Iran. Econ. Rev. Vol. 23, No. 2, 2019. pp. 451-468

The Estimation of the Rebound Effects in Household Sector: The Case of Iran

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Received: July 24, 2017 Accepted: April 29, 2018

Abstract

In recent years, the so-called Rebound effects that stem from energy efficiency gains have been of increasing interest in the economic literature. This effect happens when improvements in energy efficiency stimulate energy demand rather than decrease it. In the recent paper using Social Accounting Matrix data on the economy of Iran, the previous research has been extended on this field by evaluating the rebound effects on urban and rural household's sectors. In order to measure the degree of the rebound effect, the CGE model of Iran with household sectors was used and the simulation study, assuming an exogenous energy improvement was conducted. Based on the results of the empirical analysis in this work, the highest size of the rebound effect corresponding to the urban household's sector was found to be approximately 6.2 when oil and natural gas energy efficiency improves by 5%. Of course, except for electricity, in the rest of the cases there is a backfire. Moreover, in the rural households, the highest size of the return effect is 2.06 and belongs to the distributed gas energy. Therefore, the energy conservation policy promoted by the Iranian government may be unable to attain the desired goal.

Keywords: Rebound Effect, Energy Efficiency, CGE Model, Iranian Economy, Household Sector.

JEL Classification: O13, P28, H31, R2, C68.

1. Introduction

The low level of energy efficiency and waste of about one-third of the total energy consumption processes as well as increasing environmental problems resulted from which, increase the need for energy efficiency improvements.

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however according to some of the evidences available in some countries, improving energy efficiency resulted from reducing the energy consumption may be feasible only in the short term and in the case of the long term period, the energy consumption returns to the starting point or even increases as a result of technological shocks or performance improvements.

Undoubtedly, energy sources, and in particular fossil fuels, today are considered as one of the most important sources in the industrial cycles, so that it is by no means possible to abandon these resources by relying on any other sources of energy. Meanwhile, countries such as Iran, with no extra cost and only with the cost of extraction, are widely available to exploit these resources. Perhaps this is a reason for the insignificance and even neglecting of the proper use of fossil fuels based on economic logic, and the result is that the use of fossil fuels in the production process in Iran is much higher than global defined standards.

Therefore, the limitation of fossil fuels and high energy consumption have led the government to seek appropriate tools and strategies to reduce fuel consumption. One of the important strategies for optimizing and reducing fuel consumption is increasing energy efficiency which is possible through the use of advanced technologies and technological shocks. On the other hand, improving efficiency can lead to lower energy prices and due to the country's unemployment rate and vacant production capacities, demand for energy will increase.

Therefore, in the Iranian economy, it is necessary to examine the actual effects of improving the efficiency of energy consumption. The need to assess the economic impact has led to the advancement and development of new methods that can more accurately predict the effects of implemented policies. Over the past twenty years, there have been many innovations in the methodology of analyzing the macroeconomic effects of policies, which the computable general equilibrium models are the result of such innovations.

The main objective of this paper is to calculate the rebound effects of improving the efficiency of oil and natural gas, petroleum products, distributed gas and electricity used by rural and urban households in Iran. In this paper using social accounting matrix data on the Iran economy in 2012 a previous research on this field was extended by evaluating the rebound effects in household sector under two scenarios. In order to measure the degree of the rebound effect, the CGE model of Iran country with household sector was used and a simulation study, assuming an exogenous energy improvement was conducted.

The remainder of the paper has been structured as follows. First in Section 2, the literature of rebound effect in the general equilibrium has been presented. Then in Section 3, a standard CGE model of the Iran economy has been designed. Then in Section 4, the simulation strategy and the results of simulation have been presented. Finally, the conclusions has drawn in section 5.

2. The Rebound Effect: Literature Review

The view that economically improving energy efficiency increases the energy consumption rather than a reduction in energy use originally proposed by the British economist William Stanley Jones in 1865, which is known as the Jones paradox. After those two economists, Khazzoom (1980) and Brooks (1979, 1990), followed suit and argued in the initial formulation: With constant energy prices, improving energy efficiency increases energy consumption to a higher level than it would be without this improvement. (Saunders, 1992).

Subsequently, different countries began to study more precisely the energy efficiency and its effects on economic variables and achieved different results. In the studies of some energy researchers, the economy-wide rebound effects has studied and has been dismissed (Howarth, 1997; Laitner, 2000; Schipper and Grubb, 2000).

Johen Laitner and Donald Hanson (2006) looked at the issue of how cost-effective technologies could increase productivity in the industry and showed how changes in energy efficiency and technical investments can be effective in policymaking. The study of Laitner and Hanson was a technical approach study. Using a computable general equilibrium model, they found that using the hybrid approach could reduce the use of energy.

Allan et al. (2007) tested the belief that improving energy efficiency results in lower energy consumption. They pointed out that the rebound effect is due to the improvements in energy efficiency.

Because the improvements in energy efficiency decreases the effective price of energy services, and the reaction of the economic system to this price decline is offsetting some of the expected benefits of increasing energy efficiency. Therefore, they used a computable general equilibrium model and considered the effects of 5% increase in energy efficiency in all sectors. The short-term rebound effects were above 50%, while these effects were estimated to be about 30% in the long run, and the rebound effects were different for different energies.

Davis (2008) examined the demand of households and their sensitivity to water consumption. His review showed that with the advancement in the technology of washing machines, more volume was washed off in a shorter period of time, and finally it was concluded that the resulting rebound effects were also due to a change in energy efficiency and as a result of a change in energy services. Following his research in 2014, he examined the net effects of changes in the energy efficiency of fridges and air ventilators in parts of Mexico. As a result of increased efficiency, overall power consumption fell by only seven percent, and a huge shift in energy services was caused by revenue effects.

Patrizio Lecca et al. (2014) examined the economic effects of a five percent improvement in household energy efficiency in England. The results of this study showed that the magnitude of return effects depends on household income, aggregative economic activities, and relative prices. In the short run, the return effects of the household sector were 71.4 and the total return effects were 68.7. In the case of long run, the household rebound effects and total rebound effects were changed to 68.2 and 63.9 respectively.

Despite all the ongoing efforts and studies, there are some ambiguities about how to define and measure the rebound effect as well as determine its unreliability. Moreover, the existing studies cannot easily be compared, meaning that some parameters such as the region, area, final applications, analysis period and how to improve performance differ from one study to another. It seems that the rebound effects depend on some specific aspects of the policies which increase the efficiency, however most of these aspects are ignored (Azevedo, 2014).

Other studies are even wider and include any additional energy use that has not been counted by direct rebound effects (including macroeconomic effects) as a part of an indirect rebound effects. (Sorrell and Dimitropoulos, 2008)

Borenstein (2015) provides a theoretical framework in which the rebound effect divides into the substitution and income effects. In this framework a new understanding of the rebound effects when the pricing of goods is not in accordance with the final costs, was provided. Moreover, in this framework the customers did not do the optimization completely. One way to calculate the rebound effects is to use the following equations:

In the following equations[1]. E is natural units of energy and ε is efficiency unit (effective energy service). If there is a technological improvement or energy efficiency improvement with the rate of ρ, the relationship between the percentage change in physical energy use, $\dot{E}$, and the energy use measured in efficiency units, $\dot{\varepsilon}$ is given as:

$$\dot{\varepsilon} = \rho + \dot{E} \tag{1}$$

Equation (1) shows that, for example, with a 5% increase in energy efficiency, and if the amount of physical energy is constant, 5% increase in effective energy will be created.

$$\dot{P}_{\varepsilon} = \dot{P}_{E} - \rho \tag{2}$$

Equation (2) shows the change in relative prices. Using the same numerical example as equation (1), with the assumption of stable physical energy prices, 5% improvement in energy efficiency results in 5% reduction in energy prices. Moreover, with constant physical energy prices, it is expected that a drop in energy-efficient prices increases the energy demand, which is the source of the rebound effect. In the framework of general equilibrium:

$$\dot{\varepsilon} = -\eta\dot{P}_{\varepsilon} \tag{3}$$

1. The base of these equations comes from Herring and Sorrell (2009: 69-70).

Where η is the general equilibrium price elasticity of demand for energy and has been given a positive sign. By replacing equations 2 and 3 in equation 1, changes in physical energy demand are achieved as follows:

$$\dot{E} = (\eta - 1)\rho \qquad \mu = 1 + \frac{\dot{E}}{\rho} \tag{4}$$

Therefore, for an efficiency increase of ρ, the rebound effects (R) are obtained as follows:

$$R = 1 + \frac{\dot{E}}{\rho} \tag{5}$$

Therefore, given the above relation, when the rebound effect is unified, it means that there is no change in energy consumption as a result of the change in energy efficiency. When the effect is greater than zero and smaller than one, it assumes that there is a certain amount of energy saving as a result of improving energy efficiency, but this is not the total increase in efficiency. For example, if 5% increase in efficiency results in 4% energy reduction, twenty percent of the rebound effect is generated. (Allan et al., 2006)

3. CGE Model and Empirical Analysis

Based on the microeconomic foundations is the strongest point of the general equilibrium models; general equilibrium models stipulate the behavior of all economic agents by employing accepted principles of optimization and choice, which is very essential in experimental works. These models combine and investigate the behavior of all the economic agents in a market-based framework in equilibrium and symmetry conditions. Moreover, with such a feature of the general equilibrium models, examination of behavior of the economic agents with high-transparency is possible. The general equilibrium models make it possible for analysts to model and simulate complex equations, clarify the role and effect of various factors, and reinforce the economic analysis with new and sometimes remarkable results as well.

The model in this study for simulation and implementation of different scenarios, is a Standard Computable General Equilibrium model (Lofgren, 2002). In this model agricultural, industrial, oil and gas, electricity, service, construction activities and also agricultural, industrial and mining, crude oil and natural gas, electricity, transportation services, other services, petroleum products, distributed gas, water, transaction goods and construction are used.

The blocks are 4 and their titles and equations are as following:

Equations		
Description		**row**
	Price block	
Export price	$PE_c = pwe_c .(1+te_c).EXR$	1
Import price	$PM_c = pwm_c.(1+tm_c).EXR$	2
Demand Price of domestic non traded goods	$PDD_c = PDS_c + \Sigma PQ_c .icd_{c'c}$	3
Absorption	$PQ_c .QQ_c = (PDD_c .QD_c + PM_c .QM_c).(1+tq_c)$	4
Market output value	$PX_c.QX_c = PDS_c.QD_c + PE_c.QE_c$	5
Activity price	$PA_a = \Sigma PXAC_{ac} .\theta_{ac}$	6
Value added price	$PVA_a = PA_a \sum_{c\in C} PQ_c .ica_{ca}$	7
	production and trade block	
Activity Production function	$QA_a = ad_a \prod_f QF_{fa}^{\alpha_{fa}}$	8
Input demand for any productions activity	$\overline{WF_f} . WFDIST_{fa} = \frac{(a_{fa}).PVA_a(a_{fa}). QA_a}{QF_{fa}}$	9
Demand of intermediate input	$QINT_{ca} = ica_{ca} .QA_a$	10
Production function	$QX_c = \Sigma \theta_{ac} .QA_a$	11

Demand for Transactions Services	$QT_c = \sum icd_{c,c'} . QD_c$	12
Composite Supply (Armington) Function	$QQ_c = aq_c . \left(\delta_a^q . QM_c^{v\rho_c^q} + (1v\delta_c^q) . QD_c^{v\rho_c^q}\right)^{v\frac{1}{\rho_c^q}}$	13
Import-Domestic Demand Ratio	$\frac{QM_c}{QD_c} = \left[\frac{PDD_c}{PM_c} . \frac{\delta_c^q}{1v\delta_c^q}\right]^{\frac{1}{1+\rho_c^q}}$	14
Composite Supply for Non-imported Outputs and Non produced Imports	$QX_c = QD_c$	15
Output Transformation (CET) Function	$QX_c = at_c \left(\delta_c^t * QE_c^{\rho_c^t} + (1-\delta_c^t) . QD_c^{pc}\right)^{\frac{1}{\rho_c^t}}$	16
Export-Domestic Supply Ratio	$\frac{QE_c}{QD_c} = (\frac{PE_c}{PD_c} . \frac{1-\delta_c^t}{\delta_c^t})^{\frac{1}{\rho_c^t - 1}}$	17
Output Transformation for Domestically Sold Outputs Without Exports and for Exports Without Domestic Sales	$QX_c = QD_c$	18
Investment Demand	$QINV_v = \sum_s \overline{qinv_{v,s}} . IADJ$	19
accumulation transmission	$QAC_s = \sum_v \overline{qinv}_{vs} . IADJ + QFIN_s$	20
INSTITUTION BLOCK		
income of household h from factor f	$YF_{hf} = shry_{hf} (\sum_a WF_f . WFDIST_{fa} . QF_{fa} + tr_{f,row} . EXR)$	21
income of household h	$YH_h = \sum_f YF_f + \sum_i tr_{hi} + \sum_f tr_{f,row} . EXR$	22

consumption of commodity c by household h	$QH_{ch} = \frac{\beta_{ch}(1-MPS_h)(1-ty_h)YH_h}{PQ_c}$	23
Income of domestic, Nongovernment Institutions	$YF_{ins,f} = shry_{ins,f}(\sum_f WF_f . WFDIST_{fa} . QF_{fa} + tr_{f,row} . EXR)$	24
Firms Revenue	$YI_i = \sum_f YF_{i,f} + \sum_i tr_{i,i'} + \sum_f tr_{f,row} . EXR$	25
Firms expenditure	$EI = \sum_c PQ_c . qi_c + \sum_i tr_{i,i'} + \sum_f tr_{f,row} . EXR$	26
Fixed capital formation	$QDINV_c = \sum iiv_{c,v} . QINV_v$	27
Money Demand	$QFIN_s = ifi_s . YI_i$	28
Government Revenue	$YG = \sum_h ty_h . YH_h + \sum_c tq_c . (PDD_C . QD_C + PM_C . QM_C) + \sum_{CM} tm_c . EXR . pwm_c . QM_c * EXR + \sum_{c\in CE} te_c . EXR . pwe_c . QE_c . EXR + ty_{ins} . YI + tr_{gov,row} . EXR$	29
Government expenditure	$QG_c = qg_c . GADJ$	30
Total government expenditure	$EG = \overline{\sum_{c\in C} PQ_c} . QG_c + \sum tr_{i,gov}$	31
Government oil revenues	$YG_{oil} = rgo.QX_{oil} . PX_{oil}$	32
SYSTEM CONSTRAINT BLOCK		
Factor Markets	$\sum QF_{f,a} = \overline{QFS_f}$	33
Composite Commodity Markets	$QQ_c = \sum_{a\in A} QINI_{c,a} + \sum_{h\in H} QH_{c,h} + QC_c + QDINV_c + qi_c + QT_c$	34
current account balance for the rest of the world in terms of foreign	$\sum_{c\in CM} pwm_c * QM_c + \sum_{f\in F} transfr_{row,f} + OCAP = \sum_{c\in CE} pwe_c * QE_c + \sum_{i\in INSD} transfr_{i,row} + \overline{FSAV}$	35

currency		
Savings–Investment Balance	$\sum_h MPS_h*(1-ty_h)*YH_h+(YG-EG-tr_{row,gov}.EXR)+(YI-EI-ty_{ins}.YI)+$ $\sum_s \overline{qfin}_s=\sum_v QINV_v+\sum_s QINV_v+WALRAS$	36
Balance in financial market	$\sum_s QFIN_s+\overline{FSAV}.EXR=\sum_s \overline{qfin}_s+OCAP.EXR$	37
Normalization of prices	$\sum_c cwts_c.PQ_c=cpi$	38

3.1 Calibration and Simulation

An important issue is that CGE models are often calibrated using data from the SAM. In this process it is presumed that the economy is in equilibrium in the base year. The parameters of a CGE model are generally determined in three ways: First, structural parameters are given by the base-year data (SAM). Second, key parameters (e.g. substitution elasticities) are identified by the econometric estimation or informed judgment involving literature review. These parameters are imposed in the model but may be subjected to the sensitivity analysis. Third, all the remaining parameters are determined through calibration to the base-year data set (the SAM) which involves assuming that the base-year SAM reflects a long-run equilibrium so that running the model with no change in exogenous variables reproduces this equilibrium. One of the purposes of this paper is to estimate or calibrate the energy efficiency parameters. Since one of the energy efficiency indexes is the reversal of energy intensity, it is calibrated by estimating the energy intensity in different sectors:

$$QINT_{ca}=ica_{ca}.QA_a$$

$QINT_{ca}$: Quantity of commodity c as intermediate input in activity a

ica_{ca}: Quantity of c as intermediate input per unit of output in activity a

QA_a: Level of activity a

At this stage, the energy intensity factor (the consumption of energy to the level of activity) is calibrated as an indicator of energy efficiency. By using simulation, the effects of improving energy efficiency on different energy consumptions by urban and rural households are estimated in two scenarios of 5% and 20%, and thus, efforts have been made to make the rebound effects quantitative. After description and calibration of the CGE model, the simulation outcomes were summarized:

4. Results

4.1 The Rebound Effects of Improving Energy Efficiency in the Urban Household Sector

This section calculates the return effects resulting from improvements in the energy efficiency of 5% and 20%, which listed in the following tables:

Table 1: The Rebound Effects of Improving the Efficiency of Crude Oil and Natural Gas in Urban Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	**6/2**	**5/32**
Electricity	0/82	1/04
Petroleum products	4/32	1/64
Distributed gas	1/82	1/32

Table 2: The Rebound Effects of Improving the Efficiency of Electricity in Urban Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	-8/12	-5/34
Electricity	**-0/77**	**0/92**
Petroleum products	2/64	1/12
Distributed gas	4/45	0/77

Table 3: The Rebound Effects of Improving the Efficiency of Petroleum Products in Urban Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	27/16	3/52
Electricity	1	0/97
Petroleum products	**1/08**	**1/57**

Distributed gas	2/12	1/58

Table 4: The Rebound Effects of Improving the Efficiency of Distributed Gas in Urban Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	17/16	1/36
Electricity	0/92	0/98
Petroleum products	2/18	1/54
Distributed gas	**2/12**	**1/88**

4.2 The Rebound Effects of Improving Energy Efficiency in Rural Household Sector

Table 5: The Rebound Effects of Improving the Efficiency of Crude Oil and Natural Gas in Rural Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	**2/02**	**0/66**
Electricity	0/82	1/04
Petroleum products	4/36	1/66
Distributed gas	1/72	1/30

Table 6: The Rebound Effects of Improving the Efficiency of Electricity in Rural Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural	-10/86	-5/44
Electricity	**-0/71**	**0/92**
Petroleum products	3/05	0/78
Distributed gas	5/18	1/45

Table 7: The Rebound Effects of Improving the Efficiency of Petroleum Products in Rural Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	3/71	0/58
Electricity	1	0/97

Petroleum products	**1/22**	**1/79**
Distributed gas	1/34	1/44

Table 8: The Rebound Effects of Improving the Efficiency of Distributed Gas in Rural Households

	5% scenario(improve in energy efficiency)	20% scenario
Crude oil and natural gas	-1/03	1
Electricity	0/92	0/98
Petroleum products	2/31	1/63
Distributed gas	**2/06**	**1/85**

5. Conclusions

In urban households, according to the results of the tables presented in the last section, by improving the efficiency of crude oil and natural gas, the consumption of crude oil and gas in both scenarios has raised, which increased the efficiency up to 20 percent, moreover the rebound effects reduced accordingly.

As the electricity efficiency improves, the energy consumption reduced, and since the rebound effects are between zero and one, therefor some energy savings were also made. The consumption of petroleum products in the urban household sector has a rebound effect of more than one that with increasing efficiency to 20%, the return effect increased and back fire was created.

With the improvement in natural gas efficiency in urban households, an increase in consumption was observed, which according to the table 4, the corresponding rebound effect became more than one. By increasing the efficiency to 20%, the amount of rebound effect decreased.

In rural households, by improving the efficiency of crude oil and natural gas, in the first scenario, the consumption of energy raised sharply, with 20% improvement in energy efficiency, the rebound effect has declined.

By improving the electricity efficiency, in the case of 5% scenario the energy consumption decreased, however in the case of 20% scenario, the rebound effect was higher than 5% scenario which means somehow an increase in energy consumption occurred.

However according to the results, the rebound effect was between zero and one, which demonstrates some energy storage.

In case of 5% scenario by improvements of petroleum products efficiency, the products consumption increased and a rebound effect more than one was observed. Moreover, increasing the petroleum products efficiency to 20% increased the rebound effect.

According to the results of the last section tables, with the improvement in the efficiency of distributed natural gas, generally energy consumption was increased, and because the return rate is greater than one, the back fire was created. By increasing the efficiency to 20%, the amount of rebound effect decreased.

In developing countries such as Iran inevitable factors such as population growth, urban development, welfare and industrial enhancement lead to increase in energy consumption. This results are on the line with Vander Berg (2011) findings. Of course effective measures such as development of standards and criteria for energy labeling, establishing and developing of the national energy saving laboratory, energy optimization and load management in industries, energy audit in buildings, development of optimization consulting software and training and awareness-raising activities have been taken by Ministry of Power to optimize the energy consumption in the country.

But in spite of the accomplishments, there is still huge potential for energy consumption optimization in the country. Regarding the growth of household energy consumption and its contribution to the total energy consumption, implementation of appropriate policies for optimizing and saving energy, as well as reforming the household energy consumption model, will be one of the beneficial factors in reducing energy consumption without decreasing economic growth.
Some factors such as informing or awareness-raising, training, more efficient use of energy by households, increasing energy prices and bringing the prices closer to the costs, reducing the urbanization process, improving the quality of buildings from lower energy consumption perspective could increase the energy efficiency and reduce the energy consumption.

Household energy consumption are factors that can increase energy efficiency and reduce energy consumption. It is suggested that policies such as pricing or tax policies that expose household spending to non-energy consumption should be implemented in order to transform the household consumption structure, which will be visible in the forthcoming years.

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Appendix

definitions	Symbol	definitions	Symbol
a set activities	$a \in A$	a set of imported commodities	$c \in CM\ (\subset C)$
a set of commodities	$c \in C$	a set of non-imported commodities	$c \in CMN(\subset C)$
a set of domestic trade inputs	$c \in CT\ (\subset C)$	a set of commodities with domestic output	$c \in CX(\subset C)$
a set of exported commodities	$c \in CE\ (\subset C)$	households	$h \in H$
a set of non-exported commodities	$c \in CEN(\subset C)$	Production factors	$f \in F$
import tariff rate	tm_c	=transfers from institution i to household h	tr_{hi}
export tax rate	te_c	income of factor f from other countries	$tr_{f,row}$
yield of output c per unit of activity a	θ_{ac}	a CET function exponent	ρ_c^t
qnty of c as intermediate input per unit of output in activity a	ica_{ca}	an Armington function share parameter	δ_c^q
efficiency parameter in production function for activity a	ad_a	an Armington function exponent	ρ_c^q
share of value-added for factor f in activity a	α_{fa}	tax rate of activity	ta_a
import price in FCU	pwm_c	a CET function share parameter	δ_c^t
export price (FCU)	pwe_c	share in household h consumption spending on commodity c	β_{ch}
rate of sales tax	tq_c	rate of income tax for household h	ty_h
share for household h in the income of factor f	$shry_{hf}$	weight of commodity c in consumer price index	$cwts_c$
=government expenditure-oil income ratio	Rgo	quantity of commodity cí as trade input per unit of c produced and sold domestically	$icd_{c'c}$

quantity of commodity cí as trade input per unit of c produced and sold domestically	$icd_{c'c}$	van Armington function shift parameter	aq_c
wage distortion factor for factor fin activity a	$WFDIST_{fa}$	a CET function shift parameter	at_c
average price for factor f	$\overline{WF}_f$	government revenue	YG
investment adjustment factor	$IADJ$	supply of factor f	$\overline{QFS}_f$
level of activity a	QA_a	import price	PM_c
demand for factor f from activity a	QF_{fa}	exchange rate	EXR
price of composite commodity	$PQ_{c'}$	price of export	PE_c
quantity of goods supplied to domestic market	QQ_c	demand price for commodity produced and sold domestically,	PDD_c
quantity sold domestically of domestic output	QD_c	supply price for commodity produced and sold domestically	PDS_c
quantity of imports of commodity	QM_c	quantity of exports	QE_c
aggregate producer price for commodity	PX_c	activity price	PA_a
aggregate marketed quantity of domestic output of commodity	QX_c	producer price of commodity c for activity a	$PXAC_{ac}$
income of household h	YH_h	value-added (or net) price of activity a	PVA_a
consumption of commodity c by household h ׀	QH_{ch}	marginal (and average) propensity to save for household h	MPS_h
quantity of investment demand for commodity c	$QINV_c$	government expenditures	EG
quantity of commodity demanded as transactions service input	QT_c	quantity of exports	QE_c
quantity of commodity c as intermediate input in activity a	$QINT_{ca}$	demand of commodity c as investment commodity	$QDINV_c$
out of capital	$OCAP$	quantity supplied of factor	QFS_f