The Effect of Pollutants' Dispersion on Macroeconomic Variables based on Multi-Regional General Equilibrium Model (GTAP-E)

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Abstract:
The present study makes use of the general multiregional equilibrium method (GTAP-E) to evaluate the effect of pollutants' emission and carbon dioxide changes, GDP along with welfare and inflation rates within the format of tax scenarios followed by an investigation of technical progresses made in 2017 in Iran in such sectors as coal, petroleum, gas and oil products. The results indicated that the GDP is almost devoid of any effect on a low 5-percent tax. The increase in the carbon tax rate will not be followed by the possibility of increase in the GDP, energy consumption increase, inflation reduction and social welfare increase; furthermore, it is not envisaged capable of reducing the index of bioenvironmental pollutants' index but the scenario of increasing the devoted efficiency along with advancing the technology was unexpectedly found decreasing the dispersion of bioenvironmental pollutants and GDP growth and this can result in an increase in the government's tax income.
Keywords : Environmental CGE model: Macro-economy ; Iran ; carbon tax rate; CO2 emissions ; Multi-Regional General Equilibrium Model (GTAP)

1. Introduction

Iran's economy is passing through its stagflation period. The economic growth rate is negative (growth with oil in 2013 about -2.2 and without oil -2 percent).4 The unemployment rate more than 12%5 (21% in 2011 and 20% in 2012), severe inflation (50.76 in 2012, 41.2 in June 2013 and 14.2 in June 2014), poor foreign investment, high importing and mainly consumption one, mainly traditional and oil exporting, severe decline in financial indexes (Tehran Stock Exchange: total index from about 89500 in 01/05/2014 to 64300 in 06/28/20156, also Gini coefficient has been fluctuated in range of 41% (2010) to 37% in 20137. It has to be said that at least in recent decade the government has been faced with budget deficit and negative non-oil trade balance has been in fluctuation at least from 2001 to first quarter of 2013 in the range of 12 to 38 billion dollars8 The value of all mentioned variables and other variables of Iran's economy shows that recession and stagnation can be seen in all economic sectors. our aim is to specify these effects in a general equilibrium condition by using a new and trade related methodology. Energy is an important commodity in many economic activities. Its usage affects the environment via CO2 emissions and the Greenhouse Effect. Modeling the energy-economy-environment-trade linkages is an important objective in applied economic policy

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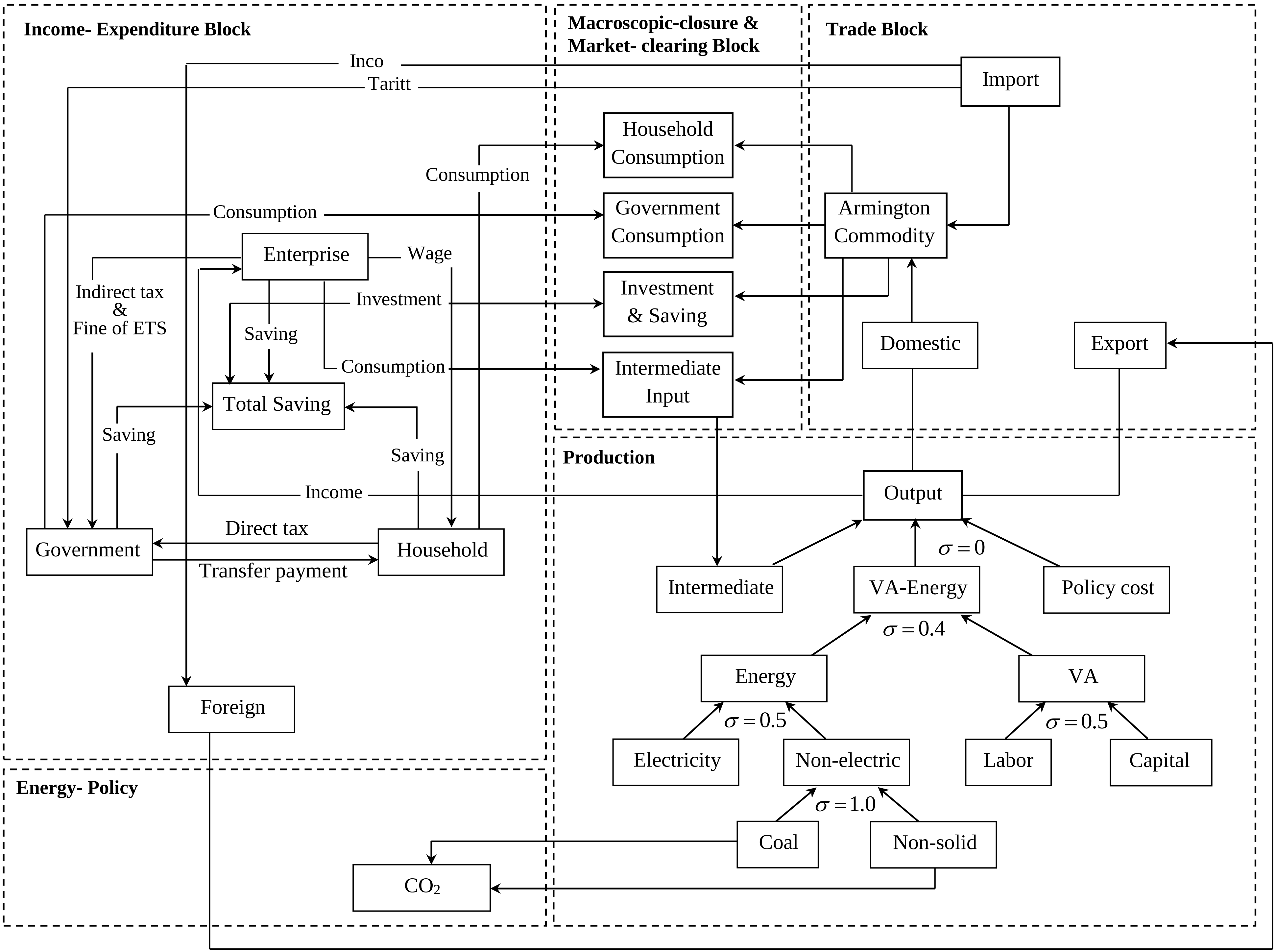
analysis. Up to now, however, the modeling of these linkages in GTAP has been incomplete. This is because energy substitution, a key factor in this chain of linkages, is absent from the standard model specification. This paper remedies this deficiency by incorporating energy substitution into the standard GTAP model. It begins by first reviewing some of the existing approaches to this problem in contemporary CGE models.The approach is implemented as an extended version of the GTAP model called GTAP-E. In addition, GTAP-E incorporates carbon emissions from the combustion of fossil fuels as well as a mechanism to trade these emissions internationally. The policy relevance of GTAP-E in the context of the existing debate about climate change is illustrated by some illustrative simulations of the implementation of the Kyoto Protocol.In an article, Lin et al (2018) "The energy, environmental and economic impacts of the carbon tax rate and taxation industry: a CGE-based study in China" Human activities have led to an increase in carbon dioxide emissions and carbon tax is one of the main policy tools for reducing global emissions. This paper constructs nine scenarios considering different carbon tax rates and the different taxable industries to analyze the impact of the Carbon Tax System (CTS) on energy, environment and the economy. It was found that the negative impact of CTS on GDP is acceptable and the maximum scenario will not exceed 0.5%. If carbon taxes are levied on energy-intensive enterprises, the impact on carbon emissions is also relatively small, even if the carbon tax rate is relatively high. A higher carbon tax rate will result in higher CO2 emission reduction and higher marginal CO2 emission reduction of CTS. In an article, Firouzeh et al (2017) investigated the exertion of green tax on the energy carriers emitting carbon dioxide and the double advantage gained thereof in Iran's economy. The results indicated that the setting tax on pollutants is accompanied by positive and significant reduction and increase in pollution and welfare, respectively, for all of the scenarios and that such a decrease in pollution and increase in welfare is boosted with the increase in tax rates. In another study, Mahmoudi (2017) "Oil price reduction impacts the Iranian economy". The results show that oil export revenue and the mineral commodity export earnings will decrease, but other production sectors' exports will increase. The trade balance of Iran will be affected negatively and strongly. Also, oil and other services production decreased. In the production sectors' market, the demand for labor, natural resources, and investment decreased dramatically, and the demand for land increased. Using equivalent variation (EV), changes in Iran's welfare is highly negative. Finally, deflation, reduction in value and quantity of GDP and changes in consumption combination from the public to private sector are the other economic impacts of a reduction in oil price on Iran's economic status. In a study, Liu et al (2015) "Economic and environmental implications of raising China's emission standard for thermal power plants: An environmentally extended CGE analysis" Thermal power plants are considered as the main source of atmospheric pollutants in China due to their massive emissions of sulfur dioxide (SO_2) and nitric oxide (NO_X). The results show that imposing the new emission standard may lead to a reduction in SO_2 and NO_X emissions by 22.8% and 11.4%, respectively per year, with the absolute amounts being reduced by 5597 and 1482 thousand tons. This is the result of the improvement of the emission removal technologies and the sharp decline of the coal consumption. On the other hand, the new emission standard may cause about 0.2% loss of GDP in the target year. In terms of changes in prices of goods and services and final demand structure, the new emission standard can make a contribution to curbing inflation, with the consumption demand reduced

Model and data

CGE model

CGE model is widely used in policy analysis (Lin and Jia, 2017; Paroussos et al., 2015; Lu et al., 2017; Zhao et al., 2018). The construction of all CGE models is based on traditional Walrus paradigm, which means that the model can be described as a system of simultaneous equations deduced from all actors' maximizing behavior. CGE model simulates the behavior of social agents such as resident enterprises, government, and foreigners (Bohringer et al., 2017; He and Lin, 2017). The CGE framework model in this paper is from Hosoe et al. (2010). In this framework, we add some parts: sectoral classification, production function, energy factor, energy-policy block, dynamic recursion, two households. It consists of five blocks: production block, income-expenditure block, trade block, energy-policy block, and macroscopic-closure & market-clearing block. The general framework

of the CGE model is illustrated in Fig(1).There is a wide range of CGE models that have explained the impact of economic variables' shocks on an economy such as the Esmailpouri et al. (2017).CGE models have been widely used in policy impact analyses such as taxes, subsidies and so on. Depending on the research purposes, various CGE models have been presented, for example, single-region model, multi-region global or country model, comparative static model, dynamic model, etc. (Dong et al., 2015). Igos et al. (2015) undertake a practical combination of a CGE and a Partial Equilibrium (PE) model by linking the outcomes from the coupling with a hybrid input-output process to assess the environmental consequences of two energy policy scenarios in Luxembourg between 2010 and 2025. Liu and Lu (2015) applied a dynamic CGE model–CASIPM-GE model to explore the impact of a carbon tax and different tax revenue recycling schemes on China's economy (Liu and Lu, 2015). This paper adopts the static environmentally extended CGE model developed jointly by Institute of Policy and Management, Chinese Academy of Sciences and Center of Policy Studies, Victoria University for the Chinese economy



General Framework of the CGE Lin(2018)

Elaboration of Model Blocks:

The general equilibrium model has been codified within the format of the following blocks in the present study.

1-1 Production block

It is assumed that one sector produces only one product in the CGE model. Moreover, in this block, the output consists of policy cost, Value-Added & Energy (VAE) and intermediate input following a Leontief function. VAE is a bundle that consists of value-added (VA) and energy following a constant elasticity of substitution (CES) function. The next level is VA bundle and energy bundle, which consists of capital and labor, electricity and non-electricity energy (fossil energy) input following a CES function. The non-electricity energy bundle consists of coal and non-solid fuel (oil and gas) following a CES function. Because Iran 139 sector input-output table does not separate the oil and gas industries, and the main energy consumption in Iran is coal, this paper does not subdivide oil and gas.

1-2 Income-expenditure block

The four social agents are government, enterprise, household (both rural residents and urban residents), and foreigner. The CGE model embodies the balance and relationship between the four agents. For the government, it gets fiscal revenue through direct tax, indirect tax, and tariff; and all the revenue are used for transfer payments, consumption and savings. For domestic enterprises, they get sales revenue from consumption by government, households, other enterprises and foreigners to support their own expenditure: indirect tax, households' income, and savings. For the households, they get income through remunerations from enterprises and transfer payments from the government, and the income is equal to the sum of their consumption, direct tax and savings.

1-3 Trade block

CGE model assumes that both domestic and foreign products of an industry are homogeneous. Thus, for one kind of product, imports and exports cannot exist at the same time. However, imports and exports do exist at the same time in one type of commodity in the real world. Therefore, as in the literature, the Armington assumption is introduced into the CGE model (Lin and Li, 2012; Hosoe, 2014; Lin and Jia, 2018) using CES and CET (Constant Elasticity of Transformation) functions to simulate import and export in the real world.

1-4 Energy-policy block

At present, at least 20 countries in the world have imposed carbon taxes. These countries are broadly divided into two categories: the first category such as Denmark and Netherlands, already had a comprehensive carbon tax system, started the implementation of the carbon tax system earlier than others, and have better policy efforts. The second category consists of countries that levied carbon tax in the context of the voice of a joint global emission reduction, but the implementation is not adequate.

Except for the rate of the carbon tax and industry coverage, other mechanisms of carbon tax are modeled following the systems of the first category countries - Denmark and the

Netherlands: 1) the carbon tax rate is fixed and will be paid in the form of energy tax; 2) for industries that pay carbon taxes, the tax can be used to deduct value-added tax (VAT), which can deduct at most 50% of the VAT, and the exceeding parts of the carbon tax will not be deductible. This block can be expressed by the following equations.

1-5 Macroscopic-closure & Market-clearing block Three principles of market closure are considered in this model: government budget balance, foreign trade balance, and investment-saving balance. The first two balances are introduced in section 2.1.2. As for investment-saving balance, CGE model assumes that all of the savings are transformed into investment, which means that total investment is equal to total savings. Two principles are considered in the market clearing. One is the market clearing of Armington composite commodity. The other is factor market clearing. The former shows that all Armington commodities are used for the consumption of household and government, intermediate input and savings, without surplus. The latter is that there is no unemployment in the market.

The Linkage of ETA to MACRO

In MACRO, the demand for composite (electric and non-electric) energy is structured as a CES function. This means the demand level for composite energy ENj in sector j is related to the sector output Qj, the sector unit cost Cj, and the composite energy price PEN,j by the relation

(i) $$EN_j = kQ_j\left(\frac{C_j}{PEN_j}\right)^{\sigma}$$

where k is some constant and) is the own-price elasticity of demand for composite energy.
Let j EN, j C, and j PEN be the 'reference level' for these variables, i.e. the level as determined in the MACRO module. The linkage of ETA to MACRO is then defined by the following equation:

(ii) $$EN_j = \overline{EN}_j\left(\frac{PEN_j}{\overline{PEN}_j}\frac{\overline{C}_j}{C_j}\right)^{-\sigma}$$

which follows from the previous relation, and

(iii) $$PEN_j = \left(\frac{P^E(1+t_j^E)+\mu_j^E}{\overline{P_j^E}}\right)^{-a_j}\left(\frac{P^N(1+t_j^N)+\mu_j^N}{\overline{P_j^N}}\right)^{1-a_j}$$

where:
t Ej, t Nj, are ad-valorem tax rates on electric and non-electric energy demand in sector j.
µEj, µNj , are distribution margins on electric and non-electric energy (cost indices).
PjE, PjN , are the reference prices (user costs) of electric and non-electric energy.
The last equation is based on the assumption that the structure of the electric and non-electric energy composition is Cobb-Douglas.

If the energy cost is only a small proportion of the overall sector cost, i.e.:

$$\frac{PEN_j.EN_j}{C_j} = \frac{PEN(\partial C_j / \partial PEN_j)}{C_j} << 1$$

then equation (b) can be approximated by:

(iv) $$EN_j = \overline{EN}_j \left(\frac{PEN_j}{\overline{\overline{PEN}}_t} \right)^{-\sigma}$$

(v) $$PEN_j = \overline{PEN}_j \left(\frac{EN_j}{\overline{\overline{EN}}_t} \right)^{-\frac{1}{\sigma}}$$

Equation (v) can be used to represent the inverse demand function for composite energy in ETA which will come out to be close to that modeled in MACRO. This is added to the list of equations for ETA (shown as equation (22) in equations).

List of Important Equations in ETA

$$\overline{en}_{r,t} = pvpe_{r,t}.\bar{e}_{r,t} + .pvpn_{r,t}.\bar{n}_{r,t} \qquad (1$$

(2 $$elvs_{r,t} = pvpe_{r,t}.\frac{\bar{e}_{r.t}}{\overline{en}_{r,t}}$$

(3 $$SURPLUS = \sum_{r,t} \left(\overline{en}_{r,t}.\frac{\sigma}{\sigma - 1} \right) \left(\frac{EN_{r,t}}{\overline{en}_{r,t}} \right)^{\frac{\sigma-1}{\sigma}} - pvcen_{r,t}.EC_{r,t}$$

(4 $$E_{r,t}^{elvs_{r,t}}.N_{r,t}^{1-elvs_{r,t}} = EN_{r,t}$$

(5 $$E_{r,t} = \sum_e PE_{e,r,t}$$

$$N_{r,t} = OILNON_{t,r} + GASNON_{t,r} + PN_{cldu,t,r} + PN_{synf,t,r} + PN_{rnew,t,r} + PN_{ne-bak,t,r} \qquad \textbf{(6}$$

$$GASNON_{t,r} = PN_{gas-lc,t,r} + PN_{gas-hc,t,r} + IMPRT_{gas,t,r} - EXPRT_{gas,t,r}$$
$$- ch_{gas-r,t,r}.PE_{gas-r,t,r} - ch_{gas-n,t,r}.PE_{gas-n,t,r} \qquad \textbf{(7}$$

7 b) $$GASNON_{t,r} \leq 0.5.N_{r,t}$$

$$OILNON_{t,r} = PN_{oil-lc,t,r} + PN_{oil-hc,t,r} + IMPRT_{oil,t,r} - EXPRT_{oil,t,r}$$
$$- ch_{oil-r,htrt,r}.PE_{oil-r,t,r} \qquad \textbf{(8}$$

$$PN_{coal,t,r} = EXPRT_{coal,t,r} - IMPRT_{coal,t,r} - ch_{coal-r,htrt,r}.PE_{coal-r,t,r} + ch_{coal-n,htrt,r}.PE_{coal-n,t,r} + PN_{cldu,t,r} + (1+syntpe).PE_{synf,t,r} \quad (9$$

$$PE_{dle,ty+1,r} \geq PE_{dle,ty,r}.decf_r^{10} \quad (10$$

$$PE_{dln,tp+1,r} \geq PE_{dln,tp,r}.decf_r^{10} \quad (11$$

$$PN_{xln,t,r}.nxpf_r^{10} + nshf_n.N_{r,t+1} \geq PN_{xln,t+1,r} \quad (12$$

$$\sum_{xle}\left(PE_{xle,tp,r}.\exp\ f_{rg}^{10}\right) + nshf_{RG}.E_{r,t+1} \geq_{xle} \left(PE_{xle,t+1,r}\right) \quad (13$$

$$RSC_{r,x,t+1} = RSC_{r,x,t} - 5.RA_{r,x,t} - 5.RA_{r,x,t+1} \quad (14$$

$$RSV_{r,x,t+1} = RSV_{r,x,t} + 5.(RA_{r,x,t} - PN_{x,t,r}) + 5.(RA_{r,x,t+1} - PN_{x,t+1,r}) \quad (15$$

$$rdf_{x,r}.RSC_{r,x,t} \geq RA_{r,x,t} \quad (16$$

$$prv_{x,r}.RSV_{r,x,t} \geq PN_{x,t,r} \quad (17$$

$$CLEV_{t,r} = \sum_e et, cece_{e,r}.PE_{e,t,r} + \sum_n nt, cecn_{n,r}.PN_{n,t,r} - \left(EXPRT_{gas,t,r} - IMPRT_{gas,t,r}\right).cecn_{gas,r} - \left(EXPRT_{oil,t,r} - IMPRT_{oil,t,r}\right).cecn_{oil,r} \quad (18$$

$$CLEV_{t,r} = EXPRT_{crt,t,r} - IMPRT_{crt,t,r} \leq carlim_{t,r} \quad (19$$

$$\sum_r (EXPRT_{q,t,r} - IMPRT_{q,t,r}) = 0 \quad (20$$

$$EC_{t,r} = \sum_e (PE_{e,t,r}.ecst_{e,r}) + \sum_n (PN_{n,t,r}.ncst_{n,r}) + ogpd_r.GASNON_{t,r} + \sum_n (cstcexp_q.EXPRT_{q,t,r}) \quad (21$$

The structure of production in the MACRO module of the CETM model groups labor and capital together, and these factors are separated from the energy branch (see Figure 1). This means that energy-capital and energy-labor will have the same substitution elasticity and this implies a severe restriction (see the discussion on the issue of capital - energy substitutability or complementarity in section 2.2 below).

On the other hand, the internal structure of the inter-fuel substitution in the MACRO module makes a useful distinction between electric and non-electric energy inputs. Although econometric evidence is scarce with respect to the substitution between electric and non-electric energy inputs, this distinction is useful at least from a theoretical viewpoint. This is because the choice of the electricity generation technologies may have an important impact on the environment (such as the emission of CO_2), and hence the focus on electric energy consumption level may help focus attention on the choice of these technologies[4]. Different forms of non-electric energy such as oil, gas, coal (direct use), synthetic fuels, renewable fuels or the non-electric backstop technologies, are treated as perfect substitutes in the ETA module (see equation (6). This assumption is perhaps rather restrictive especially from the end-user's point of view. Natural gas, for example, is known to command a premium over coal because of its ease of handling. It may also come into conflict with other assumptions made in the model such as the fact that the market share for natural gas is limited (see equation (7)). Limited market share often implies some difficulty of substitution rather than a limitation in supply. Finally, if these non-electric energy forms are perfectly substitutable, then their marginal costs (prices) must also be set equal to each other. These are strong assumptions.

Results and Discussion:

To evaluate the effect of the changes in the macroeconomic variables on the environment quality and pollution index in regard of Iran's economy with the objective of reaching methods of bioenvironmental pollution reduction, the inference stage was carried out using scenario analysis of the variables. Thus, this section presents various scenarios of the model designed and simulated for Iran's economy. The simulation results indicate the effects of executing various policies and change of variables on bioenvironmental quality index. To construct aggregation, GTAP software was employed. There are preset aggregations in this program and the databases existent therein were applied through specifying the intended regions and sectors in Iran and other spots of the world to be subjected to further research. Such sectors included coal, petroleum, gas and oil products as the sources emitting carbon dioxide as well as the other non-energy sectors.

The emission standard on Iran's Macro Economy Unit: %.			
Items	Change		Contribution to GDP
Macroeconomic variables		From the expenditure side	
GDP	3.38	Consumption	−0.1
CPI	-0.03	Saving	13.18
Regional Household	10.58	Income deflator	-1.29
Investment Export	-4.43	Emission quota	6.02
Import	0.7		0.01
The real rate of exchange	0.4	Capital	0.0
Term of trade Factor market	−0.1	Tech change From income side	0.0
money value of energy usage at agents prices	0.03	Labor	0.01
The elasticity of cost-utility	0.88	Capital	21.73
Price of capital	−0.2	Indirect tax	−0.2

[4] Furthermore, as Hogan (1989, p. 54) noted, the grouping of all energy forms together in an aggregate energy demand function may mask the historically important trend of 'electrification' in an energy economy (such as that observed in the US economy during the period from 1960 to 1982).

table (1); The emission standard on Iran's Macro Economy Unit: %.

The amounts of import and export are indicative of the idea that, unfortunately, the country's foreign trade status is not so much auspicious. The governance of uncertainty space amongst the economic activists inside the country and the continuation of embargos along with the great economic stagnations worldwide have caused Iran's international commercial exchanges to be faced with a decrease in value for four consecutive years. Carbon dioxide emission rate is increase by 10.73% with the possible increase in the trade rate (trade openness degree). Governmental investment firstly causes an increase in the GDP and influences the environment quality and pollution index in a second place. Thus, the governmental investment influences the pollution index and environment quality via GDP's intermediary role. Upon bearing witness to the increase in inflation, the investors, motivated by acquiring higher rates of profit, tend to make more investments and larger production brings about a reduction in inflation hence investment in the later periods. But, the increase in trade leads to the improvement of the environment quality in the country. Since trade can elevate production and income, the favorable effect of trade on production is accompanied by pollution emission reduction, as well, and the substantial part of pollution emission following the augmentation of trade stems from the change in the composition of the produced goods rather than from the increase in production level and the type of production technology applied. Almost most of the pollution emission reduction after trade elevation can be attributed to the change in the composition of the produced goods rather than to the increase in the production technology. Of course, the production level also incorporates the technical effects, as well. Environment quality improvement originating from the degree of trade openness can be due to the reason that the goods the production process of which causes the production of a large amount of pollutants are imported from China. Therefore, the pollution is increased in the exporting country and it is decreased in Iran, as the importing country, due to the reduction in the production of the goods causing larger deal of pollution in the course of their production as well as due to the reduction in the export trend of such other polluting heavy products as cement, glass, ceramic, iron and steel in the course of production of which a large deal of pollutants is released.

table (2); Percentage of Change in Potential GDP (PGDP)

pgdp	w	Pre w	Post w	Ch/%Ch w
Technical progress	-1.15	1	0.99	-0.01
Tax shock	0.03	1	1	0
Simultaneous shock	10.25	528424.94	582583.69	54158.75

As it is observed from table (2), the highest effect on the economic growth through imposing a simultaneous technical progress and tax shock is 10.25 with the implementation of various scenarios in the energy sectors. This is reflective of the idea that the production increase does not necessarily lead to larger deal of pollution. The necessity for omitting the technologic barriers can be related to the expansion of new energies as compared to the use of non-renewable energies in developing countries. Due to its special geographical conditions, Iran possesses capacities for the use of hydroelectric power energy, hydropower energy, wind power energy, solar power energy, geothermal power energy and biomass power energy. In case of making proper investments and achieving new technologies, optimal opportunities can be provided. By imposing green tax on the air pollutant sectors, the GDP index undergoes a decrease. According to the fact that Iran's economy is dependent on oil, the goods and services production are reduced with the establishment of a green tax system on the energy carriers as a result of which the GDP is reduced by 0.03. So, the government should accept that it is true that the carbon dioxide emission is reduced by imposing green tax on the pollutants, but, due to the high preliminary costs and finished prices of producing energy-consuming goods causing larger pollution, insufficient investment brings about an intensive reduction in production and GDP following which the government incomes suffer. Therefore, the oil exporting countries should have specific programs and strategies and make greater investments on higher levels of production and consumption based on renewable energies. One can argue that taxation is a control tool that has effects such as monopoly control, impact on investment and savings.

table (3); Carbon dioxide emission rates with the imposition of green tax and allocated efficiency

Carbon dioxide emission is reduced with the imposition of green tax along with allocation of

	Agr	Coal	Oil	Gas	Food	TWWL	petro	metal	mvo	Oil_pcts	Electricity	serv
CO2	--	-10.73	-5.95	-30.56	--	--	--	--	--	-0.68	--	--
	--	-5.12	-24.01	-29.39	--	--	--	--	--	10.1	--	--
gco2pm	2.83	10.98	11.81	109.17	0.78	1.53	8.05	6.96	4.94	5.44	3.63	14.66
gco2pd	4.28	-17.44	10.06	-38.32	7.58	14.75	15.36	13.48	15.8	12.77	14.54	11.74
gco2gm	11.55	10.09	12.76	9.97	9.08	5.16	10.11	8.13	6.17	5.23	4.85	13.21
Yco2pd	0.26	38.45	0.54	91.68	0.46	0.49	1.59	0.16	0.2	--	4.05	0.53

efficiency levels due to the use of modern production technologies.

table (4); Carbon dioxide emission rates

Tax Type Scenario	coal	oil	gas	oil_pcts
5-percent green tax	-10.73	-5.95	-30.56	-0.68

Green tax+ production technology	-5.12	-24.01	-29.39	10.1
production technology	5.44	-13.27	2.27	10.88
15-percent green tax	-18.65	-10.28	-52.66	-1.54

The scenario of imposing tax on carbon along with the technical progress 15-percent tax on carbon.

	1 Agr	2 Coal	3 Oil	Gas	Food	TWWL	petro	metal	mvo	Oil _ pcts	Electricity	serv	
Pg	-0.31	12.81	0.26	3.13	-1.78	-2.6	-0.8	-1.65	-1.92	-1.87	-3.34	1.2	0.22
Pm	0.82	9.53	10.37	9.91	-5.96	-0.66	1.86	0.26	-0.18	-2.66	-3.57	-2.08	-1.93
pm_ir	-0.08	-0.07	-0.04	0	-0.07	-0.07	-0.07	-0.07	-0.07	-0.04	-0.06	-0.07	
Pwu	-0.08	-0.07	-0.02	0.14	-0.09	-0.08	-0.08	-0.08	-0.08	-0.07	-0.09	-0.07	
Ps	-0.66	1.86	0.26	-0.18	-2.66	-3.57	-2.08	-1.93	-2.61	-3.91	-3.57	1.29	-4.63
Qgm	11.55	10.09	12.76	9.97	9.08	5.16	10.11	8.13	6.17	5.23	4.85	13.21	
Qow	0.04	-0.02	0.07	-0.08	0.04	0.01	0.01	0.03	0.04	0.1	0.1	0.04	
Qo	3.42	0.47	0.63	-19.96	6.88	13.15	8.8	8.69	17.78	11.64	11.73	8.78	21.07
Vdem		8.93	6.67	7.41	7.74	7.43							
Vxwcom	-0.07	-0.1	-0.13	0.88	-0.08	-0.07	-0.07	-0.05	-0.06	-0.02	0	0	

15-percent tax on carbon

Pg	0	24.18	-0.23	6.24	-0.11	0.3	0.27	0.25	0.01	3.81	3.74	-0.27
Pm	-0.02	-0.72	-0.23	-1.96	-0.18	0.42	0.75	0.29	0.01	-0.05	4.03	-0.29
Ps	-0.02	-0.72	-0.23	-1.93	-0.18	0.42	0.75	0.29	0.01	-0.05	4.03	-0.29
Qo	-0.03	-0.92	0.67	-10.13	0.12	-1.19	-2.23	-1.04	-0.83	-1.28	-2.56	-0.13
Vdem		-0.67	-1.51	2.48	1.93	1.88						
Vxwcom	0.01	0.02	0	1.68	0	0.01	0.01	0.01	0.01	0	-0.02	0
Qow	0	0.01	0	-0.17	0	0	0	0	0	0.01	-002	0

table (5); Carbon tax scenario plus technical progress

The increase in carbon taxes on agriculture does not change the carbon footprint of this sector, but reduces carbon production by about 11 percent ($ 11 million) The production of carbon in the oil sector has also dropped by about 6%.The carbon tax rate has no effect on the economy and energy consumption under the current status of affairs. Price of pm in various sectors, such as agricultural commodity prices, increased by 8%. Coal prices increased by 10%. The shift in carbon production in the agricultural sector is not due to the fact that production in the agricultural sector is not carbon-based, and therefore the carbon tax will not affect this sector. According to the changes in the prices of the goods and services and the final demand structure, the imposition of tax on carbon can contribute to the inflation reduction following which the consumption demand is reduced and the consumer price index that somehow indicates inflation is increased in all of the scenarios. Considering the reduction in the workforce under the current circumstances, the use of advanced technologies leads to an increase in the economic production in industrial sectors.

table (6); equivalent variation, $ US million

			Increase	Increase	scenarios
	%20	%15	%10	%5	
equivalent variation, $ US million	457.93	547.63	447.11	394.72	Iran
regional EV computed in an alternative way	-180.33	175.51	429.96	395.04	

The welfare scales used herein are EV equivalent changes. It is a monetary scale that uses the amounts of money spent before and after a shock, in lieu of the costs incurred before and after shock, to compare the consumer's optimality levels. EV welfare effect compares the income changes needed by the consumers to reach a new level of optimality in the prior prices. Positive EV welfare results indicate welfare gains and negative results thereof reflect welfare losses (Berfisher, 1995). Positive EV welfare index found herein signifies the increase in welfare in Iran. According to table (5), the imposition of tax rate in various scenarios and its effects on the amount of social welfare of the whole society demonstrate that the social welfare is seminally increased and then decreased to 457.93 with the imposition of a 20-percent tax rate.

Conclusion and Recommendations

The general multiregional equilibrium model (GTAP-E) has been drawn on 2017 database and it includes four energy sectors, namely coal, petroleum, gas and oil products) as well as four regions in Iran. The analysis of the data was conducted based on GTAP software outputs. The carbon tax rate has no effect on the economy and energy consumption under the current status of affairs. According to the changes in the prices of the goods and services and the final demand structure, the imposition of tax on carbon can contribute to the inflation reduction following which the consumption demand is reduced and the consumer price index that somehow indicates inflation is increased in all of the scenarios. Considering the reduction in the workforce under the current circumstances, the use of advanced technologies leads to an increase in the economic production in industrial sectors. Economic production has not reached a level in Iran that can cause reductions in bioenvironmental pollutants emission. Due to the low awareness regarding the bioenvironmental problems in the preliminary stages of the economic growth, it is not so much important to pay attention to the environmental problems and the environment-friendly technology is not available. Thus, the destruction of the environment is increased in line with the increase in the GDP income but a gradual decrease in the environment occurs in a higher stages of the growth through creation of structural changes, increasing of bioenvironmental awareness, implementation of bioenvironmental regulations and making efforts in line with the creation of superior technologies following which the environment quality is improved. The immethodical use of fossil fuels not only is deemed as a threat to the future uses but it is also known to have adverse effects on the environment and this has to be taken into account by the statesmen as a critical issue.

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Description of sector classification and population classificatio

Sectors	Description
Pg	government consumption price for commodity i in region r
pm	the market price of commodity i in region r
Pm _ ir	imports price index for good i and region r
Pwu	world price index for total good i supplies at user prices)pwu)
Ps	supply price of commodity i in region r
Qgm	price of imports of i in government consumption in s
Qow	quantity index for world supply of good i
Qo	industry output of commodity i in region r

Vdem	money value of energy usage at agents prices
Vxwcom	value of global merchandise exports by commodity
EV	equivalent variation, $ US million
AGR	Agriculture, forestry, animal husbandry and fishery
COL	Coal mining and washing industry
O_G	Petroleum and natural gas exploitation
PAP	Paper industry
ELC	Electricity
CST	Construction industry
SER	Service
Co2	carbon dioxide emissions
gco2gd	carbon dioxide emissions from government consumption of dom.
gco2gm	carbon dioxide emissions from government consumption of impo
gco2pd	carbon dioxide emissions from private consumption of domesti