

Macro-Economic Impacts of Lowering Interest Rate: A Real-Financial CGE Evaluation for Iran

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Abstract

In Iran, interest rate is regulated by government by setting a ceiling for the credits allocated to various economic sectors. In recent years, the old theory of financial repression in the form of reducing interest rate of credits has been considered as a necessity to stimulate and encourage investment and economic sectors expansion in Iran. This study investigates the effects of this policy on the growth of investment and production and other macro-economic variables in the context of the economy of Iran. To this end, we modified and extended the ORANI-G CGE model to appropriately present Economy of Iran and to include financial sector. This real-financial CGE model constitutes of 46 sectors producing 60 commodities and services. Then, we used this model to simulate a 4 percent reduction in interest rate of credits in all economic sectors. Results revealed that, following this policy the real GDP and total fixed capital formation will face a growth rate of 1.2 and 1.86 percent, respectively. Employment rises by 0.71 percent and overall export experiences 2.84% growth rate which leads to the 0.1% improvement of balance of trade. Following a reduction in interest rate of credits, the prices of commodities and services decline which result in

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reduction of inflation rate by 0.53 percent. In addition, households income and savings (urban and rural) increase by 0.54 and 7.83 percent, respectively. Consequently, it seems in the context of the Economy of Iran, the policy of financial repression causes positive impacts on the importance of macro-economic variables.

Key words: Interest rate, growth, CGE evaluation.

JEL Classification: C30, E41, E43, E47.

Introduction

In the absence of an advanced capital market in Iran, banks are the dominant domestic financial institutions and play a crucial role in financing investment projects and capital accumulation in the economy. Until recently, all banks were state-owned institutions. Now, most of the banks are owned and operated by private sector. All banks in Iran are operated under Islamic rule which prohibits usury in lending loans. Banks are usually required to keep high reserve ratios (about 15 percent) with the Central Bank and are supposed to allocate most of their assets towards specific “priority sectors” and have to grant loans to some sectors at preferential interest rates. In addition, the rates on bank deposits and bank loans are legally controlled by government. Deposits rates, as shown in table 1, in the form of real rates are almost negative or low. Thus, a policy of “financial repression” is adopted and operated in Iran.

*Table 1: Nominal and real interest rate of deposits
in Iran, 1991- 2008 (percent)*

year	Short time		One- year		Two- year		Three- year		Four- year		Five- year	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real
1991	5.6	-2.1	9.0	-7.1	5.1	-2.1	5.1	-2.9	-	-	15.0	-7.6
1992	5.6	-9.2	10.0	-4.1	5.1	-9.1	13.0	-4.1	-	-	16.0	-4.9
1993	5.7	-9.2	5.1	-4.1	5.1	-4.9	5.1	-4.8	-	-	5.2	-9.6
1994	8.0	-2.3	5.1	-7.2	5.1	-7.2	5.1	-7.2	-	-	5.2	-2.2
1995	8.0	-4.4	14.0	-4.3	15.0	-4.3	16.0	-4.3	-	-	5.2	-9.3
1996	8.0	-2.1	14.0	-2.9	15.0	-2.8	16.0	-2.7	-	-	5.2	-7.4
1997	8.0	-3.9	14.0	-3.3	15.0	-3.2	16.0	-3.1	-	-	5.2	2.1
1998	8.0	-1.1	14.0	-4.1	15.0	-1.3	16.0	-2.1	-	-	5.2	4.0
1999	8.0	-4.1	14.0	-4.6	15.0	-4.5	16.0	-4.4	-	-	5.2	-9.1
2000	8.0	-6.4	14.0	4.1	15.0	4.2	16.0	4.3	17.0	4.4	5.2	9.5
2001	7.0	-4.4	13.0	6.3	15.0	6.3	16.0	6.4	17.0	6.5	5.2	1.7
2002	7.0	-8.8	13.0	-8.2	15.0	-8.0	15.0	-8.0	15.0	-8.0	17.0	2.1
2003	7.0	-6.8	13.0	-6.2	15.0	-6.0	15.0	-6.0	15.0	-6.0	17.0	4.1
2004	7	-8.2	13	-2.2	15	-0.2	15	-0.2	15	-0.2	17	1.8
2005	7	-3.4	13	2.6	15	4.6	15	4.6	15	4.6	17	6.6
2006	7	-4.9	12	0.1	12	0.1	11.5	-0.4	11.5	-0.4	16	4.1
2007	7	-11.4	14	-4.4	15	-3.4	14.5	-3.9	15	-3.4	16	-2.4
2008	9	-16.4	15	-10.4	16	-9.4	17	-8.4	18	-7.4	18	-7.4

Source: Central bank of I.R.I

In 2004, the House of Representatives (parliament) passed an act that mandates the government to reduce the interest rate on loans and deposits by 4.5 percent in 1.5 years. The main objective of this policy was to keep the costs of funds low, based on the perception that cheap credit promotes development and production through increased investment. Besides, the other objectives were an increase in employment and a decrease in inflation rate.

Until the early 1970s, it was generally believed that low interest rates on bank loans and deposits would promote investment spending and growth- a notion consistent with the Keynesian and Neo-classical analyses where the interest rate is a part of the cost of capital. So, this idea prompted many developing and even some developed industrial countries to impose interest rate ceilings at below market-clearing levels to reach increased motivation to investment, improving allocation of resources between different sectors and reducing production costs.

A number of empirical studies examined the impacts of implementing financial repression policy in different countries. For example, Inakura and Shimizutani (2008) indicated that low interest rates in Japan caused a reduction in households' savings. A study by SAARI institute (2004) in Uganda revealed that low interest rates resulted in negative effects on the financial system of the country. According to this study, with high inflation rates, the real rate of interest on loans became negative leading to discourage savings, non-repayment of loans and high demand for government loans which caused the credit rationing process. Yilma et al. (2004) studied the impact of low interest rate loans paid to agricultural sector with preferential conditions in Ghana. They indicated that by implementing this policy Ghana was submerged in a deep economic crisis. So, they have released this policy in 1983 and adopted the liberalization of interest rates. Khosravi (2004) showed that, positive and even zero real interest rates have positive effects on investment in Iran. Samadi (1999) analyzed the consequences of financial repression on economic growth in Iran. He indicated that by liberalizing interest rates, investment and real savings increase which leads to an increase in income and economic growth. There are some

other studies, however, that support the positive effects of financial repression policy. For example, study of Gupta (1984) showed that this policy is supported in eight developing countries including Burma, India, Korea, Indonesia, Malaysia, Nepal, Taiwan and Singapore. In a different study, Vongpradhip (1989) indicated the positive impacts of low agricultural loan rates in Thailand in the form of increased real GDP, households' income, agricultural employment and improved trade deficit.

The contradictory results of the studies reveal the fact that impacts of adopting financial repression are economy-specific. This is the main motivation for the present study to analyze the impacts of implementing financial repression policy in the context of economy of Iran. To this end, a real- financial computable general equilibrium (RFCGE) model is used as the analytical framework, since the RFCGE models have the ability to incorporate inter- sectoral linkages and account for both the direct and indirect impacts of policy shocks on the economy of Iran (Salami, 2006). The developed real- financial CGE model for Iran, was used to simulate a shock of reducing interest rate of credits in the economic sectors and the impacts of implementing this policy on the economy of Iran was analyzed by tracing the effects of financial repression on macro- economic variables including investment and production, national accounts, prices and wage, employment and financial variables.

2. Model Specification

2.1. The Real Side of the Model

The real side of the real- financial CGE model is set up by extending and modifying the ORANI-G (Horridge, 2000) type models to appropriately present the economy of Iran. The economy of Iran is divided into 46 sectors: 6 Agricultural Sectors, 2 Mining Sectors, 19 Manufacturing Sectors, and 19 Services Sectors which produce 60 commodities. This specification allows each industry to produce more than one commodity and each commodity be produced by more than one industry. All sectors

produce and supply goods and services to both domestic and foreign markets. Following Armington (1969), domestic and imported goods are treated as imperfect substitutes. Both exports and imports are specified as a function of relative prices in domestic and foreign markets. Small country assumption is made in specifying most of the sectors' imports and exports. Market power in international market in some cases including oil sector is recognized.

Like most of the ORANI-G type models, the input technology is specified in two levels. At the first level, it is assumed that intermediate inputs and primary factor inputs are combined in fixed proportions to produce each unit of output. At the second level, substitution is made possible only among primary factor inputs based on the constant elasticity of substitution technology. The primary factor inputs include labor, uses in all sectors and is assumed fixed in total supply in the country but mobile among sectors; capital, which is specific to each sector, and land, which is used only in the agriculture sector and is assumed fixed in total supply. International migration of labor in response to shocks in the economy is not permitted. Furthermore, we model the labor market assuming that wages are rigid. Accordingly, in this Keynesian specification, labor market clears through large scale adjustments in the unemployed labor force based on the following equations:

$$\text{Totlab} = \text{Employ} + \text{Unemploy} \quad (1)$$

$$\text{Employ} = \sum_{i=1}^{46} X1\text{Lab}_i \quad (2)$$

in which *Totalab*, *Employ*, *Unemploy* and *X1Lab_i* are, respectively, total labor supply, total employed and unemployed labor in the economy and employment in each industry.

Capital input is sector specific, so its rental rate in each, which is endogenous to the model, would adjust to clear the market. A similar assumption is made for land in agricultural sector.

In this real- financial CGE model, households are separated into urban and rural categories. The income of households comes mostly

from supplying labor and land inputs to all industries and capital input to some industries, investment in foreign countries and wages received from rest of the world. Government transfers and transfers between households are the other sources of household's income. Purchase of commodities, payment of income tax to government and transfers to other households constitute their expenditure. Household's saving is residually determined as the difference between income earned and expenditure spent. Households' demand for commodities is determined through utility maximization given their budget constraint.

In the specified RFCGE model, government is characterized to collect direct and indirect taxes, tariffs revenue, rents of supplying capital to some industries and dividend of foreign investment. It pays production and import subsidies, transfers to households, and purchases commodities. Government's saving is residually determined similar to the households' saving. Government demand for commodities is a function of its disposable income, average propensity to consume and commodities' price.

Private and public enterprises are two accounts which are added to the basic ORANI-G model to more appropriately reflect the reality of the economy of Iran. Income of these two groups comes from collecting rents of capital supplied to industries and dividends from foreign investment. Public enterprises spend their income to pay income tax to the government, to finance repayment of foreign loans and dividends of the domestic households. Private enterprises only pay income tax. Their savings are residually determined as before. The linear equations of income, expenditure and saving for these accountholders are presented in appendix 1. Also the detailed definitions of variables and coefficients are displayed in Tables A.1, A.2, and A.3 of Appendix 2.

The model is short-run in nature. In this model, the markets for factor inputs respond to policy shocks through price changes while in the long-run the adjustment is mainly through quantity changes. The model is not closed in the sense that the change in exports equals the change in imports. The exchange rate is assumed fixed and the balance of payments adjusts any changes in trade balance.

2.2. Financial Side of the Model

In CGE models that formulate just real side of economy, the flow of funds is closed by equating these savings and investments in the economy. In this formulation, no information is provided about how financial resources needed for investment are generated in the economy. By adding financial side to the real CGE models, this gap is filled and the flow of funds in real and financial sides as well as the link between these two are formulated, and the sources of financial resources in financing physical and financial assets are specified. In present RFCGE model, banks play the role of linking real side to the financial side of the economy by setting interest rate for credits and deposits, collecting savings of economic agents in the real side as bank deposits, and supplying credit to the private producers for financing investment and working capital.

The interest rate charged by the banks affects cost of production by increasing the unit cost of intermediate inputs and the investment cost by increasing the price of investment commodities. The model is accommodated to take into account these effects by introducing equation (3), (4), and 5 into the model.

$$p1mat_i = SHMT_i \times \sum_{c=1}^{60} \{SHCM_{c,i} \times p1_s_{c,i}\} + SHWCRD_i \times wcrdrate_i \quad (3)$$

$$p1tot_i = \sum_{f=1}^3 SHFAC_{if} \times p1fac_{if} + SHMAT_i \times p1mat_i + 100 \times (SHTAX_i \times delPTXRATE_i + SHSUB_i \times delPSUBRATE_i) \quad (4)$$

$$p2tot_i = SHIVM_i \cdot \sum_{c=1}^{60} SHCOM_{c,i} \cdot p2_s_{c,i} + SHIVCRD_i \cdot ivcrdrate_i \quad (5)$$

As equation (3) shows, price of intermediate input i ($p1mat_i$) is a function of interest rate of working capital credits ($wcrdrate_i$) and price of composite intermediate commodities, ($p1_s_{c,i}$), which constitutes intermediate inputs. This in turn, affects the unit cost of production ($p1tot_i$) as indicated in equation (4).

In the above equations, $SHMT_i$ and $SHWCRD_i$ are share of producers' own financial resources and the banks' share of credits in financing

intermediate inputs, $SHCM_{c,i}$ shows the share of each of the composite commodities in forming intermediate inputs used in each of the private activities. Also, $SHFAC_{if}$ and $pIfac_{if}$ are, respectively, shares of primary inputs in the costs of production, and the prices of these inputs, $SHMAT_i$, $SHTAX_i$ and $SHSUB_i$ are shares of intermediate inputs, production taxes and subsidies in unit cost of production, $delPTXRATE_i$ and $delPSUBRATE_i$ are changes in rates of production taxes and subsidies. Also, $p2_{s,c,i}$ and $ivcrdrate_i$ are respectively the price of investment composite commodities and interest rate of investment credits in each private activities. $SHIVM_i$ and $SHIVCRD_i$ denote shares of investors' financial resources and banks' investment credits in financing investment costs, and $SHCOM_{c,i}$ is the share of each composite commodity in forming investment commodities.

Having the interest rate variables in equations (3) and (5), one can give any interest rate shocks including an increase or decrease in interest rate of credits supplied to any or all sectors and trace the effects of such shock on the economy of Iran.

There are three economic agents in the financial side of our RFCGE model. (i) private sector including households and private enterprises; (ii) public sector including government and public enterprises, and (iii) banks. The private sector is involved in production and investment in all industries except the 12 public industries, including crude oil and natural gas, tobacco and cigarette, oil products, main metals, energy, post and communication, banking, social security and government administrative services, defeat and fire services, education and training services, health and social services, and art, sport and cultural services.

In this model it is assumed that total credit demand for working capital and investment is constrained by total credits supplied by the banks in the economy. Demand for working capital credits is a function of the expenditure required to purchase intermediate inputs by private sector. Investment in physical assets by private sector in each activity is defined to be a function of available investment credits and the price index of investment goods in each activity. In addition to investing in physical assets, private sector invests some of its financial resources in

financial assets including “shares”, public bonds, and time deposits. Repayment of banks’ loans and keeping some cash constitute the other part of the financial expenditure of the private sector. The private sector’s demand for each of the financial assets, totally forms the assets portfolio, is a function of available financial resources and the rate of return of each asset. The cash currency demand in private sector is some percent of households and private enterprises expenditures as specified in the real side of the model.

Financial resources of public sector include savings of government and public enterprises, shares and bonds supplied to private sector, a share of bank resources, and foreign loans. These resources are used to finance physical investment expenditures, to pay public loans, to increase its share in public banks, to invest in other countries, to purchase foreign financial assets, to repay banks’ loans and to keep some bank deposits. Government is involved in production and investment of before mentioned 12 public industries. The physical investment of government in public activities is assumed to be a function of available financial resources and the price index of investment in those activities. The financial resources allocated in each public industry are a fixed proportion of total available public investment financial resources. As the allocation of bank credits to public sector is determined by the government and the central bank, the credit demand of public sector is assumed to be exogenous and no special behavioral equation has been defined in the model. Also, the purchasing foreign assets, providing loans to other countries and investment in other countries are assumed to be exogenously determined by government.

Banks, which play the role of linking between real and financial sides of the economy, are assumed to accept private and public sector’s savings as their deposits. Total amount of banks financial resources available to lend to public and private sectors is the sum of bank deposits, repaid loans, cash currency and foreign liabilities minus interest payments to depositors and payment of tax on their profit. Banks’ cash currency is some percent of total deposits and their foreign assets and liabilities, and is assumed to be exogenous.

Full linear equations of the financial side and definition of their variables and parameters are presented in appendices 1 and 2. Following Johansen (1960), the model is specified in the form of proportional rates of change in which variables are specified in a system of linear equations. In order to account for linearization errors associated with Johansen's approach, a multi step solution is obtained using GEMPACK software¹.

3. Data Base of the Model

The main source of data is the Iran input-output table for the year 2001 (Iran Statistical Centre, 2008). The National Accounts data and the balance sheet of banking system for the year 2001, published by the Central Bank of Iran, are the other sources of data used in this model. All these data have been presented in an interdependent, closed, and consistent system called real-financial social accounting matrix (RFSAM) which is compiled, based on our best knowledge, for the first time in Iran. The data on factor elasticities of substitution, Armington elasticities and other parameters are adopted from present literature².

4. Simulation Results³

Tables 2 to 7 report simulation results of reducing the interest rate of credits in the economy of Iran. These are discussed in turns as follows:

4.1. Effects on Production and Investment of Economic Sectors

By reducing the interest rate of working capital, credits supplied to economic sectors, the cost of intermediate inputs reduces, as interest rate payment is a part of each sector's intermediate costs. The same thing happens to the price of investment commodities following a reduction in the interest rate of investment credits which in turn results in a reduction

1- See Horridge (2000) for details on errors associated with linearized models.

2- Horridge (2000), Salami *et al* (1995) and Reinert & Ronald Holst (1992) are of the main references.

3- In presenting the results we have aggregated the impacts on different economic sectors into five sectors including agriculture, manufacture, mine, oil and gas, and services. Details of the effects are available on the request.

in the rental values of the capital goods in the economy. These price decreases lead to an increase in demand for inputs and a reduction in the unit cost of production and investment in economic sectors which finally lead to an expansion of production in Iran. Tables 2 and 3 report the percentage changes of production, investment, and price in different economic sectors.

As table 2 indicates, following a 4 percent decrease in interest rate of the credit supplied to different economic sectors, oil and gas sector experiences the highest production growth rate of 3.12 percent equivalent to 3576320 million Rials, and agricultural sector by the lowest growth rate of 0.39 percent equivalent to 526849 million Rials. In agricultural sector intermediate and capital inputs form 50 percent of production costs while, in oil and gas sector, intermediate and capital inputs constitute 98 percent of the production costs. Thus, an equal reduction in interest rate brings about a much less cost reduction in the former sector relative to the latter one. Therefore, the impact of such policy on the growth of production is much more revealed in the oil and gas sector as compared to the agricultural sector. It should be noted that the oil and gas sector is a public one which is not eligible to use banks' financial resources to finance its working capital and investment goods. Thus, the impact on production on this sector comes indirectly from using the other sectors' commodities as intermediate inputs and domestic investment commodities which have experienced cost reduction following the interest rate reduction in the economy.

According to table 2, the unit price of investment in oil and gas sector decreases by 0.69 percent which leads to a decrease in price of capital input. This results in an increase in demand for capital input, the main input in this sector, by 3.12 percent and causes an increase in investment in this sector by 2.28 percent and consequently an increase in production of the oil and gas sector by 3.12 percent (table 2) which is the largest growth rate among all other sectors. Expansion of production activities leads to an increase of 1.57 and 0.21 percent, respectively, in the availability of public and private financial resources (table 4). Furthermore, the production growth in all economic sectors while bring

about the prices of all productions in the economy, has resulted in an increase in demand for labor by all the economic sectors.

In addition and as it is expected, a reduction in interest rate in the economy causes a reduction in the rental price of capital input and the price of intermediate input wage of labor input and results in an increase in demand for these factors of production.

Table 2: Values of production and investment of economic sectors in base year and changes occurred following a 4% reduction in interest rate in all sectors

(Million Rials- percent)

Economic sector	Production in base year	Investment in base year	% change			
			Production	Price	Investment	Price
Agriculture	135,058,872	19,504,901	0.39	-0.38	1.15	-0.92
Manufacture	300,655,409	37,317,994	1.13	-0.71	1.25	-0.64
Oil & Gas	114,625,638	15,407,547	3.12	-0.67	2.28	-0.69
Mine	5,882,346	709,008	1.76	-0.60	0.86	-0.64
services	600,336,185	120,119,415	0.88	-0.52	1.61	-0.78

Table 3: Percentage change in demand and price of inputs in different economic sectors

Economic sector	Intermediate inputs		Capital		Labor		Land	
	Demand	Price	Demand	Price	Demand	Price	Demand	Price
Agriculture	0.46	-0.97	0.79	-0.93	0.34	0.00	0.00	0.76
Manufactur	1.02	-0.84	1.13	-0.67	0.97	0.01		
Oil & Gas	3.12	-0.44	3.12	-0.69	2.90	0.03		
Mine	1.76	-0.96	1.81	-0.64	1.61	0.02		
services	1.04	-0.88	1.00	-0.84	0.69	0.00		

Table 4: Value of investment financial resources in public and private sectors in base year and the percentage change due to interest rate reduction

Sector	Base year value	
	(Million Rials)	% change
Private	97,053,152	0.21
Public	96,005,720	1.57

4.2. Effects on macro economic variables

Table 5 reports the effects of interest rate reduction on some major macro economic variables. As this table indicates, the real GDP increases by 1.19 percent which reflects the growths of production in the economic sectors as presented in table 2. Based on this table, the financial repression policy, in terms of interest rate reduction, results in an increase in: overall employment, income of households, (both urban and rural), fixed capital formation, and a reduction in CPI. Furthermore, government income increases which results in an increase in the expansion of government expenditure. Since the price level has fallen following this policy, the need for households' expenditure in nominal term on both supernumerary and subsistence commodities has been reduced despite the fact that the income of this group has been raised by about 0.5 percent. Additionally, this table shows an increase in both export and imports and an improvement in the balance of trade by 0.1 percent. Production growth in economic sectors causes an increase of 2.84 percent in overall exports. On the other hand, increased production and investment increases the need for imported commodities in forms of intermediate inputs and investment goods which has resulted in a growth of imports by 0.43 percent. As the growth of export exceeds the growth of imports, an improvement in the balance of trade is resulted for the economy.

Table 5: Effects of interest rate reduction on national accounts

Variable		Base year value (Million Rials)	% change
Real GDP		733,908,480	1.19
Households' total consumption expenditure	Urban	323,937,600	-0.58
	Rural	92,233,912	-0.51
	Total	416,171,520	-0.57
Households' nominal supernumerary expenditure	Urban	262,405,078	-0.63
	Rural	74,963,630	-0.55
	Total	416,171,521	-0.61
Households' nominal subsistence expenditure	Urban	61,532,528	-0.61
	Rural	17,270,283	-0.53
	Total	78,802,812	-0.60
Government consumption expenditure		97,271,336	1.65
Fixed capital formation		193,058,864	1.86
Households income	Urban	371,765,472	0.53
	Rural	99,486,592	0.56
Government income		178,781,712	1.65
Enterprises income	Public	50,749,688	0.12
	Private	88,169,368	0.24
Export		153,882,380	2.84
Import		126,475,617	0.43
Balance of trade		-24,467,223	-0.10
CPI			-0.53
Employment			0.71
Wage income		296,400,384	0.71
Capital income		402,950,048	0.81

4.3. Effects on financial variables

Table 6 reports the effects of interest rate reduction on financial variables. Due to an increase in the income of both rural and urban households and a decrease in the consumption expenditures (table 5), this group experiences an increase in their savings. In addition, as the income increase of public and private enterprises and government exceeds their expenditure growth rate, a positive growth rate of saving

for these groups is resulted. The increased deposits of the banks (% 007) are the consequences of saving growths in the economy. This in turn results in an increase in the availability of financial resources to the private sector by 0.3 percent (table 7).

Table 6: Effects of 4 percent reduction in interest rate on financial variables

Financial variables		Base year value	% change
Households saving	Urban	38,549,440	8.64
	Rural	5,629,440	2.31
	Total	44,178,880	7.83
Enterprises saving	Public	39,388,704	0.08
	Private	80,265,392	0.24
Government saving		51,776,752	2.83
Bank deposit		64,498,832	0.07
Private sector's credits		99,143,000	0.30
Public sector's credits		16,042,609	0.00

Table 7: Changes in public and private sectors' deposits

Sector	% Change
Private	0.07
Public	0.01

5. Conclusion

A general conclusion from our simulation results is that implementation of financial repression policy in Iran may bring about positive effects for the economy of Iran, as it seems this policy has the potential to improve macro economic variables in the context of the economy of Iran.

Appendix 1: Equations of the Model

In all of the following equations “i” denotes industries and varies from 1 to 46, “c” denotes commodities which changes from 1 to 60, “s” represents source of each commodity (domestic/ imported) in composite commodities and takes values of 1 and 2, and “h” denotes households that are urban and rural. Because of the similarity between our models equations in production and fixed capital formation sections with those of the original ORANI-G model, it is not reported here.

1- Real side of the model

1. 1. Households Income, Expenditure and Saving

$$\begin{aligned}
 y3tot_h &= SHGHINCWAG_h . [p1lab_i + employ_i + a1lab_h] \\
 &+ SHGHINCRENT_h . [p1cap_i + x1capag_i + a1caph_h] \\
 &+ SHGHINCLREN_h . [p1lnd_i + x1lnd_i + a1lnd_h] \\
 &+ SHHRECINC_h . [nhrcv_h + p3toth_h] + SHHTRSINC_h . \\
 &[gtrs_h + p3tot] + SHHROWINC_h . [(p1labf + phi) + qhh] + fy3_h \\
 c3tot_h &= SHV3LUX_h . [x3lux_c_h + p3toth_h] + SHV3SUB_h . \\
 &[x3sub_c_h + p3toth_h] + SH3HPAYS_h . [nhpay_h + p3toth_h] + \\
 &SH3TAX_h . [y3tot_h + hhitxrate_h] + fc3_h SSI3_h \times hsav_h = y3tot_h \\
 &- [ESHI3_h \times c3tot_h]
 \end{aligned}$$

2. 1. Government Income, Expenditure and Saving

$$\begin{aligned}
 y5tot &= SHCAPGI . [p1cap_i + x1capag_i + a1capg] \\
 &+ \sum_{h=1}^2 SHIHTXG_h . [y3tot_h + hhitxrate_h] \\
 &+ \sum_{i=1}^{46} SHPTXG_i . [x1tot_i + p1tot_i + (100.delPTXRATE_i)] \\
 &+ \sum_{c=1}^{60} SHV0TRG_c . [x0imp_c + pf0cif_c + phi + t0imp_c] \\
 &+ SHROWG . [p1capf + xcapgf + phi] + SH6TAXGI . [itxrate \\
 &+ y6tot] + SH7TAXGI . [itxrate + y7tot] + SH8TAXGI . [itxrate \\
 &+ bkprofit] + fy5 c5tot = SHV5PUR . [p5tot + x5tot]
 \end{aligned}$$

$$\begin{aligned}
& + \sum_{i=1}^{46} \text{SHPSBG}_i \cdot [\text{x1tot}_i + \text{p1tot}_i + (100 \cdot \text{delPSUBRATE}_i)] \\
& + \sum_{c=1}^{60} \text{SHV0SBG}_c \cdot (\text{x0imp}_c + \text{pf0cif}_c + \text{phi} + \text{s0imp}_c) \\
& + \sum_{h=1}^2 \text{SH3TASG}_h \cdot (\text{grs}_h + \text{p3tot}) \\
& \text{SSH15} \times \text{gsav} = \text{y5tot} - [\text{ESH15} \times \text{c5tot}]
\end{aligned}$$

3. 1. Government Demand for Commodities

$$\text{x5}_{c,s} = \text{f5}_{c,s} + \text{GAPC}_{c,s} + \text{y5dis} - \text{p5}_{c,s}$$

4. 1. Public Enterprises Income, Expenditure and Saving

$$\begin{aligned}
\text{y6tot} &= \text{SHPBINCRENT} \cdot [\text{p1cap}_i + \text{x1capag}_{i\text{PubEnt}} + \text{alcappb}] \\
& + \text{SHROWPB} \cdot [\text{p1capf} + \text{phi} + \text{xcappbf}] + \text{fy6} \\
\text{c6tot} &= \text{SH6ITAX} \cdot [\text{itxrate} + \text{y6tot}] + \text{SHFRLNPY} \cdot [\text{frlon} + \text{frlnrate}] + \\
& \text{SHPBESHPRF} \cdot [\text{share} + \text{shpfrate}] + \text{fc6} \\
\text{SHSAV6} \times \text{savpbe} &= \text{y6tot} - [\text{SHEXP6} \times \text{c6tot}]
\end{aligned}$$

5. 1. Private Enterprises Income, Expenditure and Saving

$$\begin{aligned}
\text{y7tot} &= \text{SHPRINCRENT} \cdot [\text{p1cap}_i + \text{x1capag}_{i\text{PrivEnt}} + \text{alcappr}] \\
& + \text{SHROWPR} \cdot [\text{p1capf} + \text{phi} + \text{xcapprf}] + \text{fy7} \\
\text{c7tot} &= \text{itxrate} + \text{y7tot} \\
[\text{SHSAV7} \times \text{savpre}] &= \text{y7tot} - [\text{SHEXP7} \times \text{c7tot}]
\end{aligned}$$

2. Financial Side of the Model

I- Private sector

1. 2. Private Sector's Financial Resources

$$\begin{aligned}
\text{yivpriv} &= \sum_{s=1}^2 \text{SHSAVI3IV}_h \cdot [\text{hsav}_h] + \text{SHPRSAVI3IV} \cdot [\text{savpre}] \\
& + \text{SHPBNPRFIV} \cdot [\text{bond} + \text{pbbndrat}] + \text{SHHPRPRFIV} \cdot [\text{share} \\
& + \text{shpfrate}] + \text{SHHDPPRFIV} \cdot [\text{prdeposit} + \text{deprate}] \\
& + \text{SHCRDI3IV} \cdot [\text{sbhcreds}] + \text{SHSPBLONIV} \cdot [\text{shloans}]
\end{aligned}$$

2. 2. Demand Functions FOR Portfolio Assets and the Portfolio Price Index

$$\text{prdeposit} = \text{wprtfo} + \text{SIGMA3INV} \cdot [\text{deprate} - \text{p3inv}] + \text{a3dep}$$

$$\text{bond} = \text{wprtfo} + \text{SIGMA3INV} \cdot [\text{pbbndrat} - \text{p3inv}] + \text{a3pbnd}$$

$$\text{share} = \text{wprtfo} + \text{SIGMA3INV} \cdot [\text{shpfrate} - \text{p3inv}] + \text{a3shr}$$

$$\text{p3inv} = \text{SHBND} \times \text{pbbndrat} + \text{SHDEP} \times \text{deprate} + \text{SHSHR} \times \text{shpfrate}$$

3. 2. Demand Functions for Public Loans and Currency

$$\text{shloans} = \text{pbloans} + \text{a3pln}$$

$$\text{currency} = \sum_{h=1}^2 \text{SHHEXP} \times \text{c3tot}_h + \text{SHPREXP} \times \text{c7tot} + \text{a3cur}$$

4. 2. Demand Functions for Banks Credits

$$\text{SHPRCRD} \times \text{sbhcreds} = \text{bcreds} - \text{SHPBCRD} \times \text{sbpcreds}$$

5. 2. Repayment of Banks Credits

$$\text{lloan} = \text{sbhcreds} + \text{a3lln}$$

6. 2. Investment Financial Resources

$$\begin{aligned} \text{SHWCCRD} \cdot \text{swccredit}_i + \text{SHIVSRC} \cdot \text{invrespr} = & \text{SHBNPSRC} \cdot \\ & (\text{bond} + \text{pbbndrat}) + \text{SHSAPSRC} \cdot (\text{share} + \text{shpfrate}) + \text{SHDPPSRC} \cdot \\ & (\text{prdeposit} + \text{deprate}) + \text{SHCRDSRC} \cdot \text{sbhcreds} + \text{SHPLNSRC} \cdot \\ & \text{shloans} \end{aligned}$$

7. 2. Investment Function

$$\text{x2tot}_j = \text{invrespr} - \text{p2tot}_j \quad j \in i$$

8. 2. Average Interest Rate of Credits

$$\begin{aligned} \text{Crdrat} = \text{SHWCRED} \cdot \left[\sum_{i=1}^{46} \text{SHWCD}_i \times \text{wcrdrate}_i \right] + \\ \text{SHINVCRD} \left[\sum_{i=1}^{46} \text{SHICD}_i \times \text{ivcrdrate}_i \right] \end{aligned}$$

9-2. Average Interest Rate of Deposits

$$\text{crdrat} = \text{deprate}$$

II- Public Sector**10. 2. Public Sector's Financial Resources**

$$\begin{aligned} \text{yivpbiv} = & (\text{SHGSV} \cdot \text{gsav}) + (\text{SHPBSV} \cdot \text{savpbe}) + (\text{SHSHRS} \cdot \text{share}) \\ & + (\text{SHCRD} \cdot \text{sbpcreds}) + (\text{SHSBND} \cdot \text{spbnd}) + (\text{SHFRLIB} \cdot \\ & \text{pfrlb}) + \text{fy6iv} \end{aligned}$$

11. 2. Investment Financial Resources

$$\begin{aligned} \text{SHIVRES} \cdot \text{invrespb} = & \text{yivpbiv} - \text{SHPRBND} \cdot (\text{bond} + \text{pbbndrat}) - \\ & [\text{SHRPLN} \cdot \text{pbloan}] - [\text{SHPBFRV} \cdot \text{pbfriv}] - [\text{SHPDEP} \cdot \text{pbdeposit}] \\ & - [\text{SHPBLN} \cdot \text{pbloans}] - [\text{SHPBFRASST} \cdot \text{pfrast}] - [\text{SHCPACT} \cdot \\ & \text{capacont}] \end{aligned}$$

12. 2. Investment Function

$$\text{x2tot}_k = \text{invrespb} - \text{p2tot}_k \quad k \in i$$

13. 2. Remaining Financial Resources

$$\text{SHNIVRS} \cdot \text{ypbinvrm} = \text{yivpbiv} - \text{SHIVRES} \cdot \text{invrespb}$$

14. 2. Supply of Public Loans

$$\text{pbloans} = \text{ypbinvrm} + \text{a6spln}$$

15. 2. Repayment of Banks Credits

$$\text{pbloan} = \text{sbpcreds} + \text{a6plln}$$

16. 2. Banks Deposits

$$\text{pbdeposit} = \text{ypbinvrm} + \text{a6pdep}$$

17. 2. Increase in Banks Capital Account

$$\text{capacont} = \text{ypbinvrm} + \text{a6cpac}$$

III- Banks**18. 2. Banks Deposits**

$$\text{bkdeposit} = \text{SHPRDEP} \cdot \text{prdeposit} + \text{SHPBDEP} \cdot \text{pbdeposit}$$

19. 2. Banks Financial Funds

$$\begin{aligned} \text{ybnkinv} = & (\text{SHPBREP} \cdot \text{pblloan}) + (\text{SHHREP} \cdot \text{lloan}) + (\text{SHPUBDEP} \\ & \cdot \text{pbdeposit}) + (\text{SHPRVDEP} \cdot \text{prdeposit}) + (\text{SHCUR} \cdot \\ & \text{bcurrency}) + (\text{SHBFRLB} \cdot \text{bfrlib}) + (\text{SHCAPACT} \cdot \\ & \text{capacont}) + \text{fy8iv} \end{aligned}$$

20. 2. Banks Profit

$$\text{SHPFBKCD} \cdot \text{bkprofit} = (\text{bcreds} + \text{crdrat}) - \text{SHDPBKCD} \cdot (\text{hdeposit} + \text{deprate})$$

21. 2. Banks Currency

$$\text{bcurrency} = \text{SHPBDEP} \cdot \text{pbdeposit} + \text{SHPRDEP} \cdot \text{prdeposit} + \text{a8bcur}$$

22. 2. Supply of Banks Credits

$$\begin{aligned} \text{SHCRDBK} \cdot \text{bcreds} = & \text{y8inv} - \text{SHITXBK} \cdot [\text{itxrate} + \text{bkprofit}] - \\ & \text{SHDPPRBK} \cdot [\text{deprate} + \text{hdeposit}] - \text{SHFRASSTBK} \cdot \text{bfrast} + \text{a8bcd} \end{aligned}$$

Appendix 2: Variables of the Model

Table A.1: Endogenous Variables

bcreds	Bank credits
bcurrency	Bank currency
bkdeposit	Bank deposits
bkprofit	Bank profit
bond	Public bonds
c3tot _h	Households current expenditure
c6tot	Private enterprises current expenditure
c7tot	Public enterprises current expenditure
capacont	Increase in banks capital account
crdrat	Average interest rate of credits
currency	Households currency
deprate	Average interest rate of deposits
gsav	Government saving
hsav _h	Households saving
invrespb	Public sector's investment financial resources
invrespr	Private sector's investment financial resources
lloan	Repayment of credits by private sector
p1cap _i	Average capital rental
p1lab _i	Average nominal wage
p1lnd _i	Average land rental
p1mat _i	Average price of intermediates in each activity
p1tot _i	Average input/output price
p2tot _i	Cost of unit of capital
p3inv	Price index of private sector's portfolio

p3toth _h	Price index of households consumed commodities
p5 _{c,s}	Price of commodities consumed by government
p5tot	Price index, government
pbloan	Repayment of credits by public sector
pbloans	Demand for public bonds
prdeposit	Public deposits
pbdeposit	Private deposits
savpbe	Public enterprises saving
savpre	Private enterprises saving
sbhcreds	Private sector's credit demand
share	Private sector's share demand
shloans	Supply of public bonds
swccredit _i	Total working capital credits
wprtfo	Private sector's portfolio financial resources
x0imp _c	Total supplies of imported goods
x1capag _{i5}	Capital input owned by government
x1capag _{i_h}	Capital input owned by households
x1capag _{i_{PrivEnt}}	Capital input owned by Public enterprises
x1capag _{i_{PubEnt}}	Capital input owned by Private enterprises
x1lnd _i	Use of land in the economy
x1tot _i	Activity level
x2tot _i	Investment by using industry
x5 _{c,s}	Government basic demands
x5tot	Aggregate real government demands
xcapgf	Government's capital input in ROW
xcappbf	Public enterprises' capital input in ROW
xcapprf	Private enterprises' capital input in ROW

y3tot _h	Households current income
y5dis	Government disposable income
y5tot	Government current income
y6tot	Public enterprises current income
y7tot	Private enterprises current income
ybnkinv	Banks Financial funds
yivpbiv	Public sector's financial resources
ypbinvrm	Remaining financial resources of public sector

Table A.2: Exogenous Variables

a1capg	Capital augmenting technical change, government
a1cap _h	Capital augmenting technical change, households
a1cappb	Capital augmenting technical change, public enterprises
a1cappr	Capital augmenting technical change, private enterprises
a1lab _h	Labor augmenting technical change, households
a1lnd _h	Land augmenting technical change, households
bfrlib	Banks foreign liabilities
delPSUBRATE _i	Ordinary change in the rate of production subsidy
delPTXRATE _i	Ordinary change in the rate of production tax
f _{c,s}	Government demand shift
frlnrate	Interest rate of foreign loans
frlon	Foreign loans
GAPC _{c,s}	Average propensity to consume, Government
gtr _h	Government transfers to households
hhitrate _h	Interest rate of households income tax
itxrate	Interest rate of enterprises income tax
ivcrdrate _i	Interest rate of investment credits

nhpay _h	Net transfers of households to other households
nhrev _h	Net receives of households from other households
p1labf	Foreign wages
p1capf	Foreign capital rent
pbbndrat	Interest rate of public bonds
pf0cif _c	C.I.F. foreign currency import prices
pfrast	Public sector's foreign assets
pfrlb	Public sector's foreign liabilities
phi	Exchange rate
qhh	Number of households
sbpcreds	Public sector's credits
shpfrate	Interest rate of shares
s0imp _c	Power of imports subsidy
t0imp _c	Power of tariff
wcrdrate _i	Interest rate of working capital credits

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