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A Computable General Equilibrium Model for Evaluating the Effects of Value-Added Tax Reform in Iran

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Abstract: The present study uses a computable general equilibrium (CGE) model to investigate the impacts of implementing of VAT system on the Iran economy. A benchmark sequence of equilibria is compared with a counterfactual sequence of equilibria for measuring the effect of tax policy reform. Increasing of 3, 4 and 10 percent value-added tax rate are tree simulation scenarios. The results show that although Government revenue significantly manages to go up but gross domestic production and household's welfare goes down.

Key words: Value-added Tax Reform · Social Accounting Matrix · Computable General Equilibrium Model

INTRODUCTION

The Iranian government to increase investment, create opportunity of employment and enhance productivity decreased different rates of direct taxes in the law of direct taxation reforms in 2002, as a result, the government revenue declined. Therefore, the new tax system was needed to generate an increase in tax revenue which would allow the government to carry out development programs.

A main characteristic of Iran economy is the excessively dependence on production and export of crude oil. For example, in 2008, the oil sector in Iran generated 7% of the gross domestic product, 38% of the total government revenue and 51% of the total export. This high degree of dependency on revenue of crude oil is not suitable for Iran economy. Iranian authority decided to increase the share of tax revenue to reduce the dependence of oil revenue.

The government introduced and implemented the law of Value-Added Tax in 2008. Prior to its execution; the Iranian government used sale tax with many categories and several different types of dues. These dues were not imposed on all goods and activities. Some goods and activities were exempt from paying of dues. Several dues were obtained from other goods and activities. In these conditions, several problems occurred for the government, donors and due recipients. There were two major types of dues: domestic products and imported goods. Most of ministries including the Interior Ministry, the Ministry of Education, Ministry of Health and Medical Education, the Ministry of Culture and Islamic Guidance obtained dues. Duties on imports were include customs dues, Municipality dues and right record order and so on. Each category had different and especial rate of dues. After approval the law of VAT in 2008, most of dues from domestic producer and importers was assimilated and its rate was specified 3 percent. Simplification of the tax system was therefore another reason for the adoption of the VAT system.

However, any tax reform will affect the price level, resource allocation, employment, income, consumption and government revenue and expenditure.

Partial equilibrium and general equilibrium model are two important methods for calculating the effects of tax policy reforms. Partial equilibrium analysis examines the effects of proposed policy on resource allocation in the single market. In partial equilibrium analysis, the market demand and supply curve is not able to reflect the effect of relative price changes that occur in other markets and therefore can hardly produce a complete picture of the economy-wide impact of policy change. Unlike partial equilibrium analysis; in general equilibrium model all markets in the economy and theirs interactions are

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considered. For this reason, general equilibrium model is appropriate method for examining the effects of proposed policy on important economic variables. CGE model is the empirical application of the general equilibrium model for analyzing a real economic system. In other words, CGE model is a laboratory for economist.

The present study uses a computable general equilibrium (CGE) model to investigate the impacts of implementing of VAT system on the economy of Iran. A benchmark sequence of equilibria is compared with a counterfactual sequence of equilibria for measuring the effect of tax policy reform. Inducing of 3, 4 and 10 percent value-added tax rate are modeled as reform scenarios based on value-added law in Iran economy.

This paper is organized in five sections, including the present introductory section. A review of VAT system in Iran is presented in section 2. Section 3 provides a brief review of existing literature that is related to this research. The dataset and calibration procedure are described in the next section. Section 5 explains the simulation results. The last section concludes the paper.

Overview of VAT System in Iran: The value-added tax is imposed on all persons engaged in the business of selling goods and services, producers, importers and exporters. The basic rate of VAT for all goods and services except cigarettes (12%) and gasoline (20%) is 3 percent. However, the following sales of goods and services are exempted from taxation.

- Agricultural products in their natural state.
- Livestock and live birds, bees and aquatic.
- Fertilizer, pesticides, seeds and seedlings, animal feeds.
- Flour, bread, meat, sugar, rice, beans and soy, milk, cheese, vegetable oil and formula feeding for children.
- Paper, books and newspaper.
- Medicine, health services (whether for human or animal).
- Services subject to income taxation law.
- Banks and non-bank financial intermediaries.
- Public passenger transportation services.
- Educational and research services.
- Exportation of good and services.

Literature Review: General equilibrium corresponds to the well-known Arrow-Debreu model, elaborated in Arrow and Hohn (1971). Consumers maximize utility subject to the budget constraint and Producer maximizes profits. The zero homogeneity of demand function and the linear of homogeneity of profits in prices imply that only relative prices are any significance in such model. The absolute price level has no impact on the equilibrium outcome. Equilibrium in this model is characterized by a set of prices and levels of production such that the market demand equals supply for all commodities [1].

The work of Johansen [2] for the Norwegian economy is the first empirical example of a general equilibrium model that paved the way for the new type of non-linear multisectoral models. These so-called "computable general equilibrium"(CGE) models, became an empirical simulation laboratory for the quantitative analysis of the effects of economic policies and external shocks on the domestic economy.

The last three decades have witnessed an increased use of CGE models. Major areas of applications have been in taxation, international trade and to some extent in finance, macroeconomics, environmental and energy economics.

The study of tax incidence analysis using computable general equilibrium approach was pioneered by Arnold Harberger (1959, 1962) [3, 4]. In more recent years, many researchers have studied tax incidence analysis using CGE models. The leading economists in this field are Shoven and Whalley [5]. Shoven and Walley (1972) attempt to calculate the effects of differential taxation of income from capital in the U.S. In the 1985s, Ballard, Fullerton, Shoven and Walley (BFSW) developed the Harberger model. Their model included fifteen commodities, nineteen production sectors and twelve worker-consumer groups. Moreover, the structure of the model also changes. It becomes an open economy model with an extension in the consumption side, to include present and future consumption and labor-leisure choice. Their model has become a perfect example CGE model for tax policy evaluation [6]. A modified model by Ballard (1988, 2000) is used for the study of marginal cost of redistribution policy and health care programs [7, 8].

In 1993, Fullerton and Rogers extended the model to include the life time decision problem for estimating life time tax burden [9]. Further major contributions in the area of taxation have been provided by Feldstin and Slemord [1980, Ballentine and McLure [1980], Isaacson and Keller [1994], Broer and Lassila [1997] and among others. They analyzed the interaction between taxation and financial behavior for developed countries [10, 11, 12, 13].

The Adelman-Robinson model of Korea [1978] and Dervis, de Melo and Robinson's CGE model [1981] for development Policy is the first study in developing country [14, 15]. The main focus of these works is income distribution. Recently, CGE models have been used most frequently to study the impact of tax policy reforms and other area in developing country. Sahoo and Raa [2012] used a frontier- general equilibrium model for Indian economy. They categorized labor supply to skilled and unskilled labor. They investigated the productivities of skilled and unskilled labor between 1994 and 2002. Their CGE model contained endogenous labor supply equation that reflected the changes in skill labor over this period. Their results show skilled labor is underpaid in the initial period and overpaid in the second period. Unskilled labor is underpaid in both periods [16]. An empirical computable general equilibrium model was developed by Pauw and Leibbrantt [2012] for South Africa economy to simulate the effects of minimum wages on the poverty reduction. They found implementing of minimum wages will reduce poverty in South Africa [17]. Giesecke and Hoang Nhi [2010] employed a dynamic CGE model for Vietnam to analyze the welfare and distribution effects of simplifying the VAT system via adapting one rate and removing the multiple rates [18]. Cordano and Balistreri [2010] and Auriol and Warlters [2012] are two studies that use the CGE model to calculate the marginal cost of public funds (MCF) in Peru and 38 African countries respectively [19, 20]. Auriol and Walters's results indicate that VAT has low MCF and it is more efficient than other category taxes in African country. Hesham [2012] developed a dynamic general equilibrium model to evaluate the effects of removing subsidies from crude fuel on Iran economy. There are two alternative scenarios in his model. In the firs option, the extra revenue from the subsidy removal redistribute to household and in the second scenario it utilize to increase Investment. The results of firs scenario shows real GDP and household welfare increased but employment decreased. The result changes in the second option. Removing subsidies from crude fuel improve labor market in both short and long run [21].

Data and Calibration: Like other models, CGE model need to accurate and consistent data. A social accounting data (SAM) is a basic data for constructing CGE model. A social accounting matrix is a square matrix that depicts the interaction between different agents in an economy in a given year. Calibration is one of important issue in CGE modeling. It is the process of estimating the exogenous parameters in CGE models. The calibration of the model is basically conducted to replicate the equilibrium condition in a given year. In this study, the 1999 was chosen to map the Iranian economics transactions within a SAM framework. This SAM is the latest social accounting matrix that has been published by the Iranian central bank.

The values of household expenditure function are based on some study were done on the Iran economy. The Taylor approximation of the 2-input CES and direct econometric methods is used to specify the values of parameters on the production function and value added function. The values of parameters on the export and import function are obtained from literature review about Iran economy. Other parameters are estimated through calibration process.

Simulation Results

The Effects on Key Macroeconomic Variables: This part of the paper reports the simulation results of implementing a value-added tax reform in Iran. The number described below, unless otherwise specified, is reported in term of percentage changes from level that would have occurred in the initial tax steady state. In the designed scenarios, the government increases the value -added rate by 3%, 4% and 10%. Initially, implementing of the VAT will increase the indirect tax collection and, subsequently, the patterns of production and consumption and levels of household income will be changed. The impacts of the implementing of VAT on key macroeconomics variable are shown in Table 1. Like other CGE models, the price level is assumed to be fixed, then, all variables shown in the tables are real variables. A value-added tax is an efficient instrument to raise enormous tax revenue for government at a low tax rate. It is observed that Government revenue significantly increased in spite of the lower tax collection from the sectors with reduces output taxes and the lower household income. The increase in government revenue is due to the higher collections from the sectors with increased VAT tax rate. The household income is significantly fallen for both rural and urban household groups. It is consequence of the reduced labor wage in the whole of economy. Another reason for the reduction of household income is due to the increase in output prices. Because the increase in the government income could not compensate for the decrease in household income then gross domestic production (GDP) is declined. The percentage changes in GDP represent the VAT efficiency. It should be pointed out although the VAT was a more efficient revenue-raising instrument for government but it had negative effect on efficiency in the national economy. Finally, it is observed that enterpriser revenue is decreased. Decrease in enterpriser revenue is outcome of reduction in capital income.

Table 1: Percentage Changes in Key Variables

	3%	4%	10%
Gross Domestic Production	-0.26	-0.35	-0.95
Urban Household Income	-2.47	-3.22	-7.61
Rural Household Income	-2.45	-3.19	-7.56
Government Revenue	8.64	11.39	28.85
Enterpriser Revenue	-2.37	-2.93	-6.77

Table 2: Patterns of Output, Factors of Production, Household Consumption and Intermediate Input in 1999

Sector	Output	Labor	Capital	Household Consumption
Agriculture	13	22	17	19
Oil and Gas	8	1	15	0
Industry and Mining	29	19	20	45
Construction	8	11	2	1
Service	42	47	46	35
Total	100	100	100	100

Table 3: Percentage Changes in Domestic Production and Price of Output

	Production			Price of Output		
Sector	3%	4%	10%	3%	4%	10%
Agriculture	-0.25	-0.32	-0.76	-2.77	-3.58	-8.37
Oil and Gas	0.10	0.13	0.27	3.92	5.04	11.29
Industry and Mining	-0.86	-1.11	-2.58	0.72	0.93	2.28
Construction	1.55	2.01	4.61	5.72	7.68	20.80
Services	-0.58	-0.78	-2.16	-1.48	-1.89	-4.14

Table 4: Percentage Changes in Composite Goods and Price of Composite Goods

	Composite Goods			Price of Composite Goods		
Sector	3%	4%	10%	3%	4%	10%
Agriculture	-0.46	-0.60	-1.44	-2.87	-3.71	-8.59
Oil and Gas	1.12	1.41	2.88	9.29	11.95	26.56
Industry and Mining	-0.79	-1.02	-2.37	0.67	0.86	2.12
Construction	1.55	2.01	4.61	5.73	7.68	20.80
Services	-0.68	-0.92	-2.46	-1.54	-1.97	-4.32

Table 5: Percentage Changes in Domestic sales of locally-produced good

	Domestic sales			Price of Domestic sales		
Sector	3%	4%	10%	3%	4%	10%
Agriculture	-0.43	-0.57	-1.36	-2.99	-3.87	-8.96
Oil and Gas	1.12	1.41	2.89	9.29	11.95	26.56
Industry and Mining	-0.85	-1.09	-2.53	0.80	1.04	2.54
Construction	1.55	2.01	4.61	5.72	7.68	20.80
Services	-0.66	-0.89	-2.41	-1.59	-2.03	-4.45

Table 6: Percentage Changes in Labor Input

Sector	3%	4%	10%
Agriculture	-0.08	-0.08	-0.09
Oil and Gas	4.87	6.36	15.28
Industry and Mining	-0.45	-0.55	-1.05
Construction	2.42	3.16	7.61
Services	-0.64	-0.87	-2.42
Average Wage of Labor	-3.10	-4.10	-10.00

The Sectoral Effects: For better understanding and interpreting the results of sectoral effects, this section looks at the structure of output, factors of production and household consumption for each sector. One way of finding the importance of the sectors is to compare the share output of each sector in the total output. As Table 2 shows, the services sector has the largest share (42%) and the oil sector and construction sector have the lowest share (8%). The biggest sector-user of the labor is the services sector (47%). The next big users are agriculture and industry. A greater part of the capital usage is by the services sector (46%). A group of sectors with more or less the capital usage includes the industry and mining, agriculture and oil and gas sector. Industry and mining comprises a large percentage of household consumption (45%). After industry and mining sector, services sector with 35 percent and agriculture with 19 percent are important in household consumption.

One of strengths of computable general equilibrium models is that the sectoral results of policy changes can be analyzed in depth. The impacts of VAT on sectoral production and price of output are shown in Table 3 for all the alternative simulations. Table 3 shows that implementing of VAT leads to the fall of production in agriculture, industry and mining and services sectors but in oil and gas sector and construction sector expand. The same pattern happened for the composite goods and the domestic sales (Table 4, 5). The output price in all sectors except agriculture and services sectors has incremented. The same pattern occurred for price of composite goods and price of domestic sales (Table 4, 5). Since agriculture and many activities in services sector are exempted from the VAT, the output price of these sectors has declined. Because construction sector is more usage of industrial intermediate input and rising prices of intermediate input in the industrial sector, the highest output price increase has occurred in the construction sector. The household consumption in all sectors would decrease due to decline in household disposal income. However, the government has great role in the construction sector and the increasing in government demand could compensate the decreasing of household consumption and consequently production in this sector has increased.

The effect of implementing of VAT system on the labor market was shown in Table 6. The results turn out to be as expected and consistent with the output changes. The higher level of production requires an increased usage of the production factors. Table 6 shows an increase in labor forces for the oil and gas sector and construction sector with increased production. The decrease in employment is seen in industry and mining, services and agriculture sector. It is noticeable that production in these sectors decrease. The movement of labor across sectors is the result of the changes in output prices. Since labor is assumed to be fully employed, the total change in employment is zero. The average wage of labor is reduced in the whole of economy. It is due of decrease in gross domestic production. Since capital has a fixed sector-share, the capital and its price are unchanged.

CONCLUSION

A main characteristic of Iran economy is the excessively dependence on production and export of crude oil. This high degree of dependency on revenue of crude oil is not suitable for Iran economy. Iranian authority decided to increase the share of tax revenue to reduce the dependence of oil revenue by introducing and implementing the law of Value-Added Tax in 2008. However, any tax reform has implication for economic variables such as output, employment, inflation and government revenue and expenditure. In this paper, the CGE model was used to analyze the impacts of the implementing of 3, 4 and 10 percent value-added tax rate on Iran economy. The result of simulation indicates although government revenue increases significantly but household's welfare decline. Implementing of VAT causes the gross domestic production goes down. It is very important finding, because Iran economy is in recession now thus government should increase VAT rate gradually.

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Appendix

Mathematics of the Iran CGE model

Equations:

1- $$X_i = \alpha_i\left[\sigma_i AI_i^{-wi} + (1-\sigma_i)V_i^{-wi}\right]^{-1/wi}$$

2- $$\frac{AI_i}{V_i} = \left[\frac{\sigma_i PV_i}{(1-\sigma_i)PAI_i}\right]^{1/(1+wi)}$$

3- $$V_i = \beta_i\left[\theta_i L_i^{-wli} + (1-\theta_i)K_i^{-wli}\right]^{-1/wli}$$

4- $$\frac{L_i}{V_i} = \left[\frac{\theta_i PV_i}{\beta_i^{wli} PL_i}\right]^{1/(1+wli)}$$

5- $$\frac{K_i}{V_i} = \left[\frac{(1-\theta_i)PV_i}{\beta_i^{wli} PK_i}\right]^{1/(1+wli)}$$

6- $$INT_i = \sum_j A_{ij} AI_j$$

7- $$PAI_i = \sum_j A_{ij} PC_j$$

8- $$PV_i V_i = PX_i(1-TO_i) - PAI_i AI_i$$

9- $$\sum_i L_i = LST$$

10- $$\sum_i K_i = KD_i KST$$

11- $$YK = \sum_i PK_i K_i$$

12- $$HHT_h = (PL_i.\sum_i L_i.LSD_h) + YK.KH.KSD_h)THY_h$$

13- $$Y_h = (PL_i.\sum_i L_i.LSD_h) + YK.KH.KSD_h)(1-THY_h) + TRG.TRGD_h + TRF.TRFD_h.ER + YE.YE_h$$

14- $$HHS_h = SR_h.Y_h$$

15- $$C_{ih}PC_i = PC_i.CM_{ih} + (\mathrm{A}_{ih}(Y_h(1-SR_h) - \sum_I CM_{ih}$$

16- $$C_i = \sum_h C_{ih}$$

17- $$TEY = TER\ .YE$$

18- $$YE = (PL_i.\sum_i L_i.LSD_E).+YK.KED).(1-TER) + TRG.TRGED + YE.YEED$$

19- $$YE = YE.YEHD + YE.YEED + TEY + ESAV$$

20- $$YG = \sum_h HHT_h + \sum_i TA_I.P_I.X_I + \sum TC_I.PC_i.D_i + \sum TV_I.PV_i.V_i + \sum TE_I.E_I.WPE_I + \sum TM_I.M_I.WPM_I + YK.KGD + TEY$$

21- $$G_i = GEP_i.GTOT_i$$

22- $$YG = \sum_i PC_i.G_i + \sum_h TRG.TRGD_h + TRG.TRGED + TRG.TRGD_R + GSAV$$

23- $$Pe_i = WPE_i(1+TE_i)ER$$

24- $$Pm_i = WPM_i(1+TM_i)ER$$

25- $$Q_i = \theta 2_i\left[\gamma 2_i M_i^{-\rho Mi} + (1-\gamma 2_i)D_i^{-\rho Mi}\right]^{-1/\rho Mi}$$

26- $$\frac{M_i}{D_i} = \left[\frac{\gamma 2_i PD_i}{(1-\gamma 2_i)PM_i}\right]^{1/(1+\rho Mi)}$$

27- $$X_i = \theta 1_i\left[\gamma 1_i E_i^{-\rho Ei} + (1-\gamma 1_i)D_i^{-\rho Ei}\right]^{-1/\rho Ei}$$

28- $$\frac{E_i}{D_i} = \left[\frac{\gamma 1_i PD_i}{(1-\gamma 1_i)PE_i}\right]^{1/(1+\rho Ei)}$$

29- $$P_i X_i = PD_i D_i + PE_i E_i$$

30- $$Pc_i PQ_i = PD_i D_i + PM_i M_i$$

31- $$TOTSAV = \sum_h HHS + GSAV + ESAV + TKF.ER$$

32- $$KDELT = TOTSAV - \sum_i INV_i PC_i$$

33- $$INV_i = INVP_i.X_i$$

34- $$\sum_j B_{ji} PC_i KDEL_i = KDELP_i.KDELT$$

35- $$IND_i = \sum_j B_{ij} PC_i KDEL_j$$

36- $$Q_i = C_i + INT_i + IND_i + INV_i + G_i$$

37- $$TKF = \sum_i WPM_i.M_i - \sum WPE_i.E_i + TRF$$

38- $$\sum \Omega_i PC_i = PINDEX$$

Parameters:

α_i, δ_i Shift and share parameters of the production function

ω_i Exponent parameter of the production function

β_i, θ_i Shift and share parameters of the value-added function

A_{ij} Input-output coefficients

TA_i Activity tax rate

TV_i Value added tax rate

KD_i Distribution of capital stock

LSD_i Distribution of labor for households

KSD_i Distribution of capital income for households

KHD Proportion of capital income that goes to Households

$TRGD_h$ Distribution of transfers from the Government to the households

$TRFE_h$ Distribution of transfers from the foreign sector to the households

SR_h Household savings rate

A_{ih} Household marginal budget shares

CM_{ih} Household subsistence level of consumption

TER Enterpriser Tax Rate

KED Proportion of capital income that goes to enterpriser

$LSDE$ Distribution of labor to the enterpriser

$TRGED$ Distribution of transfers from the Government to enterpriser

$TRFED$ Distribution of transfers from the foreign sector to enterpriser

$YHED$ Distribution of household income to enterpriser

$YGED$ Distribution of government income to enterpriser

$YEED$ Distribution of enterpriser income to enterpriser

YED_h Distribution of enterpriser income to household

TC_i Commodity tax rate

TE_i Export tax rate

TM_i Import tax rate

KGD Proportion of capital income that goes to government

$TRFDG$ Distribution of transfers from the foreign sector Government expenditures proportion

GEP_i Distribution of transfers from the Government to foreign sector

WPE_i World price of exports

MPM_i World price of imports

$\theta 1_i, \gamma 1_i$ Shift and share parameters of the CET function (export)

ρE_i Exponent parameter of the CET function

$\theta 2_i, \gamma 2_i$ Shift and share parameters of the Armington function (import)

ρM_i Exponent parameter of the Armington function

B_{ij} Capital composition proportion

$INVP_i$ Inventory proportion

$KDELP_i$ Capital expenditures proportion

Ω_i Proportion of domestic consumption

Endogenous Variables:

X_i Domestic Production

AI_i Intermediate inputs

V_i Value-added

L_i Labor

K_i Capital

PV_i Price of value-added

PAI_i Price of intermediate inputs

PL Price of labor

PK Price of capital

P_i Price of output

INT_i Intermediate goods demand

YK Capital income, net of taxes

Y_h Household income

HHT_h Household taxes

HHS_h Household savings

C_{ih} Household consumption

C_i Consumption

YG Government revenue

G_i Government Demand

$GSAV$ Government savings

YE Enterpriser revenue

$ESAV$ Enterpriser savings

TEY Enterpriser Taxes

$TOTSAV$ Total savings

INV_i Inventory

$KDELT$ Total capital expenditures

$KDEL_i$ Capital expenditures by destination

IND_i Capital goods by origin

E_i Exports

M_i Imports

Q_i Composite good

D_i Domestic sales of locally-produced good

PE_i Domestic price of exports

PM_i Domestic price of imports

PC_i Price of composite good

PD_i Price of domestic sales

ER Exchange rate

$PINDEX$ Consumer Price Index

Exogenous Variables:

LST	[15,479,289]	Supply of labor
KST	[1,482,220]	Supply of capital
GTOT	[62,823]	Total government expenditures
TR	[10,110]	Government transfers
TRF	[-1,190]	Transfers from foreign sector
TKF	[27,999]	Total savings of foreign sector or net borrowings from ROW