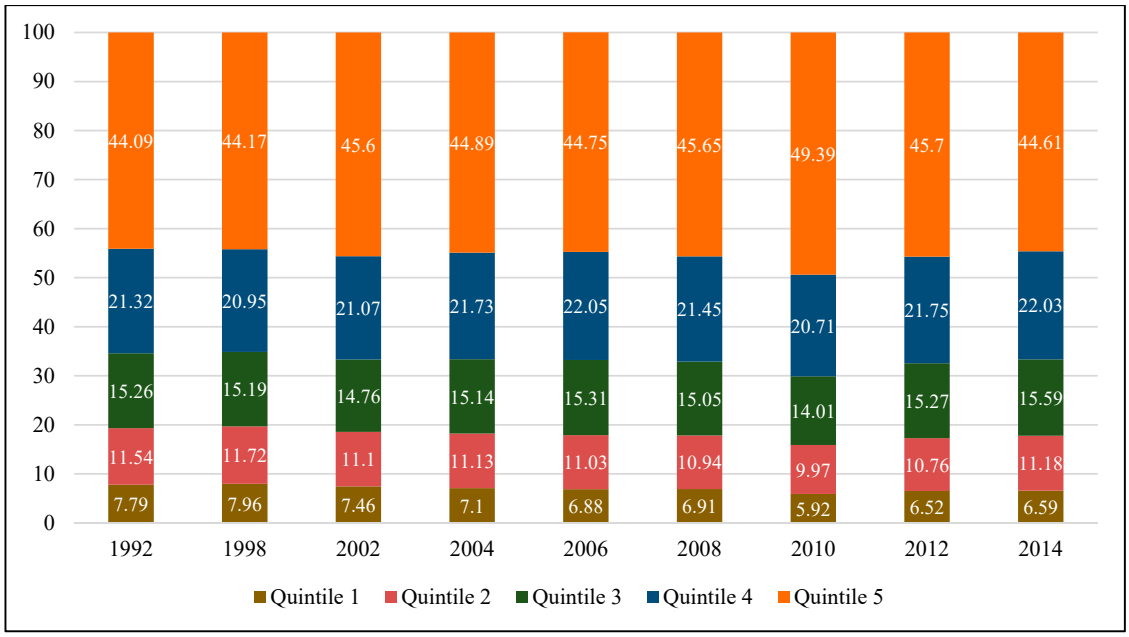

Figure A4. Distribution of Income Share in Vietnam. Source: World Development Indicators, 2017.

Appendix A.5 Corporate Income Tax Rate (%)

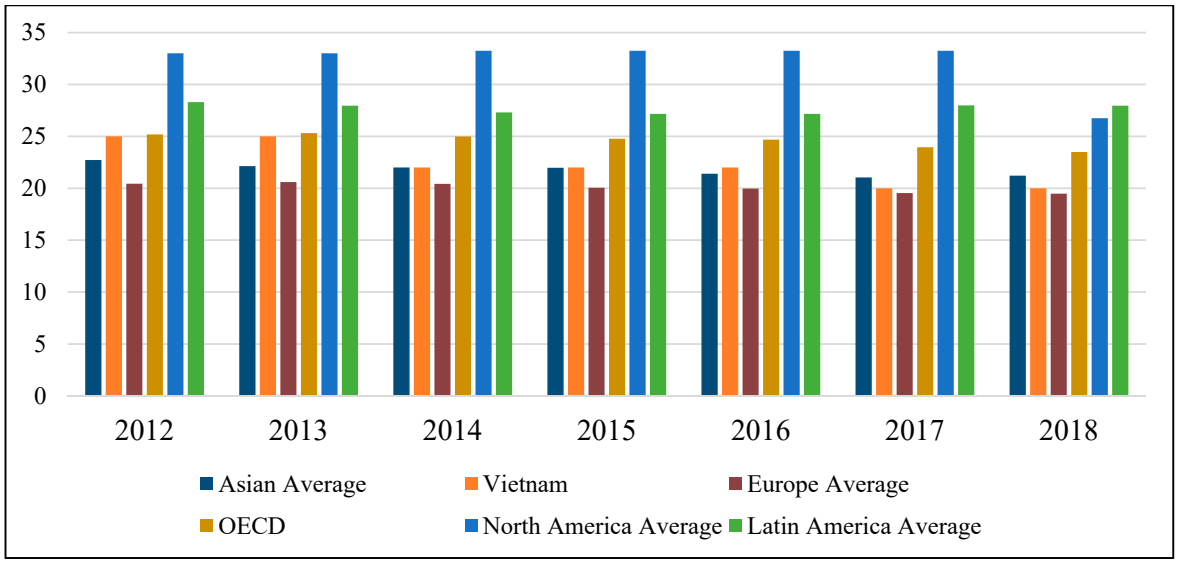

Figure A5. Corporate Income Tax Rate (%). Source: KPMG online, 2018.

Appendix A.6 Standard VAT Rate in Selected Countries (% as of August 2018)

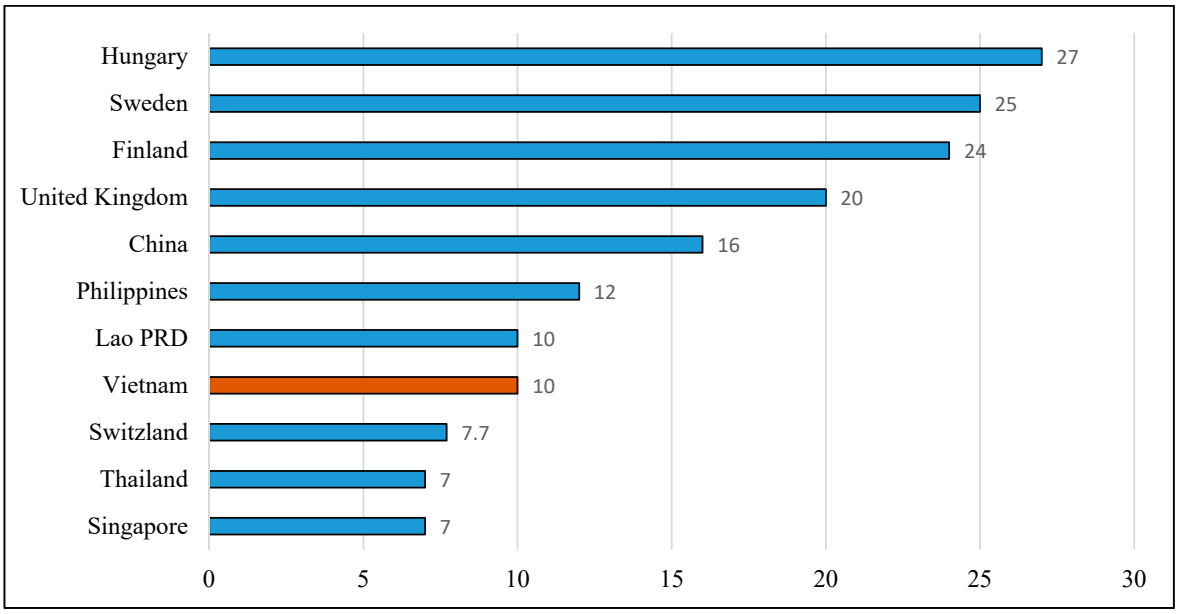

Figure A6. Standard VAT Rate in Selected Countries. Source: http://taxsummaries.pwc.com/ID/Value-added-tax-(VAT)-rates.

Appendix B Specification of the CGE Model of Vietnam

The utility function is given by:

$$U_h = \left(\sum_i \alpha_{i,h} C_{i,h}^{\rho_h} + \beta_h L_h^{\rho_h} \right)^{\frac{1}{\rho_h}} \quad \text{(A1)}$$

where U_h is the utility of household h, $C_{i,h}$ is the consumption of the composite good i by household h, L_h is the leisure taken by the household h, $\alpha_{i,h}$ is the share of full income of household spent on consumption of the good i, $\beta_{i,h}$ is the share of full income spent on leisure, and ρ is the elasticity parameter in the utility function; the elasticity of substitution between goods (and leisure) being equal to $\sigma_h = \frac{1}{1-\rho_h}$. Also $\sum_i \alpha_{i,h} = 1$.

The household receives income from capital and labour endowments, and transfers from the government, paying taxes on household, and capital income. The disposable income of a household is given by

$$H = \sum_j \sum_i r_j\left(1 - t_{j,i}\right)\theta_{j,i}\overline{K}_j + (1 - t_l)w\overline{L} + TR \tag{A2}$$

where H is disposable income, $\theta_{j,i}$ is the share of type j asset used in sector i, $\overline{K_j}$ is the endowment of capital type j for the household, r_j is the rental rate of capital by type j, $\overline{L}$ is the endowment of labour, of capital by type i for the household, is the endowment of labour, w is the wage rate, $t_{j,i}$ is the tax rate in sector i on rental income from the capital of type j, t_l is the tax rate on labour income, TR are the transfers received. Another representation of disposable income is:

$$P(1 + t_v)C + w(1 - t_l)L = H \tag{A3}$$

where P and C are prices and quantities of composite goods respectively, and t_v is the effective tax rate on consumption; consisting of tariffs, duties and levies, value-added taxes, and subsidies.

The demand function for goods and leisure are obtained by maximising Equation (A3) with respect to Equations (A1) and (A2) and take the following form:

$$C = \left(\frac{\alpha H}{(P(1 + t_v))^{1-\sigma}\left(\alpha(P(1 + t_v))^{1-\sigma} + \beta(w(1 - t_l))^{1-\sigma}\right)}\right). \tag{A4}$$

Consumption of leisure is given by:

$$L = \left(\frac{\beta H}{(w(1 - t_l))^{1-\sigma}\left(\alpha(P(1 + t_v))^{1-\sigma} + \beta(w(1 - t_l))^{1-\sigma}\right)}\right). \tag{A5}$$

The labour supply of each household LS is given by the difference between the household labour endowment, and the demand for leisure, L.

$$LS = \overline{L} - L \tag{A6}$$

In equilibrium, the labour supplied by the household must be consistent with the total demand for labour derived from the profit maximising behaviour of firms.

Composite consumption covers N sub-composite goods in the model:

$$C = \psi\left(\sum_i \delta_i^c CC_i^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma-1}{\sigma}} \tag{A7}$$

where CC_i is the ith good composite of domestic and imported consumption good, ψ is the unit parameter of the CES composite function, and δ_i^c is the share of the consumption good. The overall value of composite consumption should satisfy:

$$P.C = \sum_i P_i.\, CC_i \text{ For } i = 1 \ldots .N. \tag{A8}$$

Appendix B.1 Supply Side of the Economy

Firms behave competitively in these economies. They take prices of inputs and outputs as given and employ factors up to a point where the marginal productivity of that factor equals its remuneration. Production technology shows how inputs are transformed into output. The more efficient technology generates more output from the given inputs. Further education generates more skills, and obviously skilled workers are more productive than less skilled workers.

Producers use labour and capital in each of the 33 sectors to yield value added. This also is given by CES functions:

$$VA_i = \Omega_i\Big((1-\delta_i)(K_i)^{\gamma_i} + \delta_i(LS_i)^{\gamma_i}\Big)^{\frac{1}{\gamma_i}} \tag{A9}$$

where VA_i is the gross value added of the sectors, Ω_i is a shift parameter in the production function, K_i and LS_i are the amounts of capital and labour used in sector i, δ_i is the share parameter of labour in the CES function, and γ_i is the CES factor substitution parameter.

The gross output of each sector Y_i contains value added, VA_i and intermediate inputs. We allow substitution between domestic and imported intermediate inputs, and between value added and intermediate inputs as in Bhattarai (2008).

$$PY_iY_i = PV_i.VA_i + \sum_j PA_i\Big(1+t^d_{i,j}\Big)DI_{i,j} + \sum_j PM_i\Big(1+t^m_{i,j}\Big)MI_{i,j} \tag{A10}$$

where $DI_{i,j}$ is the demand for domestic intermediate input and $MI_{i,j}$ is demand for imported intermediate inputs, PV_i is the composite price of value added, $t^d_{i,j}$ and $t^m_{i,j}$ are taxes on intermediate demands.

At any set of prices, producers in each sector maximise profits subject to their technology constraint:

$$\begin{aligned}\prod_i = PY_iY_i - wL_i - \textstyle\sum_{i,j} r_jK_{i,j} - \sum_j PM_i\Big(1+t^m_{i,j}\Big)MI_{i,j} - \\ \textstyle\sum_j PA_i\Big(1+t^d_{i,j}\Big)DI_{i,j}\end{aligned} \tag{A11}$$

where Π_i is the profit of sector i. In equilibrium, factor demands by sectors are determined where the value of the marginal product of factors equal factor prices, and there are no positive profits for producers.

Appendix B.2 Trade and Aggregate Supply

A system of free trade allows economies to export goods in which each economy has a more comparative advantage and import goods which are not in adequate supply in the home economy. Real exchange rates are determined by ratios of average prices of tradable commodities at home and abroad. Households in an economy can raise their welfare by exporting goods which they can produce more efficiently and by importing goods which they cannot produce efficiently at the home country.

Production and aggregate supply of these model economies are represented by a set of nested functions. Initially, labour and capital inputs determine the value added for a given sector. Inter-industry linkages are given by the coefficients of the input-output table. The gross output of any sector can be exported to foreign markets or supplied to domestic markets. Following a standard Armington product differentiation, imported goods compete with domestic products in forming the aggregate supply of the economy. Volumes of exports and imports are balance for each period or intertemporal over the model horizon.

The term P is the price of composite consumption net of indirect taxes, and CC_i is the composite consumption good of both domestic and import of the ith good. The total supply, A_i, for each sector is produced using domestic and imported goods and given by a CES Armington function. It is given by

$$A_i = \Phi\left(\Big(1-\delta^m_i\Big)D_i^{\frac{\sigma_m-1}{\delta m}} + \delta^m_i M_i^{\frac{\sigma_m-1}{\delta m}}\right)^{\frac{\delta_m}{\sigma_m-1}} \tag{A12}$$

where A_i is the CES aggregate of domestic supplies D_i, and import supplies $M_i\delta_i^d$ is the share of domestic supplies for good i, and δ_i^m is the elasticity of substitution in the aggregate supply function, and Φ is the shift parameter of the aggregate supply function. Overall market clearing in the product market implies that

$$A_i = CC_i + G_i + I_i \tag{A13}$$

where G_i and I_i represent composite consumption by the government and investment respectively. In value terms,

$$PA_iA_i = PD_iD_i + PM_iM_i \tag{A14}$$

where D_i and M_i are domestic and import supplies at the price PD_i and PM_i respectively, and PA_i is the price of the total supply in sector i.

Appendix B.3 Public Sector

Governments provide public goods and transfer income to households collecting revenue from direct and indirect taxes, though former ones are more important than later ones in these economies. Social insurance is provided to low-income households who are vulnerable to market conditions. Impacts of public programmes on the welfare of households are measured in terms of money metric utility functions. The income gap between the rich and poor households may be higher without transfer programmes or good provision of public services such as education and health. In general, the government collects revenue from taxes on capital and labour income and value-added taxes on final demand, production taxes on intermediate inputs, and tariffs on imports. All tax revenues collected are either used to purchase public goods or transferred to households in lump sum form.

$$\begin{gathered} G + TR = \sum_j \sum_i t_{j,i}^k r_j K_{j,i} + \sum_i t_i^{vc} P_i CC_i + \sum_i t_i^{vg} P_i G_i + \sum_i t_i^{vk} P_i I_i + \\ \sum_i t_l wLS + \sum_i t_i^m M_i + \sum_j \sum_i PA_j t_{i,j}^m MI_{j,i} + \sum_j \sum_i PA_j t_{i,j}^d DI_{j,i} \end{gathered} \tag{A15}$$

where G os public consumption, and $t_{j,i}^k$ is the tax rate on capital income from asset j used in sector i. These rates are taken from P-Tax formulate. There are four different indirect taxes in the model: tariffs, duties and levies, VAT and subsidies. t_l^{vc} is the effective ad valorem tax rate on final consumption of households, t_l^{vg} is an effective indirect tax rate on public consumption and t_i^{vk} is an effective tax rate on investment, t_i^m is the tariff on imports.

These taxes, particularly when they are levied at different rates on different sectors and households, have distortionary impacts on the allocation of resources in the economy. These are captured by the model. The value of government consumption is given by:

$$G = \sum_i PA_iGD_i + \sum_i PA_iGM_i \tag{A16}$$

where GD_i is government consumption of domestic goods and GM_i is government consumption of imported goods.

Appendix B.4 Markets and the Relative Prices

Markets determine prices by reconciling demand for products by households to the supply of commodities by firms and demand for inputs by firms to the supply of factors by the owners of factor services. Prices adjust until these demands equal the supplies. Markets clear in the sense that the demand for products by households equals the supply of products by firms and saving by households equals investment by firms. Allocations are Pareto optimal. There is no alternative allocation which can make an economic agent better off without making another worse off. Public sector tax and transfer policies impact on households' income through their affect these relative prices.

$$Y_i = \Theta\left(\left(1-\delta_i^e\right)D_i^{\frac{\sigma_y-1}{\sigma_y}} + \delta_i^e E_i^{\frac{\sigma_y-1}{\sigma_y}}\right)^{\frac{\sigma_y}{\sigma_y-1}} \tag{A17}$$

where E_i is exports, D_i is domestic supplies, σ_y is the elasticity of substitution in total supplies, δ_i^e is the share of exports, and Θ is the shift parameter in the production function. The total value of the gross domestic product is composed of the value of domestic sales and exports.

$$PY_iY_i = PD_iY_i + PE_iE_i \tag{A18}$$

The value of exports is equal to the value of imports in equilibrium.

$$\sum_i PE_iE_i = \sum_i PM_iM_i \tag{A19}$$

where PE_i and PM_i are the world prices of exported and imported commodities in terms of the numeraire. These import and export prices could be different than the domestic prices because of the differentiation between domestic and foreign products in this model. Gross of exports tax or tariff prices of domestic commodities tends to be close to the world prices as the elasticity of transformation between domestic sales and exports and elasticity of substitution between domestic supplies and import reach to the infinity.

Appendix B.5 Definition of Competitive Equilibrium

In this model, a competitive equilibrium is given by prices of consumption goods, P_i; the rental rate of capital assets, r_j; a wage rate for labour, w; levels of gross output, Y_i (gross of intermediate use); capital use, K_i; and sectoral use of labour, L_i; imports M_i, exports X_i, intermediate inputs $DI_{i,j}$, $MI_{i,j}$, investment I_i, government consumption G_i, private consumption C_i, such that:

(i) The markets for goods and services, labour and capital clear;
(ii) Budget constraints of households, the government, and investors are satisfied

Appendix B.6 Model Closures and Savings and Investment

Total investment demand I equals the use of investment goods from domestic and imported sources.

$$I = \sum_i PA_iID_i + \sum_i PA_iIM_i \tag{A20}$$

where ID_i is investment demand for domestic good i, and IM_i is investment demand for imported good i. The savings-investment identity closes this model where I is the gross of indirect taxes.

We have taken a closed capital market view until so far. This essentially means the allocation of assets across sectors sums up to the domestic endowments of assets which implies:

$$\overline{K}_j = \sum_i K_{i,j} \tag{A21}$$

where $\overline{K}_j$ is the endowment of jth type of asset and $K_{i,j}$ allocation of type j asset in sector i. Reallocation occurs until the rental rate of capital is same across all sectors.

The closed capital market assumption is not realistic for the Vietnam economy, where capital freely moves according to the domestic and foreign rate of returns. More realistically,

$$\overline{K}_j + FK_j = \sum_i K_{i,j} \tag{A22}$$

where FK_j represents net inflow or outflow of asset type j. The inflow and outflow of a capital asset depends upon the gap between the rental rate in Vietnam and the rest of the world (RoW).

$$r_j^{VN} \geq r_j^w \Rightarrow FK_j \geq 0 \text{ or } r_j^{VN} \leq r_j^w \Rightarrow FK_j \leq 0 \quad \text{(A23)}$$

Appendix B.7 Model Equilibrium Condition and Closures

More specifically, the market clearing condition for the goods market is given by

$$Y_i = F_i^d + \sum_{j=1}^{N} a_{i,j}^d Y_j \quad \text{(A24)}$$

where $F_i^d = C_i^d + I_i^d + G_i^d + E_i^d$ is a decomposition of final demand into household consumption, investment, and government consumption, $\sum_j a_{ij}^d Y_j$ is total intermediate demand, and $a_{i,j}^d$ is sector i input per unit of sector j output.

Appendix C CGE Model Results in Details

Appendix C.1 Benchmark Output, Employment, and Capital

Table A1. Benchmark Output, Employment, and Capital.

	Output	Employment	Capital
Agriculture, hunting, forestry and fishing	54,174.5	23,333.5	3400.0
Textiles, textile products, leather and footwear	3218.7	396.6	270.5
Coke, refined petroleum products and nuclear fuel	22,963.4	1090.0	753.0
Other non-metallic mineral products	5105.9	547.1	842.4
Machinery and equipment, nec	3472.8	335.9	217.5
Motor vehicles, trailers and semi-trailers	3563.3	258.9	532.3
Electricity, gas and water supply	6593.5	2086.6	2334.2
Hotels and restaurants	14,062.6	4260.9	2613.4
Financial intermediation	10,029.5	2081.4	4277.1
Computer and related activities	427.6	110.3	92.7
Education	2592.8	1342.2	421.1
Mining and quarrying	17,640.0	2646.8	9373.5
Wood and products of wood and cork	1672.0	104.3	130.7
Chemicals and chemical products	27,491.4	2275.6	1682.7
Basic metals	12,582.0	679.2	1270.9
Computer, Electronic and optical equipment	11,669.8	648.2	823.2
Other transport equipment	1633.6	114.3	175.7
Construction	4493.4	788.4	338.4
Transport and storage	12,557.4	2980.9	2898.7
Real estate activities	8964.8	3300.2	2118.6
R&D and other business activities	2218.6	753.2	258.2
Health and social work	1705.5	795.9	237.0
Food products, beverages and tobacco	35,030.0	2201.4	2812.6
Pulp, paper, paper products, printing and publishing	7218.5	919.0	663.5
Rubber and plastics products	5496.6	377.0	470.7
Fabricated metal products	6841.5	725.0	677.1
Electrical machinery and apparatus, nec	2877.4	261.3	200.0
Manufacturing nec; recycling	2804.1	202.8	234.8
Wholesale and retail trade; repairs	38,524.1	11,117.0	7958.2
Post and telecommunications	1936.8	569.2	782.2
Renting of machinery and equipment	509.0	49.3	158.2
Public administration and defence; compulsory social security	862.7	372.2	76.3
Other community, social and personal services	3666.9	1730.6	694.7

Appendix C.2 Benchmark of Leisure and Welfare Relative to the Benchmark

Table A2. Benchmark of Leisure and Welfare Relative to the Benchmark.

	Leisure (US$ Millions)	Welfare Index
H1	3417.16	5.04
H2	7618.08	1.69
H3	2586.64	0.37
H4	8284.57	0.92
H5	12,412.13	1.28

Appendix C.3 Benchmark Consumption by Quintiles (US$ Millions)

Table A3. Benchmark Consumption by Quintiles (US$ Millions).

		H1	H2	H3	H4	H5
1	Agriculture, hunting, forestry and fishing	3433.8	1949.8	636.5	2288.5	7105.8
2	Mining and quarrying	269.9	153.2	50.0	179.9	558.5
3	Food products, beverages and tobacco	5156.6	2928.1	955.8	3436.6	10,670.8
4	Textiles, textile products, leather and footwear	358.2	203.4	66.4	238.7	741.2
5	Wood and products of wood and cork	109.2	62.0	20.2	72.8	226.0
6	Pulp, paper, paper products, printing and publishing	515.6	292.8	95.6	343.6	1066.9
7	Coke, refined petroleum products and nuclear fuel	845.1	479.9	156.6	563.2	1748.8
8	Chemicals and chemical products	2249.5	1277.3	416.9	1499.2	4655.0
9	Rubber and plastics products	93.0	52.8	17.2	62.0	192.4
10	Other non-metallic mineral products	492.2	279.5	91.2	328.0	1018.5
11	Basic metals	30.5	17.3	5.7	20.3	63.1
12	Fabricated metal products	218.9	124.3	40.6	145.9	453.1
13	Machinery and equipment, nec	241.0	136.9	44.7	160.6	498.8
14	Computer, Electronic and optical equipment	974.6	553.4	180.6	649.6	2016.9
15	Electrical machinery and apparatus, nec	80.4	45.6	14.9	53.6	166.4
16	Motor vehicles, trailers and semi-trailers	624.8	354.8	115.8	416.4	1292.9
17	Other transport equipment	261.9	148.7	48.5	174.5	542.0
18	Manufacturing nec; recycling	238.9	135.6	44.3	159.2	494.3
19	Electricity, gas and water supply	473.5	268.8	87.8	315.5	979.8
20	Construction	1.5	0.9	0.3	1.0	3.2
21	Wholesale and retail trade; repairs	3366.6	1911.7	624.0	2243.7	6966.7
22	Hotels and restaurants	2690.2	1527.6	498.6	1792.9	5567.0
23	Transport and storage	1732.1	983.5	321.0	1154.3	3584.3
24	Post and telecommunications	175.6	99.7	32.6	117.1	363.5
25	Financial intermediation	1384.3	786.0	256.6	922.6	2864.6
26	Real estate activities	1022.9	580.8	189.6	681.7	2116.7
27	Renting of machinery and equipment	73.2	41.6	13.6	48.8	151.5
28	Computer and related activities	8.8	5.0	1.6	5.9	18.3
29	R&D and other business activities	22.2	12.6	4.1	14.8	46.0
30	Public administration and defence; compulsory social security	149.7	85.0	27.7	99.8	309.8
31	Education	548.3	311.3	101.6	365.4	1134.5
32	Health and social work	370.0	210.1	68.6	246.6	765.8
33	Other community, social and personal services	557.0	316.3	103.2	371.2	1152.6

Appendix C.4 Share of Capital and Labour in the Benchmark

Table A4. Share of Capital and Labour in the Benchmark.

	Capital Share	Labour Share
Agriculture, hunting, forestry and fishing	0.1341	0.8659
Mining and quarrying	0.7833	0.2167
Food products, beverages and tobacco	0.5660	0.4340
Textiles, textile products, leather and footwear	0.4119	0.5881
Wood and products of wood and cork	0.5613	0.4387
Pulp, paper, paper products, printing and publishing	0.4250	0.5750
Coke, refined petroleum products and nuclear fuel	0.4704	0.5296
Chemicals and chemical products	0.4338	0.5662
Rubber and plastics products	0.5613	0.4387
Other non-metallic mineral products	0.6115	0.3885
Basic metals	0.6582	0.3418
Fabricated metal products	0.4888	0.5112
Machinery and equipment, nec	0.3992	0.6008
Computer, Electronic and optical equipment	0.5653	0.4347
Electrical machinery and apparatus, nec	0.4397	0.5603
Motor vehicles, trailers and semi-trailers	0.6861	0.3139
Other transport equipment	0.6108	0.3892
Manufacturing nec; recycling	0.5418	0.4582
Electricity, gas and water supply	0.5335	0.4665
Construction	0.3073	0.6927
Wholesale and retail trade; repairs	0.4224	0.5776
Hotels and restaurants	0.3890	0.6110
Transport and storage	0.5020	0.4980
Post and telecommunications	0.5836	0.4164
Financial intermediation	0.6779	0.3221
Real estate activities	0.3966	0.6034
Renting of machinery and equipment	0.7665	0.2335
Computer and related activities	0.4616	0.5384
R&D and other business activities	0.2601	0.7399
Public administration and defence; compulsory social security	0.1829	0.8171
Education	0.2435	0.7565
Health and social work	0.2375	0.7625
Other community, social and personal services	0.2941	0.7059

Appendix C.5 Share of Consumption Demands by Households (Greater or Less than One due to Imports and Exports)

Table A5. Share of Consumption Demands by Households.

		H1	H2	H3	H4	H5
1	Agriculture, hunting, forestry and fishing	0.6524	0.1862	0.0408	0.1016	0.1394
2	Mining and quarrying	0.0519	0.0148	0.0032	0.0081	0.0111
3	Food products, beverages and tobacco	0.9607	0.2742	0.0600	0.1496	0.2053
4	Textiles, textile products, leather and footwear	0.0669	0.0191	0.0042	0.0104	0.0143
5	Wood and products of wood and cork	0.0205	0.0058	0.0013	0.0032	0.0044
6	Pulp, paper, paper products, printing and publishing	0.0975	0.0278	0.0061	0.0152	0.0208
7	Coke, refined petroleum products and nuclear fuel	0.1605	0.0458	0.0100	0.0250	0.0343
8	Chemicals and chemical products	0.4264	0.1217	0.0267	0.0664	0.0911
9	Rubber and plastics products	0.0176	0.0050	0.0011	0.0027	0.0038
10	Other non-metallic mineral products	0.0925	0.0264	0.0058	0.0144	0.0198
11	Basic metals	0.0057	0.0016	0.0004	0.0009	0.0012
12	Fabricated metal products	0.0412	0.0118	0.0026	0.0064	0.0088
13	Machinery and equipment, nec	0.0454	0.0130	0.0028	0.0071	0.0097
14	Computer, Electronic and optical equipment	0.1838	0.0524	0.0115	0.0286	0.0393
15	Electrical machinery and apparatus, nec	0.0151	0.0043	0.0009	0.0024	0.0032
16	Motor vehicles, trailers and semi-trailers	0.1173	0.0335	0.0073	0.0183	0.0251
17	Other transport equipment	0.0492	0.0140	0.0031	0.0077	0.0105
18	Manufacturing nec; recycling	0.0453	0.0129	0.0028	0.0071	0.0097
19	Electricity, gas and water supply	0.0910	0.0260	0.0057	0.0142	0.0194
20	Construction	0.0003	0.0001	0.0000	0.0000	0.0001
21	Wholesale and retail trade; repairs	0.6282	0.1793	0.0393	0.0978	0.1342
22	Hotels and restaurants	0.5051	0.1441	0.0316	0.0787	0.1079
23	Transport and storage	0.3268	0.0932	0.0204	0.0509	0.0698
24	Post and telecommunications	0.0337	0.0096	0.0021	0.0052	0.0072
25	Financial intermediation	0.2665	0.0760	0.0167	0.0415	0.0569
26	Real estate activities	0.1886	0.0538	0.0118	0.0294	0.0403
27	Renting of machinery and equipment	0.0128	0.0036	0.0008	0.0020	0.0027
28	Computer and related activities	0.0016	0.0005	0.0001	0.0003	0.0003
29	R&D and other business activities	0.0040	0.0012	0.0003	0.0006	0.0009
30	Public admin and defence; comp social security	0.0289	0.0082	0.0018	0.0045	0.0062
31	Education	0.1065	0.0304	0.0067	0.0166	0.0228
32	Health and social work	0.0712	0.0203	0.0045	0.0111	0.0152
33	Other community, social and personal services	0.1057	0.0302	0.0066	0.0165	0.0226

Appendix C.6 Sensitivity of Output by Sectors to the Elasticity of Substitution between Capital and Labour (Increment is 0.25 from E1 to E10 Scenarios)

Table A6. Sensitivity of Output by Sectors to the Elasticity of Substitution between Capital and Labour.

	Agrhff	**Minq**	**Foobt**	**Textlf**	**Woowc**	**Pulppp**
e1	54,219.45	17,594.02	35,035.37	3212.80	1669.33	7203.21
e2	54,217.06	17,610.10	35,039.14	3214.66	1670.23	7208.06
…	…	…	…	…	…	…
e9	54,219.11	17,680.03	35,060.48	3222.48	1674.05	7228.59
e10	54,220.73	17,686.90	35,063.15	3223.23	1674.41	7230.54
	Cokpnf	**Checp**	**Rubpp**	**Othnonmmp**	**Basm**	**Fabmp**
e1	22,910.32	27,428.00	5485.78	5090.41	12,551.28	6825.01
e2	22,932.89	27,452.37	5489.35	5095.12	12,560.91	6830.08
…	…	…	…	…	…	…
e9	23,034.88	27,560.49	5504.63	5114.95	12,601.71	6851.43
e10	23,045.34	27,571.34	5506.11	5116.83	12,605.60	6853.45
	Macq	**Comeoe**	**Elema**	**Motts**	**Othte**	**Manr**
e1	3465.04	11,639.65	2870.62	3549.54	1628.20	2797.38
e2	3467.58	11,649.24	2872.79	3553.17	1629.71	2799.36
…	…	…	…	…	…	…
e9	3478.41	11,689.85	2881.99	3567.97	1635.86	2807.61
e10	3479.45	11,693.73	2882.87	3569.32	1636.42	2808.38
	Elegw	**Cons**	**Whortr**	**Hotres**	**Trasto**	**Postel**
e1	6578.66	4485.74	38,467.11	14,053.19	12,527.12	1931.64
e2	6583.05	4488.43	38,487.60	14,056.77	12,536.45	1933.10
…	…	…	…	…	…	…
e9	6601.29	4500.07	38,576.41	14,072.65	12,575.93	1939.13
e10	6602.98	4501.21	38,585.11	14,074.25	12,579.69	1939.68
	Finint	**Reaea**	**Rencaeq**	**Comreac**	**Rdbuac**	**Pubadsocse**
e1	9991.01	8950.64	506.66	426.58	2213.21	862.83
e2	10,001.01	8955.21	507.29	426.90	2214.89	863.02
…	…	…	…	…	…	…
e9	10,041.24	8974.41	509.83	428.27	2221.98	864.08
e10	10,044.83	8976.23	510.07	428.39	2222.65	864.22
	Edu	**Heasowo**	**Othcosope**			
e1	2594.42	1705.76	3664.51			
e2	2594.45	1705.98	3665.58			
…	…	…	…			
e9	2595.04	1707.21	3670.42			
e10	2595.14	1707.36	3670.92			

Appendix C.7 Abbreviations of Sectors of Production in the CGE Model

Table A7. Abbreviations of Sectors of Production in the CGE Model.

Agriculture, hunting, forestry and fishing	Agrhff
Mining and quarrying	Minq
Food products, beverages and tobacco	Foobt
Textiles, textile products, leather and footwear	Textlf
Wood and products of wood and cork	Woowc
Pulp, paper, paper products, printing and publishing	pulppp
Coke, refined petroleum products and nuclear fuel	Cokpnf
Chemicals and chemical products	Checp
Rubber and plastics products	Rubpp
Other non-metallic mineral products	Othnonmmp
Basic metals	Basm
Fabricated metal products	Fabmp
Machinery and equipment, nec	Macq
Computer, Electronic and optical equipment	Comeoe
Electrical machinery and apparatus, nec	Elema
Motor vehicles, trailers and semi-trailers	Motts
Other transport equipment	Othte
Manufacturing nec; recycling	Manr
Electricity, gas and water supply	Elegw
Construction	Cons
Wholesale and retail trade; repairs	Whortr
Hotels and restaurants	Hotres
Transport and storage	Trasto
Post and telecommunications	Postel
Financial intermediation	Finint
Real estate activities	Reaea
Renting of machinery and equipment	Rencaeq
Computer and related activities	Comreac
R&D and other business activities	Rdbuac
Public administration and defence; compulsory social security	Pubadsocse
Education	Edu
Health and social work	Heasowo
Other community, social and personal services	Othcosopese

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