A Financial General Equilibrium Model for Assessment of Financial Sector Policies in Developing Countries

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University of Economic Sciences, University of Economic Sciences

2015

A FINANCIAL GENERAL EQUILIBRIUM MODEL FOR ASSESSMENT OF FINANCIAL SECTOR POLICIES IN DEVELOPING COUNTRIES

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ABSTRACT

This paper introduces a real financial CGE (computable general equilibrium) model for economic policy analysis. It is a multi-investor, multi-asset, and multi-sector model appropriate for what-if policy analysis in a single-country open-economy framework. The financial side includes a central bank, commercial banks, deposits, loans, equities, bonds, and foreign currency. We also consider markets for loanable funds. The model assumes small open economy, imperfect capital mobility, imperfect Armington substitution between imported and domestic commodity, nested CES (constant elasticity of substitution) structure in production, nested CES structure in consumption, and heterogeneity of domestic products in one commodity category. We consider the transport margin, wholesale margin, import tariffs, import subsidy, production tax, value added tax, goods and services tax, and other transfer payments. We calibrate the model based on the 1999 Social Accounting Matrix of Iran. This matrix includes 47 production activities and 112 commodity categories detailed on hydrocarbon resources.

Keywords: financial general equilibrium; social accounting matrix; financial assets; portfolio optimization; FCGE.

1 INTRODUCTION

Consider a small open economy. Let it be abundant with one of the natural resources. Here we introduce a computable general equilibrium (CGE) model with financial sector for policy analysis in countries with this characteristic. We calibrated the model on the Iranian economy. However, this model may be applied for Algeria, Angola, Azerbaijan, Brazil, Colombia, Congo, Ecuador, Indonesia, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Norway, Oman, Qatar, Saudi Arabia, United Arab Emirates, Venezuela, etc.

We assume the revenue from exporting resources belongs to a hypothetical Sovereign Wealth Fund (SWF). SWF determines the allocation of resources revenue. The socially optimum allocation could be a basket of domestic investments and foreign financial investments (Hartwick, 1977). However, SWF can transfer the revenue to the central government assuming not socially optimal behavior. In this paper, we assume that SWF is not socially optimal and transfers the revenue to the government[1].

Figure 1 depicts the complete linkage between petroleum revenues, government, and the financial sector. The revenue of oil and gas extraction sector is either from domestic sales of oil and gas or from exports of crude oil and gas. Part of this revenue is extraction costs and is spent on compensation of employees and purchase of intermediate goods and services. Part of the surplus is paid directly to the government and the rest is the savings of our hypothetical SWF. These funds in addition to the funds earned from equities and loans, form financial sources of hypothetical SWF. SWF allocates its financial sources to domestic investment, deposits, and interest payments. Mathematical equations related to the behavior SWF is discussed in the next sections in more details.

The structure of government income and spending is depicted in Figure 2. State revenues are classified into two general categories: 1) income from capital; and 2) tax and transfer payment received. Capital income is from oil revenues and the operating surplus of government owned firms. The government allocates part of the revenue to education, health, and infrastructure which are affecting the future production levels. It allocates the leftover to cover the costs of “White Elephant projects”, unnecessary provision of public goods, cash payment to people and institutions,

[1]- This assumption is like MENA’s region behavior. They historically allocate most of the petroleum revenue to the central government.

and ambitious defense projects[2]. The financial portfolio of government also includes low interest loans and deposits, purchase of low profit equities and stocks, and capital formation in the provision of public goods.

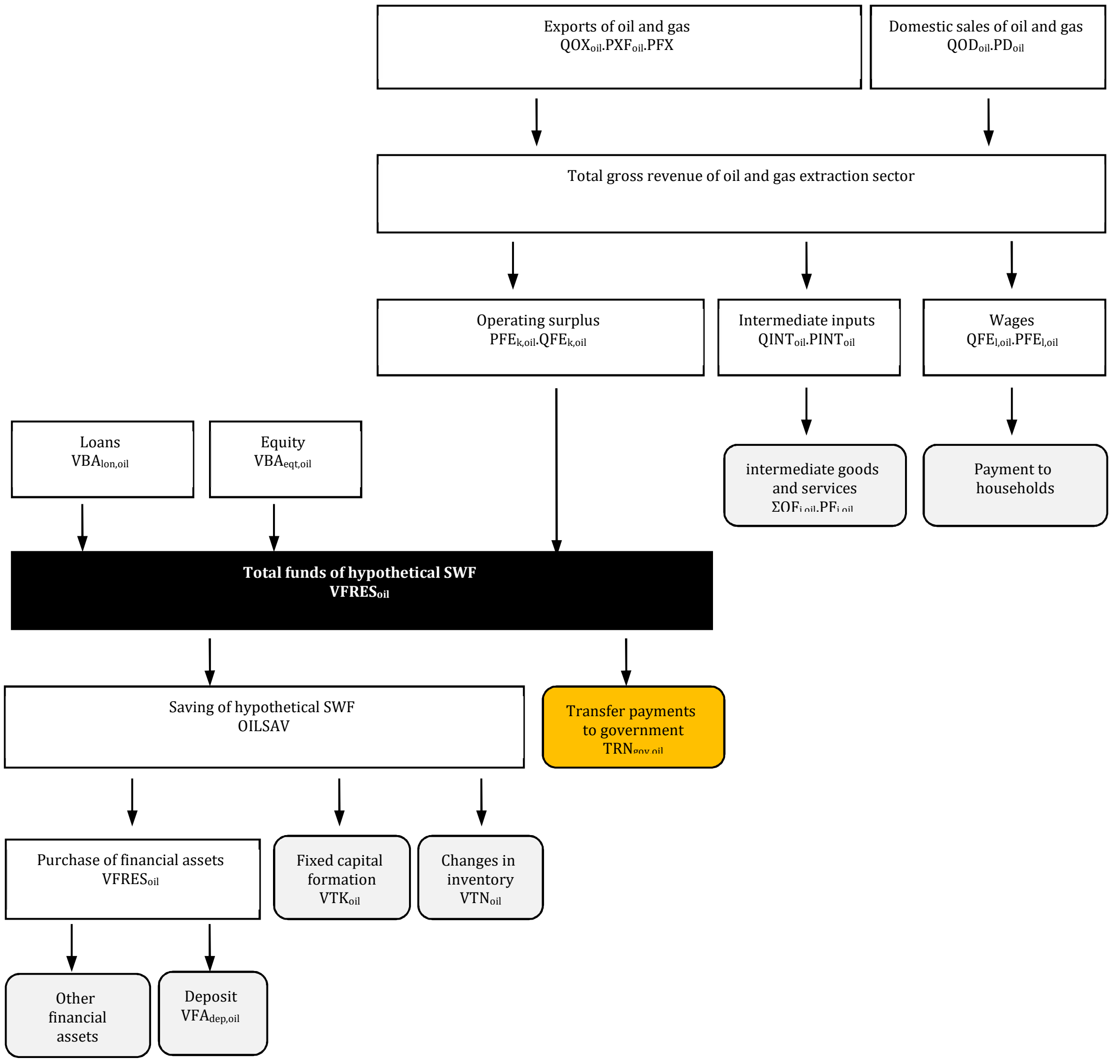

Figure 1: Allocation of oil and gas revenue in Iran

According to this framework, a reduction of oil and gas exports may decrease payment to the government. It may shrink the available funds. By the decline in government income, probably its transfer payments, public expenditure, and supply of interest-free loans will decrease[3]. Changes in

[2]- For simplicity, assume that the socially efficient level of public good is equal to tax revenue.

[3]- We consider a regulated credit market. Note that it can be compensated by monetary policy in nominal terms.

government public expenditure not only affect on the level of provision of public services but also the income of employees in the sector. It also affects the demand for intermediate products. It is also possible that the government borrow from financial companies (central bank and commercial banks) or non-financial companies (energy companies and other governmental companies). These changes will result in a change of activity levels and prices of various products in the economy (in the next section, the whole model will be discussed).

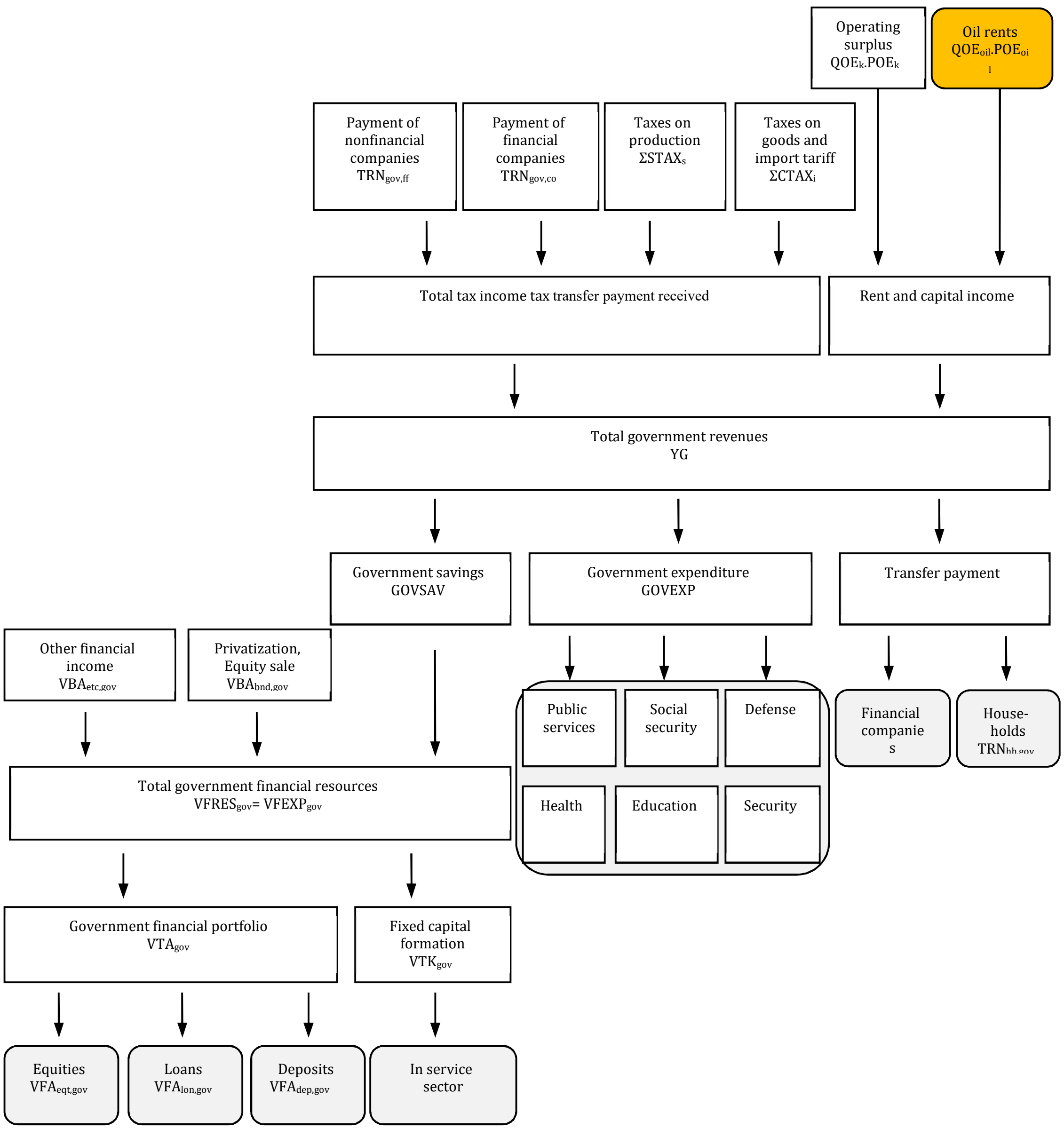

Figure 2: Expenditures and income sources of the government

2 MATERIALS AND METHODS

This paper introduces a large scale static general equilibrium model with five types of agents: natural resources SWF, government, representative household, financial corporations, and non-financial firms. The model assumes utility maximization and consumption bundle optimization for households. It assumes profit maximization and perfect competition for firms. It is assumed that households, government, SWF, and financial corporations are maximizing the value of their financial portfolio. Saving rates of households, government, and SWF are exogenous. And financial institutions invest all their resources. The model considers inter-sectoral relationships with 112 categories of commodities and 10 financial assets. The activity level in each sector and the relative prices in the economy are determined via simulation of supply and demand of all goods and services simultaneously. Thus, the demand for one good depends on the price of all various commodities in the economy.

Each agent of the model has real income sources and expenses as well as financial resources and financial expenses. Real income comes from the supply of capital or labor and transfer payments received. Expenditure of agents includes the consumption of commodities and transfer payments. Figure 3 briefly displays a simplified income flow for agents in the model. For instance, the representative household receives income from supplying factors of production (1) and receives financial resources from the financial market (2). Households allocate their resources to purchase of goods and services (3) and forming a portfolio for saving (4). Savings either go directly to the fixed capital formation (5) or are used for making a domestic (6) or foreign financial portfolio (7). Revenue from commodity market belongs to local producers (8) or foreign exporters (9). Producers allocate their revenue of selling goods and services for purchasing intermediate goods (10) or paying the wage of factors of production (11). The foreign sector earns from financial markets (7), sales of goods and services (9) and supply of foreign production factors (12). It also pays to domestic production factors (13) and invests in the domestic financial market, capital inflow (14), or purchase domestic products, exports (15).

Each agent has financial resources and financial expenses. Expenses are either fixed capital formation or investment in financial instruments. Households allocate their savings to either fixed capital formation in different economic sectors or financial portfolio. Their financial portfolio consists of deposits, bonds, and equities. Financial resources of households are mainly borrowing but it also includes financial transfers. Financial institutions may borrow from the government, sell bonds and equities, and take deposits. Their portfolio includes fixed capital formation, lending, purchase of equity and other financial assets. Similarly, non-financial companies make their resources by selling bonds and equity and borrowing. Financial expenses of non-financial companies include fixed capital formation, deposits, and other assets.

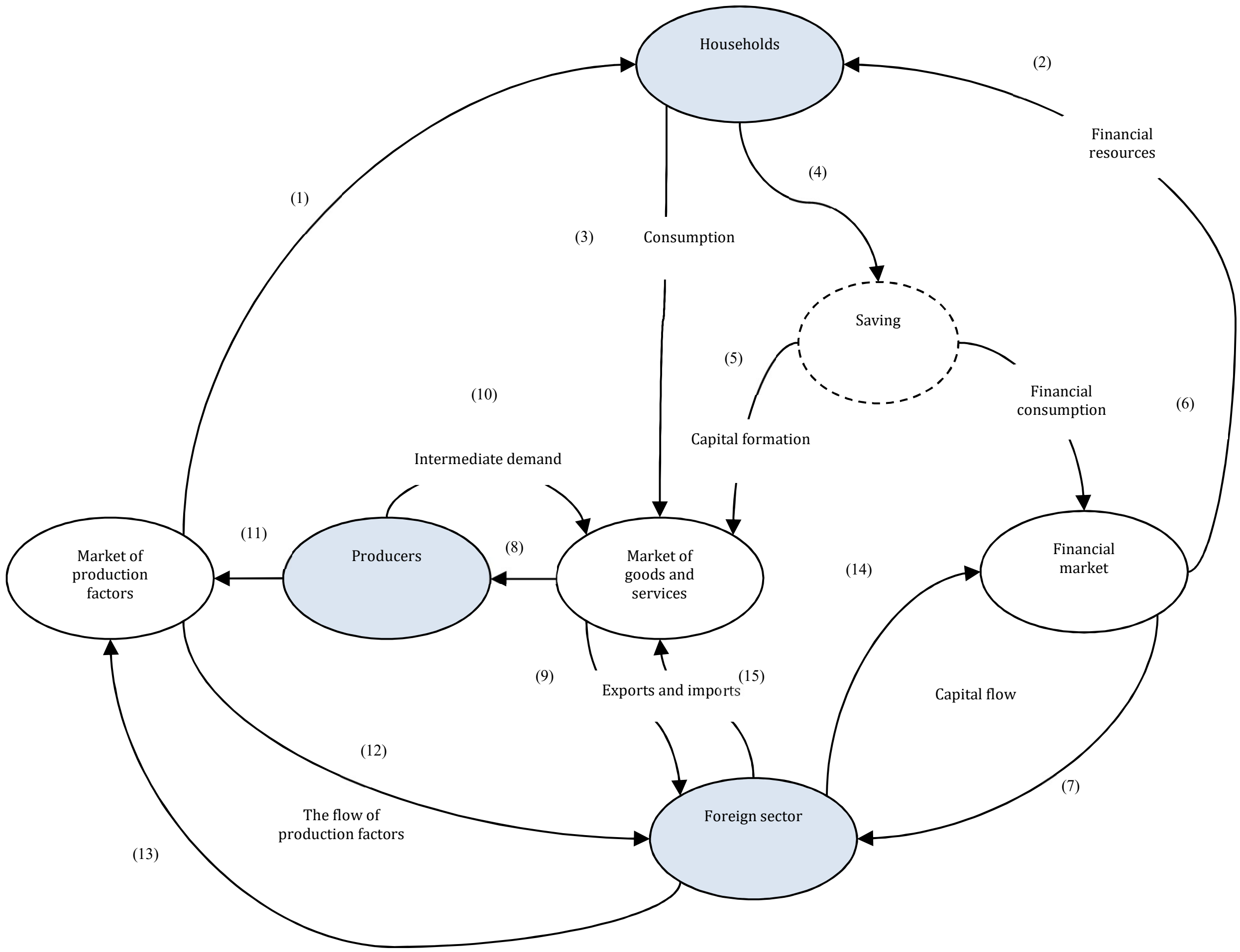

Figure 3: Income flow in an aggregated form

In this study, any financial instrument, regardless of the holder or the issuer, is considered as a homogeneous asset. In other words, supply and demand for funds in any financial instrument is expressed as the total supply and total demand. For example, the total purchase of bonds by households is determined; but households do not distinguish between governmental bonds, corporate bonds, or foreign bonds. So, the model includes one market for each asset type. The demand for assets depends on relative prices. Thus, all financial markets are inter-related.

The model assumes market clearing condition in all markets. In other words, the value of supply in each market is equal to the value of demand. Perfect competition exists in all markets; this means that the agents are price takers. Markets in the model are the goods and services market (112 categories), capital and labor market, financial assets market (bonds, deposits, loans, equity), and foreign exchange market. There is a zero-profit condition for production activities. In other words, the revenue of activities is equal to their costs. In this model, we consider 47 activity categories. Income balance condition is satisfied for households and institutions. In other words, the sum of financial and non-financial resources is equal to the sum of financial and non-financial expenses for each agent. This condition shows the balance-sheet of economic agents. It is important to note that the perfect competition assumption in the model does not mean perfect competition in all the active markets in the real economy. In the model, goods and services are aggregated. For example, agriculture is an aggregation of rice, wheat, corn, potato, and etc. It is assumed that aggregated agriculture is price taker, despite, for instance, the wheat market may not be perfectly competitive. Thus, perfect competition is a plausible assumption. In fact, we consider a multi-sector framework of the model of aggregate supply and aggregate demand of the overall economy.

In summary, the model consists of optimization behavior for all agents. This optimization leads to demand and supply for commodity markets, financial markets, factors of production markets, and foreign exchange market. The system must be solved for equilibrium prices and quantities in each market. The computation of this system, however, is not easy. Computable General Equilibrium (CGE) models are efforts of economists to solve similar complex systems[4]. Most CGE models correspond to the real part of the economy, not including financial assets. However, change in resources revenue may affect the financial sector especially when the degree of government intervention is high. It will affect the foreign exchange rate, the provision of low interest loans, and supply (or demand) of equities.

Few CGE models are introduced considering financial assets: Taylor (1981) introduces a static financial model; Feltenstein (1986) employs a dynamic model; Bourguignon (1992) considers demand for money; Lewis (1992) introduces substitution between financial assets; Yeldan (1997) and Ulussever (2009) study financial liberalization in Turkey; Naastepad (2003) analyzes structural adjustment policies in India; Xiao (2011) introduces a financial CGE for Australia; Haqiqi et al., (2014) study the liberalization of credit markets; Haqiqi and Bahaloo (2014) and Haqiqi and

[4]- The framework is used for tax and subsidy policies (Pereira, and Shoven, 1988), tariff and trade policies (de Melo, 1988; Shoven and Whalley, 1984), and energy policies (Bergman, 1988), demographic change and aging of labor populations (Peng , 2008), immigration, employment and labor market developments (Scarlato, 2002), oil shocks (Aydin and Acar, 2001), and change in currency regimes (Ngandu, 2008).

Bahalou (2015) consider export barriers . This study employs real structure introduced in Rutherford (1999) and the financial structure of Xiao (2011) and Dixon et al. (2015).

The real part of the model is developed in a team of economists and is well-documented and well-known. This framework is applied in the assessment of the following policies: Cash Subsidy Transfer (Shahmoradi et al., 2011; Manzoor & Haqiqi, 2013); Access to Public Services (Mortazavi et al., 2013; Haqiqi & Mortazavi, 2012); Resources Boom (Manzoor et al. 2012a; Haqiqi & Bahador, 2015; Haqiqi & Bahalou, 2013); Generational Justice (Haqiqi, 2012; Haqiqi et al, 2013); Trade Barriers (Haqiqi & Bahalou, 2013) ; Labor Market Policies (Haqiqi & Bahalou, 2015; Manzoor and Bahaloo, 2015); Environmental Emissions (Manzoor and Haqiqi, 2012a); Energy Price Reform (Manzoor et al. 2010; Manzoor et al. 2012b; Manzoor & Haqiqi, 2012b; Sharifi et al., 2014) ; Energy Efficiency (Manzoor et al., 2011; Haqiqi et al., 2013) ; Energy Demand (Manzoor et al., 2012c; Manzoor & Haqiqi, 2013); Direct Investment (Manzoor et al. 2013).

The purpose of this paper is to fill the gap between the CGE literature and the policymakers' need in the economic analysis of financial policies in developing countries. The financial sector is growing very fast in many developing countries. But little numerical studies exist which show the detailed impacts of such a change. Real CGE models are very limited in financial sector analysis, while nearly no financial model contains sectoral variables. We need a tool for analyzing the sectoral impacts of deficit financing, credit rationing, interest rate ceilings, and similar shocks in the financial sector. The contribution of this study is introducing government intervention in financial markets. The intervention includes price setting, buying, and selling of equities, and supply of low interest loans. Another technical improvement is considering the price of assets instead of the rate of return on assets. This approach simplifies the computation for large models. The model includes seven financial assets, 47 production activities, and 112 commodity categories. Defining the role of government in the financial sector in high details is another significant contribution. Linking financial sector to the real sector is a step toward more accurate analysis of government budget deficit and financial imperfections. The model simulates credit rationing, public debt to the central bank, government debt to commercial banks, issuance of bonds, sectoral capital formation, public deposits, oil-and-government financial interactions, foreign debt, and other financial transfers. We beleive that the proposed framework is an appropriate tool for real-financial analysis in developing countries. Next section is describing the model in more details.

2.1 COMMODITY MARKET EQUILIBRIUM CONDITION

For all goods and services, market clearing is necessary. In other words, the balance in the market of commodity i requires that in a specified period, the value of supplied commodity i equals the value of demanded commodity i in the economy. In the model, the total supply of a commodity is the summation of production of goods in the country of the current year, the supply out of inventory (production of past years), and imports. In other words, the total supply is equal to:

$$QTO_i = QIM_i + QNO_i + \sum_s QFO_{i,s}$$

where, QTO is the total supply of a commodity, QIM denotes imports, QNO shows inventory supply, and QFO is production by different activities. Also, i is the index of various goods and services while s is the index of production activities.

On the other hand, the demand for a commodity is determined by households, government, investors, foreign sector (exports), and production activities.

$$QTO_i = QP_i + QG_i + \sum_k QI_{k,i} + QX_i + \sum_s QF_{i,s}$$

QP is the demand of private sector households, QG shows government demand, QI denotes investor demand for fixed capital formation, QX indicates exports, and QF is intermediate demand by firms. In equilibrium we have the following:

$$QIM_i + QNO_i + \sum_s QFO_{i,s} = QP_i + QG_i + \sum_k QI_{k,i} + QX_i + \sum_s QF_{i,s}$$

The volume of demand and supply for each agent are determined from the optimization behavior.

2.2 Factors Markets Equilibrium Condition

The market-clearing condition holds in the market for factors of production too. Thus, the supply of a production factor must be equal to its demand. Institutions are the owners and suppliers of factors of production. Production activities demand factors. For each production factor we have:

$$\sum_h QOE_{f,h} = \sum_s QFE_{f,s}$$

where $QOH_{f,h}$ is the endowment of factor 'f' owned by the institution h; and $QFE_{f,s}$ is demand for the factor of production 'f' by the sector s.

2.3 Financial Markets Equilibrium Condition

Savings of institutions go to either capital formation in machinery, equipment, buildings, and inventory formation, or financial instruments (deposits, loans, bonds, equities, etc). Thus, for each investing institution we have[5]:

$$VSAV_h + VBOR_h = VTA_h + VTK_h + VTN_h + VNCO_h \qquad \forall h \in \{hh, gov, ff, co, oil\}$$

$$VBOR_h = \sum_a VBA_{a,h} \quad a \in \{dep, bnd, eqt, lon, etc\}, \forall h \in \{hh, gov, ff, co, oil\}$$

$$VTA_h = \sum_a VFA_{a,h} \quad a \in \{dep, bnd, eqt, lon, etc\}, \forall h \in \{hh, gov, ff, co, oil\}$$

$$VTK_h = \sum_j VAI_{j,h} \quad j \in \{agr, oil, mng, ind, utl, cns, trn, cmn, dwl, etc\}, \forall h \in \{hh, gov, ff, co, oil\}$$

$$VTN_h = \sum_i VNI_{i,h} \quad i \in \{goods\ and\ services\}, \forall h \in \{hh, gov, ff, co, oil\}$$

In other words, total financial resources include savings (VSAV) and debt to other institutions (VBOR). Total financial expenses include financial assets (VTA), total payments for fixed capital formation (VTK), investment in inventories (VTN), and capital outflow (VNCO); VBA represents the amount of financing through each financial asset while VFA is volume of investment in financial assets; VAI shows volume of sectoral investment in fixed capital formation (in each sector j), and VTN represents the volume of investment in i commodity as inventory. Agents of the model are households (hh), government (gov), financial firms (ff), nonfinancial companies (co), and the SWF of oil and gas (oil). Assets and debts are in the form of deposit (dep), bonds except for equities (bnd), equities (eqt), loans (lon), and other assets (etc). Fixed capital formation is made in the agricultural sector (agr), oil and gas extraction (oil), mining (mng), industry (ind), utility (utl), construction (cns), transportation (trn), communications (cmn), real estate (dwl), and other services (etc).

Equilibrium condition in the financial assets market is equality of supply and demand of funds through each asset. As in the case of loans, the total value of the offered loans must be equal the total

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[1] In this part the net capital transfer payment is deducted from the savings.

value of loans received; total value of bonds sold is equal to the total value of bonds purchased; and so on. For each financial asset a, we have:

$$\sum_h VBA_{a,h} = \sum_h VFA_{a,h} \qquad \forall a \in \{dep, bnd, eqt, lon, etc\}, h \in \{hh, gov, ff, co, oil\}$$

2.4 Market Clearance for Foreign Currency (Trade and Capital Balance)

We assume that the foreign exchange market is cleared. Supply of foreign exchange into the country is made through the export of goods and services (including oil and gas) and net income of factors from abroad. Foreign currency demand is for imports or net capital outflow. Thus for the foreign exchange market, we have:

$$\sum_i QX_i PFX + NIFA = \sum_i QIM_i PFX + \sum_h VNCO_h \qquad i \in \{goods\ \ and\ \ services\}, h \in \{hh, gov, ff, co, oil\}$$

2.5 Price relations

In the model, a product has different prices according to its point of trade. The different price of a product is due to taxes and subsidies, transport margin, trade margins, and different points of entry into the economy. For example, the supply price of a product in domestic markets varies from the price of imported product in the border. Also, the price of the product purchased by households is different from the price of the product purchased by activities.

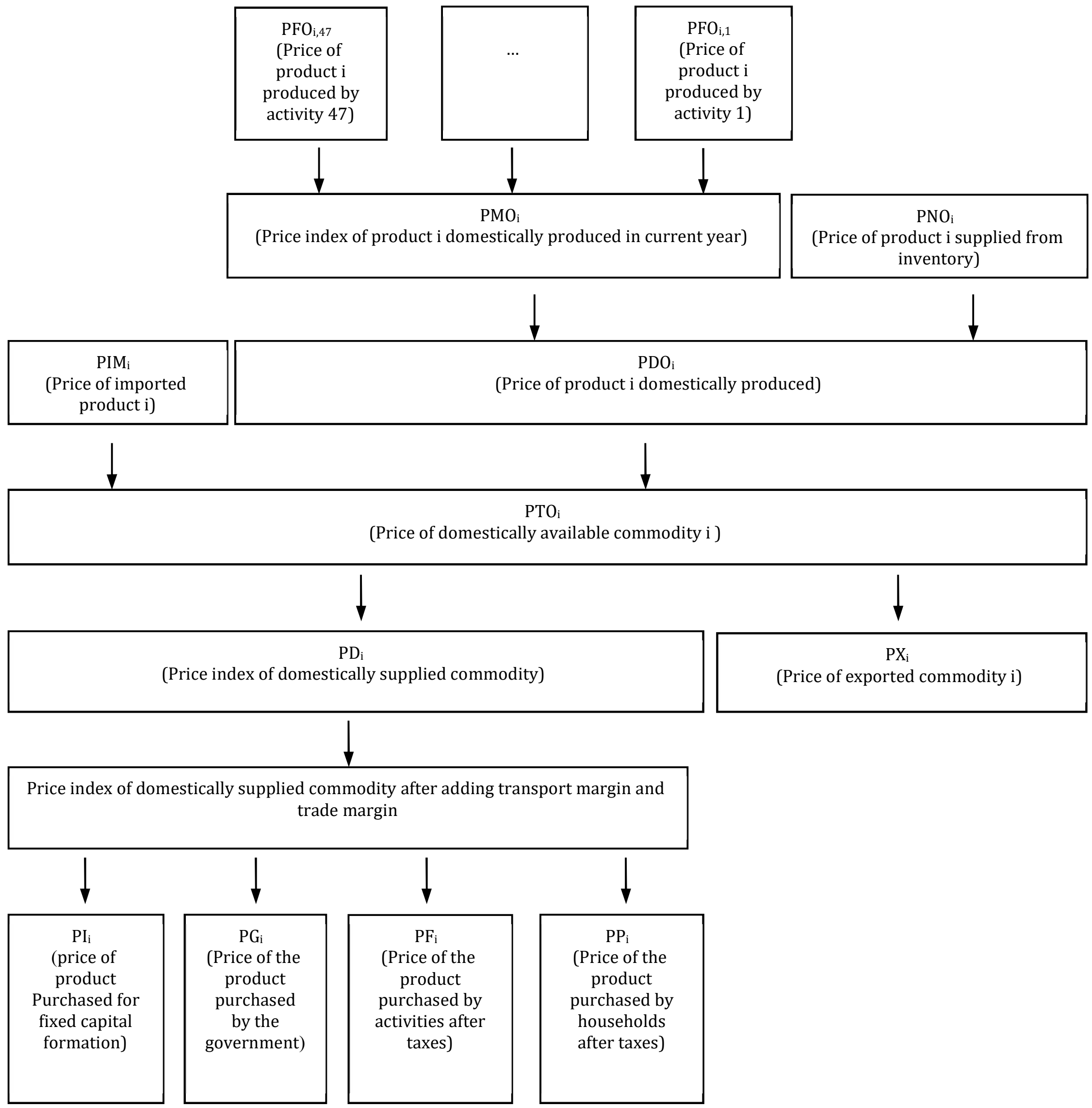

Figure 4: Price linkages in model

Figure 4 shows the price relations in the model. The price index of a domestically produced commodity is a weighted average of activities' output price index and inventory supply price index. The average price of domestically produced commodity and the price of imported goods indicate the price of the domestically supplied commodity. The consumer price of each commodity is based on the tax rates, transport margin, and trade margin (wholesale and retail).

2.6 Optimal Behavior in Production

The model employs the resulting demand and supply function from optimization. I introduce cost minimization problem as the dual problem which leads to equivalent results. Producers minimize the cost of production. With weak separability assumption (Berndt and Christensen, 1973), we can formulate production functions and cost functions as nested functions with constant elasticity of substitution. The top nest consists of aggregated value added and composite intermediate inputs. The problem of the optimal behavior of activity s is:

$$\min PVA_s.QVA_s + PINT_s.QINT_s$$

$$QO_s = \left(\delta_{va,s}^{1/\sigma_{u,s}} QVA_s^{\frac{\sigma_{u,s}-1}{\sigma_{u,s}}} + \delta_{nt,s}^{1/\sigma_{u,s}} QINT_s^{\frac{\sigma_{u,s}-1}{\sigma_{u,s}}} \right)^{\frac{\sigma_{u,s}}{\sigma_{u,s}-1}}$$

where QO denotes output level; QVA is quantity index for value added nest; QINT shows quantity index for intermediate nest; δ is production function parameter; σ shows substitution elasticity between value added nest and intermediate composite; va, nt, and u are index for value added nest, index for intermediate composite, and upper layer, respectively. Solving the problem, we obtain the optimal volume for the lower layers as follows:

$$QINT_s = \delta_{nt,s} AL_s QO_s \left(\frac{\left(\delta_{va,s} PVA_s^{1-\sigma_{u,s}} + \delta_{nt,s} PINT_s^{1-\sigma_{u,s}} \right)^{\frac{1}{1-\sigma_{u,s}}}}{PINT_s} \right)^{\sigma_{u,s}}$$

$$QVA_s = \delta_{va,s} AL_s QO_s \left(\frac{\left(\delta_{va,s} PVA_s^{1-\sigma_{u,s}} + \delta_{nt,s} PINT_s^{1-\sigma_{u,s}} \right)^{\frac{1}{1-\sigma_{u,s}}}}{PVA_s} \right)^{\sigma_{u,s}}$$

The model assumes producers minimize the cost of each composite. In each nest, a constant elasticity of substitution is considered. Let i be set of intermediate goods and services. The producer problem for a nest of intermediate commodities is:

$$\min \sum_i PF_{i,s} QF_{i,s}$$

$$QINT_s = \left(\sum_{i=1}^{112} \delta_{i,s}^{1/\sigma_{nt,s}} QF_{i,s}^{\frac{\sigma_{nt,s}-1}{\sigma_{nt,s}}} \right)^{\frac{\sigma_{nt,s}}{\sigma_{nt,s}-1}}$$

where QF is demand for intermediate goods and services and PF shows the price index of goods and services purchased by firms. There are 112 categories of goods and services in our model. Solving this optimization problem, the optimal volume of intermediate inputs in the intermediate layer is:

$$QF_{i,s} = \delta_{i,s} QINT_s \left(\frac{PINT_s}{PF_{i,s}} \right)^{\sigma_{nt,s}}$$

where the price index for the layer of the intermediate commodity is:

$$PINT_s = \left(\sum_{i=1}^{112} \delta_{i,s} \left(PF_{i,s} \right)^{1-\sigma_{nt,S}} \right)^{\frac{1}{1-\sigma_{nt,S}}}$$

Price of goods purchased by firms derived from the following equation:

$$PF_{i,s} = \left(\psi_i PJ_i + \left(1-\psi_i\right) PD_i \right)\left(1 + tx_i\right)$$

where ψ is share parameter to the trade margin and transport margin, PJ shows the price index of transport margin and trade margin, PD determines the price index of domestically supplied commodity, and tx denotes tax rates and tariffs levied on commodity i. The share of transport margin and trade margin varies in each product and the price index is derived by the following equation:

$$PJ_i = \left(\chi_i PTRANS + \left(1-\chi_i\right) PRETAIL \right)$$

where PTRANS is the price index of transport services and PRETAIL determines price index of trade services (wholesale and retail).

Let f be an index for endowment commodity (labor and capital). We have the following problem for value added nest:

$$\min \sum_f PFE_{f,s} QFE_{f,s}$$

$$QVA_s = \left(\sum_{f=1}^{3} \delta_{f,s}^{1/\sigma_{va,s}} QFE_{f,s}^{\frac{\sigma_{va,s}-1}{\sigma_{va,s}}} \right)^{\frac{\sigma_{va,s}}{\sigma_{va,s}-1}}$$

where PFE is sectoral price index of endowment commodity and QFE shows firm demand for endowment commodity. Three endowment commodities are considered in our model. Solving this optimization problem, the optimal demand for a factor inside the nest is:

$$QFE_{f,s} = \delta_{f,s} QVA_s \left(\frac{PVA_s}{PFE_{f,s}\left(1+tx_s\right)} \right)^{\sigma_{va,s}}$$

Where the cost index for value added nest is:

$$PVA_s = \left(\sum_{f=1}^{3} \delta_{f,s} \left(PFE_{f,s}\left(1+tx_s\right)\right)^{1-\sigma_{va,s}} \right)^{\frac{1}{1-\sigma_{va,s}}}$$

Putting together the optimal values, we extract the full form of demand functions for inputs. Accordingly, the full form of the demand function for intermediate input i is obtained as follows:

$$QF_{i,s} = \delta_{nt,s} \delta_{i,s} QO_s \left(\frac{\left(\delta_{va,s} PVA_s^{1-\sigma_{u,s}} + \delta_{nt,s} PINT_s^{1-\sigma_{u,s}} \right)^{\frac{1}{1-\sigma_{u,s}}}}{PINT_s} \right)^{\sigma_{u,s}} \left(\frac{PINT_s}{PF_{i,s}} \right)^{\sigma_{nt,s}}$$

where QO is the index of the activity level of sector s, PVA indicates the cost index of value added nest, PINT denotes cost index of intermediate commodity composite, and P_i determines price index of input i. This statement shows that the demand for each input directly depends on the level of production and the demand for each input reversely depends on the level of own price.

Finally, the demand for endowment commodity f is:

$$QFE_{f,s} = \delta_{va,s} \delta_{f,s} QO_s \left(\frac{\left(\delta_{va,s} PVA_s^{1-\sigma_{u,s}} + \delta_{nt,s} PINT_s^{1-\sigma_{u,s}} \right)^{\frac{1}{1-\sigma_{u,s}}}}{PVA_s} \right)^{\sigma_{up,s}} \left(\frac{PVA_s}{PFE_{f,s}\left(1+tx_s\right)} \right)^{\sigma_{va,s}}$$

This equation shows that the demand for endowment commodities reversely depends on price and it has a direct relationship with the level of production. It also has a direct relationship with the price of substitute inputs.

2.7 OPTIMIZATION IN SUPPLY OF LABOR AND CAPITAL

Institutions (households, government, corporations, etc.) are the owners of factors of production. Although total endowment of factors of production is constant, the supply of labor and capital to different sectors is not fixed. The model assumes imperfect mobility for factors of production across sectors. Owners of factors maximize revenue from the supply of factors of production. Level of optimal supply to each sector is determined according to the difference in wage and demand in various sectors. The optimization problem for the factor owner is:

$$\max \sum_{s} PFE_{f,s} QFE_{f,s}$$

$$\sum_{h} QOE_{f,h} = \left(\sum_{s=1}^{47} \xi_{f,s}^{1/\tau_f} QFE_{f,s}^{\frac{\tau_f - 1}{\tau_f}} \right)^{\frac{\tau_f}{\tau_f - 1}}$$

where QFE is the supply of factors of production, QOE denotes the amount of primary endowment of factors of production, ζ is a parameter, and τ is a parameter that indicates the ease of movement for factors of production among different sectors and its value is negative. Here, s, f, and h respectively are the index of productive activity, index of primary inputs and index of institutions. We consider the supply of capital and labor into 47 activities. Solving this optimization problem, the optimal supply of labor and capital to different sectors are achieved.

$$QFE_{f,s} = \xi_{f,s} \left(\sum_{h} QOE_{h,f} \right) \left(\frac{POE_f}{PFE_{f,s}} \right)^{\tau_f}$$

$$POE_f = \left(\sum_{s=1}^{47} \xi_{f,s} PFE_{f,s}^{1-\tau_f} \right)^{\frac{1}{1-\tau_f}}$$

where POE is the price for each factor of production f. As τ is a negative parameter, there is a direct relation between price and supply of factors of production in to a sector. In other words, by a rise in relative wages in a sector, supply of labor to that sector will increase.

2.8 Income and Expenditures of Private Households

People allocate their resources to consumption and saving. The model assumes a constant saving rate. Therefore, the level of household savings is a function of income and saving rate. If household income is YP, we have:

$$YP = PRIVEXP + PRIVSAV$$

$$PRIVSAV = sav_{priv} YP$$

where PRIVEXP is expenses of households, PRIVSAV shows savings of households and sav indicates saving rate. Household expenses include transfer payment to other institutions and consumption. In other words:

$$PRIVEXP = PRIVCON + \sum_{h} TRN_{h,priv}$$

where PRIVCON is household consumption, TRN shows household transfer payment to other institutions. Amount of consumption and level of transfer payment are determined as follows:

$$PRIVCON = \alpha_{privcon} PRIVEXP$$
$$TRN_{h,privtrn} = \alpha_{h,privtrn} PRIVEXP$$

where α is a positive parameter. Households earn income from labor and capital. We also consider household transfer payment in our model. So, we show the income of households as follows:

$$YP = \sum_{h} TRN_{priv,h} + \sum_{f} QOE_{priv,f} .POE_{f} + NIFA$$

where TRN is transfer payments from each institution h to households of the private sector, QOE determines endowment of each factor of production f from households of the private sector, POE indicates price index of each factor of production f, and NIFA shows net income from abroad. Income from abroad is achieved using the foreign exchange rate and factors supply abroad:

$$NIFA = \sum_{f} PFX .\overline{QOEA_{f}}$$

where PFX is foreign exchange rate and QOEA shows the factor of production supplied to abroad. Factor supply to abroad is fixed.

2.9 Optimal Consumption of Goods and Services

Consumption demand for goods and services is achieved according to optimal consumption pattern. Households optimize their utility subject to their budget constraint. In general, we display utility function in the form of constant elasticity of substitution for a household h.

$$\max U = \left(\sum_{i=1}^{112} \alpha_i^{\frac{1}{\sigma_{priv}}} QP_i^{\frac{\sigma_{priv}-1}{\sigma_{priv}}} \right)^{\frac{\sigma_{priv}}{\sigma_{priv}-1}}$$

$$PRIVEXP = \sum_i PP_i QP_i$$

where QP shows the quantity of private demand and PP indicates the price of consumption commodities purchased by private households. Each product or service is displayed with index I, and 112 potential goods and services are defined in households consumption bundle. The demand of household h for commodity i is determined as a function of income and prices. The demand for a commodity is inversely related to its price and directly depends on income and price of other substitute commodities.

$$QP_{i,h} = \frac{\alpha_{i,h} PRIVCON}{PP_i^{\sigma_h}} PPRIV^{\sigma_{priv}-1} = \frac{\alpha_{i,h} PRIVCON}{PPRIV} \left(\frac{PPRIV}{PP_i} \right)^{\sigma_{priv}}$$

$$PPRIV = \left(\sum_{i=1}^{112} \alpha_{i,h} PP_i^{1-\sigma_{priv}} \right)^{\frac{1}{1-\sigma_{priv}}}$$

where, PRIVCON is income devoted to consumption by households, QP shows the amount of household demand for the commodity i, α is the utility parameter, and PPRIV determines the price index of household consumer basket. In other words, household demand is a function of income, price of the commodity, price ratio and the elasticity of substitution between commodities. Note that the effect of the price of other commodities on the demand of a product according to the elasticity of substitution may be high or low. If the elasticity of substitution is equal to the unity (Cobb-Douglas functional form), demand function for a product or service i by household h is:

$$QP_{i,h} = \frac{\alpha_{i,h} PRIVEXP}{PP_i}$$

$$PPRIV = \prod_{i=1}^{112} PP_i^{\alpha_{i,h}}$$

Similarly, household demand is a function of income, price of the commodity, price ratio, and elasticity of substitution between goods. Note that the price of other goods has no effect on the demand of the commodity. Price of the commodity purchased by households of the private sector is:

$$PP_i = \left(\psi_i PJ_i + \left(1-\psi_i\right) PD_i\right)\left(1+tx_i\right)$$

where ψ is the share parameter of trade margin and transport margin, PJ shows price index of trade margin and transport margin, PDS denotes price index of domestically supplied commodity, and tx determines tax rates and tariffs levied on commodity i.

2.10 Government Expenses

Government allocates resources to public expenses and government savings. If all sources of government revenue equal YG, the income balance requires:

$$YG = GOVEXP + GOVSAV + \sum_h TRN_{h,gov} \,,$$

where GOVEXP is current government expenses and TRN shows government transfer payment to other institutions. Government transfer payments and savings are determined as follows:

$$\begin{aligned} GOVEXP &= \alpha_{govxp} YG \\ TRN_{h,gov} &= \alpha_{h,gov} YG \quad , \\ GOVSAV &= \alpha_{govsav} YG \end{aligned}$$

where α is a positive parameter[6]. Government revenue is from capital income (natural resources and public firms) and taxes. So the revenues can be represented as:

$$YG = QOE_{oil} POE_{oil} + QOE_{gov,k} .POE_k + \sum_i CTAX_i + \sum_s STAX_s + \sum_h TRN_{gov,h} \,,$$

[6] The model assumes that the government expenses are exogenous and saving (budget deficit) is determined endogenously.

$$GOVSAV = YG - \overline{GOVEXP} - \overline{\sum_h TRN_{h,gov}}$$

$$\begin{aligned} GOVEXP &= \overline{GOVEXP} \\ TRN_{h,gov} &= \overline{TRN_{h,gov}} \end{aligned}$$

where QOE_{oil} is capital endowment in the oil sector; POE_{oil} determines price index of capital in the oil sector; $QOE_{gov,k}$ shows government capital endowment in other sectors; POE_k is price index of capital in other sectors; CTAX depicts taxes and tariffs on commodities; TRN illustrates transfer payment of each institution to government including SWF. Government consumption expenditures mainly consist of expenses related to public services, defense services, police services, social security, educational services, health services, recreation, and cultural and sports services. To determine the optimal level for each of these expense categories, we assume a utility function for the government[7]. A constant elasticity of substitution is considered for government behavior. The model assumes a small elasticity of substitution due to the nature of government activity. Therefore, the government optimal solution for the consumption of goods and services is:

$$\max U_{gov} = \left(\sum_{i=1}^{112} \alpha_{i,gov}^{\frac{1}{\sigma_{gov}}} QG_{i,gov}^{\frac{\sigma_{gov}-1}{\sigma_{gov}}} \right)^{\frac{\sigma_{gov}}{\sigma_{gov}-1}},$$

$$GOVEXP = \sum_i PG_i QG_{i,gov}$$

where QG is goods and services purchased by the government; PG determines price index of goods and services purchased by the government; U indicates government utility index; α shows utility parameter, and σ denotes substitution parameter. Solving this optimization problem yields the level of government expenditure in each component:

$$QG_i = \frac{\alpha_{i,gov} GOVEXP}{PGOV} \left(\frac{PGOV}{PG_i} \right)^{\sigma_{gov}},$$

$$PGOV = \left(\sum_{i=1}^{112} \alpha_{i,gov} PG_i^{1-\sigma_{gov}} \right)^{\frac{1}{1-\sigma_{gov}}},$$

where PGOV is the price index of government expenses bundle. This statement shows that if prices rise, the government reduces the demand for goods and services, and if GOVEXP increases, demand

[7]- The model assumes government behavior like an agent that has no restrictions on the provision of public goods. According to the budget constraint, government is maximizing utility. To find out more information about this assumption, please refer to Barro (1990).

for goods and services will increase by the government. The price of the commodity purchased by the government is:

$$PG_i = \left(\psi_i PJ_i + \left(1-\psi_i\right) PD_i\right)\left(1+tx_i\right),$$

where ψ is share parameter of trade margin and transport margin, PJ shows price index of trade margin and transport margin, PDS denotes price index of domestically supplied commodity, and tx determines tax rates and tariffs levied on commodity i.

2.11 Optimal Commodity Supply

Some activities produce more than one product. Therefore, the supply level of each product depends on the price of all products. In this case, the producer problem is maximizing revenue from selling all products. A function with constant elasticity of transformation (CET) is introduced to demonstrate choosing between products. The problem of the producer is:

$$\max \sum_i PFO_{i,s} QFO_{i,s}$$

$$QO_s = \left(\sum_i \omega_{i,s}^{1/\tau_s} QFO_{i,s}^{\frac{\tau_s - 1}{\tau_s}}\right)^{\frac{\tau_s}{\tau_s - 1}},$$

where PFO is the price of the supplied commodity and QFO shows the amount of supplied commodity.

2.12 Optimal Variety Mix

Commodity i may be produced by several sectors. The model assumes imperfect substitution across varieties. Therefore, commodity i produced in the one sector is not homogeneous with the commodity i produced in the second section. There is a degree of substitution between varieties. The objective is to minimize the cost of the mix of varieties for each commodity:

$$\min \sum_s PFO_{i,s} QFO_{i,s}$$

$$QMO_i = \left(\sum_{s=1}^{47} \kappa_{i,s}^{1/\upsilon_i} QFO_{i,s}^{\frac{\upsilon_i - 1}{\upsilon_i}}\right)^{\frac{\upsilon_i}{\upsilon_i - 1}},$$

Where s is the index for varieties; QMO is the sum of all varieties for each commodity domestically produced; QFO shows the supply of each variety to market by each activity; κ is CES parameter; υ indicates substitution elasticity parameter. Solving this problem determines the optimal value for each variety of product i.

$$QFO_{i,s} = \kappa_{i,s} QMO_i \left(\left(\sum_s \kappa_{i,s} \left(PFO_{i,s} \right)^{1-\upsilon_s} \right)^{\frac{1}{1-\upsilon_s}} \Big/ PFO_{i,s} \right)^{\upsilon_s} .$$

2.13 Optimal Supply from Inventory

Part of supply to the market is from inventory, which is past production. Production of the current year and past years are not homogeneous. Thus, the economy chooses between new produced products and old inventory products:

$$\min PMO_i .QMO_i + PNO_i .QNO_i$$

$$QDO_i = \left(\varphi_{qmo,i}^{1/\varepsilon_i} QMO_i^{\frac{\varepsilon_i - 1}{\varepsilon_i}} + \varphi_{qno,i}^{1/\varepsilon_i} QNO_i^{\frac{\varepsilon_i - 1}{\varepsilon_i}} \right)^{\frac{\varepsilon_i}{\varepsilon_i - 1}} ,$$

where QDO shows total supply of domestic products; PMO is price index for current year production; QMO denotes supply of commodity produced this year; PNO shows price index of product from inventory; and QNO indicates supply from inventory; φ is CES parameter; ε depicts elasticity of substitution; and lower letter qmo, and qno are index of commodities produced current year and index of supply from inventory, respectively. In this frame, supply function out of inventory is:

$$QNO_i = \varphi_{qno,i} QDO_i \left(\frac{\left(\varphi_{qmo,i} PMO_i^{1-\varepsilon_i} + \varphi_{qno,i} PNO_i^{1-\varepsilon_i} \right)^{\frac{1}{1-\varepsilon_i}}}{PNO_i} \right)^{\varepsilon_i} ,$$

and the supply function of current year production is:

$$QMO_i = \varphi_{qmo,i} QDO_i \left(\frac{\left(\varphi_{qmo,i} PMO_i^{1-\varepsilon_i} + \varphi_{qno,i} PNO_i^{1-\varepsilon_i} \right)^{\frac{1}{1-\varepsilon_i}}}{PMO_i} \right)^{\varepsilon_i} ,$$

and the price index of domestic production will be:

$$PDO_i = \left(\varphi_{qmo,i} PMO_i^{1-\varepsilon_i} + \varphi_{qno,i} PNO_i^{1-\varepsilon_i}\right)^{\frac{1}{1-\varepsilon_i}}.$$

2.14 OPTIMAL IMPORT

Economic agents minimize the cost of purchasing goods and services. Goods and services can be provided by domestic production or imports. The model assumes that there is an imperfect substitution between domestic goods and services and imported goods and services (Armington, 1967). The following problem shows the choice between import and domestic goods for the whole economy.

$$\min PDO_i .QDO_i + PIM_i .QIM_i$$

$$QTO_i = \left(\varphi_{d,i}^{1/\beta_i} QDO_i^{\frac{\beta_i - 1}{\beta_i}} + \varphi_{m,i}^{1/\beta_i} QIM_i^{\frac{\beta_i - 1}{\beta_i}} \right)^{\frac{\beta_i}{\beta_i - 1}},$$

where PDO is price index of domestically produced commodity; QDO determines total supply of domestic products; QIM indicates imports; PIM shows price index of imported commodity; QTO denotes total domestic supply from all sources; β is Armington elasticity of substitution; m is index of import; d is index of domestic products; and φ is CES parameter. Solving the optimization problem yields demand for the imported commodity**:**

$$QIM_i = \varphi_{m,i} QTO_i \left(\frac{\left(\varphi_{d,i} PDO_i^{1-\beta_i} + \varphi_{m,i} PIM_i^{1-\beta_i}\right)^{\frac{1}{1-\beta_i}}}{PIM_i} \right)^{\beta_i},$$

$$PIM_i = PFX .PMF_i$$

where PFX denotes foreign exchange rate and PMF indicates the global price of commodity i. An increase in the exchange rate or an increase in the global price of a commodity will decrease the demand for imports. Note that the total demand of a commodity is the summation of demand by institutions and different activities. Therefore, by an increase in income of institutions or a rise in the activity of production sectors, total demand will increase. As a result, it will increase demand for imports. The Optimal volume of purchasing domestic commodity is:

$$QDO_i = \varphi_{m,i} QTO_i \left(\frac{\left(\varphi_{d,i} PDO_i^{1-\beta_i} + \varphi_{m,i} PIM_i^{1-\beta_i} \right)^{\frac{1}{1-\beta_i}}}{PDO_i} \right)^{\beta_j}.$$

Finally, PTO or price index of the domestically supplied commodity is given by:

$$PTO_i = \left(\varphi_{d,i} PDO_i^{1-\beta_i} + \varphi_{m,i} PIM_i^{1-\beta_i} \right)^{\frac{1}{1-\beta_i}}$$

2.15 Optimal Export

Agents choose between domestic supply and exports. Structure of domestic-export supply follows a CET (constant elasticity transformation) functional form. The model assumes supply revenue comes from either domestic supply or exports. Thus, the problem is maximizing supply revenue:

$$\max PD_i .QOD_i + PX_i .QOX_i$$

$$QTO_i = \left(\theta_{d,i}^{1/\lambda_i} QOD_i^{\frac{\lambda_i - 1}{\lambda_i}} + \theta_{x,i}^{1/\lambda_i} QOX_i^{\frac{\lambda_i - 1}{\lambda_i}} \right)^{\frac{\lambda_i}{\lambda_i - 1}},$$

where QOD is total domestic supply; QOX shows total export of a commodity; PX denotes export price; PD indicates the price of the domestically supplied commodity; θ is CET parameter; λ is the parameter of transformation elasticity; x is an index for export, and d is defined as an index for domestic supply. Solving this problem, optimal supply to abroad (export) is:

$$QOX_i = \theta_{x,i} QOT_i \left(\frac{\left(\theta_{x,i} PX_i^{1-\lambda_i} + \theta_{d,i} PD_i^{1-\lambda_i} \right)^{\frac{1}{1-\lambda_i}}}{PX_i} \right)^{\lambda_i},$$

$$PX_i = PFX .PXF_i$$

where PFX is exchange rate and PXF denotes global export price. This statement shows that the export of each commodity has a direct relationship with the level of production and the price level. Similarly, the optimal domestic supply of goods and services is:

$$QOD_i = \theta_{d,i} QOT_i \left(\frac{\left(\theta_{x,i} PX_i^{1-\lambda_i} + \theta_{d,i} PD_i^{1-\lambda_i}\right)^{\frac{1}{1-\lambda_i}}}{PD_i} \right)^{\lambda_i}$$

2.16 Financial Portfolio Optimization

Agents allocate their savings either directly to fixed capital formation or to financial assets. Financial resources and financial expenses are given by:

$$VFRES_h = VSAV_h + VBOR_h$$
$$VFEXP_h = VTK_h + VTA_h + VTN_h + VNCO_h$$

where VFRES stands for total financial recourses; VSAV demonstrates total financial expenses; VSAV indicates saving of each agent; VBOR denotes total funds from various sources of financing, VTK determines investment in fixed capital formation; VTA shows investments in financial portfolios; VTN denotes investment in inventories, and VNCO shows net capital outflow. In the model, the capital outflow of each institution is determined by a fixed parameter α via:

$$VNCO_h = \alpha_{nco,h} VFEXP_h .$$

Agents maximize the return on their portfolio of asset types. Asset types include deposits, bonds, equities, loans, and etc. The model assumes that there is an imperfect substitution between asset types in the financial portfolio[8]. Agents solve the optimization problem:

$$\max \sum_a r_a VFA_{a,h}$$

$$VTA_h = \left(\sum_a \theta_{a,h}^{1/\sigma_{a,h}} VFA_{a,h}^{\frac{\sigma_{a,h}-1}{\sigma_{a,h}}} \right)^{\frac{\sigma_{a,h}}{\sigma_{a,h}-1}}$$

where r is the rate of return on financial asset types; VFA stands for the value of investment in a financial asset type α; VTA denotes the total value of the financial portfolio; θ indicates CET

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[8] Only when risk and return are equal there is complete substitution between assets. For more information about the substitution between financial assets refer to: Tobin, James (1969) "A General Equilibrium Approach to Monetary Theory." Journal of Money, Credit, and Banking, 1:1, 15—29.

parameter; σ determines substitution (transformation) parameter; α is an index of asset types; and h is index of institutions. Note that θ is nonnegative and σ is negative. Solving this optimization problem yields the optimal size of financial asset type α in the portfolio of agent h:

$$.VFA_{a,h} = \theta_{a,h} VTA_h \left(\left(\sum_{a=1}^{7} \theta_{a,h} r_a^{1-\sigma_{a,h}} \right)^{\frac{1}{1-\sigma_{a,h}}} \Big/ r_a \right)^{\sigma_{a,h}}$$

As expected there is a direct relationship between the rate of return and demand for the asset. For example, by increasing deposit interest rates, people prefer to allocate more of their savings into bank deposits and allocate a smaller volume of their savings to other asset types compared to initial equilibrium.

2.17 Optimal Financial Variety Mix

Agents maximize the return on each asset. In the model, each asset type is issued by various institutions. Assets are different based on their issuer. For example, government bonds are different from bonds issued by financial institutions. The difference may come from different rate of return, risk, and expectations. Thus, the model assumes bonds issued by the government are "imperfect substitutes" bonds issued by companies. Agents solve the following problem:

$$\max \sum_h rr_{a,h} VAI_{a,h,hh}$$

$$VFA_{a,hh} = \left(\sum_h \theta_{a,h}^{1/\sigma_{a,h}} VAI_{a,h,hh}^{\frac{\sigma_{a,h}-1}{\sigma_{a,h}}} \right)^{\frac{\sigma_{a,h}}{\sigma_{a,h}-1}}$$

where $rr_{\alpha,h}$ is rate of return on financial asset α issued by institution h; $VAI_{\alpha,hh,h}$ shows total value of asset type α purchased by institution h, from institution hh; VFA denotes total value of asset type α purchased by an institution hh; θ indicates CET parameter; and σ indicates substitution (transformation) parameter. Solving this optimization problem yields financial variety demand:

$$VAI_{a,h} = \theta_{a,h} VFA_a \left(\left(\sum_{i=1}^{5} \theta_{a,h} rr_{a,h}^{1-\sigma_{a,h}} \right)^{\frac{1}{1-\sigma_{a,h}}} \Big/ rr_{a,h} \right)^{\sigma_{a,h}}$$

Note that θ is nonnegative and σ is negative in this equation.

2.18 OPTIMAL FINANCING PORTFOLIO (BORROWING PORTFOLIO)

The financial system provided various assets. Thus, borrowers have various ways to finance their investment and consumption needs. The goal of borrowers is to minimize the cost of financing from different asset types. However, financial assets are not perfectly substitute. Thus, the problem of a borrower is:

$$\min \sum_a rr_{a,h} VB_{a,h}$$

$$VBOR_i = \left(\sum_a \beta_{a,h}^{1/\gamma_{a,h}} VB_{a,h}^{\frac{\gamma_{a,h}-1}{\gamma_{a,h}}} \right)^{\frac{\gamma_{a,h}}{\gamma_{a,h}-1}}$$

where rr is rate of return on each asset; VB shows value of funds borrowed via asset type α; VBOR denotes total borrowing; β indicates CES parameter in financing portfolio; and γ determines elasticity of substitution in financing portfolio; Solving the optimization problem yields the optimal volume of financing via asset α by institution h.

$$VB_{a,h} = \beta_{a,h} VBOR_i \left(\left(\sum \beta_{a,h} rr_{a,h}^{1-\gamma_{a,h}} \right)^{\frac{1}{1-\gamma_{a,h}}} \Big/ rr_{a,h} \right)^{\gamma_{a,h}} .$$

In this equation β is nonnegative and γ is positive.

2.19 OPTIMAL MIX OF SECTORAL INVESTMENT

Agents may invest in different sectors from agriculture to oil and gas sectors. Their goal is to minimize investment costs. The model assumes imperfect substitution across sectoral investments. Investing in each sector is determined by specific cost index of that sector. The problem of investing agents is:

$$\min \sum_k PK_k QK_{k,h}$$

$$VTK_h = \left(\sum_i \theta_{k,h}^{1/\sigma_{k,h}} QK_{k,h}^{\frac{\sigma_{k,h}-1}{\sigma_{k,h}}} \right)^{\frac{\sigma_{k,h}}{\sigma_{k,h}-1}}$$

where PK is the cost index of investment in a sector; QK shows the volume of investment; VTK denotes total fixed capital formation by each institution; θ indicates CES parameter, and σ determines the parameter of substitution; k and h respectively are the index of sectoral capital formation and index of agents. Solving this optimization problem determines the volume of capital formation in sector k by agent h.

$$QK_{k,h} = \theta_{k,h} VTK_h \left(\left(\sum \theta_{k,h} PK_k^{1-\sigma_{k,h}} \right)^{\frac{1}{1-\sigma_{k,h}}} \Big/ PK_k \right)^{\sigma_{k,h}}$$

2.20 Capital Formation in Each Sector

Investment in any sector consists of purchasing machinery, equipment, buildings, and etc. Each sectoral investor minimizes the total cost of capital formation constrained to capital formation function. The sectoral investor problem is:

$$\min \sum_i PI_i \, QI_{i,k}$$

$$QK_k = \left(\sum_{i=1}^{147} \theta_{i,k}^{1/\sigma_{i,k}} QI_{i.k}^{\frac{\sigma_{i,k}-1}{\sigma_{i,k}}} \right)^{\frac{\sigma_{i,k}}{\sigma_{i,k}-1}}$$

where PI is price of goods and services purchased by investors; QI shows amount of goods and services purchased for investment; QK denotes capital formation in a sector; θ is CES parameter that indicates technology of capital formation; and σ determines elasticity of substitution between equipment, machinery, and buildings; i is index of goods and services; and k is index of sectoral investment. Solving the optimization problem yields the amount of commodity i demand by investors to invest in sector k.

$$QI_{i,k} = \theta_{i,k} QK_k \left(\left(\sum_{i=1}^{147} \theta_{i,k} PI_i^{1-\sigma_{i,k}} \right)^{\frac{1}{1-\sigma_{i,k}}} \Big/ PI_i \right)^{\sigma_{i,k}}$$

Price of each commodity purchased by investors for fixed capital formation is defined by:

$$PI_i = \left(\psi_i PJ_i + (1-\psi_i) PDS_i\right)(1+tx_i),$$

where ψ is share parameter of trade margins and transport margins; PI shows price index of trade margins and transport margins; PDS indicates price index of the domestically supplied commodity, and tx denotes tax rates and tariffs levied on commodity i.

2.21 DATA AND CALIBRATION

The model is calibrated based on the 1999 Iranian Social Accounting Matrix[9]. Financial information is obtained from the Flow of Funds Database. The initial matrix consists of 112 categories of goods and services, 47 production activities, and 10 financial assets. Main agents are households, government, financial companies, non-financial companies, the central bank, and institutional sector of oil and gas. Aggregated form of this matrix is displayed in Table 1 and Table 2.

Table 1: Summary of Social Accounting Matrix of 1999, Central Bank of Iran (Billion LCU)

		1	2	3	4	5	6	7	8
1	Commodities		241,572		309,080	6,357	128,289		93,116
2	Production	698,039							
3	Value added		456,467						1,051
4	Institutions	14,068		456,447					
5	Savings				160,876	20,313		194,929	1,769
6	Capital formation					128,289			
7	Financial					222,928			8,786
8	ROW	66,307		1,071	559			36,785	(27,999)
	Sum	778,414	698,039	457,518	470,515	377,887	128,289	231,714	76,723

Note: The matrix is a symmetric square. The column number is associated with the same row number.

Table 2: Summary of Social Accounting Matrix of 1999, Central Bank of Iran (Million USD, 1 USD = 8632 LCU)

		1	2	3	4	5	6	7	8
1	Commodities		27,986		35,806	736	14,862		10,787
2	Production	80,866							
3	Value added		52,881						122
4	Institutions	1,630		52,878					
5	Savings				18,637	2,353		22,582	205
6	Capital formation					14,862			
7	Financial					25,826			1,018
8	ROW	7,682		124	65			4,261	(3,244)
	Sum	90,178	80,866	53,003	54,508	43,777	14,862	26,844	8,888

Note: The matrix is a symmetric square. The column number is associated with the same row number.

[9]- This is the latest reliable Social Accounting Matrix with financial sector and Oil and Gas information. The economy faces lots of fluctuations including oil price jumps, sanctions, energy subsidy reform, a 200% exchange rate shock, and etc. However, the 1999 information is enough for initial calibration of parameters.

According to this information, the value of Iranian production of goods and services in 1999 is about 80,866 million USD (intersection of commodities column and production row). This matrix shows that the value of imports is about 7,682 million USD (intersection of commodities column and ROW row). The total value of goods and intermediate services in this matrix is 27,986 million USD. (Intersection of production column of and commodities row). The total value of payments to labor and capital is about 52,881 million USD (Intersection of production column and value added row). According to the matrix, the sum of private and public consumption is 35,806 million USD. Fixed capital formation of all institution in the economy is 14,862 million USD. The matrix shows that the total value of exports in this year is 10,787 million USD. Finally, the total value of the savings of institutions is about 18,637 million USD.

3 CONCLUSIONS

This study makes the first step towards the investigation of the linkage between natural resources and the financial sector in resource abundant countries. The paper introduced FGE, a Financial General Equilibrium model specialized for policy analysis in resource rich countries. This model not only includes conventional real sector channels of the resource curse but also includes financial sector channels. In the framework of this model, a positive resource shock affects the level of government intervention in the financial sector. Empirically, the government offers low interest loans; it purchases equities and bonds and invests in production sectors. The level of intervention increases with positive resource shocks. In this framework, it would be useful to analyze the impact of adjustments in resource policy as well as financial liberalization policies. As countries move towards more efficient resource policy and more transparent SWF management, adding a time dimension to this analysis provides a better environment for optimal resource revenue distribution.

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