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Investigating the Impact of Exchange Rate Variation and the Oil Price Shocks on Household Welfare: CGE Model Approach

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Abstract

The exchange rate and international oil price are key variables to cause the effects of external shock on economics and the relationship to domestic economy. Since in countries like Iran, most government revenues come from exchange earnings from the international markets by oil exports, the impact of these two variables on the economy has significant consequences. In addition, it should be considered how fluctuations in the exchange rate and international oil prices can impact policy and international relations. According to the international trade perspective, it is believed that the exchange rate affects the economy through the changes in exports and imports commodities; therefore, expectations of the exchange rate will affect the price of the products traded. Moreover, the impact of oil price on the production of commodities changes the level of supply for activities and income of institutions through changes in the production factors and intermediary imports price. We conclude that if any change in both exchange rate and oil prices occurs, it will cause a change in welfare indicators. This research has therefore arisen to fill this void in the literature. Moreover, it utilizes a logistic model to represent the change in the exchange rate and oil price. Based on empirical results, a recursive computable general equilibrium model is constructed to predict future social welfare and simulate the impact of exchange rate fluctuations along with the oil price shock. The results are presented in different scenarios using the 2011 Social Accounting Matrix (SAM).

Highlights

- This study intends to examine the effects of exchange rate fluctuations and oil prices on household welfare.
- In this paper, economic parameters are modeled based on the CGE.
- We simulate the proposed model using GAMS software.
- The results show that with the increase in exchange rates and oil prices, the amount of EV decreases.
- The results also demonstrate that shifts in the exchange rate will increase the welfare of households, and the increase in oil prices will decrease the welfare of households.

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1. Introduction

In spite of the importance of the exchange rate variable in macroeconomic, fluctuations and crises of this phenomenon, lead to the deviation of the equilibrium through economy. Actually, instability of the exchange rate derives from an imbalance. In other words, it is the link between the host country and the rest of the world that also plays an essential role in advancing political negotiations (International Monetary Fund, 2012). Any change in the foreign economy at this rate will lead to the domestic economy's more turbulence. Continuous and persistent imbalances demonstrate the economic imbalance and the source of the emergence of that macroeconomic crisis. In addition, the asymmetry of the exchange rate more than the specified limen could spring upswing exchange rates and help predict the exchange rate crisis (Holtemöller & Mallick, 2013). Thus, exchange rate is a strong link between domestic and foreign prices from the encouragement of exports, monetary and fiscal policies, furthermore, changes in global markets, international economies leading to an influence on a country's economic strength.

Concerning another perspective, the effect of the exchange rate on a host country is efficient in the productivity of the country's economic sectors. On the other hand, fluctuations in the exchange rate are marked by the price of the production factors, the final price of domestic goods, and foreign exchange earnings from oil sales in the international market, especially for oil-exporting countries. Exchange rate fluctuation will have substantial impacts on nominal and relative price changes. To be more precise, if the real exchange rate is declining, the value of trade goods and services compared to the former one will decrease. Exchange rate fluctuation has two replacements and income effects. Impacts expected of the income effect in a period of economic growth will increase the consumption of foreign goods and the utility of the consumer, while elasticity substitution of the exchange rate will reduce the consumption of domestic products.

The exchange rate fluctuation through the money flow and currency crisis could have three reasons: first, based on the principle of macro economy, where the diversity in economic growth rate, the difference in profit and price levels may prompt a decline in the exchange rate. The second reason could be a different type of exchange rate determiners, for instance, whether the exchange rate is more affected by the nominal price or the relative price. In terms of the capital market failure theory, the third reason is investors may adjust their dynamic expectations based on the strength and vulnerability of institutions such as households, firms, banks, and the state. (Flaschel & Semmler, 2006). Fourth, negotiation and international agreements based on which, contracting countries are obliged to implement the instructions as mentioned; Iran is a good example here.

In the macroeconomic perspective, especially in open economies, the exchange rate is considered as a significant important variable. The exchange rate has been determined as the price of a currency under other circumstances (Mishkin, 2004). Romelli et al. (2015), articulated that the most notable change

observed in the exchange rate is the change in the balance of the current account. The real exchange rate is the nominal exchange rate applied to check the difference in inflation in different countries, which means it is considered as an interpretation of the power of buying two currencies. The real exchange rate is also used to represent competition in international trade. Considering the changes in the exchange rate and its impact on exports and imports of goods, and also because Iran is an open-economy country, it generates most of its income through the sale of oil in international markets. Therefore, the exchange rate can have a significant impact on the Iranian economy and the competition in the global economy for the export of goods and services, especially oil. Iran's revenues from crude oil sales in the international markets have the largest share of GDP.

Increase in the real exchange rate leads to the substitution of production factors from the non-commercial sector to the commercial sector because it is more profitable export, commercially and internationally marketable than export to the domestic market. In other word, exporters and importers face a high risk when the exchange rate dramatically fluctuates, therefore, exporters and importers push for currency trading activities. Increasing the real exchange rate leads to the substitution of production factors from the non-commercial activity to the commercial activity because it is more profitable to export commercial goods to the international market than export to the domestic market (Edwards, 1989b; Edwards & Savastano, 1999). Compared to this, in a situation where the increase in the nominal exchange rate has a reverse impact on trade, the quality of laws, development, and amendment of government size can have benefits in improving commercialization. In this regard, establishing the business firms by beneficiary countries can reduce the negative effects of exchange rate fluctuations on different activities of the economy (Fertő & Fogarasi, 2014). Therefore, there are two reasons stating that exchange rate policy in developed economy could have less percentage of stability or flexibility: first, a weak substitution among the factor of domestic labor production and the intermediate input in the commercial sector, and the second reason is the preponderance coefficient of foreign exchange for determining the export price (Shi et al., 2015).

Exchange rate stability and supportive policies such as banking and insurance make trade take place in a logical process. In other words, by reducing exchange rate fluctuations, a favorable environment for production and business is created. Extreme exchange rate fluctuations lead some firms to be dropped out from the business cycle. Often more foreign trades have more risk-averse if the share of international trade in the gross domestic product (GDP) is high. Fluctuations will have a more significant impact on the reduction of GDP, rising prices and threats to foreign trade, the feeling of stability and security necessary for planning and economic activities will significantly reduce (Helleiner, 1981). Sometimes exchange rate fluctuations derive from quota and control in the allocation of foreign exchange due to increased government spending. If the current account surplus of the currency is very low, compared to the debt at the time of the change of government, the exchange rate will also decrease. Thus, a

significant reduction in the existing value of the government debt is necessary to repay the financial debt (Daniel, 2010).

In spite of a rising range of information on the unpredictable impact of the crude oil industry, the literature has not concluded yet. For instance, concerning the results of economic instability shocks on oil price volatility, some research indicates empirical evidence of a growing outcome (Bakas & Triantafyllou, 2019). Oil price shocks through changes in production and operating costs could have negative impacts on macroeconomic variables (Rafiq et al., 2009). An increase in oil prices could increase investment and increase risk. Moreover this increase reallocates resources (Bernanke, 1983). When an activity confronts the choice of investing with energy-saving or inefficient energy, the uncertainty caused by the fluctuation in the price of oil increases the willingness to choose to expect higher-value investment (Ferderer, 1996). Additionally, oil price shock has a significant impact on macroeconomic variables such as GDP, interest rates, investment, inflation, unemployment, and exchange rates. Secondly, the effect of oil price changes in the economy is asymmetrical; the negative impact of rising oil prices is higher than the positive influences of oil prices (Rafiq et al., 2009). If exogenous changes such as changes in exchange rates and oil prices and endogenities (government policies), the structure of the domestic economy and all indicators will easily change. There are many studies in this field (Daniel, 2010; Edwards, 1989; Edwards & Savastano, 1999; Fertő & Fogarasi, 2014; Flaschel & Semmler, 2006; Holtemöller & Mallick, 2013; Romelli et al., 2018; Shi et al., 2015).

In order to contribute to the research in this aspect, the current research examines the relationship among exchange rate and oil prices to welfare in Iran. The thesis focuses on this issue for two significant reasons. Firstly, Iran's economy relies profoundly on crude oil because Iran is one of the considerable exporters of crude oil, which makes it feasible for crude oil prices to play a crucial role in market decisions for export and import of goods and services. Secondly, exchange rate and oil prices are related to foreign exchange rate and international crude oil prices (respectively), so they respond to fluctuations in worldwide prices. As a consequence of unpredictable foreign exchange rates and crude oil prices, the asymmetrical answer could appear in market imbalances and non-productivity, thereby impacting social welfare. According to this, any change in oil prices and exchange rate by changing the price level lead to shifting in substitution and income effect on inflation, and resulting social security effects may have a political influence on the Iranian oil pricing and exchange rate regime. The political debate over the oil price and exchange rate regime is mostly based on the possible effects of the oil price and exchange rate on the social welfare of the economy through its inflationary impact. With a detailed understanding of the outcomes of external shocks on the domestic economy and welfare, government could have a considerable influence on society. Economic indicators play an essential role in understanding economic conditions (Sasaki, 2019). One of the most crucial indicators is the welfare of society, depending on various definitions.

Welfare is divided into three categories: first, happiness and hope for individual life, another definition is source of happiness and hope for an individual life and the latest definitions refers to the plan preparation for the primary happiness and hope for an individual life of those community members (Wellman, 2015). Accordingly, in the economic analysis by deeper investigation in welfare, the third definition provides an exact meaning about the welfare from the economic perspective. The measuring of welfare depends on the compensation variation (CV) and the equivalent variation (EV), which demonstrates the effects of endogenous and exogenous fluctuations on the economy, both of which can change the utility of consumers (Bhattacharya, 2018). One of the channels that change social welfare is price changes which can easily spread across the economy (Sasaki, 2019). Households choose various combinations of goods and services in their portfolio. If there is a change in the price level, the amounts of individual consumption and utility will change. Consequently, social welfare is reformed. Furthermore, the amount of household income will be reallocated for various consumption. Consumption changes can be divided into two categories. Firstly, declining the prices of goods and services, consumers buy more cheap goods, and the latter means that consumers have more revenue for consuming goods and services. It means substitute effect (equivalent variation) refers to changes in value. On the other hand, income effect (compensation variation) refers to the purchase of other goods and services by changes in income (Bhattacharya, 2018; Moshiri & Aliyev, 2017).

In view of the former information, this research considers the literature of the impacts of the oil price shock and exchange rate fluctuation on social welfare by studying significant issues that have remained uncertain. These issues include the followings; does social welfare reply asymmetrically to the positive and negative shocks of the exchange rate and oil prices? Does the exchange rate answer to the asymmetry variations in oil price have any indication for the welfare of the country? Are the effects of oil price and exchange rate variations damaging? Do income and substitution effects have asymmetric changes in various shocks? Which of the following asymmetric changes in oil prices and exchange rates is greater for social welfare? What about the indicators that determine welfare?

This study aims to examine the effect of exchange rate fluctuations and oil prices on household welfare. These impacts also affect the decision of the amount of consuming, incomes and so on. Therefore, the elaboration of a precise planning framework for economic stability requires the mechanism knowledge for these impacts on microeconomic and macroeconomic variables. In this regard, due to the importance of these variables on the economy, we utilize a computable general equilibrium model to study the impact of the oil price shock and fluctuations of the exchange rate on the welfare. The CGE model used in this study, households are own part of the production factors and earn money by renting or selling them (Calzadilla et al., 2017). Households buy their goods and services at market prices, which include sales taxes and transfer fees. Household consumption is allocated among a variety of goods, which is based on the linear cost system (LES)

of the demand function, which is satisfying from the Stone-Geary utility function (Dong et al., 2017; Francois & Reinert, 1997; Van Ruijven, 2015; Wang et al., 2017a, 2017b, 2017c).

This article is structured as follows: the introduction is elaborated in the first section and the relevant analysis in this field is discussed in section 2. The current theoretical foundations are presented. In section 3, we describe the methodology of CGE model that affect the structure of economy and household. In section 4, we present Scenario design and database. Section 5 presents the results, and section 6 Conclusion.

2. Literature Review

In this study, politicians can investigate the impacts of fluctuation on the price of oil price and exchange rates on the welfare of households. In a recent study, welfare is measured in a different issue, for instance, tax, energy policy, transportation and so on. Griffith et al identified that the impact of a specific tax (per unit) on fat consumes was more than a normal tax. The results illustrated the fact that the consumption of these products reduces, but costs for more consumers and welfare changing. A recent study about the impact of oil on households investigated based on a CGE approach by Twaha et al. (2019), showed the oil exports correspondingly reduced the income of households and welfare. Further, the income received from oil export increases household consumption, which may drive to a rise in expenditures, exploring the macroeconomic and household welfare results of oil sanctions in Iran. Results showed that higher-income households are being wasted more significantly following oil sanctions. Total imports, exports, private consumption and GDP decreased through reaction to the oil sanctions (Farzanegan et al., 2015). Pacudan & Hamdan (2019), by presenting a model that reduced energy subsidies, the results showed that the disadvantages would be higher for higher-income households, while social welfare would be reduced and the government determined the tariffs for structural reforms, while contrarily the results will be reverse. Any change in commodity prices is possible to change the purchasing power of households. As a result, these consumers may have to change their expenditure behavior (Baez et al., 2018). Ayisi (2020), examining the effect of oil prices on social welfare using the NARDL method. The study showed in the long term that inflation reacted asymmetrically to oil prices. The welfare costs involved with the asymmetric reply are rising at an increasing rate. Within this framework, oil prices adjust following the prices of crude oil and exchange rates on the foreign market. Although this strategy could be reasonably effective, proof asymmetrical reaction of inflation to changes in oil prices poses some concerns about the welfare impact of the policy.

Bhattacharya (2015) demonstrated the correlation among changing the price of goods, the compensation variation (CV) and equivalent variation (EV), eventually, they investigated the reasons for the impact on welfare as a result of the change in the CV and EV indexes. Also, the impact of prices on household consumption depends on intensity price changes (Renner et al., 2019). There is a

large volume of published studies describing the role of the prices in changing consumption, expenditure and the utility of households, which ultimately leads to a change in their welfare. Considering the difference in the welfare of households, their incomes, use of two compensation and equivalent variations as a standard method was considered to conclude that quantitative measures would usefully supplement and extend the qualitative analysis (Deaton, 1989; Minot & Dewina, 2015; Baez et al., 2018). In this study, we analyze the impact of oil price shocks and exchange rate fluctuation on household welfare using computable general equilibrium (CGE) model based on a specific empirical pattern of household in Iran. A case study approach was chosen to allow for indicating the effect of external exogenous shocks on the domestic economy that thrives on the welfare of households. Moreover, in the last decade, Iran has experienced changes in the exchange rate and oil prices, which has been affected by it. Although extensive research has been carried out on welfare and defining the indicators of welfare, no single study exists to address the impact of an exogenous variable that is very important for a country like Iran and its the effects on households.

According to International Energy Agency 2016 (IEA), the World Energy Outlook (WEO) under the current policy scenario (CPS), even without the shock of oil prices, oil prices in the country will rise to 82 $ in 2021, according to the IEA. The Dollar Per Barrel will reach $ 127 per barrel in 2030 and $ 146 per barrel in 2040. Global and domestic price changes influence the economy of the entire country. The government budget has a significant impact on economic circumstances and economic judgments such as labor supply, investment, and savings. It is also one of the primary and essential factors for each country in the promotion and development of the country (Irandoust, 2018).

Despite limited evidence, concerns about the relationship among exchange rate and oil prices with social welfare remain extremely primary in relation to methodological problems for Iran's country, and significant exporter of crude oil country macroeconomic stimulus measures. This research has therefore arisen to fill this void in the literature.

3. Model

3.1 Structure of the CGE Model

First of all, a Computable General Equilibrium (CGE) model is a simplified structure for the whole economy, and an important approach to CGE models is to represent the circular flow of the economy (Ghadimi, 2006). Another point about CGE model is based on a Walrasian condition, which describes how resources are allocated in the market as a result of supply and demand as well as how equilibrium prices are acheived (Gharibnavaz et al., 2018; Zhang et al., 2017). Making blocks of these models is equations that represent the behavior of economic agents (Lin & Jia, 2019). In general, CGE model makes the whole economy and models the interaction of economic agents to cast the framework of the circular flow of economics and markets (Borges, 1986; Severini et al., 2018). Based on the definition given by Sherman Robinson (1989), CGE model consists

of four elements: 1) specifying the behavior of various economic agents, 2) identification of the behavioral rules of the economic agents and the conditions in which they operate; 3) determining the symptoms that economic agents make decision-based on it; and 4) determining the game rule that defines the structure of economic institutions. The crucial point about the microeconomic framework in general equilibrium models is that it completely reflects the behavior of economic actors and makes clear the anticipation to derive optimized ability of policymakers to have more effective analytical frameworks (Böhringer & Rivers, 2018; Yeldan, 2002). In general equilibrium model, several economic sectors are examined. Also, depending on the type of investigation and analysis, the effects of different policy incorporate various ranges of study. For instance, to estimate economic impacts, we can measure the consequence of different projects and policies at the spatial economy (Thissen, 1998b, 1998a). It can be noted that the origins of the equations in general equilibrium model were based on the assumptions in optimizing the economic behavior of agents and the fundamental of behavior of economic agents In CGE model microeconomic theories and relative prices consist of a key role in producing for each economic sector (Cicowiez et al., 2017; Lofgren et al., 2002; Norén, 2013). Behavior reveals that producers seek to minimize costs (maximize profits) of their production technology, and consumers look for their maximum utility for consuming goods and services that they spend on their income (Norén, 2013). Companies and economic activities assuming that they should maximize their profits in the first situation, and the wage of labor will be equal to the final income caught up from them, also employing labor continuing until their wages will be equal to their income (Lofgren et al., 2002). In simulating the CGE model, be it closer to the real world, it is necessary to introduce the assumptions that determine the economic conditions into the model. Economic assumptions, depending on the subject under study and the theoretical framework governing the model, can create different theoretical foundations. In CGE model, it is assumed that the market has perfect competition, and there is an imperfect substitution among domestic and foreign commodities (Armington, 1969; Feenstra et al., 2018; Kim et al., 2018; Oyamada, 2015). The export or demand of foreigners is based on foreign exchange demand and determined by the export demand function. In addition, the price of international markets is not equal to domestic prices, because the general equilibrium model considers foreign exchange as an exogenous variable (Aydın & Acar, 2011). In short, in the CGE model, production is performed by using the combination of intermediate import and primary production factors. Households and governments are the owners of the production factors; households consuming or saving their income after fractioning direct taxes on revenue. In this model, the government provides income through renting of production factors, absorbs direct taxes, indirect taxes and foreign transfers. In the end, these revenues are allocated to the consumption of goods and services or in the classification of the budget surplus to be saved or invested in the capital market (Yin et al., 2019). In this framework, we explain some parts of structure

CGE model. It consists of four blocks: price block, production and trade block, institution block, and system constraint block. The simple and general framework of the CGE model is illustrated in Figure 1.

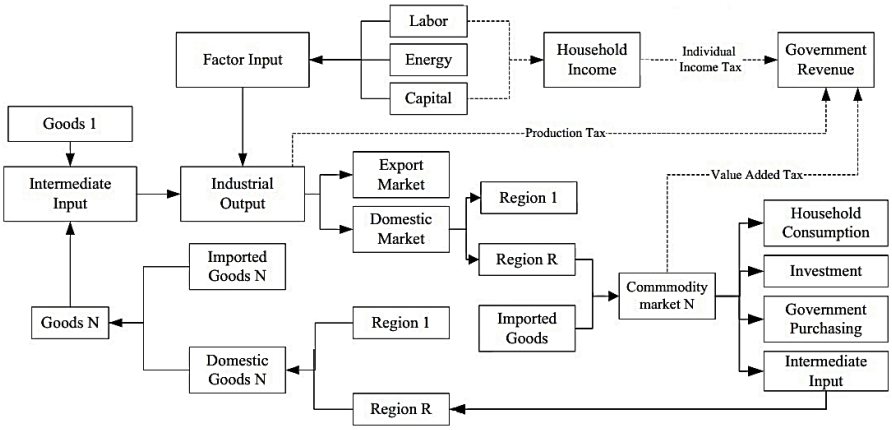

Figure 1. The simple and general framework of the CGE model
***Source**: Dong et al, 2017*

Given is a diagram Fig.1 illustrating the process by which blocks in the CGE model are connected and resources are allocated among different agents. It is evident from the information provided that there are four main phases involved. Before the actual processing of the resources, it is first necessary for the abstract of tax on revenue from households to the government, this process reveals individual income tax. The resources then set into factor input to forward directly for manufacturing to begin. At this point, the production of certain commodities occurs, and the intermediate input is added to manufacturing. The second stage of the manufacturing process, meanwhile, involves the separation of products from the export market and the domestic market. Having further separated the commodity into different regions, these commodities are then divided among final consumers, household, government and investment as intermediary input. Finally, it returns to the production cycle. In the third phase, the commodities are returned to the production cycle as an intermediary input, involving the combination of the import market and the domestic market injunctive to intermediate input. The final phase is while the government revenues through the latter are subsequently received. Meanwhile, the government absorbs a different kind of taxes, for instance, production tax and value-added tax.

3.2 Price Block

The most important feature of the general equilibrium model is the price block (see Appendix A). In this block, assuming that more than one activity can produce the same commodity, in the beginning, the prices of different activities of the manufacturer decrease a specific product to a producer price for that

commodity. The activity price not only includes the activity taxes that are in the output of each industry but also consists of taxes on the factors of production used in the production process (Deng et al., 2014). Considering the exports commodities, if net taxes and tariffs are added to the price of the producer, the price of exports commodities and services will be determined. Through merging the price of domestic products and the price of imported commodities, the final price of the supply goods and services will be obtained (Bhattarai et al., 2018). By focusing on consumption instead of production, the domestic demand price will be obtained by adding trading costs to domestic supply prices. Considering the import tariff, the import prices are obtained. Through combining the price of domestic prices with the price of imported goods, the price of a composite will be calculated (Lofgren et al., 2002). Finally, the final price of the market is obtained by adding sales taxes to the price of composite goods. Similarly, for primary production factors, in which each producer at first has an initial demand, we can obtain the price of factors production by combining the supply prices of the factors (Raihan et al., 2017).

3.3 Production and Commodity Market Block

Producers seek to maximize their profits (minimizing their costs) by the difference among earnings, operating costs, intermediary production and import factors. The maximization of profits about production technology is divided into two levels. At first stage, the level of activity is determined by the CES function (Constant Elasticity of Substitution) or Leontief function. Also, on the lower level, quantities of value-added are determined by the CES function, and intermediate inputs are determined by the Leontief function sales (Robinson et al., 2014). All production is sold in domestic markets and/or exports to other countries (Zhong et al., 2018). The total demand in domestic markets consists of total imports and domestic production, which is sales in domestic markets (Cicowiez et al., 2017; Zhong et al., 2018). Due to the incomplete transfer between domestic import and domestic production, this feature was expressed by the CES function and assumptions in which the function depends on the amount of substitution between domestic import and domestic production of goods and services (Calzadilla et al., 2017; Garaffa et al., 2018; Gurgel et al., 2017; Shen & Whalley, 2017; Zhong et al., 2018). The function is as follows:

$$QQ_c = \left(\delta_c^q . QM_c^{-\rho_c^q} + \left(1 - \delta_c^q\right). QD_c^{-\rho_c^q}\right)^{-\frac{1}{\rho_c^q}} \quad (1)$$

Where QQ_c stands for total sales of good and services in the domestic market, QM_c is a total import of goods and services for domestic consumer, and QD_c refers to total demands of local productions from domestic consumer. With assuming an imperfect substitution between export and supply to the domestic market, the function CET (constant elasticity of transformation) is expressed as follows:

$$QX_c = a_c^t.\left(\delta_c^t.QE_c^{\rho_c^t} + (1-\delta_c^t).QD_c^{\rho_c^t}\right)^{\frac{1}{\rho_c^t}} \quad (2)$$

Where QX_c stands for total products of goods and services by domestic producer, Qe_c is total export of goods, and services and QD_c refers to the total supply of local productions to the domestic market.

3.4 Institution Block

In the CGE model, institutions constitute households, enterprises, governments and the rest of the world. Households are own part of the production factors and money earned by renting or selling (Calzadilla et al., 2017). Households buying theirs consume at market prices, which include sale taxes and transfer costs besides consumption is allocated among a variety of goods and services, which is based on the linear cost system (LES) of the demand function, which was determined by maximizing the Stone-Geary utility function (Dong et al., 2017; Francois & Reinert, 1997; Van Ruijven, 2015; Wang et al., 2017a, 2017b, 2017c).

Instead of factor income paid directly to households, it may be paid to one or more other enterprises. Moreover, enterprises may receive transfer payments from other institutions. Afterwards, paying corporate income is allocated to direct taxes, savings, and transfers to other institutions (Fujimori et al., 2012; Guo et al., 2014; Li et al., 2019; Lin & Jia, 2018; Liu et al., 2015). An important issue to be considered in the general equilibrium model is that enterprises are not consumers of goods and services (Lofgren et al., 2002).

Governments collect taxes and transfers coming from other institutions. In the base model, all taxes are priced at a constant rate (Bhattarai et al., 2018). Governments spend their income on the consumption of final goods and services or transfers to other institutions. In real terms, consumption is stable, while transfers to other institution (households and enterprises) depend on the consumer price index (CPI) (Yamazaki et al., 2018).

Transfer payments from the rest of the world into domestic institutions and production factors are calculated to foreign payments account. Foreign saving is the fraction among payments and external receipts; however, all payments and incomes are fixed at an external price. Payments and receptions from the rest of the world describe a trade balance (Lofgren et al., 2002).

3.5 Closure Rules

In general, in every actual and simulated structure, it encounters a series of constraints and limitations. Also, in the general equilibrium model, constraints and limits must be determined in equilibrium condition. The general equilibrium model has three macroeconomic balance: government equilibrium (state budget), rest of the world balance (balance of trade balance, including payments and receipts), and investment-savings equilibrium (Li et al., 2017; Lin & Jia, 2018). In the CGE model, it is commonly known that macroeconomic closure for

achieving that balance is necessary for any model to be solved mathematically (Mahmood & Marpaung, 2014).

The imperative point here is that all parameters are selected based on the data in the SAM table, which is properly formulated according to the initial values and coefficients in the table. In addition to this part, there is the most significant section of the model calibration for general closure rules that the researcher must determine the parameters correctly and accurately; otherwise, the model will not be settled and will face many errors.

Table 1. constrains used in this research

Constraint	Saving		Direct tax		Exchange rate		Investment		MPS		Capital formation	
	Flexible	Fixed	Uniform direct tax rate	Scaled direct tax rates	Flexible	Fixed	Flexible	Fixed	Flexible	Fixed	Flexible	Fixed
Government	✓	✓	✓	✓								
Rest of the World	✓					✓						
Savings–Investment	✓								✓			✓

***Source**: Author's calculation*

4. Scenario Design and Database

4.1 Scenario Design

The formation of the economy resembles human anatomical structure also as a framework composed of a system communicating with each other. It means, changes in one component is transferred to other components through a loop. As a result, a change in the structure of the system is introduced. In a real sense, if changes in the economic system are considered commodity and service markets and production factors will change the entire structure of the economy of a country. It is important to note that the components of an economic system interact together with the change in one variable despite direct impacts on domain and sector; it will indirectly impact other variables in the system, therefore, by considering the outcome of component changes on the economic system, the estimation of the ultimate impact of the whole system will be more useful for policy analysis. In assessing the economic impact, it is possible to examine the effects of various projects and policies in a region, country and world. This way, the CGE model simulates the entire economy to implement an endogenous and exogenous variation by using the social accounting matrix. It can be noted that the CGE model has an equilibrium condition, for instance, when the external or internal shocks occur, the change starts to transfer inside the entire economic system, and all variables will change. Eventually, the components of the system

have to change and it returns to equilibrium. In this research, the changes made to the system are simulated in the form of several scenarios. The scenarios include the effects of shock changes in exchange rates and oil price as shown in Table 1. Given in Table.1, information on the fluctuation of the exchange rates and oil price shocks in this study are simulated in various scenarios as illustrated below. Selecting scenarios is based on events that have occurred in Iran for over two decades and anticipated to recur in coming years, besides, two different modes will be considered for government closures.

Table 2. Scenario description

Scenario	20% increase	20% decrease	20% increase	20% decrease
	exchange rate		oil prices	
SIMA1	✓			
SIMA2		✓		
SIMA3			✓	
SIMA4				✓
SIMB1	✓		✓	
SIMB2	✓			✓
SIMC1		✓	✓	
SIMC2		✓		✓

***Source**: Author's calculation*

4.2 Database

The primary source of data sets the basis for the model in this study in Iran 2011 social accounting matrix (SAM) published by the Department of Statistics. The table distinguishes 72 various commodities and 72 different activities. Moreover, the final demand includes private households with varying levels of income, government, enterprises, exports, investments, and stock change. As is often the case, the structure of the published data is not in the required format of a CGE database and requires transforming the former into the format of the model. The model of this study requires a database with separate matrices for basic, tax, and margin flows for both domestic and imported sources to domestic and foreign users. Besides, the primary factors of production for the latest possible year are considered. It should be noted that the factor of energy production includes all types of energy except oil. All data used in the study are shown in Table 3.

This data set used in this research to describe model parameter values in a way that specifies the base solution to the model faithfully reproduces the values in the SAM. The model is, in other words, 'calibrated' to meet the SAM requirements. In addition, it is convenient for researchers to create new data sets for other apps.

Table 3. Description of data used in this research

Data	Source
Social accounting matrix	Research Center of the Islamic Consultative Assembly of Iran
Exchange rate	The central bank of Iran
Crude oil price	OPEC
Production factors	Statistical yearbook of Iran
Labor employed	Statistical yearbook of Iran
Government tax	Statistical yearbook of Iran
Energy	Ministry of Power
Transportation cost	Statistical yearbook of Iran

***Source**: Research Center of the Islamic Consultative Assembly of Iran, The central bank of Iran, OPEC, Statistical yearbook of Iran, Statistical yearbook of Iran, Statistical yearbook of Iran, Ministry of Power, Statistical yearbook of Iran (respectively)*

5. Results

We simulated the impact of oil price shocks and exchange rate fluctuations on household welfare in different scenarios and obtained results for household welfare change. With attention to the fluctuations in the oil market and the exchange rate, it is possible to raise more than 20 per cent in Iran for the future years. Correspondingly, the best plan is to predict the outcomes of foreign exchange in the domestic economy. Besides, the goal of government policy in reacting to external shocks is to increase national welfare, especially households. In this study to assess the welfare of the household, different indices were applied. In estimating the economic development, the CGE model would be more beneficial because it can predict more intellectual results, considering all the factors involved in the economy and the basis of a firm's theoretical microeconomics.

We now introduce an index forming household welfare. Table 2 presents the results obtained from the preliminary of indirect compensation (IC). Compensation refers to all household incomes and inclusion of direct and indirect compensations. Direct compensation is the amount of household income received through the salary and income derived from the lease of production factors. On the other hand, indirect compensation includes the benefits of households, insurance and subsidies received from companies and the rest of the world (Nasurdin et al., 2015). Compensation will perform an essential function in the performance growth of households. Additionally, it is one of the significant indicators for maintaining the welfare of households. Indirect compensate regularly is illustrated in the class of allowances and welfare facilities (Sari & Tridayanti, 2018).

Table 4. Indirect compensation for urban and rural household

Scenario	IC-UHHD	IC-RHHD
SIMA1	-0.34	-0.35
SIMA2	0.30	0.30
SIMA3	-0.11	-0.11
SIMA4	0.11	0.11
SIMB1	-0.45	-0.46
SIMB2	-0.23	-0.23
SIMC1	0.31	0.31
SIMC2	0.29	0.29

Note: numbers based on per cent change
***Source**: Author's calculation based on dataset*

Table 4 compares the indirect compensation for urban and rural households based upon various scenarios through the change in oil price and exchange rates.

It can be seen from the responses that both households in scenario SIMC1 have the highest volume of IC, 0.31. By contrast, with more moderate volumes, it is clear in scenario SIMB1 for urban and rural households, respectively has a -0.45 and -0.46 changes in IC. In scenario SIMB1, amount IC change was minimizing for the households.

Overall, it is obvious that if the exchange rate and oil prices increase, the income inputs to the country and the compensation for households will increase. There were significantly different results regarding the indirect compensation in an increase in oil price and exchange rates. Moreover, similar changes between two households show an insignificant difference.

Another indicator that is applied to calculate the welfare of households is of particular importance, Equivalent Variation (EV) being the classic example. EV evaluating the income change at base prices would be comparable to the change for the simulation. Thus, the disadvantages and advantages of the exogenous shocks are quite calculated when valued at the initial set of the price (Guerra & Sancho, 2018). It can be seen from the data in Table 5 as the results of simulations.

Table 5. Equivalent variation for urban and rural household

Scenario	EV-UHHD	EV-RHHD	total
SIMA1	-815678	-214464	-1030140
SIMA2	715467	188324	903791
SIMA3	-260739	-67472	-328211
SIMA4	259046	66963	326008
SIMB1	-1082940	-282726	-1365660
SIMB2	-540960	-144181	-685141
SIMC1	733329	193128	926457
SIMC2	688930	180475	869404

Note: numbers based on thousand million Rial (R)
***Source**: Author's calculation based on dataset*

The table 5 shows the equivalent variation for urban and rural households in different scenarios. The experimental data from Table 5 are adapted to fit the demand system with home and market consumptions.

The amount of EV for urban household groups through the decrease in the exchange rate and the increase in oil price has increased to the highest preponderance of 733329. It describes approximately 80 percent of total EV change in SIMC1. Also for rural household groups, it is similar in every respect. By contrast, with more large-scale decline in EV, it can be seen in SIMB1 that there was a sharp decline in the number of EVs with an increase in both variables.

It can be concluded for both households that the amount of EV experiences the same change; it means if the EV declines for reaction to changes in oil price and exchange rate, for both household groups, it will be changed in the same vector. Moreover, by an increase in exchange rates and oil prices, there was a significant negative correlation between the changes in EV, oil price and exchange rates.

An important indicator that plays an essential role in welfare calculation is the Compensation Variation (CV). The CV is measured at simulated prices and incomes. It demonstrates the maximum payment the consumer would be willing to make to avoid having the simulated change undone (i.e., the payment after which the consumer would have been just as well-off as without the change). For positive (negative) welfare change, CV > 0 (< 0) (Blonigen et al., 1997; Sadoulet & De Janvry, 1995). This indicator is estimated using the CGE model and is composed of separate parameters and indicators as shown in Table 6.

Table 6 below illustrates some characteristics of the CV consisting of the price index for UHHD and RHHD (PIU-R), subsistence spending of UHHD and RHHD (SSU-R), an indirect utility for UHHD and RHHD (IUTU-R), base-utility of UHHD and RHHD (BUTU-R) and auxiliary term based on marginal spending shares. The auxiliary for UHHD and RHHD estimating in the CGE model based on SAM. Auxiliary terms for UHHD and RHHD are respectively 0.332 and 0.318.

Table 6. Parameters and indicators of CV

Scenario	base	SIMA1	SIMA2	SIMA3	SIMA4	SIMB1	SIMB2	SIMC1	SIMC2
PIU	1	1.02	0.97	1.00	1.00	1.02	1.03	0.97	0.97
PIR	1	1.03	0.96	1.00	1.00	1.03	1.04	0.95	0.96
SSU	1195289	1216468	1168774	1194823	1195417	1215933	1216878	1166955	1172774
SSR	309812	319117	298505	309524	310050	318711	319502	297765	300056
IUTU	397121	126121	634826	310493	483185	37328	217393	640760	626009
IUTR	98379	30277	158181	76954	119643	8601	52595	159706	155688
BUTU	2390578	2440101	2325953	2389182	2391369	2438290	2441628	2321685	2335473
BUTR	619623	639255	594988	619004	620155	638372	640089	593426	598362

Note: PIU, PIR based on per cent change and SSU, SSR, IUTU, IUTR, BUTU, BUTR based on thousand million Rial

Source*: Author's calculation based on dataset*

A glance at Table 6 reveals several primary parameters and indicators for the CV. It is clear that different parameters explain major measurement agents for calculating household welfares in various scenarios.

There is a dramatic change in the price index when the exchange rate changes. In SIMA1, the PIU changes by 2 and PIR changes by 3 per cent, it indicates that index price for a rural household has more elasticity changes to the fluctuation of the exchange rate. On the other hand, in SIMC1 the PIU and PIR respectively decreased 3 and 5 percentages. Moreover, for rural households dramatically declined in comparison with that of urban households. Similarly, the subsistence spending of households has more elasticity changes than the fluctuation of the exchange rate; it can be seen in all scenarios except for SIMA3-4.

The indirect utility explains the highest change through different scenarios, one especially interesting point highlighted by the data of indirect utility is that more numbers change considerably in SIMA2 and SIMC1 than others. Varieties in SIMC1, indirect utility is the largest of the appropriate lists and the flexible, changing from 397121 in the base and 640760 in SIMC1 for urban household, and 98379 to 159706 for rural households. Likewise, the second largest reaction to the indirect utility is also the reaction to the change in the exchange rate in SIMA1-2. By contrast, SIMB1 in a whole scenario is less than the reaction to the increase in both variables.

The largest increase in base-utility was from SIMB2 and numbers soared significantly by approximately 2442000 for urban household and 640000 for rural household. Nevertheless, the sensitivity of base-utility reveals more changes than increase in the exchange rate.

It is interesting to note that in Table 6, the price index in the scenarios of raising the exchange rate, the index of prices for households increased but did not show any sensitivity to changes in the oil price. Moreover, when fluctuations in oil prices and the exchange rate occur, the SSU and SSR have more interactions with the exchange rate. Indirect utility is equal to the ratio of total household expenditures to which the subsistence spending amount is deducted, divided by the household price index. According to Table 6, a high degree of flexibility is witnessed in indirect utility ration economics shocks. It is also clear that with the rise in the exchange rate and the oil price, this index will have a version reaction. Base utility (BUT) is equal to the amount value of indirect utility multiplied by the new price index which is added to the subsistence spending amount. What is interesting in this data of base utility (BUT) is that it has little flexibility when the shift in oil price and the exchange rate occurs.

Compensation Variation (CV) Table 7 is equal to the deduction of total household expenditures and the base utility.

Table 7. Compensation variation for households

Scenario	SIMA 1	SIMA 2	SIMA 3	SIMA 4	SIMB 1	SIMB 2	SIMC 1	SIMC 2
CVU	670146	692656	-260536	259189	-1107460	-554293	708445	670146
CVR	173772	180222	-67400	67026	-291714	-149196	184307	173772
Total CV	843919	872878	-327936	326215	-1399174	-703489	892751	843919

Note: the numbers based on thousand million Rials
***Source**: Author's calculation based on dataset*

Table 7 shows the variation in household welfare through the reaction to the changes in oil price and exchange rate. Depending on the condition for positive (negative) welfare change, CV > 0 (< 0), shifts in the exchange rate will increase the welfare of households, and the rise in oil prices will reduce the welfare of households. Accordingly, the change in oil prices has a reverse correlation with the welfare of households. The single most remarkable observation to emerge from the data of Table 7 was the equity of household welfares between SIMA1 and SIMC2.

Household expenditures can be compared in Table 8. EXHU is urban household expenditures and EXHR is rural household expenditures.

Table 8. Household expenditures

Scenario	Base	SIMA1	SIMA2	SIMA3	SIMA4	SIMB1	SIMB2	SIMC1	SIMC2
EXHU	2390578	1605081	3018609	2128646	2650558	1330830	1887335	3030130	3005619
EXHR	619623	417643	775210	551604	687181	346658	490893	777733	772135

Note: the numbers based on thousand million Rials
***Source**: Author's calculation based on dataset*

Table 8 provides some information on the household expenditures in different scenarios. Overall, it can be seen that the change in the exchange rate results in a reverse reaction. It means if the exchange increases, the expenditure of both households will decrease. Besides, households exhibit a direct reaction to the increase in oil price.

6. Concluding Remarks

To understand the fact that the exchange rate and oil price changes in oil-exporting countries can alter the overall structure of a country's economy, this paper with a CGE model, is organized to investigate the impact of an oil price shock and fluctuation in the exchange rate on household welfare in Iran. The principal purpose of this paper is to conceive if the household faces fluctuations at these two variables, which variable has the most significant impact on welfare changes and how the government can decide on the results of such shocks. The present study was designed to determine the impact of the exchange rate and oil price on welfare. The most interesting conclusion was the significantly different

results on the indirect compensation and an increase in oil price and exchange rate. Although growth in income leads to an increase in indirect consumption, in this study, the results of a quite reverse case are obtained in different scenarios. Also, with the increase in exchange rates and oil prices, EV decreases, in other words, there was a significant negative correlation among changes in EV and oil price. Moreover, exchange rates and EV changes in the increasing exchange rate are the reverse of CV. This finding is in agreement with Bhattacharya's (2015) findings, which showed that the reason for the impact of welfare resulted from the CV and EV. Another important result of this study is that shifts in the exchange rate will increase the welfare of households, and the rise in oil prices will decrease the welfare of the households. This study produced results that corroborate with the findings of a great deal of previous works in this field such as Twaha (2019) and Farzangan (2015). Hence, a change in oil price has an inverse relationship with the welfare of the households. One unanticipated finding revealed that in the CV, an increase in the oil price is equal to simultaneous reduction of the exchange rate and oil prices. Another possible explanation for this might be related to Baez (2018), based on which any change in economics can change the prices and it is possible to shift the purchasing power of households.

It is therefore suggested that increasing productivity, promoting science and technology, increasing the provision of low-cost facilities, supporting producers, generating support for the disadvantaged workforce, increasing investment and creating wealth in the agricultural sector, losses incurred by the producers will be minimized among vulnerable populations through increasing production and income, which leads to increased employment and increased competition efficiency.

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Appendices

Appendix A. Key equations used in this research:

Price block

$$1.PM_c = pwm_c.(1+tm_c).EXR + \sum_{c' \in CT} PQ_{c'}.icm_{c'c}$$

$$2.PE_c = pwe_c.(1+te_c).EXR + \sum_{c' \in CT} PQ_{c'}.ice_{c'c}$$

$$3.PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'}.icd_{c'c}$$

$$4.PQ_c.(1-tq_c).QQ_c = PDD_c.QD_c + PM_c.QM_c$$

$$5.PX_c.QX_c = PDS_c.QD_c + PE_c.QE_c$$

$$6.PA_a = \sum_{c \in C} PAXC_{ac}.\theta$$

$$7.PINTA_a = \sum_{c \in C} PQ_c.ica_{ac}$$

$$8.PA_a.(1-ta_a).Qa_a = PVA_a.QVA_a + PINTA_a.QINTA_a$$

$$9.\overline{CPI} = \sum_{c \in C} PQ.cwts_c$$

$$10.DPI = \sum_{c \in C} PDS.dwts_c$$

Production and commodity block

$$11.\ PA_a = \alpha_a^a.(\delta_a^a.QVA_a^{-\rho_a^a} + (1-\delta_a^a).QINTA_a^{-\rho_a^a})^{\frac{1}{\rho_a^a}}$$

$$12.\ \frac{QVA_a}{QINTA_a} = \left[\frac{PINTA_a}{PVA_a}.\frac{\delta_a^a}{1-\delta_a^a}\right]^{\frac{1}{1+\rho_a^a}}$$

$$13.\ QVA_a = inv_a.QA_a$$

$$14.\ QINTA_a = \text{int}a_a.QA_a$$

$$15.\ QVA_a = \alpha_a^{va}.(\sum_{f \in F} \delta_a^{va}.QF_{fa}^{-\rho_a^{va}})^{\frac{1}{\rho_a^{va}}}$$

$$16.WF_f.\overline{WFDIST_{fa}} = PVA_a.(1-inv_a).QVA_a.(\sum_{f \in F} \delta_a^{va}.QF_{fa}^{-\rho_a^{va}})^{-1}.\delta_a^{va}.QF_{fa}^{-\rho_a^{va}-1}$$

$$17.\ QINT_{ca} = ica_{ca}.QINTA_a$$

$$18.\ QXAC_{ac} + \sum_{h \in H} QHA_{ach} = \theta_{ac}.QA_a$$

$$19.\ QX_c = \alpha_a^{ac}.(\sum_{a \in A} \delta_{ac}^{ac}.QXAC_{ac}^{-\rho_a^{aa}})^{\frac{1}{\rho_a^{ac}-1}}$$

$$20.\ PXAC_{ac} = PX_c.QX_c.(\sum_{a \in A} \delta_{ac}^{ac}.QXAC_{ac}^{-\rho_a^{aa}})^{-1}.\delta_{ac}^{ac}.QXAC_{ac}^{-\rho_a^{aa}-1}$$

$$21.\ QX_c = \alpha_c^t.(\delta_c^t.QE_c^{-\rho_c^t} + (1-\delta_c^t).QD_c^{-\rho_c^t})^{-\frac{1}{\rho_c^t}}$$

$$22.\ \frac{QE_c}{QD_c} = \left[\frac{PE_c}{PDS_c}.\frac{\delta_c^t}{1-\delta_c^t}\right]^{\frac{1}{\rho_c^t-1}}$$

$$23.\ QX_c = QD_c + QE_c$$

$$24.\ QQ_c = \alpha_c^q.(\delta_c^q.QM_c^{-\rho_c^q}+(1-\delta_c^q).QD_c^{-\rho_c^q})^{-\frac{1}{\rho_c^q}}$$

$$25.\ \frac{Qm_c}{QD_c} = \left[\frac{PDD_c}{PM_c}.\frac{\delta_c^q}{1-\delta_c^q}\right]^{\frac{1}{1+\rho_c^t}}$$

$$26.\ QQ_c = QD_c + QM_c$$

$$27.\ QT_c = \sum_{c'\in C'}(icm_{cc'}.QM_{c'} + ice_{cc'}.QE_{c'} + icd_{cc'}.QD_{c'})$$

Institution block

$$28.\ YF_f = \sum_{a\in A} WF_f.\overline{WFDIST_{fa}}.QF_{fa}$$

$$29.\ YIF_f = shif_{if}.\left[(1-tf_f).YF_f - trnsfr_{rowf}.EXR\right]$$

$$30.\ YI_i = \sum_{f\in F} YIF_{if} + \sum_{i'\in INSDING} TRII_{ii'} + trnsfr_{igov}.\overline{CPI} + trnsfr_{irow}.EXR$$

$$31.\ TRII_{ii'} = shii_{ii'}.(1-MPS_{i'}).(1-TINS_{i'}).YI_{i'}$$

$$32.\ EH_h = \left[1 - \sum_{i'\in INSDING} shii_{ih}\right].(1-MPS_h).(1-TINS_h).YI_h$$

$$33.\ PQ_c + QH_{ch} = PQ_c.\gamma_{ch}^m + \beta_{ch}^m.\left[EH_h - \sum_{c'\in C} PQ_{c'}.\gamma_{c'h}^m - \sum_{a\in A}\sum_{c'\in C} PQAX_{ac'}.\gamma_{ac'h}^h\right]$$

$$34.\ OXAC_{ac} + QHA_{ach} = PXAC_{ac}.\gamma_{ach}^h + \beta_{ach}^h.\left[EH_h - \sum_{c'\in C} PQ_{c'}.\gamma_{c'h}^m - \sum_{a\in A}\sum_{c'\in C} PQAX_{ac'}.\gamma_{ac'h}^h\right]$$

$$35.\ QINV_c = \overline{IADJ}.\overline{qinv_c}$$

$$36.\ QG_c = \overline{GADJ}.\overline{qg_c}$$

$$37.\ YG = \sum_{i\in INSDING} TINS_i.YI_i + \sum_{f\in F} tf_f.YF_f + \sum_{a\in A} tva_a.PVA_a.QVA_A$$
$$+ \sum_{a\in A} ta_a.PA_a.QA_a + \sum_{c\in CM} tm_c.pwm_c.QM_c.EXR + \sum_{c\in CE} te_C.pwe_c.QE_C.EXR$$
$$+ \sum_{c\in C} tq_c.PQ_c.QQ_c + \sum_{f\in F} YIF_{govf}.trnsfr_{govrow}.EXR$$

$$38.\ EG = \sum_{c\in CE} PQ_C.QG_c + \sum_{i\in INSDING} trnsfr_{igov}.\overline{CPI}$$

$$39.\ \sum_{a\in A} QF_{fa} = \overline{QFS_f}$$

$$40.\ QQ_c = \sum_{a\in A} QINT_{ca} + \sum_{h\in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c$$

$$41.\ \sum_{c\in C} pwm_c.QM_c + \sum_{f\in F} trnsfr_{rowf} = \sum_{c\in CE} pwe_c.QE_c + \sum_{i\in INSD} trndfr_{irow} + \overline{FSAV}$$

$$42.\ YG = EG + GSAV$$

System constraint block

$$43.\ TINS_i = \overline{tins_i}.(1+\overline{TINSADJ}.tins01_i) + \overline{DTINS}.tins01_i$$

44. $MPS_i = \overline{mps_i}.(1 + \overline{MPSADJ}.mps01_i) + \overline{DMPS}.mps01_i$

45. $\sum_{i \in INSDING} MPS_i.(1 + TINS_i).GSAV_i + EXR.\overline{FSAV} = \sum_{c \in C} PQ_c.QINV_c +$

$\sum_{c \in C} PQ_c.qdst_c$

46. $TABS = \sum_{h \in H} \sum_{c \in C} PQ_c.Q_{ch} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{ac}.QHA_{ach} +$

$\sum_{c \in C} PQ_c.QG_c + \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c$

47. $INVSHR.TABS = \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c$

48. $GOVSHR.TABS = \sum_{c \in C} PQ_c.QG_c$

Sets	
A	activities
ACES	activities with CES fn at top of technology nest
ALEO	activities with Leontief fn at top of technology nest
C	commodities
CD	commodities with domestic sales of output
CDN	commodities without domestic sales of output
CE	exported commodities
CEN	non-exported commodities
CM	imported commodities
CMN	non-imported commodities
CX	commodities with output
F	factors
INS	institutions
INSD	domestic institutions
INSDNG	domestic non-government institutions
H	households

Parameters	
$cwts_c$	consumer price index weights
$dwts_c$	domestic sales price weights
$ica_{c\,a}$	intermediate input c per unit of aggregate intermediate
$ice_{c\,c}$	trade input of c per unit of com cp exported
$icm_{c\,c}$	trade input of c per unit of com cp imported
$inta_a$	aggregate intermediate input coefficient
iva_a	aggregate value added coefficient
mps_i	marg prop to save for dom non-gov inst ins (exog part)
$mps01_c$	0-1 par for potential flexing of savings rates
pwe_c	export price
pwm_c	import price
$qdst_c$	inventory investment by sector of origin
qg_c	exogenous (unscaled) government demand
$qinv_c$	exogenous (unscaled) investment demand
$shif_{i\,f}$	share of dom. inst i in income of factor f
$shii_{i\,i}$	share of inst i in post-tax post-sav income of inst ip
ta_a	rate of tax on producer gross output value
te_c	rate of tax on exports
tf_f	rate of direct tax on factors (soc sec tax)
$tins_i$	rate of (exog part of) direct tax on dom inst ins
tm_c	rate of import tariff
tq_c	rate of sales tax
$trnsfr_{i\,f}$	transfers fr inst. or factor ac to institution ins
tva_a	rate of value-added tax
α_a^a	shift parameter for top level CES function
α_a^{va}	shift parameter for domestic commodity aggregation fn
α_a^{ac}	shift parameter for domestic commodity aggregation fn
α_c^q	marg shr of hhd cons on home com c from act a
α_c^t	marg share of hhd cons on marketed commodity
$\beta_{a\,c\,h}^h$	share parameter for top level CES function
β_{ch}^m	share parameter for domestic commodity aggregation fn
δ_a^a	share parameter for Armington function
$\delta_{a\,c}^{ac}$	share parameter for CET function
δ_c^q	share parameter for CES activity production function
δ_c^t	per-cap subsist cons of market com c for hhd h
$\delta_{f\,a}^{va}$	per-cap subsist cons for hhd h on home com c fr act a
$\gamma_{c\,h}^m$	yield of commodity c per unit of activity a
$\gamma_{a\,c\,h}^h$	CES top level function exponent
$\theta_{a\,c}$	CES activity production function exponent
ρ_a^a	domestic commodity aggregation function exponent
ρ_a^{va}	Armington function exponent
ρ_c^{ac}	CET function exponent
ρ_c^q	0-1 par for potential flexing of dir tax rates
ρ_c^t	trade input of c per unit of com cp produced & sold dom'ly
$tins01_i$	shift parameter for top level CES function
$icd_{c\,c}$	shift parameter for domestic commodity aggregation fn

Variables	
$\overline{DPI}$	consumer price index (PQ-based)
$\overline{CPI}$	index for domestic producer prices (PDS-based)
$DMPS$	change in marginal propensity to save for selected inst
$\overline{DTINS}$	change in domestic institution tax share
$\overline{FSAV}$	total current government expenditure
$GADJ$	household consumption expenditure
$\overline{IADJ}$	exchange rate
$\overline{MPSADJ}$	foreign savings
$\overline{QFS}_f$	government demand scaling factor
$\overline{TINSADJ}$	govt consumption share of absorption
$WFDIST_{f\,a}$	government savings
EG	investment scaling factor (for fixed capital formation)
EH_h	investment share of absorption
EXR	marginal propensity to save for dom non-gov inst ins
$GOVSHR$	savings rate scaling factor
$GSAV$	output price of activity a
$INVSHR$	consumer price index (PQ-based)
MPS_i	index for domestic producer prices (PDS-based)
PA_a	change in marginal propensity to save for selected inst
PDD_c	demand price for com c produced & sold domestically
PDS_c	supply price for com c produced & sold domestically
PE_c	price of exports
$PINTA_c$	price of intermediate aggregate
PM_c	price of imports
PQ_a	price of composite good c
PVA_a	value added price
PX_c	world price of exports
$PXAC_{a\,c}$	world price of imports
QA_a	average output price
QD_c	price of commodity c from activity a
QE_c	level of domestic activity
$QF_{f\,a}$	quantity of domestic sales
QG_c	quantity of exports
$QH_{c\,h}$	quantity demanded of factor f from activity a
$QHA_{a\,c\,h}$	quantity of factor supply
$QINTA_a$	quantity of government consumption
$QINT_{c\,a}$	quantity consumed of marketed commodity c by household h
$QINV_c$	quantity consumed of home commodity c fr act a by hhd h
QM_c	quantity of intermediate demand for c from activity a
QQ_c	quantity of aggregate intermediate input
QT_c	quantity of fixed investment demand
QVA_a	quantity of imports
QX_c	quantity of composite goods supply
$QXAC_{a\,c}$	quantity of trade and transport demand for commodity c
$TABS$	quantity of aggregate value added
$TINT_i$	quantity of aggregate marketed commodity output
$TRII_{i\,i}$	quantity of ouput of commodity c from activity a
WF_f	total absorption
YF_f	rate of direct tax on domestic institutions ins

(Continued). Variables	
YG	direct tax scaling factor
YI_i	transfers to dom inst insdng from insdngp
YIF_{if}	Savings–Investment imbalance (should be zero)

Selective elastisity in this research	
Elasticity of CES function	2
Elasticity of CET function	1,5
Elasticity of production function	0,6
Substitution elasticity among factors of production	0,5
The substitution elasticity between value added and intermediate imports	0,6
The substitution elasticity between value added and intermediate imports	0