Alternative Options in the Design of a CO_2 Tradeable Emission Permits Scheme in Turkey

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Abstract

In this paper, we address the issue of the feasibility and the implications of a trading system in addressing commitment to reducing global greenhouse gas emissions under the framework established by the Kyoto Protocol. This paper overviews a wide range of issues and options associated with the potential design of a emissions trading system. A major issue is how to organize it ? We explore the impacts of emission permits market under the following two levels : i) an upstream scheme regulate the producers, processors and distributors of energy. This approach would impact energy use through a price signal to energy consumers ii) a downstream system would include energy users, small industrial and transports. All emission sources would be required to hold emission permits. Both cases will be tested first for a free initial allocation of permits, which will be compared with a second case where there exists a permit price. We chose to apply this discussion to the Turkish case. Using a general equilibrium model, we provide estimates of possible scenarios in which GHG emissions are controlled in Turkey in order to test the results of adopting a tradable emission system.

I Introduction

Since the Kyoto Protocol in December 1997, at the Third Conference of the Parties to the United Framework Convention on Climate Change (UNFCC), international attention is growing toward a consensus in favor of reducing carbon emission to mitigate climate change. Therefore, since this protocol will enter into force in 2008, national carbon emissions in signatory countries (OECD and others) will be significantly constrained to the level that would prevent dangerous anthropogenic interference with climate system.

As a member of OECD, Turkey delayed his ratification of the Kyoto protocol until recently. Negotiations between the Turkish government and the international authorities are continuing. If Turkey decides to join with the other Annex B - OECD countries in ratifying the protocol, it should develop incentives to stabilize its emissions.

One of most leading option for achieving emission reduction cost-effectively is a cap-and-trade approach. The use of emissions trading could then have a role to play in minimizing the economy-wide costs of that constraint. Indeed, tradable permits represent a lower cost method to increase the cost efficiency of stabilizing global emissions. As a case in point, the basic elements of a baseline-credit scheme are to impose a ceiling on global emission, to allocate this constrained emissions profile among participants, and to allow trade.

Under such a program, Turkey will have to impose a cap to limit the total level of carbon emissions. Therefore, Turkey is calling to develop rules and guidelines for emission trading in order to meet the constraint on its CO_2 emissions. It should then identify the consequences that such scheme might have.

The leading options for achieving cost-efficiency in carbon emission reductions address the design issue of how to implement an emission cap-and-trade system in Turkey. We therefore examine the design of alternatives permits trading programs to address carbon emission related energy-consumption. In this context, tradeable emission permits would entitle holders to emit up to a specified level of carbon emissions. By issuing a fixed number of allowances less than business-as-usual current emissions, Turkey could reduce its national CO_2 emissions to meet its internationally targets.

In a carbon cap-and-trade program, regulated entities would have to surrender allowances to their CO_2 emissions. Entities able to reduce their emissions below the level of the allowances could sell the excess. Similarly, a regulated entity unable to cover its emissions with its allowances could purchase additional allowances on an open market. Therefore, a key issue in the design of a domestic emissions trading on carbon in Turkey is to identify the appropriate incidence of regulation, meaning who is requiring to surrender emissions allowances. A Turkish carbon emission cap-and-trade system could then be based on either an upstream approach (at the level primary energy producers) or downstream approach (at or near the point of emissions).

The purpose of our paper is to identify the best sectors in order to implement a cap-and-trade system on carbon emission in Turkey. In evaluating the proper point of regulation, we will consider alternative hybrid systems, combining both upstream and downstream options.

II Energy and Environmental Performances in Turkey

Turkey has not yet signed the UNFCC because by objecting to be included in Annex I of the Convention and its position is that Turkey should be considered as a developing country according to the criteria used by the United Nation and the World Bank. Turkey argues that although it is a member of OECD, its economic development and emission pattern correlate more with those of non-Annex I, developing countries. As such, Turkey has chosen not to become a party of the Convention although it agrees with the UNFCC's overall objectives to stabilize concentrations of greenhouse gas in order to avoid dangerous levels of anthropogenic emissions that would adversely affect the climate system. Since 1992, permanent debates take place in Turkey on the feasibility of reducing carbon dioxide emissions.

Table 1: CO_2 emissions per capita in various countries (per tons)

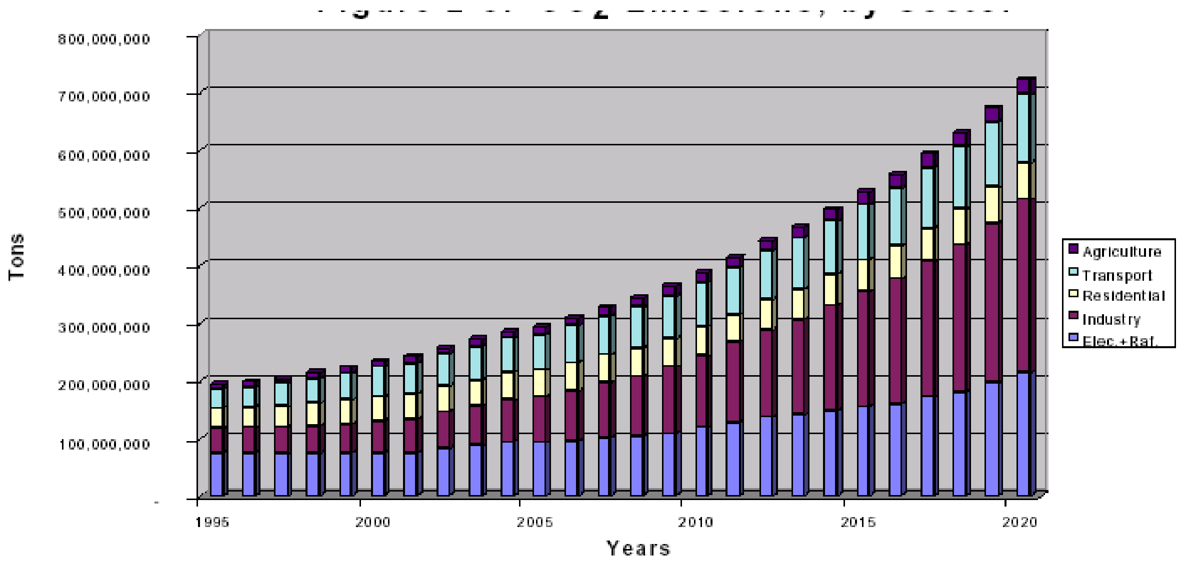
Country	*1990*	*1995*
Annex 1 average	12.02	11.18
Non-Annex 1 average	2.42	2.29
United States	19.64	19.88
Republic of Korea	5.40	7.87
Mexico	3.58	3.46
Turkey	2.53	2.79

Source: MoE et al., Turkey: National Report on Climate Change, 1998.

In Turkey, carbon dioxide is a key polluant associated with the energy and transport sectors. Hence CO_2 emissions in Turkey are still the lowest among OECD countries in terms of per capita emissions, they have been increasing rapidly as there is a continuing increase in demand for energy. CO_2 emissions reach approximately 191 million tons in 1997, with a 34 percent increase since 1990. Coal use is responsible for half of Turkey's

CO_2 emissions, whilst oil represent 46 percent and gas consumption less than 4 percent The following breakdown of carbon emissions give the contribution of different sectors:

Table 2: CO_2 emissions path by sector in Turkey



Rapid increase in CO_2 emissions results in an increases in the consumption of fossil fuels (imported coal, oil and natural gas). By 2010 all fossil fuels combined could represent about 90 percent of total primary energy supply. As CO_2 emissions increased from 143 million tons in 1990 to nearly 200 million tons in 1995, they are expected to rise to 400 million tons by 2010 and up to 700 million tons by 2020.

Table 3: CO_2 emissions from fossil fuel combustion by sector

	Energy (including Power)		*Industry*		*Transport*		*Other (residential, agriculture)*		*Total*	*Per Capita*
Year	*Mt*	*% of total*	*Mt*	*%*	*Mt*	*%*	*Mt*	*%*	*Mt*	*tons*
1990	51.1	36	37.4	26	26.4	19	27.8	19	142.7	2.53
1992	56.3	37	39.1	26	25.9	17	30.6	20	151.9	2.62
1995	61.3	36	41.6	25	33.7	20	32.7	19	169.3	2.79
1997	71.1	37	50.3	26	34.3	18	35.9	19	191.6	3.07

Source: SIS, 1999.

III Effects of different methods for CO_2 emission permits allowances

In this section, we present the alternative options to design a CO_2 cap-and-trade system in Turkey. The effective implementation of an emission trading scheme would result in identifying the point of regulation and then determine who is requiring to surrender CO_2 emissions reduction. A key issue in the design of such scheme is to capture high coverage of total emissions (ie. the percentage of total emissions covered by the cap-and-trade structure) with low costs and associated to administrative feasibility. The paper deals with the incidence of different systems: the implementation upstream, at the level of energy producers, and downstream, where emissions actually occur due to energy use. These two approaches can be combined in a hybrid system.

III.1 Upstream option

In an upstream cap-and-trade scheme, energy producers and processors are requiring permits allowances for the potential CO_2 emissions embodied in their energy. Therefore, the suppliers of energy (fossil fuels, oil, coal and natural gas) have the obligation to cover their sales with emission permits. This approach provides a nearly full coverage of energy-related emissions in the sense that it impacts energy and CO_2 emissions through a price signal to energy users. This great coverage would then capture all carbon emissions in the Turkish economy at low administrative costs.

The price of permits, resulting the market, will affect the Turkish economy through an increase in the energy prices. It results that higher carbon intensive energies rise more in price than those with low carbon content. Energy users would thus be impact and encourage to switch toward cleaner energy use. The question remains whether or not this price signal of such upstream option is strong enough to influence energy-efficiency and improve innovation.

It has been argued that an upstream option may not provide a full incentive for energy switching toward low carbon content one, owning to the fact that energy users do not respond in the same way to a price signal as to a quantity signal as in a downstream system. Indeed, in an upstream approach, emitting sources are impact through a price signals rather than a direct constraint on CO_2 emissions. No incentive would be provided for cost-effective emissions reduction and these opportunities may missed, which would drive up the cost of compliance to the cap-and-trade program. Among possible disadvantage of an upstream system, market power has to be considered due the few number of participants. The low political acceptability is an other potential drawback of such scheme.

III.2 Downstream option

In a downstream CO_2 emissions trading, all energy consumers are required to hold emission allowances. It regulates directly carbon emitting sources. The energy users receive a quantitative signal in the form a ceiling on their carbon emissions. If permits are grandfathered, based on historical emission per sources regulated, a downstream approach enhances the political acceptability of emission trading scheme.

As the price signal in an upstream system wouldn't provide a full stimulus for energy-efficiency, the downstream approach offers stronger incentive for technical innovation, which implement profitable energy saving and more cost-effective mitigation opportunities in the emission trading scheme. However, the lower coverage of this system for total emission in the Turkish economy would result in less environmental effectiveness to achieve the burden of CO_2 emissions reduction objectives. An other drawback of a downstream cap-and-trade system is closely linked to major administrative cost associated to monitoring of the carbon emissions and checking compliance of regulated sources.

III.3 Hybrid option

We may address a hybrid approach for a carbon cap-and-trade in Turkey by combining a downstream and upstream system. Such a hybrid option would target polluting energy users directly through a downstream program and the remaining polluters would be regulated as in an upstream program. This hybrid option seeks to achieve the benefits of an upstream approach that derive from broad coverage and the potential energy effectiveness standing from a downstream approach. It 's a compromise between both options providing a relevant level of political acceptability and low administrative costs. One major interest is that all sources are covered in the tradeable emission permits market. Thus, a hybrid option require surrender of allowances by energy producers, manufacturing and other polluting sources. This begs the issue of the distribution of carbon emission abatement between sectors in the Turkish economy.

IV The analytical model

IV.1 An overview of the TURCO model[1]

This section provides a brief algebraic summary of the specifications for our static-comparative model underlying the simulations of the alternative options to implement a tradeable emission trading scheme in Turkey. The TURCO model is a computable

[1]The complete specifications of the model are available in Sahin (2002)

general equilibrium model designed to quantify the economic implications of a tradeable permits market on the Turkish economy and, more particularly, it examines the impacts of introducing emission permits in different sectors. As in Turkey, regions differ in their industrialization levels, the TURCO model projects economic activity, energy consumption and CO2 emissions for three Turkish regions ($z : I,\ SI,\ R$) ; as industrialized (I Marmara and Aegean regions), semi-industrialized (SI Central Anatolia, Black Sea and Mediterranean regions) and rural regions (R Eastern and South-Eastern Anatolia).

A representative household is distinguished in each regions in relation to the segmentation of labor market (skilled and unskilled). Each representative agent maximizes its utility from consumption C_k with $\overline{C}_k$, the corresponding subsistence levels. It is combined to the total stock of pollution POL_{TOT} with the corresponding coefficient Θ_k, which comes as a disutility, under an intertemporal budget constraint.

$$\begin{cases} Max \quad U(C_k) = u_k - \Theta_k POL_{TOT} \\ RV_k = \sum\limits_{ts} C_{k_{ts}} pc_{k_{ts}} + \sum\limits_{nt} C_{k_{nt}} pc_{k_{nt}} \\ \text{with } \mathbf{u}_k = \sum\limits_{ts} \boldsymbol{\beta}_{1k_{ts}} \ln\left(\mathbf{C}_{k_{ts}} - \overline{C}_{k_{ts}}\right) + \sum\limits_{nt} \boldsymbol{\beta}_{2k_{nt}} \ln\left(\mathbf{C}_{k_{n}t} - \gamma_{zi}\right) \end{cases}$$

The following conditions are verified for budget coefficients $\left(\beta_{1k_{ts}} + \beta_{2k_{nt}} = 1\right)$ with $\left(0 < \beta_{1k_{ts}}, \beta_{2k_{nt}} < 1\right)$, and the corresponding consumption levels ($C_{k_{ts}} - \overline{C}_{k_{ts}} > 0$ with $C_{k_{nt}} - \overline{C}_{k_{nt}} > 0$).

Households' demands are derived from the first order conditions for non transport goods

$$\mathbf{C}_{k_{nt}} = \overline{C}_{k_{nt}} + \boldsymbol{\beta}_{2k_{nt}} \frac{\left(RV_k - \sum\limits_{nt} pc_{k_{nt}} \overline{C}_{k_{nt}}\right)}{pc_{k_{nt}}}$$

and for transport services:

$$\mathbf{C}_{k_{ts}} = \overline{C}_{k_{ts}} + \boldsymbol{\beta}_{1k_{ts}} \frac{\left(RV_k - \sum\limits_{ts} pc_{k_{ts}} \overline{C}_{k_{ts}}\right)}{pc_{k_{ts}}}$$

Nested separable constant elasticity of substitution (CES) functions characterize the use of inputs in production. The TURCO model has 4 producing sectors ($j : EN$ Energy, TR Transports, MN Manufacture and AG Agriculture). Economics details are maintained in the energy supply and transformation sectors important for CO_2 projections. The choice of sectors captures key dimensions in the analysis of emission reduction in the Turkish economy. The production Y_{zi} of good i in the region z is derived from composite production factors (KL Capital/Labor, EM Energy/Intermediate goods and TR Transports). The model puts the emphasis on the Transport activities, due to their large contribution to GHG emission in Turkey. Transports activities represents a decomposition between national transports (urban and inter-urban), international and domestic transportation services). For example, in the Manufacturing sector we use the following CES production function with three factors in proportions:

$$Y_{zi} = \left[\alpha_1 KL^{1-\frac{1}{\rho_2}} + \alpha_2 EM_{zi}^{1-\frac{1}{\rho_2}} + (1-\alpha_1-\alpha_2)TR\right]^{\frac{1}{1-\frac{1}{\rho_2}}}$$

Consider a decomposition of energy demand in the model. Thus, we emphasize the energy sector due to its contribution to CO_2 emissions at the national level in Turkey. Our analysis proceeds by the decomposition of energy activities and disaggregate demand both for households and producers. The first classification as energy used in transports sector ETR and in other needs EOT. Energy demands are determine from the cost minimization programs:

$$\begin{cases} Min \quad p_{EN}EN = p_{ETR}ETR + p_{EOT}EOT \\ sc\ EN = A_{EN}\left[\vartheta_4 ETR^{1-\frac{1}{\kappa_4}} + (1-\vartheta_4)\,EOT^{1-\frac{1}{\kappa_4}}\right]^{\frac{1}{1-\frac{1}{\kappa_4}}} \end{cases}$$

Energy demand for transport activities is determined by the following condition:

$$ETR = A_{ET}\left[\vartheta_5 DIE^{1-\frac{1}{\kappa_5}} + \vartheta_6 NBEN^{1-\frac{1}{\kappa_5}} + (1-\vartheta_5-\vartheta_6)\,LPG^{1-\frac{1}{\kappa_5}}\right]^{\frac{1}{1-\frac{1}{\kappa_5}}}$$

Energy demand for other activities is determined through a disaggregation as in the previous nomenclature in the model. Energy demand, electricity EL and non electric energy NEL demands, are combined using a nested separable constant elasticity of substitution function. It follows the cost minimization program for energy demand for other needs:

$$\begin{array}{l} Min \quad p_{EOT}EOT = p_{EL}EL + p_{NEL}NEL \\ sc\ EOT = A_{ET}\left[\vartheta_5 EL^{1-\frac{1}{\kappa_5}} + (1-\vartheta_5)\,NEL^{1-\frac{1}{\kappa_5}}\right]^{\frac{1}{1-\frac{1}{\kappa_5}}} \end{array}$$

From first order conditions, we derive the energy demand for electricity EL and non electric energy NEL:

$$\begin{aligned} EL &= EOT\left(\frac{\vartheta_7 p_{EOT}}{p_{EL}}\right)^{\kappa_7} \\ NEL &= EOT\left(\frac{(1-\vartheta_7)\,p_{EOT}}{p_{NEL}}\right)^{\kappa_7} \end{aligned}$$

The choice between domestic and imported varieties of the same good are modelled with Armington [1969] specifications towards 3 country blocs ($OECD - EU$:European

OECD countries, $OECD - NEU$: Non European OECD countries and ROW : Rest of the world).

Two classes of condition characterize the competitive outcome for the TURCO model: zero profit conditions and market clearance conditions. Differentiating the profit function with respect to input and output prices gives the demand and supply function, which subsequently appear in the market clearance conditions. The markets said to clear when the model solves for the set of prices for all markets so that demands and supplies of each market are in equilibrium.

IV.2 The integration of a national carbon dioxide emissions trading scheme

Before implementing tradeable emission permits conditions, we consider how to introduce CO_2 emissions in the TURCO model. The stock of pollutions is coming from households POL_{HH}, industry POL_{IND}.

$$PPOL_{TOT} = POL_{HH} + POL_{IND} \tag{1}$$

Both on the consumer and producer sides, emissions are differentiated into two. Emissions coming from transport activities POL_{ETR} and from other use of energy POL_{EOT} (ex: lighting, heating etc...)

In this perspective, the total amount of pollution coming from households is the sum of these two types of pollution :

$$POL_{HH-TOT} = POL_{HH-ETR} + POL_{HH-EOT} \tag{2}$$

This diffrenetiation depends on the type of fuels. The use of liquefied petroleum gas LPG, oil OIL and diesel $DIESEL$ are at the origin of one type of emissions coming from transport activities of the households POL_{HH-ETR}. They are calculated from the energy consumption of the households in these kind of energy (LPG, oil OIL and diesel $DIESEL$) and the corresponding emission coefficients w:

$$POL_{HH-ETR} = LPG\ w_{LPG} + OIL\ w_{OIL} + DIESEL\ w_{DIE}$$

Electricity, Natural Gas GAS, Fuel $FUEL$ and Coal CH determines the emissions coming from the other type of use of energy by the households.

$$POL_{HH-EOT} = EL\ \bar{w}_{EL} + GAS\ \bar{w}_{GAS} + FUEL\ \bar{w}_{FUEL} + CH\ \bar{w}_{CH}$$

We use the same method in order to determine the pollution coming from the use of transport activities consumed by the industry $POL_{IND-ETR}$ and this coming from the use of other types of energy $POL_{IND-EOT}$.

Alternative tradeable emission permits schemes are then implemented in the model considering as a primal approach, see Mc Kibbin and Wilcoxen [1992], which would consist to introduce the permits as a factor of production. In our framework, we consider that the Turkish environmental authorities decide to reduce the national emissions level in the different sector and to create a domestic market for tradeable emission permits by setting a standard $\overline{POL} = \mu_j POL$ on polluting emissions. μ_j represents the abatement requirement at the national level, which is differentiate for each sector in the following. $\overline{POL}$ stands for the fixed supply of permits. The initial endowment of permits to each sector is determined by "grandfathering" based on the regulation level of emission, such that: $\overline{POL}_j = \mu_j \frac{POL_j}{POL}$. Thus, sector j's net demand for permits is given by its business-as-usual emissions less its initial permits allocation. Firms, that reduce their carbon-dioxide emissions below the number of allowances, would sell the allowances not used, whilst firms with business-as-usual emissions exceeding allowances would have to buy additional permits. For a representative sector $j = EN$, TR, MA, AG, the "zero profit condition" has to be written as follows:

$$p_{Y_j} Y_j = p_{KL} KL - p_{EM} EM - p_{TR} TR - p_{pet}(POL_j - \overline{POL}_j)$$

Permits, allowed to be transferred or sold, stand for a "right to pollute" up to certain fix amount. To define the permits price p_{pet}, the market clearance condition is applying for:

$$\sum_j p_{pet}(POL_j - \overline{POL}_j) = 0$$

In the emission permits trading scenarios, the TURCO model calculates the overall effect of the cap on CO_2 emissions on the Turkish economy and determine to what extent this may impact the economic structure of the country.

V Policy Scenario and Simulation Results

In the following analyses, we specially address issues associated with carbon emissions reduction with special emphasis given toward performing the following types of scenario:

▲ Scenario I: E provides estimates of consequences of implementing an upstream emission trading for energy producers

▲ Scenario II : MAT provides estimates of consequences a pure downstream approach

▲ Scenario III : ET provides estimates of the economic cost of hybrid system considering both abatement requirement for energy producers and transport sectors

▲ Scenario IV : MATE provides estimates of the impacts of a hybrid option regulated all carbon emission sources

The main macroeconomic results are summarized in Table 4. The simulation shows that cost of CO_2 reduction is rather low, as far as macroeconomic impacts are considered.

Table 4: National Macroeconomic Results

	Scenario E	Scenario MT	Scenario ET	Scenario MATE
Consumption	0	0	-0.44	0
Investment	+0.014	0	0	0
Exports	0	0	0	0
Imports	0	-0.003	0	+0.12
Employment	0	0	+ 0.007	0
Consumer Price	0	0	+ 0.009	0
Wage	0	0	- 0.039	0
GDP	-0.0001	-0.002	+0.274	+ 0.139
Welfare	0	-0.002	- 0.478	+ 0.004

The introduction of energy sector, in an hybrid system (scenario MATE) is a quite positive impact on the emission reductio. The negative impact on GDP is notably reduced as there is a broad coverage. Indeed there is a +0.139% increase in GDP in a full hybrid system (scenario MATE), compared with a -0.002% decrease in the a pure downstream system. With these policies simulations, lack of coverage as in scenario E and MT prevents some energy user from responding to price signal. Therefore many profitable energy efficiency and fuel switching opportunities are not taken while other argue that in general consumers do respond to prices. Lower energy input coefficients contribute to the bulk of energy reduction and hence carbon dioxide emissions under the four constraint scenarios, which results in a change in the structure of Turkish economic activity.

In the scenario E, where only energy producers are requiring emission allowances, the impact on the Turkish economy is rather low owning to the dillution of the price signal impacted by emission constraints. Then, consumption and production are not affected by the environmental policy on CO_2 emissions. These results have to be mitigated in the case of a pure downstream approach (scenario MT), where energy user are covered. They face a quantity constraint on their emissions, which result in a -0.002% decrease in production.

In the scenario ET, a mixed hybrid system combining the energy sector and transports services we observe the most efficient policy. The consumption decreases by (-0.44%) as there is a +0.009 increase in consumer price due the constraint on carbon emissions. This leads to an improvement in employment (+0.007%) and a decrease in the wage level (-0.039%). Then GDP rises about +0.274%. In the scenarios with emission ceiling on the energy sector, we notice a subsitution of energy goods by manufactured goods. Hence the level of production rises even in this constrained case (+0.274% in ET scenario).

Theses results can be summarized as follows :

Table 5: Emissions Reduction

	Scenario E	Scenario MT	Scenario ET	Scenario MATE
Energy	-1.131	0.101	-1.568	-2.232
Transport	-1.568	0.07	-1.313	-1.641
National	-0.001	0.109	-1.645	-2.405

The possible disadvantage of an upstream approach (scenario E) is that it might not provide as great an incentive for energy efficiency and fuel switching as a pure downstream system (scenario MT) due to market imperfections. Therefore, broad coverage prevent the possibility of leakage from covered to non-covered sources as shown with scenario. Furthermore, we notice significant impacts at the sectorial level, even when the macro-economic results are marginal. We can see that the most energy intensive sectors always suffer from the policy scenarios. CO_2 emissions decrease of -2.405% in a full hybrid approach (scenario MATE) and -1.645% in a mixed hybrid options (scenario ET) whether the reduction is less effective in pure upstream (scenario E) or downstream (scenario MT) approach. However only in the downstream approach (scenario MT) we observe an increase of emissions (+0.101%). This impact comes from a lack of emission constraint on the energy sector.

In the generalized scenario (MATE) emission reductions are the most effective. In this scenario, agricultural sector was not constraint by an emission ceiling whereas all the other sectors had to reduce their emission levels (Energy -2.232% and transport - 1.641%). This improvement in environemental quality is accompanied by an increase of production (+0.139%). From a cost-efficiency and welfare standpoint, the full hybrid system based on regulation of most emitting sectors in Turkey offer a higher positive impact on economy as CO_2 emissions decrease more and welfare increase of +0.004%.

VI Conclusion

We have analyzed the implications of different incidence of regulation in dioxide carbon emission trading in Turkey. Our main findings can be summarized as follows: an upstream approach to CO_2 emission trading would be more economically efficient and probably more environmentally effective, however downstream approach offers greater flexibility.

Then, the objective of the paper was to evaluate the possibilities to combine alternative approaches to design emission trading. In this purpose, a computable general equilibrium model of the Turkish Economy was used. Further analysis is needed to extend the design of emission trading scheme to other kind of greenhouse gas emissions to provide a broad coverage of pollution in Turkey. These macroeconomic impact would be them nearly greater, specially in term of switching toward cleaner energy with lower emission content.