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RESEARCH PAPER

The Impact of Exchange Rate Fluctuations and the Oil Price Shocks on Government Budget: CGE Model Approach

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Abstract
The exchange rate and international oil prices are vital variables that indicate the impact of external economic developments, agreements, and relationships. Since in countries like Iran, most of the government's revenue comes from exchange earnings from the international markets by oil exports, the impact of two variables on the economy has a significant outcome. Also, it should be considered how fluctuations in the exchange rate and international oil prices can affect the policy and international relations. According to a global trade standpoint, it is believed that the exchange rate affects the economy through the changes in exports and imports commodities; therefore, expected the exchange rate will affect the price of traded products. Moreover, the impact of the oil price on the production of items changes the level of supply for activities and income of institutions through the changes in the production factors and intermediary imports price. The results show that rising exchange rates and oil prices increase government revenue from sales of production factors; with rising prices and more sensitivity to oil prices, the government faces budget surpluses. Also, when the government faces a surplus or deficit, as much as consumption, saving, and changes a payment, which results from the optimality of the model. In addition, it is more critical that Iran's economy use policies that uniform direct tax rate point change for selected institutions, which is more optimal because the budget is less unstable.
Keywords: Exchange Rate, Oil Prices, Computable General Equilibrium Model, Social Accounting Matrix, Surplus, Deficit, Budget.
JEL Classification: C68, D60, E16, F31, H12, H62, Q02.

Introduction

The fluctuation of the exchange rate is one of the most important macroeconomic variables, and its crises lead to the departure of the economic equilibrium economy. The exchange rate can affect the various aspects of different economic sectors. It can also be assumed that the exchange rate imbalance has emerged as an indicator for adjusting the future exchange rate concerning the currency crisis.

The real effective exchange rate (REER) as a competitive indicator has identified connections on the imbalances of the exchange rate (Holtemöller and Mallick, 2013). Any change in the other country will lead to economic turbulence in the home country. The instability of the exchange rate derived from the disequilibrium of the foreign economy plays an essential role in advancing political negotiations (International Monetary Fund, 2012). Continuous and persistent imbalances demonstrating the economic imbalance are the origins of the macroeconomic crisis. Also, the asymmetry of the exchange rate more than the

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specified limen could bring about upswing exchange rates and help predict the exchange rate crisis (Holtemöller and Mallick, 2013). Romelli et al. (2015) investigated the change in the balance of the current account following the change in the exchange rate. Exchange rate as the immense link between domestic and foreign prices could enhance exports, and influence monetary and fiscal policies, furthermore, could make changes in global markets, international economies, and affect the country's economic strength.

From another perspective, the foreign exchange rate can efficiently affect the domestic economy in terms of productivity and the welfare of the households. On the other hand, fluctuations in the exchange rate are marked by the price of the production factors, the price of final domestic goods, and foreign exchange earnings of oil sales in the international market. A decline in the real exchange rate indicates a reduction in the value of foreign goods compared to the previous one. Exchange rate fluctuation has two substitution and income effects. During the economic prosperity, given the impacts of the income effect, will increase the consumption of foreign goods and the utility of the consumer. By contrast, by the elasticity of substitution, the consumption of domestic commodities will be reduced.

The exchange rate fluctuation due to the money flow and currency crisis could have three reasons: First, it is based on the principles of macroeconomics, suggesting the diversity in economic growth rate. The difference in profit and price levels may prompt a decline in the exchange rate. Secondly, the presence of different determinants of the exchange rate which might lead to instability in the exchange rate. Thirdly, according to the capital market failure theory, it is because of investors who might adjust their dynamic expectations based on the strength and vulnerability institutions, such as households, firms, banks, and the state (Flaschel and Semmler, 2006). An increase in the real exchange rate leads to the substitution of production factors from the non-commercial sector to the commercial sector because exporting commercial goods to the international market is more profitable than to the domestic market (Edwards, 1989; Edwards and Savastano, 1999). By contrast, in a situation where the increase in the nominal exchange rate has a reverse impact on trade, the quality of laws, improvement, and reforming the government size can be useful to improve commercialization. In this regard, the establishment of business firms in different sectors of the economy by the beneficiary countries could reduce the negative effects of the exchange rate fluctuations (Fertő and Fogarasi, 2014). Two reasons stated that exchange rate policy in the developed economy able to decrease the percentage of stability or flexibility: the first, weak substitution between the production factors, including domestic labor, 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).

Exporters and importers are facing a high risk when the exchange rate dramatically fluctuates. So they push for currency trading activities. Exchange rate stability and supportive policies such as banking and insurance make import and export a reasonable process. In other words, by reducing the exchange rate fluctuations, a more favorable environment for production and trade will be created. Dramatic fluctuations in the exchange rate will make some people drop out of the business cycle. Also, the more the foreign traders are risk-averse, and the share of international trade in GDP is higher, the more fluctuations will have a significant impact on the reduction of GDP, rising prices, and threats to foreign trade. Thus, the sense of stability and security that is necessary for planning and economic activities will significantly reduce (Helleiner, 1981).

Sometimes the exchange rate fluctuations lead to imposing quota and control in the allocation of foreign exchange due to the increased government expenditures. If the current account surplus of the currency is very low compared to the debt at the time of the change in government, the exchange rate will decrease, and a significant reduction in the real value of the government debt to repay the financial debt will be necessary (Daniel, 2010).

From a macroeconomic perspective, especially in open economies, the exchange rate is considered as a significant important variable. The exchange rate is determined as the price of a currency in other circumstances (Mishkin, 2004). The real exchange rate is the nominal exchange rate with the difference in inflation in different countries, which means it considers the purchasing power of 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 is essential, and also because Iran has an open economy that most of its income earned by selling oil in international markets, the exchange rate has a significant impact on the Iranian economy and competition in the global economy for the export of goods and services, especially oil. The share of Iran's revenues of crude oil sales in GDP is vaster than other revenue resources.

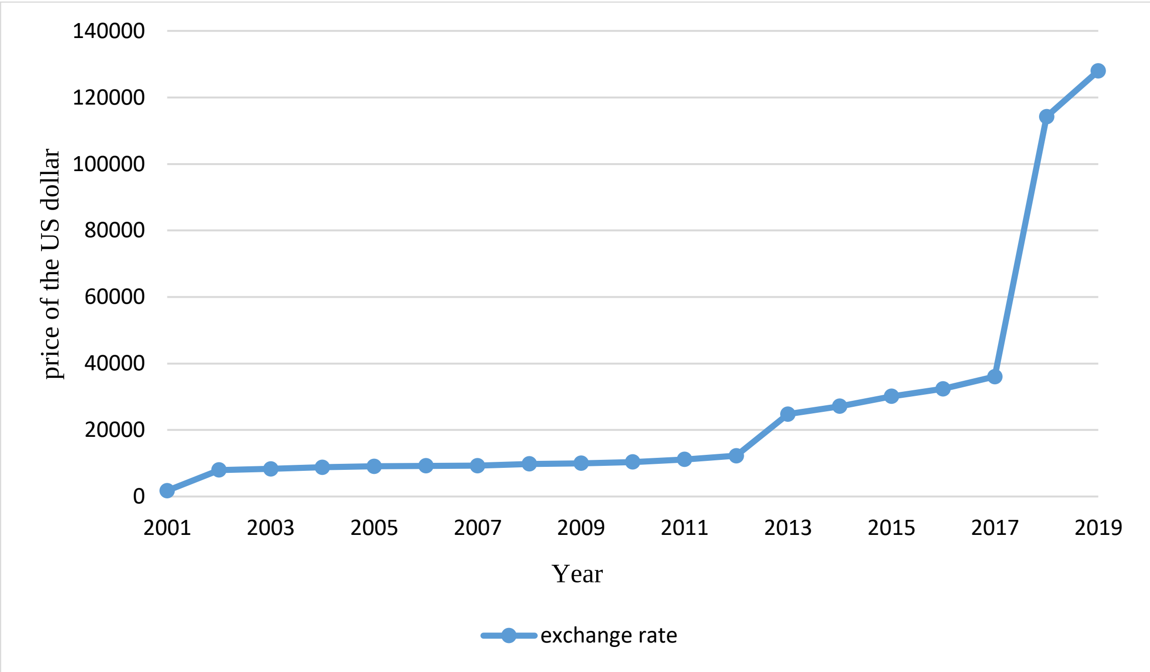


Figure 1. Value of one US dollar in Iranian Rials (2001-2019)
Source: Central Bank of Iran.

Figure 1 illustrates the change in the market price of one US dollar in the Iranian Rials between 2001 and 2019. Overall, it can be seen that the value of the US dollar remained constant between 2002 and 2012. Over the following five years, it rose gradually. Then in 2017, it increased dramatically until 2019, when it peaked at 128000 Rials. It is interesting to note the steady increase in the US dollar value after this time.

Oil price shocks by changing the production and operating costs could have negative impacts on macroeconomic variables (Rafiq et al., 2009). An increase in oil prices could increase investment and also increase risk as well as reallocate resources (Bernanke, 1983). When an economic activity deals with choosing between investing in energy-saving or inefficient energy, the uncertainty caused by the fluctuations in oil prices would increase the willingness to choose higher-value investment (Ferderer, 1996). Besides, 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 shocks in the economy is asymmetrical: the negative impact of increasing oil prices is higher than the positive impacts of it (Rafiq et al., 2009).

According to the International Energy Agency 2016 (IEA), the World Energy Outlook (WEO) under the current policy scenario (CPS), even without oil price shocks, oil prices in the country will rise to $82 in 2020. The oil price will reach $127 per barrel in 2030 and $146 per barrel in 2040. Global and domestic price changes affect the entire economy. The government budget has a significant impact on economic circumstances and economic judgments such as labor supply, investment, and savings. In addition, the government budget is one of the primary essential factors for each country in the promotion and development of the country (Irandoust, 2018).

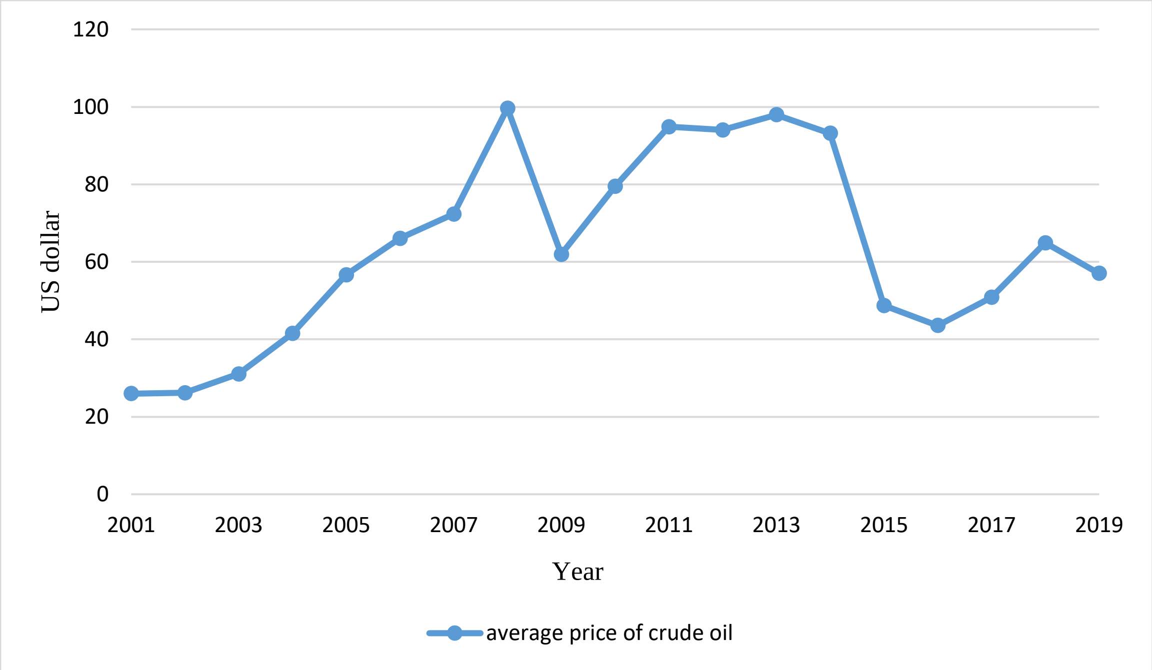


Figure 2. The Price of Crude Oil per Barrel (2001–2019)
Source: OPEC oil market.

The line graph in Figure 2 reveals some changes in the price of crude oil per barrel in the US dollar. Crude oil prices rose steadily from 2001 to 2007 and then increased markedly until it reached a peak of $100 in 2008 and then dropped in 2009. Since then between 2009 and 2011, there was exponential growth in crude oil prices. Over the following four years, it was stable approximately $95, next in 2014, plunged to $43. There was a dip in 2016, and from 2016 to 2018, it again increased gradually. After 2018, it is also projected to fluctuate, but more gradually.

The remainder of this research is constructed as follows: Section 2 provides a brief review of the literature. In Section 3, the methodology of the CGE model is discussed. Section 4 explains the different scenarios of the model and data used in the model. In Section 5 divides into two parts, which discuss the results of the first and second scenarios. Finally, Section 6 concludes the paper.

As previously stated, governments and major investment firms assess the impacts of external shocks on budget and want to project for the near future. For those governments, such as Iran, whose revenues come from oil sales in the international market, the inflow of foreign exchange is the source of funding for the government's expenditures and controlling the factor of financial policy to achieve more favorable economic outcomes. Generally, because projecting the future optimal tax system and its impacts is not accurate in the real world, the presence of errors due to the incomplete information is probable. Oil and exchange rate shocks can also affect government spending including investment, consumption, transfer payments, etc. The government budget which is derived from receipts and payments deals with change in the form of deficit, surplus, and balance. Understanding the fact that the government, with the control of the budget and its components, can easily deal with economic shocks and to some extent, neutralize them, in this research, we focus on the essential problems as follows.

1) How can the oil price shocks and exchange rates affect the government budget?

2) How can budget variables neutralize the effect of shocks?

3) What kind of tax policies can be optimal and less unstable for Iran?

4) How have the key components of the government budget changed in different scenarios, and what has been their final effect on the budget?

5) If the government faces a budget surplus or budget deficit, how budget gets balanced?

6) How does government payments change as a result of a surplus or deficit?

In this research, for the government balance, we have several economic closures: 1) Government saving is flexible, and all tax rates are fixed; 2) Savings are fixed, and uniform direct tax rate point change for selected institutions. In this paper, since our goal is to study the response of the government budget to external shocks, we use both closures to show the results. For the rest of the world balance, the closure is that the real exchange rate is fixed while foreign savings is flexible. In the investment and saving balance, total savings equal to the sum of domestic savings and external savings should be equal to the planned investment. The various constraints of savings and investment closure relate to the point that whether economic closure is investment-driven or saving-driven. In this research, it is assumed that all savings that are made by institutions in the capital market are invested. Thus the model is saving-driven. Moreover, the study is based on predictions of possible scenarios for the government budget and is not a basis for accurate estimates.

Literature Review

The importance of oil revenues in Iran’s economy and its direct and indirect impacts on GDP and macroeconomic variables are irreversible issues. The oil industry is one of the most important economic sectors that affect other economic variables, as well as the revenues earned from oil sales, plays an essential role in financing the budget in the economy. Oil shocks in the economy have led to a global recession, domestic inflation, and unemployment. On the other hand, most countries across the world, such as Iran, have gained foreign exchange earnings from oil sales. So changes in oil prices and exchange rates can easily change the domestic economy. In oil-producing countries, important variables such as inflation, oil revenues, tax revenues etc. can affect economic growth and macroeconomic variables. In the contemporary era, oil and exchange rates have played an important role in the development and industrialization of countries (Huang et al., 1996). Therefore, examining the possibility of measuring the asymmetric effects of shocks caused by the economy and macroeconomic variables can help improve the government’s decision making to deal with economic fluctuations. Kreishan et al. (2018) and Adedokun (2018) showed that as the government’s revenues from the oil sector increased, consumption would increase, and thus government should invest in other sectors rather than oil in order to be safe from oil shocks. In Iran, Davoudi et al. (2018) studied the effects of oil shocks on the stock market fluctuations. Results indicated that positive oil shocks on stock returns were the primary motive for the growth of the stock price index in Iran (Davoudi et al., 2018). Also, in some studies, oil shocks have an asymmetric effect on the government budget (Rahma et al., 2016). Exchange rates and oil are also interrelated in the economy of OECD members. After the Great Depression, the ability to explain oil shocks for exchange rates has increased (Chen et al., 2016). Dong et al. (2017) investigated the effect of the exchange rate fluctuations and oil price shocks on the regional economy in China by using a DSGE model and concluded that a decline in the exchange rates and oil prices would both lead to economic growth. Reducing exchange rates and oil prices will both increase employment, but rising oil prices will be beneficial for employment in the northeast of China. Some studies have shown that the exchange rate fluctuations would lead to economic instability (Cheikh, 2013). Some studies have analyzed the effect of increasing non-oil exports on economic growth and output changes of the Iranian economic sectors by using a CGE model. Results show that the manufacturing and mining sectors in Iran will have a more significant impact on growth than other non-oil sectors (Jafari et al., 2014). The oil price shock has significant effects on the exchange rate in the short- and long-term (Abdelaziz et al., 2008; Amano and Van Norden, 1995; Basher et al., 2016; Chen and Chen, 2007; Ferraro et al., 2015; Kilian and Zhou, 2019; Ozturk et al., 2008; Rautava, 2004). In this regard, several academic studies have analyzed the impact of oil price variables on economic activity, and most importantly, such studies have been conducted almost exclusively in developed economies, in particular, the United States. For instance, the real decline in oil prices during the period of 1970-1980s was explained by higher US interest rates. Eventually, oil demand and foreign oil supply shocks have caused fluctuations not only in the real oil price but also in the real US interest rate. This is the result of changes in production investment, supply volumes, and demand for all economic agents that have become commercial (Bodenstein et al., 2012; Kilian and Lewis, 2011). In studies on China, the increase in oil revenues, in turn, has reduced economic growth, but it is also necessary for long-term growth in the economy (Dong et al., 2017).

In recent studies, the impact of oil price shock on many variables such as the economy (Aydın and Acar, 2011), budget (Rahma et al., 2016), long-term economic effects (Boratynski and Kasek, 2015), energy pricing policy (Akinyemi et al., 2018), etc. has been assessed by using the CGE model. In addition, the CGE model has been used to study the effect of the exchange rate fluctuations on many variables such as GDP and economic performance (Willenbockel, 2006), setting tax configuration (Robinson and Thierfelder, 2017), employment (Frenkel and Ros, 2006), trade balance (Hertel and Villoria, 2012), etc. This paper intends to study the effect of the exchange rate fluctuations and oil prices on the government budget, which also affect the decision of economic agents, production costs, intermediate imports, etc. Hence, the elaboration of planning a precise framework for economic stability requires understanding the effects of such variables on macroeconomic variables. Also, due to data limitations, the DSGE model does not meet all the economic structures and variables that settled simultaneously in long and short terms. In this regard, due to the importance of the mentioned variables in the economy and the economic sectors, the computable general equilibrium model is used to investigate the impact of the oil price shock and fluctuations of the exchange rate on the government budget.

Methodology

CGE Model

First of all, a computable general equilibrium (CGE) model is a simplified structure for the whole economy, and an important approach of CGE models is to represent the circular flow of the economic activities (Ghadimi, 2006). In addition, CGE models are based on Walras's law, which describes how allocated resources in the market are the result of supply and demand as well as achieving equilibrium prices (Böhringer et al., 2017; Gharibnavaz et al., 2018; He et al., 2014; Zhang et al., 2017). Making blocks of these models is equations that represent the behavior of economic agents (Lin and Jia, 2019). In general, the CGE model illustrates the whole economy and models the interaction of economic agents to provide a framework of the circular flow of economic activities and markets (Borges, 1986; Severini et al., 2018). Based on the definition given by Sherman Robinson (1986), the 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 signals based on which economic agents make their decision, and 4- Assigning the rules of the game that defines the structure of economic institutions. The crucial point about general equilibrium models is that these models provide a microeconomic framework which completely reflects the behavior of economic actors, and provides clear estimation to optimize the ability of policymakers to have more effective analytical frameworks (Böhringer and Rivers, 2018; Yeldan, 2002). In addition, depending on the type of examination and analysis of the effects of different policy makings, general equilibrium models cover a wide range of studies. For instance, to estimate the economic impacts, we can measure the consequences of different scenarios and policies by using spatial economic analysis (Thissen, 1998b; 1998a). It can be noted that the equations of the general equilibrium model are based on the assumptions of optimizing the behavior of economic agents, and this behavior per se is based on microeconomic theories and relative prices. Both of these assumptions play an essential role in production of the each economic sector (Cicowiez et al., 2017; Lofgren et al., 2002; Norén, 2013). Behavior reveals that producers seek to minimize the costs (maximize the profits) of their production technology, and consumers attempt to maximize the utility of consuming goods and services that they spend for their expanses (Norén, 2013). It is assumed that companies and economic sectors should maximize their profits. The wages are equal to the product of the marginal revenues of labor, and labor would be employed until their wages are equal to the revenues they produce (Lofgren et al., 2002). In order to stay close to the real world, in simulating the CGE model, it is necessary to introduce the assumptions that determine the economic conditions into the model. Economic assumptions, depending on the case study and the theoretical framework, can create different theoretical foundations. In a CGE model, it is assumed that the market is perfectly competitive, and there is an imperfect substitution between domestic and foreign commodities (Armington, 1969; Feenstra et al., 2018; Kim et al., 2018; Oyamada, 2015). The export or demand for foreigners is based on foreign exchange demand and is determined by the export demand function. The price in international markets is not equal to that in domestic prices. Because the general equilibrium model considers foreign exchange as an exogenous variable (Aydın and 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 consume or save their income after deduction of direct taxes from income. In this model, the government gains its revenues by renting the production factors, direct taxes, indirect taxes, and foreign transfers. In the end, these revenues are allocated to the consumption of goods and services or will be saved or invested in the capital market (Yin et al., 2019). In this framework, we explain some parts of the CGE model structure. It consists of four blocks: price, production, and trade, institution, and system constraint. The simple and general framework of the CGE model is illustrated in Figure 3.

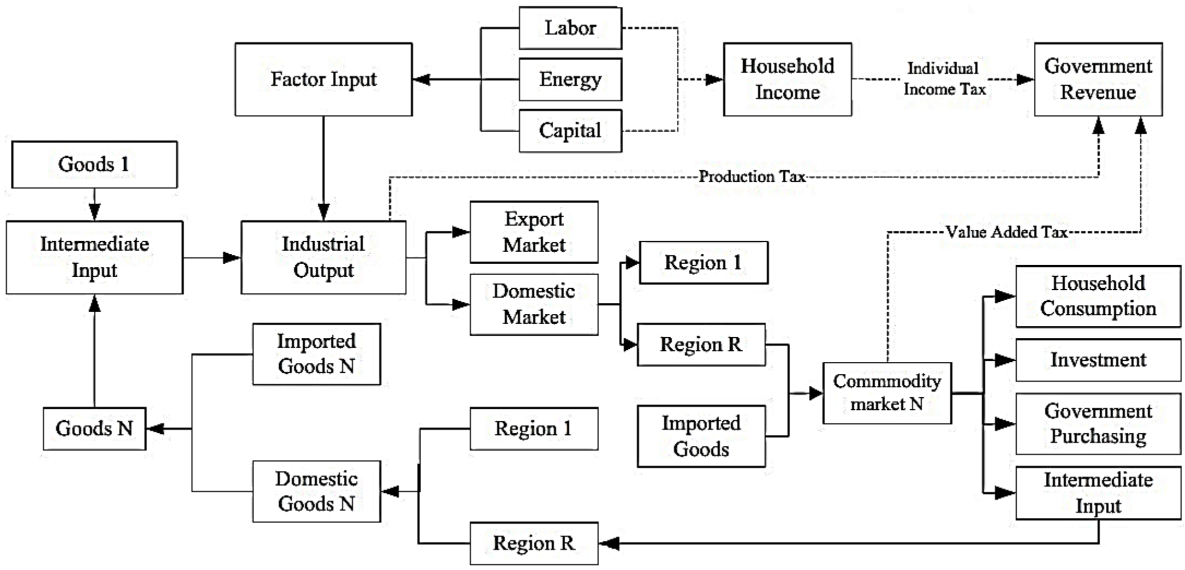


Figure 3. The Simple and General Framework of the CGE Model
Source: Dong et al. (2017) / Energy Economics 140

Figure 3 illustrates the process by which blocks in the CGE model are connected and how resources are allocated between different agents. Based on information provided in Figure 3, it is clear that there are four main phases involved. Before the actual processing of the resources, first of all, it is necessary to show the transfer of income tax from household to government in the form of individual income tax. Then, resources are used as inputs to start manufacturing. At this point, certain commodities are being produced. In addition, the intermediate input will be added to manufacturing process. Meanwhile, the second stage of the manufacturing process involves the separation of export market from domestic market. Following the regional separation of the product market, these products are allocated to the final consumers, household, government and investment sector or again, as intermediary input, they return to the production cycle. In the third phase, the commodities, which are returned to the production cycle as an intermediary input, involve the combination of both import market and domestic market. The final phase is when the government revenues which have been through the process are subsequently received. Meanwhile, the government absorb different kind of taxes, for instance, production tax and value-added tax.

Price Block

According to Appendix A, an important feature of the general equilibrium model is the price block. In this block, it is assumed that more than one activity can produce the same commodity. In the beginning, the prices of different activities of the manufacturer have decreased the producer price of that commodity. The activity price not only includes activity taxes that are in the output of each industry, but consists of taxes on the production factors which are used in the production process (Deng et al., 2014). If net taxes and tariffs are added to the producer price, then the price of exports will be determined. By merging the price of domestic products and the price of imports, the marginal supply price of goods and services will be obtained (Bhattarai et al., 2018). By focusing on consumption rather than production, the domestic demand price will be obtained by adding trading costs to domestic supply prices. By considering the import tariff the import prices will be obtained. By combining domestic prices with import prices, the composite prices will be calculated (Lofgren et al., 2002). Finally, the market price is obtained by adding sales tax to the price of composite goods. Similarly, for the primary production factors, which are demanded by producers, by combining the supply prices of the factors, we can obtain the price of production factors (Raihan et al., 2017).

Production and Commodity Market

Producers seek to maximize their profits (minimizing their costs) defined by the differences between earnings, operating costs, intermediate products, and imported production factors. Maximization profits in terms of production technology is divided into two levels. At first stage, the production level is determined by the constant elasticity of substitution (CES) production function (PF) or Leontief production function. In addition, at the lower level value added are determined by the CES production function, and intermediate inputs are determined by the Leontief production function (Robinson et al., 2014). All products are sold in domestic markets and/or are exported to other countries (Zhong et al., 2018). The aggregate demand in domestic markets consists of total imports and domestic products, which are sold in domestic markets (Cicowiez et al., 2017; Lofgren et al., 2002; Zhong et al., 2018). Due to the incomplete transfer between imports and domestic production, this feature is expressed by the CES production function, and it is assumed that the production function depends on the marginal rate of substitution between imports of goods and services and domestic products (Calzadilla et al., 2017; Garaffa et al., 2018; Gurgel et al., 2017; Shen and Whalley, 2017; Zhong et al., 2018). The productions function is defined as follows.

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

Where QQ_c is the total sales of good and services in the domestic market, QM_c is the total import of good and services for domestic consumers, and QD_c is the total demand of domestic consumers for domestic products. By assuming an imperfect substitution between export and domestic supply, the constant elasticity of transformation (CET) production function is expressed as follows.

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

where QX_c is the total products of goods and services by domestic producers, Qe_c is the total export of goods and services, and QD_c is the aggregate supply of local products in domestic market.

Institution Block

In the CGE model, institutions constitute of households, enterprises, governments, and the rest of the world. Households are the owners of the production factors, and earn money by renting or selling them (Calzadilla et al., 2017). Households purchase consumer products at market prices, which includes sales tax and transfer costs. Besides, consumption is allocated between a variety of goods and services, which is based on the linear expenditure system (LES) of demand function, determined by maximizing the Stone-Geary utility function (Dong et al., 2017; Francois and Reinert, 1997; Van Ruijven, 2015; Wang et al., 2017a; 2017b; 2017c).

Unlike the production factors whose income is paid directly to households, and might be paid to one or more other enterprises, these enterprises may also receive transfer payments from other institutions, when corporate income is allocated to direct taxes, savings, and transfers to other institution (Fujimori et al., 2012; Guo et al., 2014; Li et al., 2019; Lin and Jia, 2018; Liu et al., 2015). An important fact that should be considered in the general equilibrium model is that enterprises are not the consumers of goods and services (Lofgren et al., 2002).

Governments collect taxes and transfers 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 in foreign payments account. Foreign saving is the fraction between payments and external receipts, but all payments and incomes are fixed at an external price. Payments and transfers from the rest of the world show the trade balance (Lofgren et al., 2002).

System Constraint Block

In general, each actual and simulated structure encounters a series of constraints and limitations. Even in the general equilibrium model, the constraints and limitations must be determined in equilibrium condition. The general equilibrium model has three macroeconomic balance: government balance (state budget), rest of the world balance (trade balance, including payments and receipts), and investment-savings balance (Li et al., 2017; Lin and Jia, 2018). In CGE model, it is known that macroeconomic closure for achieving that balance is necessary for any model to be solved mathematically (Mahmood and Marpaung, 2014).

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: Research finding.

Designing Scenarios and Data

Designing Scenarios

The configuration of the economy has resembled with human anatomy structure also known as a system which is composed of components that have communication with each other. That is changes in one component is transferred to the other components through a loop, which leads to a change in the structure of the system. In the real world, changes in the economic system that means changes in goods and services markets and production factors can change the entire economic structure of a country. It is important to note that the components of an economic system have interaction. So that a change in one variable which has a direct effect on its domain and sector will also indirectly affect other variables in the system. Therefore, by considering the outcome of component changes in the economic system, estimating the ultimate impact on the whole system will be more useful for policy analysis. In assessing the economic impact, it is possible to study the effects of various plans and policies in a region, country, and world. In this way, the CGE model simulates the entire economy to implement endogenous and exogenous variables by using the social accounting matrix. It can be noted that the CGE model provides an equilibrium condition. For instance, when external or internal shocks occur, the change starts to be transferred inside the entire economic system, and all variables will change. Eventually, the components of the system have to change and the entire system returns to equilibrium. In this paper, the changes are simulated in the form of several scenarios. The scenarios include the effects of exchange rates and oil price shocks as shown in Table 1. Table 1 provides the information of fluctuations in the exchange rates and oil price as a result of different scenarios. Selecting scenarios is based on what have been observed in Iran for over two decades, and is expected to recur in near years to come. Besides, two different models 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: Research finding.

Data

The primary source of data used in the model in this study is the 2011 social accounting matrix (SAM) published by the Statistical Center of Iran. Table 3 distinguishes 72 various commodities and 72 different sectors. In addition, final demand includes private households with varying levels of income, government, enterprises, exports, investments, and stock exchange. As is often the case, the structure of the published data is not in the required format of a CGE database, and requires to be replaced with a new format that fits the model. The model of this study requires a database with separate matrices for basic, tax, margin flows of both domestic and imported resources to domestic and foreign users, besides, the primary production factors for the latest possible year. All data used in the study are shown in Table 3.

Table 3: Description of Data Used in This Research

Data	**Source**
Social accounting matrix	Statistical Center 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

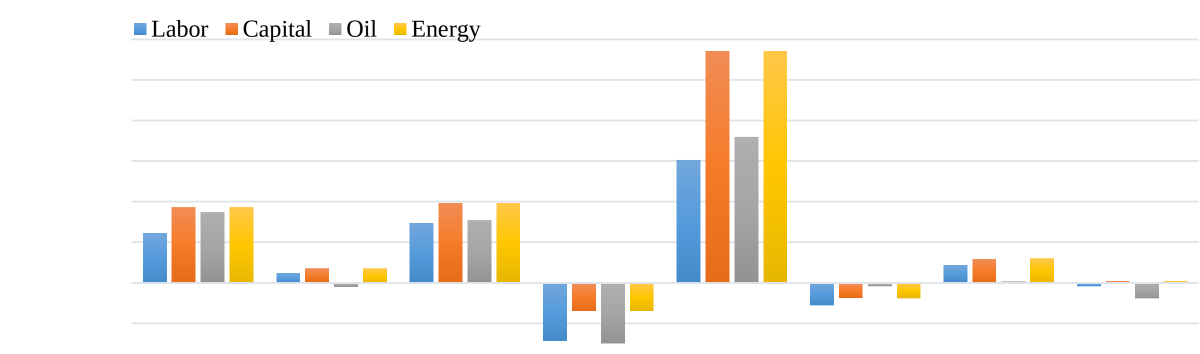
Transportation cost	Statistical yearbook of Iran

Source: Research finding.

Results

Results of the Fixed Tax Assumptions

Considering the fact that the CGE model views a highly competitive environment, under this framework, manufacturers try to minimize costs, and consumers including households and the government, who have limited budget, seek to maximize their utility. It can also be assumed that exogenous price shocks are not due to domestic policies (Grainger et al., 2019). Therefore, following any external shocks, producer's costs, household incomes, and government budgets as a result of all planned policies will be affected. The CGE model, used in this study, describes a circular economy that households and government supply production factors to the producers for producing goods and services. Domestic products are consumed by the domestic consumers or used as intermediate input in production cycle or exported to abroad. From the beginning to the end, the model framework changes. For instance, the government revenues in this model including government revenues that are derived from the production factors, value-added tax, production tax, sales tax, income tax, production tax, and import tariff will change. Moreover, government payments including consumption of goods and services transfers to institutions and investment will change. Figures 4 and 5, which indicate changes in government revenues received from production factors and government taxes, provide an appropriate answer to the deficit or surplus budget through the applied scenarios.



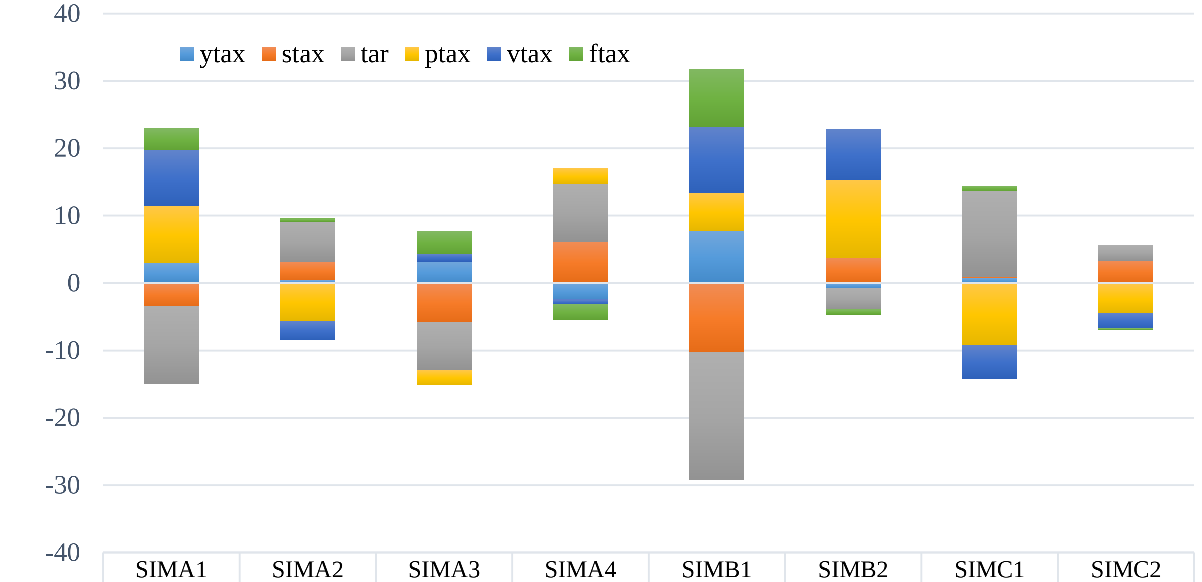
	SIMA1	SIMA2	SIMA3	SIMA4	SIMB1	SIMB2	SIMC1	SIMC2
Labor	2.447057522	0.477602123	2.939796962	-2.86536522	6.051718952	-1.087786547	0.873374187	-0.164113964
Capital	3.71659715	0.683153567	3.921134622	-1.380695069	11.41480186	-0.727418487	1.176321244	0.075990523
Oil	3.468072337	-0.18048605	3.050886822	-2.976489278	7.171341557	-0.168444832	0.054284789	-0.761667136
Energy	3.704609165	0.690549653	3.926701383	-1.385255895	11.41215168	-0.747854338	1.18914115	0.081089267

Figure 4. Government Receipts through Production Factors (In Percent) (simulation 1)
Source: Research finding.

The bar chart compares the percentage change of the government revenues received from production factors for different scenarios. Overall, it can be seen that the government revenues received from the sale of production factors has increased except for SIMA4, SIMB2, and SIMC2.

Higher percentage of income respectively observed in the scenarios SIMB1, SIMA3, and SIMA1 is the result of a rise in the exchange rate and oil price.

Concerning higher income, the columns in SIMA4 figures are much lower throughout the whole scenarios. In SIMA4, some -2.86% of labor, -1.38% of capital, -2.97% of oil and -1.38% of production factors gain a lower rate of income. Conversely, only 11.41% of the capital and energy production factors show the highest sensitivity. Oil was nearly as sensitive as the labor.



	SIMA1	SIMA2	SIMA3	SIMA4	SIMB1	SIMB2	SIMC1	SIMC2
ftax	3.234927564	0.38578824	3.367485825	-2.28115944	8.541201582	-0.69566391	0.77644222	-0.22436253
vtax	8.304091931	-2.73049028	1.104865626	-0.68912831	9.823209666	7.426095295	-4.94486854	-2.23260843
ptax	8.452505352	-5.64430345	-2.22236567	2.395037572	5.682596112	11.59396437	-9.20228802	-4.25485465
tar	-11.4766656	5.993376168	-7.06796827	8.494302482	-18.862071	-3.14960098	12.7245622	2.265373449
stax	-3.42557559	2.735489105	-5.86317316	6.173611499	-10.2918984	3.796533825	0.128440734	3.368404769
ytax	2.973801201	0.425833281	3.21304691	-2.45344167	7.711937286	-0.809655	0.811677287	-0.19176988

Figure 5. Changes in Government Revenues Received from Taxes (In Percent) (Simulation 1)
Source: Research finding.

In addition, it is noteworthy that in the case of government revenues received from the production factors, the effect of oil price shock is more than the exchange rate fluctuation, but less is expected to be the same for all variables.

Figure 5 provides information about the percentage change in government revenues received from taxes. In this case, the most striking feature is that if an increase in tax revenues is observed, it means that the amount increases and not the rate as it is assumed in constant tax rate. For instance, if the government revenues increase through the imports, it refers to an increase in the amount of imports not the tariffs rate.

While an increase in the exchange rate and decrease in oil price experience high levels of fluctuations, it seems that the government revenues received from taxes in SIMA1 and SIMB1 are more than that in other scenarios. All scenarios and six types of taxes illustrate that the components of the government budget can dramatically change policy making and planning. Increasing the exchange rate and oil price, meanwhile, has considerably changed all taxes between -18.8% and 9.8%.

There was a considerable percentage change in the import tariffs (tar) between lower -18.86% and upper 12.72% in different scenarios, although this type of tax is the most sensitive among others. The results for income tax (y-tax) shows more change in respond to the increase in both the exchange rate and oil price. By contrast, the effect of oil price shock is more effective than the exchange rate. The income tax response is in contrast to sales tax (s-tax) and import tariffs, while as can be observed, the sensitivity of sales tax and import tariffs are more than the income tax. Taxes on production factors (f-tax) in the incremental scenarios show different reaction.

Any increase in the exchange rate and oil price will increase government revenues taxes, while it is possible that the government revenues will reduce through import tariffs or vice versa. Production tax, sales tax, value added tax, and tax on production factors in all scenarios depend on the increase or decrease in production factors and output demand. As Figures 4 and 5 show, decision about the deficit or surplus of the government budget is a bit tricky. In this regard, Figure 6 displays the final result of the total effect of different scenarios. The chart shows and compares the total effect of the exchange rate and oil price on the government budget in different scenarios.

The most outstanding feature of the chart is an increase for both variables which is high. For example, in SIMA1 and SIMA3, there are 3.67% and 2.51% values respectively, indicating surplus budget. The largest change is observed in SIMB1. Besides, there is also little difference between SIMA2, SIMC1, and SIMC2, and in these scenarios, the percentage change is almost equal. There is also a big difference in the size of the budget deficit in SIMA4 that is approximately -2%.

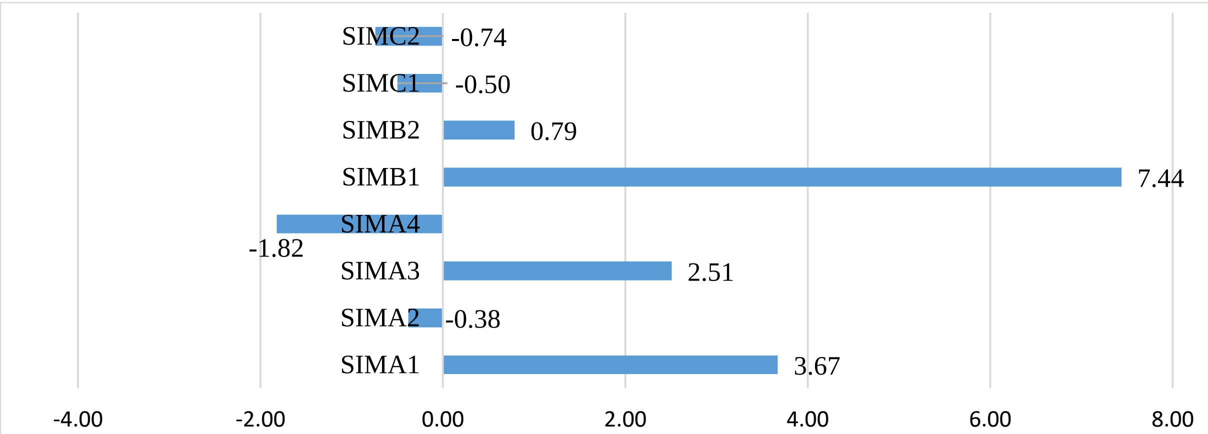


Figure 6. Government Budget Changes in Different Scenarios (Simulation 1)
Source: Research finding.

In summary, the effect of the exchange rate is more effective. In addition, the sensitivity of the budget show more flexibility to the exchange rate. Moreover, the budget has a unidirectional response to variables of the exchange rate and oil price.

The question that arises here is that if the government faces a budget surplus or budget deficit, how the budget balances.

Table 4. Percentage Change in Government Payments in Response to Deficit and Surplus of Budget in Different Scenarios (In Percent) (Simulation 1)

Scenario	Consumption of Goods and Services			Payments to Households	Savings-Investments	Total
	Agr-c	Cons-c	Serv-c	HHD	S-I	
SIMA1	2.71	4.03	-0.88	4.68	-532.66	3.67
SIMA2	-3.10	-3.22	0.92	-5.79	6.34	-0.38
SIMA3	-0.23	1.22	0.13	-0.13	-373.33	2.51
SIMA4	0.16	-1.19	-0.18	0.08	262.35	-1.82
SIMB1	2.39	5.50	-0.65	4.50	-1089.23	7.44
SIMB2	3.00	2.58	-1.12	4.85	-112.25	0.79

SIMC1	-3.53	-3.20	0.96	-6.16	18.86	-0.50
SIMC2	-2.58	-3.07	0.87	-4.96	77.59	-0.74

Source: Research finding.
Note: Based on CGE Model Simulation 1

In Table 2, we can find an appropriate answer to the above question. Besides, we compare the results of budget fluctuations with government payment and expenditures, until we reach a balance in budget. All eight scenarios suggest that when the government faces a financial crisis or financial boom, it aims to make rapid changes in the economy in order to bring it into balance. Government will return the economy to equilibrium and neutralize exogenous shocks by changing the consumption of goods and services, transfer payments, and savings-investments.

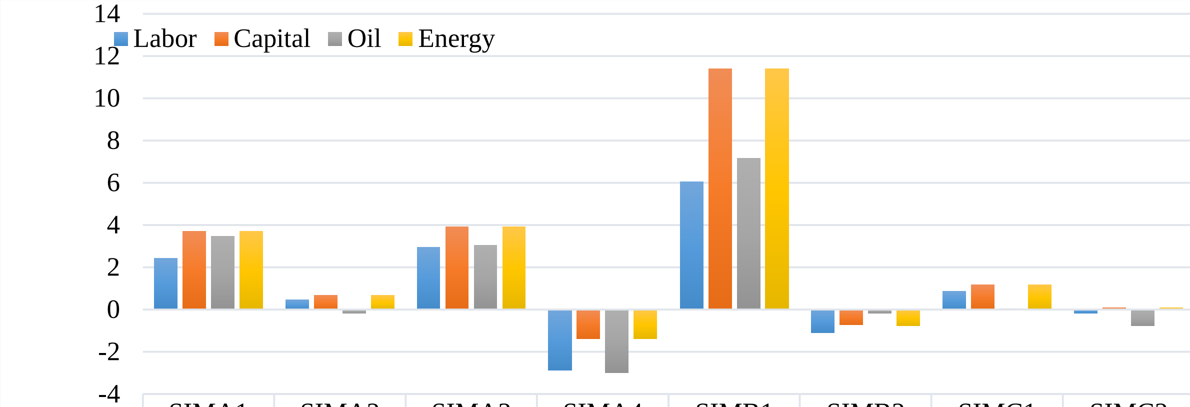
A glance at Table 4 reveals clear differences between the various scenarios, and how government budget surplus and deficits react to these conditions until the budget reaches a balance.

One interesting point highlighted by the data is that the more percentage change is, the more saving-investment is. Variations in SIMB2 show that saving-investment is the largest and also the most flexible variation, changing -1089% in SIMB2 and 262% in SIMA4. Likewise, the second-largest reaction to the budget is for payments to households in SIMC1 which is -6.16%. By contrast, the consumption of agricultural goods and services sector in consumption column in a whole scenario show the lowest reaction to the budget.

In terms of change in budget and its reactions, how balance is achieved, as mentioned in the table, varies considerably. Yet, it can be seen if the budget has surplus, the government allocate its expenditures in the agricultural and construction sectors. But reaction to the service sector is reverse. The 5.5% change in construction sector in SIMB1 is also noticeable. Besides, there is also an increase in payments to households and government investment (or reduction in savings).

Results of the Flexible Tax Assumptions

As we have already mentioned, there are two economic closure assumptions in this research. First, government saving is flexible and the direct tax rate is fixed. Secondly, government saving is fixed, and direct tax rate is uniform for the selected institutions. Therefore, we will analyze the comparison between these two economic assumptions. Figure 7 indicates that due to the changes in revenues received from the sales of factors, there is no deviation with the assumptions in the study. So the results are equal with that of Figure 4.



	SIMA1	SIMA2	SIMA3	SIMA4	SIMB1	SIMB2	SIMC1	SIMC2
Labor	2.44705752	0.47760212	2.93979696	-2.8653652	6.05171895	-1.0877865	0.87337419	-0.164114
Capital	3.71659715	0.68315357	3.92113462	-1.3806951	11.4148019	-0.7274185	1.17632124	0.07599052
Oil	3.46807234	-0.1804861	3.05088682	-2.9764893	7.17134156	-0.1684448	0.05428479	-0.7616671
Energy	3.70460917	0.69054965	3.92670138	-1.3852559	11.4121517	-0.7478543	1.18914115	0.08108927

Figure 7. Changes in the Government Revenues Received from Production Factors (In Percent) (simulation2)
Source: Research finding.

The line graph illustrates the change in government revenues from the income tax in different simulations for Iran.

In simulation with fixed direct tax and flexible saving, government face higher fluctuation than uniform direct tax and fixed saving, which is about 7.71% increase in SIMB1. This shows a large difference and in SIMA2 the change is approximately 0.5% with no difference. In SIMC1 and SIMC2 0.6 and 0.3% change is shown respectively indicating a little difference.

Yet, in SIMA1 and SIMB1, the difference between two simulations is significant. The amount of income tax which is absorbed for simulation 1 is positive, while for simulation two is negative. In contrast, in SIMA4 it is clear that in both simulations, the change should be falling, but for the fixed direct tax with flexible saving, it is more levelled off than uniform direct tax with fixed saving.

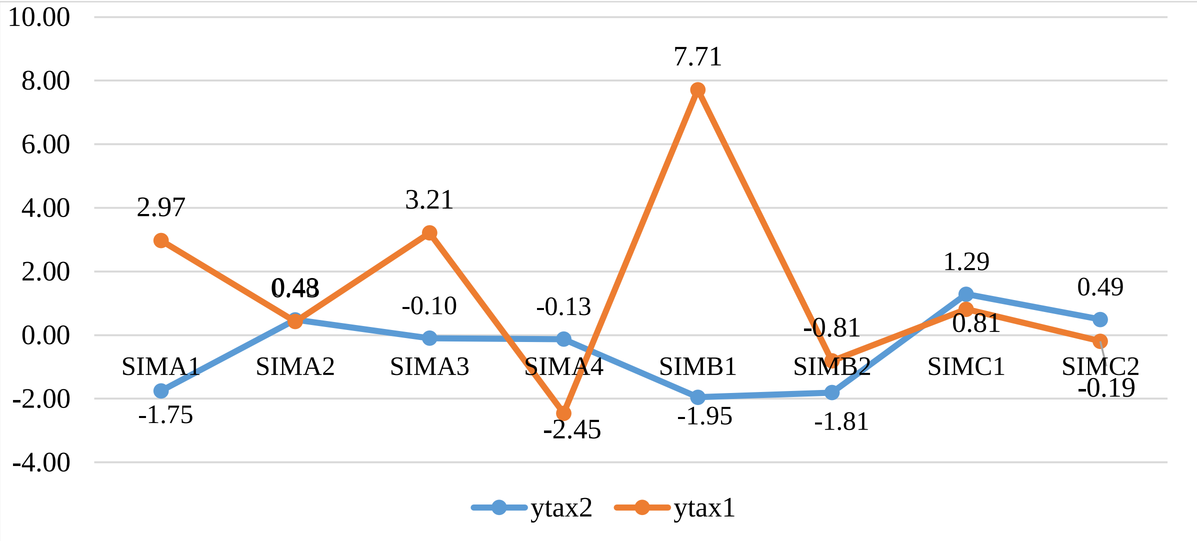


Figure 8. Changes of Income Tax (In Percent)
Source: Research finding.

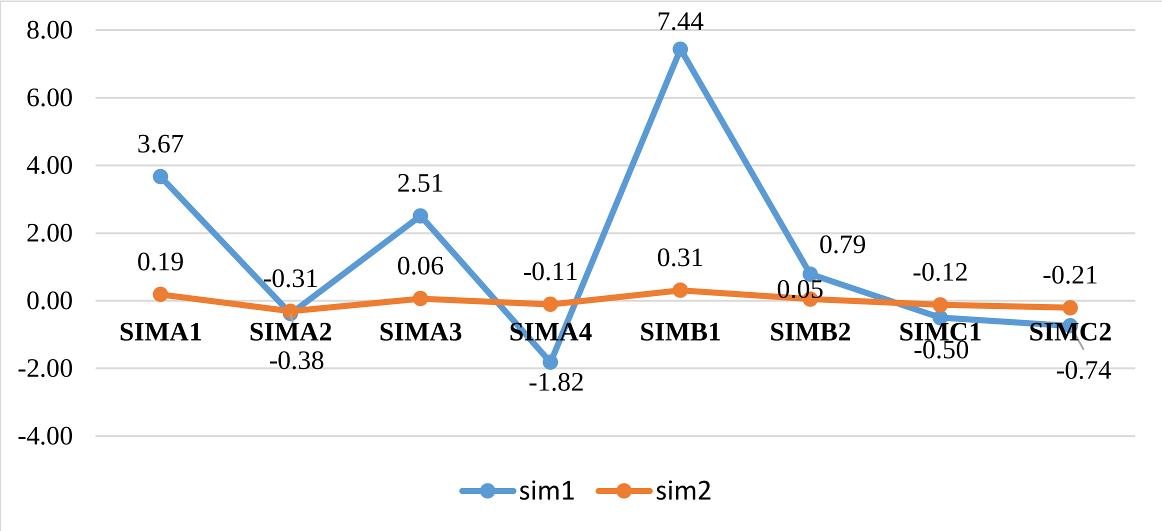


Figure 9. Government Budget Changes in Different Simulations
Source: Research finding.

A glance at the line graph reveals some significant similarities between the uniform and fixed direct tax rates for different scenarios. It is evident that both lines show considerable fluctuations in reaction to the exchange rate fluctuations and oil price shock, with the lowest value in SIMA2 and highest value in SIMB1.

Significant differences between the two scenarios are presented approximately 7.44%, 3.67%, and 2.55% increase respectively in SIMB1, SIMA1, and SIMA3 in simulation with fixed direct tax that present the significant difference between the two scenarios. Besides, the major decrease belongs to the simulation with fixed direct tax rate in SIMA4. In contrast, it can be seen that the uniform direct tax rate has a bit fluctuation in response to different external and internal shocks. It is worthy to note that while the difference between the two scenarios was comparable in SIMA2, SIMC1, and SIMC2, the gap between the two widens in response to the shocks.

It is obvious that if the goal of the government is to balance the budget and reduce the fluctuations, the best solution is the second simulation model with government fixed savings and uniform direct tax rate point change for the selected institutions.

Conclusion

To demonstrate the fact that the exchange rate and oil price shocks can alter the overall structure of the economy in oil exporting countries, this paper is organized to examine the effect of both variables to manage changes in the government budget for Iran, by using a CGE model. The main goal of this paper is to realize if the government faces fluctuations of these two mentioned variables, in terms of tax policies. Depending on what policies will be used to balance the budget, the economy will dramatically change. For investigating the effect of these two important economic variables, we use two assumptions: fixed direct tax with flexible saving and uniform direct tax rate point change for the selected institutions with fixed saving in eight scenarios. Results show that an increase in the exchange rates and oil prices increase government revenues from sales of production factors due to the rising prices, and it is more sensitive about oil prices, as well as the government faces budget surpluses. If the government faces the budget surplus, the consumption of goods and services, payments to households, and investment will increase. This confirms the results of Kreishan et al. (2018)

and Adedokun (2018).

Generally, given the results of the general equilibrium model and the breakdown of structural budget deficits in the oil exporting countries, it can be said that the effect of the structural deficit of budget on fiscal policy shock is more than the budget deficit, indicating the strong role of discretionary fiscal policy in countries. Expenditure-type fiscal policy has also played a greater role than taxation in generating structural deficits, and income tax have also played a greater role in changing budget deficits. Thus, the government's fiscal policies in oil exporting countries are mostly expenses, and lead to an increase in the structural budget deficit, which may also lead to imbalance and instability within the economy of oil exporting countries and adoption of more discretionary fiscal policy. Among the research goals, a decline in the exchange rate and oil prices contributes the most to the changes in the budget deficit and an increase in the structural budget deficit (especially in Iran). In general, the response functions of the present study in the selected oil exporting countries as well as Iran indicate that oil price fluctuations have an adverse effect, such as low economic growth of countries, depreciation (or devaluation), and increase in structural budget deficits through discretionary fiscal policies and power decline. The effect of fiscal policy on economic stabilization keeps the budget situation uncertain.

Another important result of this study is that in the CGE model, income must be equal to expenditure. That is the budget is balanced when the government faces a surplus or deficit, consumption, saving and payments change as the model is optimal. When the exchange rate and oil price increase in simulation 1, the government tax revenues increase, but decrease in simulation2, and there is a lot of volatility in the government tax revenue. In both simulations, when the exchange rate declines, the change in the budget level will be approximately equal. For Iran, using the uniform direct tax policies is more optimal, because the budget is less unstable.

Today, many policy makers favor to reduce the effect of external shocks on the domestic economy the most. Based on the results presented in this study, Iran with a single-product economy, faces large fluctuations in budget and investment. The important point is that in order to neutralize the effect of external shocks, converting the single-product economy to multi-product economy is a wise solution.

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Appendix: The key equation 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. $PA_a = \alpha_a^a \cdot \left(\delta_a^a.QVA_a^{-\rho_a^a} + (1-\delta_a^a).QINTA_a^{-\rho_a^a}\right)^{\frac{1}{\rho_a^a}}$

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

13. $QVA_a = inv_a . QA_a$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table I

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

Table II

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

Parameters	
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
$\text{icd}_{c\,c}$	shift parameter for domestic commodity aggregation fn

Table III

Variables	
$\overline{\text{DPI}}$	consumer price index (PQ-based)
$\overline{\text{CPI}}$	index for domestic producer prices (PDS-based)
DMPS	change in marginal propensity to save for selected inst
$\overline{\text{DTINS}}$	change in domestic institution tax share
$\overline{\text{FSAV}}$	total current government expenditure
GADJ	household consumption expenditure
$\overline{\text{IADJ}}$	exchange rate
$\overline{\text{MPSADJ}}$	foreign savings
$\overline{\text{QFS}_f}$	government demand scaling factor
$\overline{\text{TINSADJ}}$	govt consumption share of absorption
$\text{WFDIST}_{f\,a}$	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

Variables	
$PXAC_{a\ c}$	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
YG	direct tax scaling factor
YI_i	transfers to dom inst insdng from insdngp
$YIF_{i\ f}$	Savings–Investment imbalance (should be zero)