

## Economic and environmental impacts of CO<sub>2</sub> tax in Iran

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**Abstract:** Emission tax is an environment protecting policies in economy context. This study also aims at investigating economic and environmental impacts of emission taxation levied on CO<sub>2</sub> emitted from fuel and production process in Iran. To get the objective a computable general equilibrium framework based on the Iranian social accounting matrix of 1999 was used. CO<sub>2</sub> is taxed based on World Bank (2004) estimated damage cost. The results show that tax policy impact on emission and macroeconomic variables depend on whether energy subsidies are reformed. CO<sub>2</sub> tax is more effective in emission reduction after energy subsidy reform while implementing it at the presence of energy subsidies does not induce significant effects.

[Farzaneh Taheri, Reza Moghaddasi and Seyed Nematollah Mousavi. **Economic and environmental impacts of CO<sub>2</sub> tax in Iran.** *Life Sci J* 2013;10(3s):225-232]. (ISSN: 1097-8135). <http://www.lifesciencesite.com>. 33

**Keyword:** Economic, Environmental, Impacts, CO<sub>2</sub> Tax.

### 1. Introduction

On average, per capita CO<sub>2</sub> emission in Iran is around 0.78 Kg per USD income which is much higher than the corresponding world figure, i.e. 0.5 Kg per UDS income and all industrialized economies but Russia has lower pollution (UN data, 2007). Energy products accounts for 90 percent of CO<sub>2</sub> emission. Energy products also are main sources of emission of CO, NOx and SO<sub>2</sub> as they account for 92, 97 and 100 percent of their total emission respectively. The corresponding value for CH<sub>4</sub> is 50 percent. N<sub>2</sub>O and CH<sub>4</sub> are the only pollutants that energy products are not important as much as production process. Around 60 percent of N<sub>2</sub>O and 25 percent of CH<sub>4</sub> are produced by agricultural activities (UNDP, 2010; Iran's Energy Balance, 2009). The Iranian energy use per USD 1000 output is 250 Kg oil equivalent. The corresponding value among all countries as a whole is also less than 217 (UN data, 2007). Subsidized energy is responsible for this. The high amount of energy subsidies in the country (12.42% of its GDP in 2009) has resulted in increasing government financial burden as well as greenhouse gas (GHG) emission due to over-consumption of energy for years (Iran's Energy Balance, 2009; UN data, 2009).

As the Iranian government is facing greater challenges from financial burden of the energy subsidies and pollutants emission, energy subsidies become a critical issue to be addressed. The government has recently commenced reforming the energy subsidy system and redistributing it as a part of the Subsidy Targeting Program.

Although cutting energy products subsidy is expected to induce a reduction in energy-based emission, in order to meet some obligations in this context like Kyoto Protocol, more efforts are needed like imposing tax on CO<sub>2</sub>. Wissema and Dellink (2007) concludes that a carbon tax of 10-15 Euros per ton of CO<sub>2</sub> may decrease Irish CO<sub>2</sub> emission by

25%, while the same amount of tax on energy products induces a lower reduction in emission. However emission tax may result in lower welfare. For instance Wissema and Dellink (2007) showed that emission reduction is accompanied by 1 percent welfare reduction. Liang et al (2007) conclude that imposing CO<sub>2</sub> tax without paying subsidy to production or tax exemptions induces a GDP reduction and energy-intensive and trade-intensive sectors will be affected more negatively. However, combining the tax policy with tax exemption of energy-intensive and trade-intensive sectors even may result in a GDP increment. Bureau (2011) also shows that implementing a carbon tax of 31 Euros per ton of CO<sub>2</sub> in France will impose an average loss of 65 Euros to households while the loss is higher for rich households. However, uniform redistribution of tax income among the households will increase the poor households' income. In this context some studies not only put an emphasis on compensating policies, but they point out this policy as an obligation. Bjertnæs and Fæhn (2008) suggest that taxing energy based emission in Norway while compensating measures are not taken induces a reduction in production, export, import, employment and consumption. However, subsidizing production of export-intensive sectors results in higher welfare. Contrary to Bjertnæs and Fæhn (2008) Dissou and Eyland (2011) show that CO<sub>2</sub> tax of 40 \$ per ton while border tax adjustments is taken, revenue recycling leads to more reduction in GDP and welfare compared to scenario that tax revenue is not recycled. In addition to the above experimental works in which pollutants emission mitigation by taxing has been pointed out, there are also some works that cast some doubts. For instance, Dessus and Bussolo (1998) in Costa Rica conclude that taxing each pollutant may induce only a reduction in emission of that pollutant. Van der Mensbrugge et al. (1998) also found that same findings for Chile. In

general, imposing a tax may result in better off situation in some countries while it fails to do so in all countries (Carraro and Simiscalco, 1993). This may stem from the cost of implementing the policy (Dissou and Eyland, 2011).

To the best of our knowledge, works referring to the Iranian policy of emission tax are limited, and the work conducted by Moghimi et al (2011) is unique in this context in which CGE framework has been applied. They considered emission tax while the pollutants production was considered in terms of energy products consumption. In this regard the linear relation was estimated between pollutants emission and the energy products consumption as a whole and the difference in emission capacity of energy products was not taken into account. They found that emission tax of 10 percent results in reduction in emission of CO<sub>2</sub>, CH<sub>4</sub> and NOx by 5.6-5.9 percent.

The most commonly-used environmental index is CO<sub>2</sub> emission that has the largest contribution to global warming (Bohringer and Loschel, 2006) and the most of studies have investigated CO<sub>2</sub> tax. However, CH<sub>4</sub> and N<sub>2</sub>O are important in climate change and acidification (Kerkhof, et al., 2009). Here also we addressed the tax policy by implementing tax based on CO<sub>2</sub> emission while the emission of other pollutants also has been considered. We apply a CGE model to investigate the emission tax effect. For tax reform policies general equilibrium models are pre-eminently suitable (Devarajan, 1988; Devarajan and Hossain, 1998; Geurts et al., 1997; Gooroochurn and Milner, 2005; Kumbaroglu, 2003; Toh and Lin, 2005; and Yilmaz, 1999).

Energy products are highly subsidized. The average subsidy rate in Iran was estimated to nearly 75% in 2008 (Iran's Energy Balance, 2008). The high distortion induced by energy subsidy is expected to affect the emission tax policy possible impacts. In other words the effect of tax policy may be overshadowed by energy subsidy elimination. Therefore, it is addressed while energy subsidy also is removed. In other words, emission tax is considered while energy subsidy also is taken into consideration. Although, emission tax is important to address, investigating it in the context of highly subsidized energy products is issue that distinct our work.

Exploring the possible sectoral, macroeconomic and environmental impacts of CO<sub>2</sub> emission tax while energy subsidies are removed is the question that the rest of this paper aims to achieve. The remainder of the paper is structured as follows: Section 2 introduces the model features; Section 3 applies the Computable General Equilibrium (CGE) model to simulate the impact of CO<sub>2</sub> tax on macroeconomic and environmental variables; conclusion and policy suggestions are presented in Section 4.

## 2. Model

The analytical instrument of the study is a static Computable General Equilibrium (CGE). Our Small Open Economy (SOE) model is designed for energy policy and emission tax analysis with 21 sectors covering agriculture, agriculture industries and non-agriculture sectors. The model is a constant return to scale general equilibrium and uses Social Accounting Matrix (SAM) data. Explanations of the equations may be founded in Jensen and Tarr (2003); de Melo and Tarr (1992, ch. 3); McDonald et al. (2007); Begin et al. (2002) and Farajzadeh et al (2012). Goods are produced using primary factors and intermediate inputs based on the Leontief production structure and a constant return to scale technology in a perfectly competitive environment. Primary factors which are perfectly mobile include unskilled and skilled labor and capital. Goods used as intermediate inputs are an Armington composite of domestic and imported goods. Iran is considered as small economy so the world prices of imported and exported goods are fixed. Outputs of all sectors are allocated between domestic and foreign markets which are determined by Constant Elasticity of Transformation (CET) function.

Government revenues from rents on crude oil, mining products, import tariff revenues, and exogenous lump-sum taxes finance demand for goods and services, transfers to households, subsidies to energy products and food items. The exchange rate in the model is also fixed and foreign capital inflow adjusts such that balances the value of exports and imports.

The model specification described is a standard applied general equilibrium model. At the equilibrium, each industry gains zero profits, the budget constraint is satisfied and for goods in each industry the demand is equal to the supply. There is also external trade balance.

Household utility functions are assumed to be Stone-Geary or linear expenditure system. Welfare change also is measured by Hicksian equivalent variation (EV). The equilibrium module includes market clearing and agents' income balance conditions including the equilibrium of commodity market, factor market, domestic transfer, international trade, and savings and investment.

Among the others, environmental and emission tax blocks are important. The environmental effect is based on exogenous coefficients for each sector. Changes in pollutants emission as environmental index may arise from intermediate consumption, output production and final consumption (Dessus and Bussolo, 1998). Production process pollution is the residual amount of pollution in production that is not explained by consumption of inputs (Begin et al., 2002). Total emission of each pollutant is determined by the following equation (Begin et al., 2002).

$$EN_p = \sum_a \beta_a^p X_a + \sum_c \pi_c^p \left[ \sum_a INT_{ac} + \sum_h C_{ch} + \sum_f Qf_{cf} \right] \quad (1)$$

where  $X_a$  is the output of production process

"a",  $\beta_a^p$  is the emission of pollutant "p" per unit of output in production process "a". The first term represents what is called production process pollution. It is the residual amount of pollution in production that is not explained by consumption of inputs (Beghin et al., 2002). The second term is the pollution assigned to direct consumption of goods.

Parameter  $\pi_c^p$  is the emission coefficient of consumption "c". The emissions of consumption in the bracket are from the use of polluting intermediate input in production process "a" ( $INT_{ac}$ ),

the consumption by household "h" ( $C_{ch}$ ), and the

$$PQS_c = (\delta_c PD_c^{-\rho_c} + (1 - \delta_c) PM_c^{-\rho_c})^{-\frac{1}{\rho_c}} + \sum_p \pi_c^p \tau^p \quad (2)$$

Where PD represents domestic price, PM is import price,  $\delta_c$  is share parameter,  $\pi_c^p$  is the emission coefficient of pollutant "p" from consumption energy product "c",  $\tau^p$  is emissions tax of pollutant "p", and  $\rho_c$  is elasticity. The optimal domestic ( $XD_c$ ) and import demand ( $XM_c$ ) after taxing are as follows:

$$XD_c = \delta_c \left[ \left( PQS_c - \sum_p \pi_c^p \tau^p \right) / PD_c \right]^{-\frac{1}{\rho_c}} \quad (3)$$

$$XM_c = (1 - \delta_c) \left[ \left( PQS_c - \sum_p \pi_c^p \tau^p \right) / PM_c \right]^{-\frac{1}{\rho_c}} \quad (4)$$

aggregate demand. Equation (5) also represents the corresponding equation when CO<sub>2</sub> tax is imposed on pollution emitted from production process:

$$PX_a (1 - TX_a) XP_a = (PVA_a VA_a) + (PINT_a INT_a) \quad (5)$$

Where PX is activity price in sector "a" before imposing tax, TX is emission tax, XP is output, PVA and VA are price and quantity of value added, PINT and INT are intermediate price and quantity. Imposed tax is equal to the damage cost developed by World Bank (2004). World Bank (2004) estimate for damage costs of pollutants contain three ranges of low, medium and high levels. However we imposed the medium level.

final demand ( $Qf_{cf}$ ). We will consider the emissions of CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CO, NOx and SO<sub>2</sub> in this study. The first three pollutants are aggregated into CO<sub>2</sub> equivalent using the corresponding transformation coefficients reported by the UNDP (2010).

Emission tax is implemented as a tax per unit of emission in the local currency. This tax covers both of production and consumption process. Given the difference in emission of pollutants emitted from the above mentioned sources, output as well as polluting intermediates is taxed by different rates. Tax on energy products as polluting intermediates is presented as follows (Beghin et al, 2002).

### 2.1. Data

Main data source is Social Accounting Matrix (SAM) table of Iran for 1999 that is the latest SAM prepared by the Iranian Central Bank. Estimates of the Iranian elasticities are from Jensen and Tarr (2002); and emission of the selected pollutants obtained from the report of Iran second national communication to UNFCCC for 2010 (UNDP, 2010) and the Iranian Energy Balance (Iranian Energy Balance, 2009). We aggregated most of industrial and services sectors, while agricultural sectors are decomposed into more sectors using shares of total costs and revenues. CO<sub>2</sub> tax is equal to damage cost developed by World Bank (2004).

### 3. Results

The model was solved for CO<sub>2</sub> emission tax of 10 USD per ton under two scenarios of with and without energy subsidies. In addition, in order to investigate the energy subsidies role, another scenario also was considered as energy subsidies elimination while based on the Iranian Subsidy Targeting Program 50 percent of subsidy revenue back to households and 30 percent is paid to producers. We name the tax policy under assumption of energy subsidies as scenario 1 and the other one scenario 3 while energy subsidies removal is mentioned as scenario 2.

#### 3.1. Sectoral impacts

Table 1 shows sectoral impacts of the scenarios. Under scenario 1 mining, forestry and energy products shows a higher output reduction as their production process is more polluter. To make clearer the results, manufacturing should be

considered as it is more connected with other sectors as well as it produce a significant amount of CO<sub>2</sub>. Imposing a tax on CO<sub>2</sub> push production cost and leads to shrink in output and increase in output prices of manufacturing as it is a polluter sector. Under scenario 1, manufacturing output decreases by 0.6 percent accompanied by price increase of 0.4 percent. Reduction in manufacturing output entails a reduction in energy products output by 0.5-1.5 percent due to shrink in intermediate demand.

Lower output and higher prices of manufacturing are the main source of output reduction in agricultural industries as well. This sector experiences an output reduction of 0.7 percent. Reduction in agricultural industries and households income induces a reduction in demand for agricultural products, leading to reduction in their output. However, among the agricultural products forestry experiences a higher output reduction as a high tax is imposed on its polluter production process.

Output price of energy products, transportation, manufacturing, forestry and mining tends to increase as their production process is more polluter. While those of the other sectors turn to be decreased. Among the above mentioned sectors, mining and forestry experience a higher price increase as their production process is more polluter. While transportation emission only comes from energy products use, manufacturing and mining are regarded as polluter sectors for both of their production process and high energy use.

CO<sub>2</sub> tax under scenario 1 expands export of energy, services and some of the agricultural sectors. Among the agricultural sectors livestock and other agriculture sectors export experience an increase. Given the higher share of these sectors that account for more than half the Iranian agriculture, we may come into conclusion that CO<sub>2</sub> emission tax policy is a agricultural export encouraging measure.

Scenario 2 indicates energy subsidy removing impacts. Here, the energy subsidy removal impacts are considered briefly as CO<sub>2</sub> tax impacts is the central aim of the study. According to the Iranian subsidy targeting program (STP), 50% of the additional revenue obtained from energy subsidy removal is assumed to be received by the household in equal absolute amount and 30% of it is transferred to producers as production subsidy. Removing energy subsidies results in output expansion of some agricultural and services sectors while output of agricultural industries, energy products, manufacturing and mining tends to decrease. Production process f sectors that experience output reduction is energy-intensive. Among the others, transportation and manufacturing are more important as their production process is more energy-intensive and are more connected with other sectors. Although these sectors also receive production subsidy based on their energy costs,

subsidy removal results in an output reduction of over 6 percent. Output reduction in manufacturing means lower intermediate demand for other sectors commodity while its higher prices compared to the initial equilibrium may increase production cost of them. In other words manufacturing sector can shrink other sectors output by both of lower output and higher prices compared to the initial equilibrium. Output of energy products decreases significantly as energy subsidies is removed. However, fuel oil contrary to the others, experiences an output expansion by 90 percent. Contrary to the other energy products, a greater part of fuel oil production value accounts for value added factors. So, decrease in value added factors price as well as export expansion may be responsible for output expansion of fuel oil compared to its initial level.

Agricultural industries are also affected by output and price changes in manufacturing as their output decreases by 6.1 percent while output price also increases by 0.7 percent. Decreased output of agricultural industries is the main source of agricultural products output reduction. However, in the case of aquaculture a part of its significant output reduction of 25.6 percent is resulted from higher energy prices as it is more energy-intensive than other agricultural sectors. Other agriculture production process, among the agricultural sectors, is not highly dependent on energy products while it enjoys lower price of value added factors. Therefore it experiences an output expansion compared to the initial level.

Removing energy products subsidies increases output prices of the most on non-energy sectors as they pay higher prices for energy products and experience a cost push. Especially price increment of transportation and manufacturing is more important as their products are used as important intermediate input by other sectors. Their prices increase by 12.1 and 2.9 respectively. However, output price in the most of energy products tends to increase since they lose a significant part of their demand, i.e. intermediate demand. Electricity shows a price increment of 6.5 percent as its production process is highly dependent on manufacturing products. Prices in agricultural sectors show a wide variety of changes. While aquaculture output price increases by 14 percent due to its lower energy use efficiency, other agriculture sector experiences price reduction of 4 percent. In general, sectors which experience price reduction with output expansion, lower prices of value added factors may be responsible for such changes. On the other hand, higher prices of sectors with higher output, is mainly expected to stem from higher demand.

Energy subsidy removal is also expected to shrink manufacturing and mining as well as services exports while energy sectors and to some extent agricultural sectors may enjoy higher export.

Scenario 3 contains two policies including energy subsidy removal and CO<sub>2</sub> emission tax. However, we will focus more on the CO<sub>2</sub> tax effects. As table 1 illustrates, removing energy subsidies and imposing CO<sub>2</sub> emission tax results in output reduction of all sectors but other agriculture, fuel oil and services as their production process is less polluter and low energy-intensive. While the output impacts of scenario 1 that contains only CO<sub>2</sub> tax is not considered highly significant, it imposes a more significant impacts as is implemented after energy subsidy removal. In other words, CO<sub>2</sub> tax impact is strictly dependent on the environment in which is implemented. For instance, while energy subsidy removal results in output reduction of rice,

other grains and livestock by less than 0.7 percent under scenario 1, implementing both of energy subsidy removal and CO<sub>2</sub> tax, scenario 3, induces an output reduction of more than 3 percent. For wheat also output reduction of 11.4 percent under scenario 2, amounts to over 29 percent in scenario 3. The same conclusion may be derived for forestry and agricultural industries as their output decrease by 3.4 and 6.1 percent respectively after removing energy subsidies (scenario 2) while the corresponding values for scenario 3 are 15.1 and 20.9 percent. Transportation and manufacturing are also affected significantly by CO<sub>2</sub> tax after energy subsidy removal as their output reduction from less than 7 percent amounts to over 12 percent.

**Table 3:** Sectoral impacts of selected scenarios (%)

Sectors	Scenario 1			Scenario 2			Scenario 3		
	Output	Prices	Net export	Output	Prices	Net export	Output	Prices	Net export
Wheat	-0.6	-	-0.4	-11.4	6.2	-35.4	-29.3	10.6	-54.3
Rice	-0.6	-0.4	0.6	5.3	-3.7	16	-4.5	-5.3	10.6
Other grains	-	-0.2	-	1.4	-0.5	-	-3.5	0.5	-
Livestock	-	-0.2	0.6	1.2	0.8	-7.9	-3.1	3.7	-18.7
Forestry	-7.9	10.3	-7.6	-3.4	-3.1	0.8	-15.1	3.4	-8.8
Aquaculture	-0.5	-0.1	-0.3	-25.6	14	-51	-35.1	17.3	-60
Other Agriculture	0.7	-0.3	1.5	10.4	-4	20.7	13.4	-4.4	25.3
Mining	-12.7	9.4	-13.1	-25.3	10.1	-52.1	-39.4	18.4	-63.9
Agricultural industries	-0.7	-0.2	-0.3	-6.1	0.7	-11.3	-20.9	3.1	-29.7
Crude oil and gas	-	-0.6	1.1	-7.6	-9	8.4	-6.9	-11.5	14.3
Gasoline	-0.3	-0.3	-	-10	-7.3	-	-14	-8.5	-
Kerosene	-0.5	-0.5	1.3	-39.2	-8.4	-21.6	-41.3	-10.6	-18.7
Gasoil	-0.4	-	1.2	-5.6	-7.6	16.1	-10.6	-8.5	14.8
Fuel oil	2.8	-1.4	4.1	89.2	-23.8	122.7	133.7	-24.5	184.2
Liquid gas	-6.6	-0.9	-5.3	-100	-36.1	-100	-100	-36.1	-100
Other oil products	-2.5	2.3	-4.5	-18.2	8.7	-56.3	-20.9	6.2	-53.8
Natural gas	-1.3	0.2	-	-13.6	-7.2	-	-19.5	-9.3	-
Electricity	-0.3	0.3	-1.3	-7.7	6.5	-28	-9.5	12.2	-39.8
Manufacturing	-0.6	0.4	-1.1	-6.3	2.9	-20.4	-12.7	7	-33.5
Transportation	-0.2	0.2	-0.8	-6.6	12.1	-60.1	-12.5	20.1	-69.4
Services	0.5	-0.3	1.4	6.9	1.2	-4.3	11.9	1.3	-0.3

Scenario 1: imposing CO<sub>2</sub> tax of 10 USD per ton

Scenarion2: removing energy products subsidy and allocating it to households and producers by 50 and 30 percent, respectively.

Scenarion3: scenario 1 + Scenario 2

Comparing the price changes of the scenarios to their corresponding output changes shows that prices are affected less than output as CO<sub>2</sub> tax is accompanied with the energy subsidy removal. Taxing CO<sub>2</sub> after subsidies removal (scenario 3) induces a reduction in energy products prices compared to the scenario 2 in which the energy subsidy is removed. For instance, gasoline price decreases by 7.3 and 0.3 percent after removing energy subsidies (scenario 2) and taxing CO<sub>2</sub> (scenario1) respectively. However, implementing both policies in scenario 3 entails 8.6 percent reduction in gasoline price which is higher than simple summation of changes obtained for scenario 1 and 2. The corresponding values for natural gas gasoil are 7.6, 0.4 and 8.5.

Contrary to those of energy products, under scenario 3 output price of manufacturing, mining, transportation and services tends to increase

compared to the scenario 2. This increase in prices stems from production cost push of higher energy prices. Output price increase of manufacturing under scenario 2 and 3 are 2.9 and 7 respectively. The corresponding values for transportation (agricultural industries) are 12.1 and 20.1 (0.7 and 3.1) percent. Export also changes in the same direction of scenario 2, however in terms of absolute values the changes are more significant compared to scenario 2.

In general, CO<sub>2</sub> tax policy impacts differ with existence of energy subsidy distortions and it can be considered as more important policy when energy prices distortions are removed.

### 3.2. Macroeconomic impacts

The macroeconomic impacts of the scenarios are presented in Table 2. Under scenario 1 Changes for all variables but government tax

revenues and government expenditure are insignificant as they shows relative changes less than 1 percent. Government tax revenues increases by 8.7 percent, nevertheless government total revenues are expected to decrease under scenario 1 as the public expenditure shows significant reduction of over 12 percent. CO<sub>2</sub> tax induces a GDP reduction of 0.4 percent with value added factors return reduction. However skilled labor is not affected by the tax policy as its return shows an insignificant reduction. The Iranian households as a whole lose about 0.75 percent of their consumption which entails 0.8 and 0.6 percent welfare lose for urban and rural households, respectively. In general under scenario 1 macroeconomic impacts of CO<sub>2</sub> while energy products are heavily subsidized is not significant.

Contrary to the first scenario, energy subsidies removal under scenario 2 has significant changes. It induces significant GDP reduction of 15.5 percent while prices level also tends to increase by 10.8 percent. Regarding the current inflation this increase in prices is considerable. Factors also suffer from a return reduction of 11-16 percent which skilled labor is less vulnerable than two others. Although tax revenues account for an insignificant part of government revenues, this policy induces a significant reduction of 21.2 percent in tax revenues and push down government expenditures by 7.7 percent. Households revenue also decrease as much as GDP and factors income, however, to extent that rural and urban households are considered as a whole, their consumption affected less since some

commodities are provided at subsidized prices and due to income transfer. I addition, rural households experience higher consumption by 7.8 percent and welfare increment of 9.7 percent under scenario 2. The rural households receive a disproportionately large share of the transfers relative to their current incomes, leading to significant increase in their consumption.

Scenario 3 also shows significant changes in variables like scenario 2. In addition the results for scenario 2 and 3 show close similarities as all variables changes in the same direction. However the all variables but trade as well as CPI is at a lower level compared to those of scenario 2. In other words scenario 3 results in more reduction in GDP compared to scenario 2 and prices level increase more. The central point is that implementing together scenario 1 and 2 which known as scenario 3 induces more significant impacts than their individual aggregate impact. However, there are some differences among the variables in terms of their comparative changes. For instance, while adding CO<sub>2</sub> tax to energy subsidy removal induce more reduction in GDP (CPI) from 15.45 (10.81) to 19.15 (13.98) the corresponding values for total consumption are 6.28 and 16.25. It sound households responds beyond their income changes. The corresponding welfare changes for urban households are also 5.53 and 15.34 percent. Contrary to the urban households, rural households experience welfare gain as the income transferred accounts for a significant part of their total income.

**Table 3: Macroeconomic impacts of selected scenarios (%)**

Macroeconomic variables	Scenario 1	Scenario 2	Scenario 3
GDP	-0.38	-15.45	-19.15
CPI	-	10.81	13.98
Government expenditure	-12.04	-7.67	-14.02
Tax revenues	8.68	-21.19	-17.56
Households consumption	-0.75	-6.28	-16.25
Urban households consumption	-0.75	-9.91	-20.47
Rural households consumption	-0.74	7.78	0.06
Urban households income	-0.36	-14.98	-18.62
Rural households income	-0.44	-15.34	-19.66
Investment	0.20	-7.66	-7.99
Exports	0.53	3.94	6.92
Imports	0.77	6.12	10.56
Net export	0.04	0.03	0.16
Factor prices			
Unskilled labor	-0.53	-14.21	-19.54
Skilled labor	-0.02	-10.50	-12.12
Capital	-0.38	-15.08	-18.74
Factor employment			
Unskilled labor	-	-0.88	-0.87
Skilled labor	-	-0.84	-0.80
Capital	-	-0.89	-0.87
Households welfare	-0.74	-5.53	-15.34
Rural households welfare	-0.79	-10.32	-21.13
Urban Rural households welfare	-0.61	9.67	3.42

Scenario 1: imposing CO<sub>2</sub> tax of 10 USD per ton

Scenarion2: removing energy products subsidy and allocating it to households and producers by 50 and 30 percent, respectively.

Scenarion3: scenario 1 + Scenario 2

### 3.3. Environmental impacts

Changes in emission of selected pollutants are shown in Table 3. Gasoline, gasoil, fuel oil and natural gas are the main pollutant producing products among the energy products. Regarding the total emissions of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub> measured in terms of CO<sub>2</sub> equivalent, total emission of the selected pollutants tends to decrease by 0.3-1.3 percent under first scenario. There is a significant differences among the pollutants emitted from production process. While NOx and CO<sub>2</sub> emission decrease by over 3 percent, the corresponding value for CO is only 0.2 percent. As expected, CO<sub>2</sub> shows the highest reduction since the emission sources are directly affected by tax policy followed by NOx in both of production and energy sources of emission. This may allow concluding that the production process and energy products which release CO<sub>2</sub> have also significant role in NOx emission.

Under scenario 2 emissions from production process for all pollutants but CO and CH<sub>4</sub> tends to decrease. However, emission changes

are very different. Emission of NOx, SO<sub>2</sub>, and CO<sub>2</sub> decreases by 5.5-7.5 percent. Reduction in output of oil and gas as well as manufacturing and mining are sources of emission reduction. Emission from consumption also corresponds to consumption changes which are presented in Table 2. As expected, emission from energy use shows a significant reduction. Except for SO<sub>2</sub>, emission of pollutants from energy use source decrease by at least 8.4 percent, amounting to 13.2 percent for CO<sub>2</sub>. SO<sub>2</sub> emission shows an insignificant reduction due to lower reduction in fuel oil consumption. If CO<sub>2</sub> equivalent is considered as total emissions of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub> as well as ignoring SO<sub>2</sub>, scenario 2 may induce emission reduction of 8.9-9.9 percent in which emission reduction from energy use plays the central role. Among the sectors also manufacturing and transportation which are the most energy-intensive sectors are the main source of this emission reduction as their output tends to decrease by removing energy subsidies (Table 2).

**Table 5:** Impact of selected scenarios on pollutants emission (%)

scenario	Emission sources	NO <sub>x</sub>	SO <sub>2</sub>	CO	CO <sub>2</sub>	NH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2</sub> equivalent
Scenario 1	Energy consumption	-3.29	-0.02	-0.20	-3.63	-0.30	-0.11	-2.02
	Production process	-	-	-	-	-0.79	-0.75	-0.77
	Non-energy final consumption	-0.70	-0.28	-0.34	-1.06	-0.70	-0.53	-1.06
	Total	-0.74	-0.27	-0.33	-1.56	-0.36	-0.36	-1.34
Scenario 2	Energy consumption	-7.40	-7.63	0.44	-5.57	0.13	-0.07	-2.87
	Production process	-	-	-	-	-9.93	-6.21	-8
	Non-energy final consumption	-8.89	-2.17	-10.32	-13.26	-12.18	-8.37	-13.22
	Total	-8.87	-2.33	-9.83	-11.77	-1.49	-2.76	-9.90
Scenario 3	Energy consumption	-14.23	-6.86	-3.16	-9.31	-0.98	-6.56	-6
	Production process	-	-	-	-	-20.66	-16.08	-18.29
	Non-energy final consumption	-14.04	-6.98	-14.38	-18.39	-16.71	-13.35	-18.35
	Total	-14.04	-6.97	-13.87	-16.62	-4.06	-10.27	-14.63

Contrary to the insignificant impact of carbon tax on pollutants emission under scenario 1, after removing energy subsidy, i.e. combining two policies (scenario 3) it induces more reduction in emissions. For example, while scenario 2 is expected to induce total emission reduction of 8.9-9.9 percent and the corresponding value is less than 1.5 percent for scenario 1, taxing CO<sub>2</sub> under assumption of energy subsidy removal (scenario 3) is expected to induce a reduction of over 13 percent (except for SO<sub>2</sub>).

## 4. Conclusion

CO<sub>2</sub> emission in Iran is higher than corresponding world as a whole. However, now a significant reform is expected to be implemented by government, i.e. energy subsidies reform. It is crucial to investigate the emission tax in the context of energy subsidies reform. CO<sub>2</sub> tax impact on sectoral output and macroeconomic variables and even on pollutants emission while energy products are highly subsidized is not significant since the imposed tax accounts for an insignificant part of

subsidies paid to them. However, as implementing it after energy subsidies reform, more considerable impacts are expected. In general energy subsidy elimination deserves to be considered as a great shock since it induces a GDP reduction of over 15 percent and prices increase by more than 10 percent. Given these impacts, it is recommended energy subsidy reform to be implemented with caution. CO<sub>2</sub> tax after energy subsidies reform even makes this shock more significant, needing to be implemented when subsidy reform is completed. However, CO<sub>2</sub> tax is an effective measure in emission reduction especially after energy subsidy reform.

Removing the energy subsidies and imposing CO<sub>2</sub> tax, is expected to change the output composition in favor of some of agricultural sectors and services as they are less dependent on energy and less polluter, needing for preparation to transfer the resources.

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