METU Studies in Development, 23 (4) 1996, 577-600

How the doctor's prescriptions may fail : Environmental policy under alternative market structures[1]

Terry L. Roe
University of Minnesota, St. Paul, 55100 Minnesota, USA
A. Erinç Yeldan
İktisat Bölümü, Bilkent University, 06533 Ankara Turkey

Abstract

Existing applied modeling analyses of carbon taxation scenarios to reduce emissions of CO_2 discharges have generally relied on perfectly competitive markets. It is argued in the current paper that, to the extent non-competitive producer behavior is prevalent in the modeled economy, environmental policies may fail in their objectives. Alternative pricing strategies are simulated in a computable general equilibrium model of the Turkish economy to highlight the sensitivity of environmental pollution abatement under different market structures.

I. Introduction

In recent years applied general equilibrium studies of restricting carbon dioxide (CO_2) emissions from industrial production and use of fossil fuels

1 A previous version of this paper was presented at the Fifth International CGE Modeling Conference, Ottawa, Canada, October 1994. The authors wish to acknowledge their indebtedness to two anonymous referees, Sherman Robinson, Oktar Türel, Ahmet Köse, and to the participants of the Ottawa Conference and the seminars at Bilkent, METU and Minnesota for their comments and suggestions. Research for this paper was supported by the USAID/MUCIA project titled "Environmental and Natural Resources Policy and Training Project" under the Macro Economics Team.

became an increasingly important area of research. Given sound theoretical evidence[2] that the most efficient policy instrument for controlling such emissions is market-based incentives, a number of applications on the economic effects of carbon tax incidences have already been analyzed in the literature.[3] Although there is an understanding that such analyses should ultimately be undertaken for particular economies on an independent basis,[4] little attention has yet been paid to the distinguishing attributes of the market structures and the surrounding policy environment of the analyzed economies. A common trait of many of the applied modeling attempts is the perfectly competitive specification of the commodity and the labor markets often under steady-state intertemporal equilibrium. However, it is the perception of this paper that non-competitive or missing market structures and heavily politicized, regulated managerial practices, often based on imperfect and biased information, are pervasive facts of life in many developing economies. At a theoretical level, the implications of pollution control in monopolized markets have been studied in a series of seminal papers by Buchanan (1969), Buchanan and Tullock (1975), and Misiolek (1980; 1988). However, policy-oriented, applied modeling exercises seem to have not yet paid due attention to this literature. As Misiolek (1988: 1) points out, this forms "a curious anomaly given the importance which has been ascribed to rent-seeking losses in monopoly and the attention which has been afforded to developing an optimal environmental strategy for these markets". In this paper it is argued that under a second best setting of non-competitive, oligopolistic market composition, theoretically sound environmental policies may not attain the desired objectives. To this end, an applied general equilibrium model for Turkey is employed to simulate the effects of introducing direct carbon taxes against CO_2 emissions. To highlight the sensitivity of the results to different market structures, we contrast the efficiency and welfare effects of carbon taxation policy in an oligopolistic mark-up pricing environment *versus* a perfectly competitive setting. It is argued that given oligopolistic mark-up pricing possibilities, industrial producers may render environmental policy counter-productive. Turkish economy is known to display a long history of non-competitive producer behavior based on rent-seeking towards import quotas (Krueger, 1974); towards subsidized fictitious exports (Öniş, 1992; Roe and Yeldan, 1991);

2 See, e.g. Baumol and Oates (1988) and/or Eskeland and Jimenez (1992) for lucid expositions of efficiency properties of the environmental policy alternatives.

3 See, e.g. Robinson (1993); Nordhaus (1993); Gunter *et al.* (1992); Whalley and Wigle (1992); Whalley (1991); Bergman (1991).

4 The argument is put most vehemently in Blitzer (1992).

towards speculative stock exchange operations and privatization attempts of state-owned enterprises (Çapoğlu, 1992; Boratav *et al.,* 1996); and towards supra-normal profits *via* price inflation (Yeldan, 1993). Thus, we believe it will serve as a typical developing economy encompassing a variety of non-competitive market rigidities of interest to the policy analyst. We take up the distinguishing features of the economy and the way they are incorporated into the modeling framework in the next section. We contrast the effects of the carbon tax using the general equilibrium model in Section 3, and reserve Section 4 for summary comments. The algebraic equations of the model are further summarized in the appendix.

2. Model specification

2.1. General features

To implement the intended policy scenarios, we make use of a static computable general equilibrium (CGE) model of the domestic economy. The data base of the model relies on the 1987 social accounting matrix with five production sectors organized around the agriculture-industry-services linkages, and with three behaviorally distinct private households. The bureaucratic apparatus on carbon taxation is envisioned through the actions of the government as an independent agent. The government is solely responsible for implementing the "green taxes" towards carbon emission control, and is assumed to have access to the necessary bureaucratic command to sustain its policies.

2.2. Producer behavior and the factor markets

Sectoral production technology is modeled *via* a CES aggregation of capital and labor for value added. Intermediate input use is specified through fixed (Leontief) coefficients. Sectoral physical capital is specific and fixed; henceforth sectoral profit rates differ even under macro-equilibrium. Labor is perfectly mobile across sectors and is employed given relative price signals.

An important feature of the model is its accommodation of oligopolistic mark-up pricing behavior in the industrial output market. Industrial producer price is set as average variable costs plus a mark-up, and with price being pre-determined as such, industrial output is driven by aggregate demand.

Mark-up induced pricing behavior in Turkish manufacturing industry is studied at length in Şahinkaya (1993), Boratav *et al.* (1996), Boratav (1991), Karaaslan (1989) and Özmucur (1986). Kaytaz *et al.* (1993), on the other hand, analyze the non-competitive structures in the manufacturing sectors directly *via* measures of "concentration". Yeldan and Bakan (1993) further regard non-competitive producer behavior as an important factor explaining the poor performance of environmental pollution abatement policies among Turkish industrialists in the 1980s.

A general synthesis that emerged from these studies is that there exists a fairly stable relationship between the wage share and the mark-up rates in the manufacturing sectors. Boratav *et al.* (1996) examine the behaviour of industrial mark-ups in the post-1980 trade liberalization era, and conclude that the removal of trade restrictions and foreign liberalization have not yet brought forth the expectations of the theory, prognosticating a fall in the mark-ups. On the contrary, the producers seem to have alleviated the pressures of foreign competition *via* intensified rent-seeking on various other aspects of macro policy-making, as the average mark-up rate in industry is observed to rise secularly after 1985, to reach the plateau of 40% in the early 1990s (See Boratav *et al.,* 1996: Table IV.3). Kaytaz *et al.* (1993) and Yeldan (1994) also suggest disaggregated data supporting those conclusions.

Furthermore, it has to be noted that these arguments pertain mostly to *aggregate* manufacturing where about a third of the value added is produced within the public enterprise system. It is a widely accepted fact that public enterprise pricing is more often a politically regulated process; and the behavior of mark-ups can be regarded to be mostly under the influence of the *private* directives. Thus we adhere to the *private* manufacturing indicators of distribution and costs in summarizing the relevant data in Table 1. The data in Table 1 distinguishes five sub-periods between 1971 and 1987. These roughly aggregate the cycles that the economy went through over the time horizon considered. Data shown at these sub-periods are annual averages.

To better analyze the data in Table 1, observe that the mark-up induced price formation satisfies:

$$P^x X^s = (1+m)\ (wL + C) \qquad (1)$$

where P^x is the producer price; X^s is gross supply of industrial output; m is the mark-up rate; w is the wage-rate; and L and C denote the labor employment and the value of intermediate inputs, respectively. Conceptually, the mark-up rate in Eq. (1) gives the relationship between aggregate profits, R, and total variable costs; i.e., $m = R/(wL+C)$. The *profit rate*, however, gives the returns to capital stock and is defined as:

Table 1

Factors Affecting the Profit Rate in Turkish Private Manufacturing, Selected Years

	1971-76	1977-80	1981-82	1983-85	1986-87	1988	1989	1990
Annual rate of growth (%)								
1. Private producer price	13.8	70.6	28.9	39.3	37.8	79.7	63.6	43.7
2. Real gross output	9.7	1.0	7.4	8.0	9.7	1.8	3.2	10.1
3. Real wage rate[a]	5.5	-6.2	3.5	-4.6	5.4	-1.7	12.5	26.6
4. Mark-up rate (%)	41.4[b]	34.8	33.5	31.1	38.2	39.8	36.3	40.8
5. Profit rate[c] (%)	-	24.0	32.2	24.1	38.9	50.9	41.7	52.4
6. Capacity utilization rate (%)	-	45.0[d]	64.0	53.0	63.0	77.1	73.1	76.0
7. Wage share in value added (%)	28.1	31.2	26.5	23.7	17.5	16.7	19.7	21.8
8. Intermediate costs / wage costs	5.522[e]	5.312	7.057	9.102	11.118	11.577	10.246	7.815

Notes:

a. Private manufacturing wage rate deflated by the private producer price index.

b. Refers to 1971-75 and pertains aggregate manufacturing (from Şahinkaya, 1993).

c. Extrapolated from the relation r = [m / (1+m)] u. See text for derivation.

d. Refers to aggregate manufacturing (from Şahinkaya, 1993).

Source: Rows 1, 2, 5-6: SIS Manufacturing Surveys, various years; Rows 3, 4, 7: Boratav *et al* (1996).

r = R/P^{x}K, where K is the (real) capital stock. Since R = m(wL+C) by definition, the profit rate must satisfy:

$$r = [m / (1+m)]\, u \qquad (2)$$

where u = (X^s/K) is interpreted as a proxy for the capacity utilization rate of the sector[5]. In the absence of reliable capital stock data, existing studies chose to interpret m as the (gross) profit rate and used the two terms interchangeably. Here we try to extrapolate the value of the profit rate by using the State Institute of Statistics (SIS) data on private manufacturing capacity utilization rate and report r separately in Row 5 of Table 1.

The data reveal a secular rise in r since 1985. Prior to that, 1977-80 is a period of crisis where GDP fell by an annual average of 1% in real terms. 1981-85 can also be regarded as a "stabilization period" during which a major structural adjustment program had been initiated. Under "normal" business conditions, the mark-up displays a relatively stable trend, fluctuating mildly around 41% (1971-76) and 36% (1989). Especially after 1985, one

5 Since R = m (wL+C), dividing by P^{x}K, and using Eq. (1) gives Eq. (2).

witnesses a close co-movement of the profit rate with the annual rate of change of the producer price.

In general, wage share (wL/P^xX^s) and the profit rate (r) follow an inverse pattern. The late 1980s demonstrate, however, the feasibility of a simultaneous co-movement of both variables. Conceptually, the wage share in value added is bound to fall due to (i) an increase in the mark-up rate; or (ii) an increase in the capacity utilization rate; or (iii) a decline in the real wage rate *relative* to the intermediate (non-labor) input costs. We observe that the wage-share and the mark-up rate can simultaneously be increased if the intermediate costs fall sufficiently relative to wage costs to allow for expansion of the value added. This seems to characterize what has happened in the Turkish industry during 1989-90. Wage growth seems to be concomitant with the dramatic fall in the cost of material inputs (mostly produced and priced in the public enterprise system) and the increase in capacity utilization.

These observations are accommodated in the model by setting the industrial producer price, P^x as:

$$P^x = (1+m)\,AVC \qquad (3)$$

where AVC is the average variable cost, and is given by:

$$AVC_i = \frac{wL + \sum_j a_{ji} P_j^c X_i^s}{X_i^s[1-t_n] - \tau POL} \qquad (4)$$

where the indexes i and j refer to the output sectors (i, j: 1,...,5). Here P^c is the composite user cost price; t_n is the indirect tax rate; τ is the carbon tax rate; and POL is the amount of carbon emitted (in metric tons) as specified below. Since the producer price is pre-determined, industrial supply is set by the aggregate demand conditions:

$$X^S = X^D \qquad (5)$$

We hypothesize that equilibrium in the industrial goods market is satisfied *via* endogenous adjustments of the capacity utilization rate, u:

$$X^S = u\, f(K,L) \qquad (6)$$

where f (. , .) is the production function depicting the presumed CES technology.[6] As output adjustment is achieved through u, producers are

---

[6] Alternative conceptualizations of mark-up induced pricing regimes can also be envisaged and applications do exist in the CGE literature. Models belonging to the classic structuralist tradition, for instance, impose fixed mark-ups and drop the respective production function entirely from the model. In turn, they rely on the

assumed to be on their labor demand schedules, and hire labor according to the marginal productivity rule:

$$PVA \,.\, (\partial X^s / \partial L) = W \qquad (7)$$

In Eq. (7) PVA is the value added price, net of indirect taxes and intermediate costs. The wage rate in the labor market is taken nominally fixed to account for the non-competitive structure of the industrial labor markets, a typical characteristic of many developing economies.[7] Given this specification, labor markets clear through quantity adjustments of employment, following real wage movements along Keynesian lines.

2.3. Pollution technology and carbon taxation

Two sources of CO_2 emissions are distinguished in the model: (i) due to industrial production; and (ii) due to energy consumption as intermediate input. Following Robinson *et al.* (1993), carbon emissions are hypothesized proportional to gross output. As noted in Gunter *et al.* (1992), the amount of CO_2 emitted in the aggregate depends primarily on the level of pollutant-emitting inputs used, but is independent of the technology applied. Thus at the last resort, gaseous emissions can be regarded to ultimately depend on the industrial activity. The major implication of this approach is that the only way to reduce emissions of gaseous pollutants is to shift the structure of production -through relative prices- away from the polluting industry.

Carbon tax is introduced at the rate τ per ton of CO_2 emitted, and the revenues are directly added to the revenue pool of the government budget.

---

product market equilibrium to determine the quantity supplied (see, e.g. Taylor (1991) for a variety of CGE models in this framework). The advantage of this approach is that it highlights the consequences of oligopolistic mark-up pricing rules along a downward sloping demand curve: mark-up ridden prices lead to falling revenues. However, they suffer from the fact that, with production functionals omitted, substitution possibilities between capital and labour are lost, and the role of physical capital in production technology becomes blurred. Our specification here follows that of Bourguignon *et al.* (1991). Here, by keeping the sectoral production function intact, we remain more in the realm of micro-foundations of labor allocation decisions in response to the marginal product-wage signals. For further theoretical discussion on mark-up induced pricing behavior in the CGE modeling framework, see Gibson *et al.* (1986).

7 See Şenses (1989) for a thorough overview of the Turkish labor market.

Data on gaseous pollutants are further summarized in the Appendix Table 1.

2.4. *Income generation and government's fiscal balances*

Sources of private income originate from value added, and from fiscal and external transfers. Fixed tax rates are applied on household income to generate tax revenues to the government. Other sources of public income are taxes on carbon emissions, on foreign trade, and on production, and exogenous flows of external borrowing.

Fiscal deficit is calculated as the difference between the government's expenditures (on public consumption, public investment and transfers) and the revenues and foreign borrowing. The deficit claims resources from the private saving pool, and private investment is crowded out as it is determined as a residual of aggregate private savings and the net fiscal deficit.

Private consumption demand is specified through applications of fixed sectoral consumption shares with the underlying presumption that the agents have Cobb-Douglas preferences. Import decisions are based on the Armingtonian tradition of constant elasticity of substitution specification to form a composite consumption good between import and the domestically produced component. The composite price, P^c, reflects both the import price and the domestic supply price.[8]

2.5. *General equilibrium*

The overall model is brought into equilibrium through endogenous adjustments of product prices, and the exchange rate to clear the commodity markets and the balance of payments accounts. With nominal wages being fixed, equilibrium in the urban labor market is sustained through quantity adjustments of employment. Domestic price level, which is a weighted average of producer prices, serves as the *numéraire* of the system.

3. Carbon taxation under alternative market structures

We now turn to the comparative analysis of the incidence of carbon taxation under a perfectly competitive market *versus* an oligopolistic environment. The threat of global warming has already led to a number of applications of CO_2 taxation in certain countries (e.g. Sweden, Finland, Denmark and France), and the economic effects of the policy have been

8 See Derviş *et al.* (1982) for a theoretical discussion on the underlying price structure of applied general equilibrium models of the CGE type.

studied in the CGE framework through the works cited in footnote (3) above.

The carbon tax is imposed in the industrial sector parametrically at discrete intervals of 2000 TL (in 1987 prices) per ton of CO_2 emitted. Figure 1 discloses the main thrust of our arguments succinctly: within a perfectly competitive setting, aggregate emissions are reduced secularly, and a total of 1.05% reduction in CO_2 pollution is achieved corresponding to the tax rate of 10,000 TL per ton. Under the presence of mark-up based pricing practices, *per contra,* the policy fails in generating any reductions at all. In fact CO_2 emissions do rise by a small margin. The main mechanism behind this result is the relative price effect in favor of industry which emanates from oligopolistic mark-up protection of profits. The mark-up effectively fixes the relative price of industrial output against the other sectors, secures labor employment, and maintains the existing level of production. The mechanics of this process is highlighted in Figure 2 wherein the industrial rate of profit is contrasted. As observed, the profit rate is squeezed under competitive conditions and falls by a full percentage point when T = 10,000 TL/ton. In contrast, it is well-protected with the mark-up under the oligopolistic practices, where the fall in the profit rate amounts only to 0.2% at the same carbon tax rate.

But what is the underlying mechanism enabling continued production of industrial output at relatively higher prices and maintaining its market demand? If producer prices were fixed, and increased variable costs were passed on to the final consumer, we would expect the final demand to fall and ultimately reduce the level of production. The answer to the riddle lies in the behavior of public expenditures. With the introduction of the carbon taxes, the government acquires an unexpected flow of additional revenues, as no compensatory reduction in the existing level of taxes takes place. The proceeds of the CO_2 tax at the rate of 10,000 TL per ton, for instance, when calculated by the observed increase of CO_2 emissions at the rate of 0.14% (Table 2), amount to a total of 7.1% of combined fiscal revenues under the oligopolistic market scenario. Increased fiscal revenues augment aggregate public consumption and investment. Given the high share of industry in aggregate public expenditures, the level of final demand to industrial output is maintained.[9]

[9] The alternatives of recycling the green tax revenues through restructuring the existing tax system are investigated in the CGE framework in the DICE model of Nordhaus (1993) and in Roe and Yeldan (1993).

Figure 1

Index of Aggregate CO_2 Emissions Under Alternative Market Structures

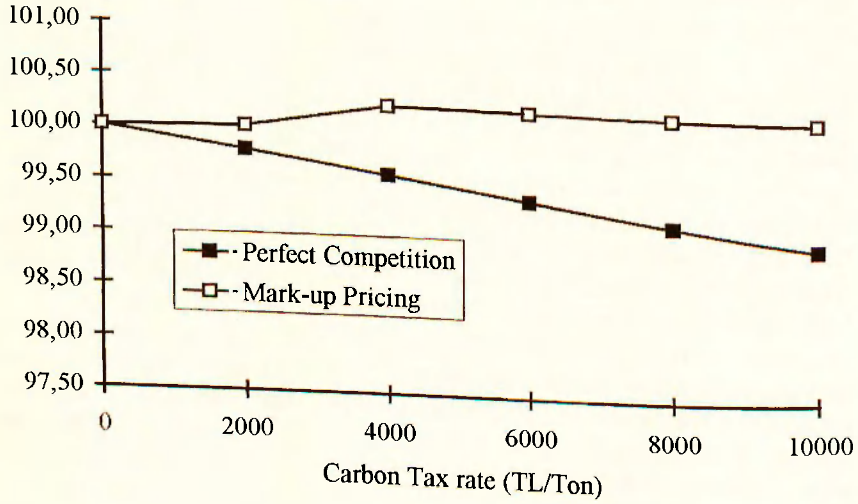


Figure 2

Rate of Profit in Industry (%)

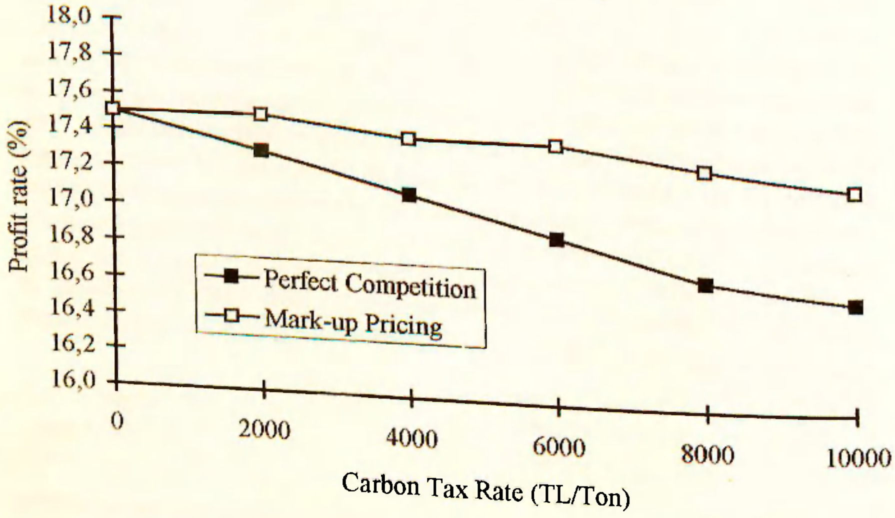


Table 2

Macro Balances and Percentage Changes from the Base-Run

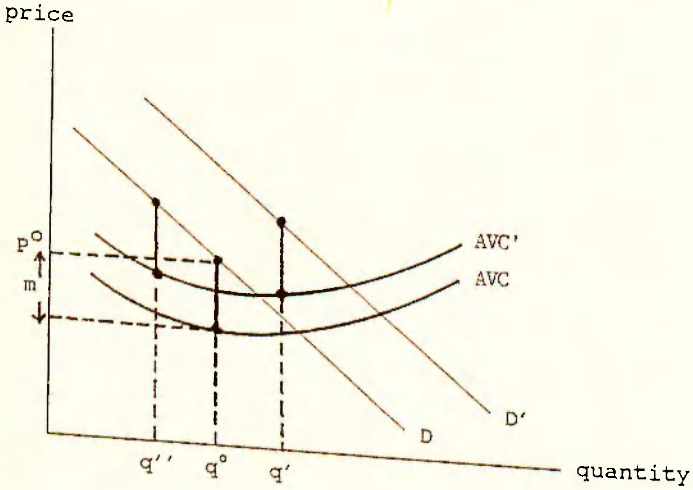
		τ = 2,000[b]		τ = 10,000[b]	
	Base-Run[a]	Perf. Comp.	Mark-up	Perf. Comp.	Mark-up
GDP	52921.5	–0.10	0.03	–0.45	0.11
Private disposable income					
Rural	10104.4	0.84	–1.01	3.04	–3.78
Urban worker	8898.0	0.30	0.88	1.70	0.44
Urban capitalist	22712.9	–1.06	–0.94	–4.91	–2.58
Aggregate profits					
Industry	12696.4	–1.13	0.01	–5.27	0.44
Commerce	8762.8	–1.45	–1.29	–6.96	–7.31
Aggregate consumption					
Private	39084.5	–0.28	–0.36	–1.40	–1.24
Public	5322.7	0.98	1.48	5.20	7.35
Industrial output	54293.2	–0.21	0.02	–1.05	0.19
CO_2 emissions[c]	154224	–0.21	0.01	–1.04	0.14
Industrial terms of trade	100.0	-0.32	1.47	-0.62	6.53
Urban real wage rate[d]	1639.5	0.98	1.48	5.21	7.33
Average profit rate (%)	15.7	15.5	15.6	14.8	14.9

Notes: a. Billion TL, at 1987 prices, unless otherwise noted.
b. TL / metric ton (1987 prices).
c. Thousand metric tons.
d. Thousand TL, at 1987 prices.

The geometry behind this result is portrayed in Figure 3. Given schedules for final demand (D) and average variable costs (AVC), the mark-up induced producer price sets quantity demanded, and hence production. Abatement to CO_2 taxation shifts costs to AVC'. The vertical distance between the D and the AVC curves are accounted by the mark-up rate, where for expositional convenience we depict the mark-up as fixed in absolute levels. Thus we portray its magnitude of the same length in the figure. It has to be noted that, the algebraic structure of the model utilizes the mark-up rate as fixed in *ad valorem* terms. Conceptually the figure narrates the same adjustment principle in that the increased public expenditures lead to increased aggregate demand to D'. Output supplied increases to q'. Had final demand on industrial output were maintained at its level, quantity supplied would have fallen to q''.

Figure 3

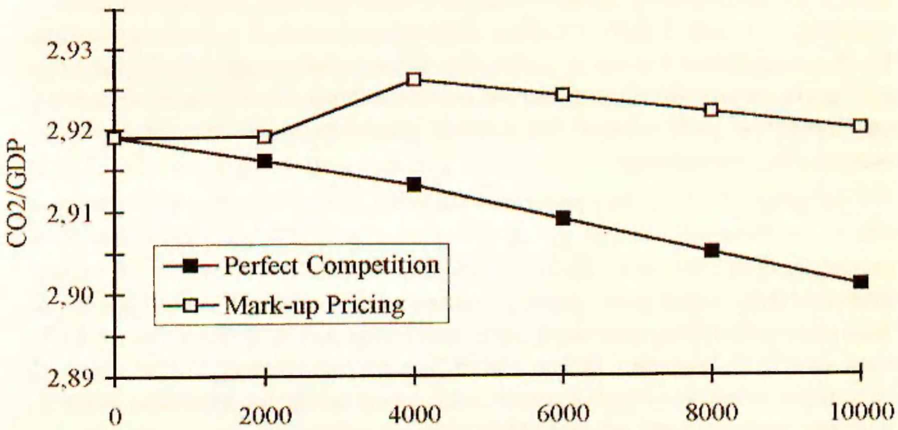
Effects of Carbon Tax on the Oligopolistic Market



In addition to increased public expenditures, this phenomenon seems to have benefited additionally from the second-best nature of green taxes. As shown in Oates (1992), the interesting aspect of implementing direct pollution taxes as instruments of environmental protection is that such charges may reveal, at least over some feasible range, a negative efficiency burden; that is, they may improve efficiency of resource allocation by enhancing revenues from the existing (distortionary) taxes. In our current model, it seems that at a rate of $\tau = 4{,}000$ TL, the mark-up inclusive (oligopolistic) gross domestic output reaches a maximum, and tapers off as the carbon tax rate is increased (Figure 4).

With the culmination of the favorable demand and efficiency effects, gross domestic product is observed to increase under the oligopolistic economy, whereas it suffers a loss under the competitive environment (see Table 2). However, as displayed in Figure 4, carbon emissions *per TL GDP* fall continuously in the competitive scenario, while it is observed to fluctuate around its initial level under the oligopolistic setting. Thus, environmental policy fails to achieve the desired result within an oligopolistic economy, yet succeeds in promoting its objectives under competitive conditions, albeit at significant output loss.

Figure 4
CO_2 Emissions per GDP



The ongoing general equilibrium effects are felt differently across the income groups, as Table 2 attests. Rural household improves its income under the competitive scenario; whereas it suffers losses under the oligopolistic economy. This outcome is the result of the domestic terms of trade effect: since industrial price is maintained by the mark-up, price adjustment falls to the rest of the economy; agricultural price falls; hence rural incomes erode. Urban capitalist incomes are observed to fall under both scenarios. However, under the oligopolistic conditions, the model results reveal that the secondary (subsumed) relations of distributional conflict will be favorable towards the industrial capitalists against the commercialists. We witness that while aggregate industrial profits are maintained, commercial profits decline severely.

4. Concluding comments

In this paper we have made use of a CGE model to suggest that environmental policies based on producer taxes may generate adverse results in an economy in which non-competitive behavior is prevalent. With mark-up induced pricing, oligopolistic producers may succeed in shifting the burden of taxes to the final consumers, and to the extent that final demand to their output is secured, emissions of polluting industries may persist, counteracting wide ranges of environmentally sound policy instruments.

It is a well-accepted fact that current global warming due to carbon emissions is inherently a problem of "global commons"; and that individual attempts to secure a pollution-free atmosphere will fail in their objectives. To the extent that pervasive non-competitive markets enable oligopolistic producers to promote divergence of private interests from social objectives, environmental policy based on market incentives alone are not likely to achieve the desired ends.

The propositions of the paper are subject to two important assumptions: one is the presumption that the environmental policy is put into effect as if its implementation has no additional administrative costs. Thus fiscal revenues from green taxes directly augment public expenditures and expand final demand. Citing evidence from numerous applications in the OECD countries, Eskeland and Jimenez (1992) point out, however, that costs of abatement control almost exhaust total revenues from pollution control, without much of a net return to the fiscal authority.

Secondly, the oligopolistic environment is envisioned in the model as if such behavior involves no additional costs to the producer. However, maintenance of an imperfectly competitive position in any market will likely affirm expenditures towards protecting the firm's oligopolistic status to secure supra-economic rents. Such "necessary" efforts and expenditures towards protecting these rents are termed under the rubric of "rent-seeking" or DUP (directly unproductive profit seeking) activities in the literature, and are regarded wasteful in the sense that they utilize resources which could alternatively be used in the production process. Given these abstractions, however, the original message of the paper remains clear: "when utilizing market incentives for policy-making, pay due attention to market structures"

Appendix

Algebraic Specification of the Model

This appendix spells out explicit algebraic formulations of the important model equations as summarized in Section 2 of the paper. We highlight only the distinguishing characteristics of the main equations. The reader is asked to refer to the traditional CGE literature for the "classic" model formulations in implicit closed form. Uppercase letters without (with) a bar are endogenous (exogenous) variables. Lowercase letters are either exogenous policy variables or structural parameters. We have omitted the sectoral index i in favor of simplicity in notation, whenever possible.

In Eq. (A1), f (K, L^D) is a CES function of capital (K) and labor employed (L^D); u being the (endogenous) capacity utilization rate. Eq. (A3) states that the industrial producer price is proportional to the average variable costs (AVC) where the constant of proportionality is linear in mark-up rate (m). Thus, the linear expression of the constant of proportionality yields the mark-up induced composition of the final price set by non-competitive producers.

Eq. (A5) calculates the value added price (PVA) as the difference between the (net) industrial output price and intermediate input costs, a weighted sum of the composite prices of domestic goods and imports. We subtract the production tax (tn) from the gross industrial output price (P^x) in order to compute the net amount. Eq. (A6) presents the first-order necessary condition for profit maximization from which labor employment at the sectoral level is determined.

Eq. (A9) models environmental pollution as proportional to the industrial output-capital ratio, given elasticity ε. The measurement of air pollutants in the study is simplified by taking the level of CO_2 emissions to the atmosphere. Also, Eq. (A10) models the air pollution effect of intermediate energy use among the different sectors; with ε' denoting the average pollutant content of the "energy" used as an intermediate input in sector i.

With a tax rate of τ, Eq. (A11) formulates a simple carbon tax relation expressed as a function of air pollutants. With this policy, the value added price in Eq. (A5) becomes:

$$PVA = P^x[1 - tn - \tau\, POL/X^s] - \sum_i a_{ij} P_j^c$$

which accounts for the abatement costs.

Fiscal policies are modeled in Eqs. (A12)-(A14). In the first identity, government revenue is a sum of income taxes, production taxes, tariffs, and carbon taxes. In the second identity, total government expenditures is the sum of public investments, public consumption, and transfers. In the third identity, fiscal deficit is calculated as the difference between government expenditures and the sum of government revenues and borrowings. Eqs. (A15)-(A24) model the mechanisms that generate income as well as final demand. In this study, the household is categorized into three types: rural, worker, and capitalist.

Eqs. (A15)-(A17) show the private income generation function for each type of household. Eq. (A18) presents the private consumption demand by each sector, while Eq. (A19) shows the public consumption demand by each sector. The symbols cd and gd stand for sectoral consumptions shares and σ_h is the household saving rate. The fiscal deficit claims resources on the private savings pool in Eq. (A20), with private investment being determined as a residual of aggregate private savings and the net fiscal deficit.

In an environment where domestic goods and imports exist as imperfect substitutes, Eq. (A21) shows the implicit functional form of the Armingtonian composite good. Eq. (A22) presents a general functional form of the constant elasticity of transformation. Import and export quantities are expressed as a function of their respective prices and the elasticities of substitution, ψ, and of transformation, η, in Eqs. (A23)-(A24).

Domestic price level (which serves as the wholesale price index) is a weighted average of the producer prices in Eq. (A25). The final set of identities closes the model form. In Eq. (A26), an equilibrium is assumed to exist in the product market. And, lastly, in Eq. (A27) an equilibrium is assumed to exist in the balance of payments accounts, where the exchange rate, ER, is solved.

Technology, producer behavior and factor markets

(A1) $X^s = u \cdot f(\bar{K}, L^D)$ output supply

(A2) $INT_i = \sum_j a_{ij} X_j^s$ intermediate input demand

(A3) $P^x = (1 + m)\, AVC$ industrial output price

(A4) $AVC = \dfrac{\bar{W} \cdot L^D + \sum a_{ji} P_j^C X_j^S}{X^S[1 - tn] - \tau POL}$ average variable cost

(A5)	$PVA_i = P^x_i (1-tn_i) - \sum_j a_{ij} P^c_j$	value added price
(A6)	$PVA \cdot (\partial X^s / \partial L^D) = \overline{W}$	marginality condition for labour demand
(A7)	$UNEMP = L^S - \Sigma L^D_i$	unemployment
(A8)	$\Pi = PVA \,.\, X^S - \overline{W} \,.\, L^D$	profits

Pollution and environmental policy

(A9)	$POLXS = \overline{P} (X^S / \overline{K})^{\varepsilon}$	emission of pollutants out of industrial production ($POLXS$: CO_2)
(A10)	$POLINT_i = \sum_i \varepsilon' a_{Ei} X_i$	emission of pollutants from intermediate energy
	with POL = POLXS + POLINT	
(A11)	$CBNTAX = \tau \cdot POL$	imposition of carbon tax

Government's fiscal constraint

(A12)	GREV = HHTAX + PRODTAX + TARIFF + CBNTAX	
	with:	
	$HHTAX = \Sigma tx_h Y_h$	fiscal revenues
	$PRODTAX = \Sigma tn_i P^X_i X^S_i$	
	$TARIFF = \Sigma tm_i \overline{PWM}_i M_i ER$	
(A13)	$GREXP = \overline{GIF} + \overline{GDTOT} + \Sigma \overline{TR}_h$	government expenditures
(A14)	$GRDEF = GREXP - GREV - \overline{GBOR} \cdot ER$	fiscal deficit

Income generation and final demand

(A15)	$Y_R = PVA_R X^S_R + \overline{TR}_R$	rural household income
(A16)	$Y_W = \Sigma \overline{W}_i \cdot L^D_i + \overline{TR}_W$	worker household income
(A17)	$Y_K = \sum_{i \neq R} \Pi_i + \overline{TR}_K$	capitalist income

(A18)	$C_i^D = (cd_i / PC_i) \sum_h Y_h (1-t_h^x)(1-\sigma_h)$	private consumption demand by sectors
(A19)	$GD_i = (gd_i / PC_i) \overline{GDTOT}$	public consumption by sectors
(A20)	$PRINV = \sum \sigma_h Y_h (1-t_h^x) - GRDEF$	private investment
(A21)	$CC = g(DC,M)$	Armingtonian composite good aggregate between domestic good and import
(A22)	$X^D = h(DC,E)$	constant elasticity of transformation frontier
(A23)	$M = DC \; [\delta/(1-\delta)]^{\psi} \; (PD / PM)^{\psi}$	import demand
(A24)	$E = DC \; [(1-\gamma)/\gamma]^{\eta} \; (PE / PD)^{\eta}$	export supply
(A25)	$PLEV = \sum_i \omega_i P_i^x$	aggregate price level

General equilibrium

(A26)	$X_i^S = X_i^D$	product market equilibrium
(A27)	$\sum_i \overline{PWM}_i \cdot M_i = \sum_i \overline{PWE}_i \cdot E_i + \overline{GBOR} - \Delta FCUR$	balance of payments equilibrium

Table A1

Gaseous Emissions and Other Pollutants from Industrial Processes in Turkey (Late 1980s)

	Aggregate Level[a]	Ratio to Industrial Output[b]	Ratio to Workers Employed[c]
Emissions from Industrial Activity			
CO_2	126078	2.322	44.588
SO_2	354	0.007	0.125
NO_2	175	0.003	0.062

	Aggregate Level[a]	Ratio to Aggregate Energy Demand[b]
Emissions from Energy Use		
CO_2	28140	21.158

Notes: a. thousand metric tons.
b. tons per million 1987 TL.
c. tons per worker-year employment.

Sources: Resources for the Future (1994: Tables 24.1 and 24.5); *OECD* (1991: 19).

Table A2

Social Accounting Matrix, Turkey, 1987, TL Billion

	Activities				Commodities				Factors	
	Agriculture	Industry	Commerce	Pub.Serv.	Agriculture	Industry	Commerce	Pub.Serv.	Labor	Capital
Activities										
Agriculture					13146.8					
Industry						50914.4				
Commerce							14776.0			
Pub. Services								13822.0		
Commodities										
Agriculture	1597.3	8020.5	19.1	54.2						
Industry	1590.6	19811.5	2917.9	790.9						
Commerce	418.1	7084.3	867.5	274.3						
Pub. Services	650.8	2270.8	992.6	342.5						
Factors										
Labor	5519.8	4512.1	3705.2	3611.8						
Capital	4010.6	14489.8	8762.5	8310.4						
Households										
Rural									5519.8	4010.6
Urban-Worker									11829.1	
Urban-Capitalist										27253.9
Government	37.6	1719.5	1126.3	438.0	61.6	1994.1	0.0	0.0		4308.8
Capital Accounts										
Private Savings										
Public Investment										
Pub. Sav.- Inv. Deficit										
Total Investment										
Rest of the World					675.3	11543.0	0.0	0.0		
Total Expenditures	13824.8	57908.6	18391.1	13822.0	13883.7	64451.5	14776.0	13822.0	17348.9	35573.3

Table A2 (cont'd)

	Households				Capital Account					
	Rural	Urban Worker	Urban Capitalist	Government	Private Savings	Public Investment	Public Sav.- Inv.Deficit	Total Investment	ROW	Total Receipts
Activities										
Agriculture									678	13824.8
Industry									6994.2	57908.6
Commerce									3615.1	18391.1
Pub. Services									0.000	13822.0
Commodities										0.0
Agriculture	1988.0	869.8	1284.0	30.1				20.8		13883.7
Industry	5120.1	6687.9	12184.0	1433.9				13914.3		64451.3
Commerce	1172.5	1356.9	3155.3	280.5				166.6		14776.0
Pub. Services	1017.7	1271.3	2977.0	3578.1				721.2		13827.1
Factors										0.0
Labor										17348.9
Capital										35573.3
Households										0.0
Rural				393.3					864.7	10788.4
Urban-Worker				1824.5					864.7	14518.3
Urban-Capitalist				3299.3					505.7	31058.9
Government	340.7	2810.4	4173.7						69.3	17079.9
Capital Accounts										0.0
Private Savings	1149.3	1522.0	6485.5							9156.8
Public Investment				4825.9			2964.1			7790.0
Pub. Sav.-Inv. Deficit					2123.8				840.3	2964.1
Total Investment					7033.0	7790.0				14823.0
Rest of the World			799.3	1414.3						14431.9
Total Expenditures	10788.4	14518.3	31059.0	17079.9	9156.8	7790.0	2964.1	14822.8	14431.9	

Source : Authors' calculations.

References

BAUMOL, W. and OATES, W. (1988), *The Theory of Environmental Policy*, Cambridge and New York: The Cambridge University Press.

BERGMAN, L. (1991), "General Equilibrium Effects of Environmental Policy: A CGE-Modeling Approach", *Environmental and Resource Economics*, 1 (1), 43-61.

BLITZER, C., ECKAUS, R.S., LAHIRI, S. and MEERAUS, A. (1992), "Growth and Welfare Losses from Carbon Emissions Restrictions: A General Equilibrium Analysis for Egypt", The World Bank Working Paper, No. WPS963, August.

BORATAV, K. (1991), *1980'li Yıllarda Türkiye'de Sosyal Sınıflar ve Bölüşüm* (Social Classes and Distribution in Turkey in the 1980's), İstanbul: Gerçek Yayınevi.

BORATAV, K. TÜREL, O. and YELDAN, E. (1996), "Dilemmas of Structural Adjustment and Environmental Policies under Instability: Post-1980 Turkey", *World Development*, 24(2), 373-93.

BOURGUIGNON, F, de MELO, J. and SUWA, A. (1991), "Modeling the Effects of Adjustment Programs on Income Distribution", *World Development*, 19(11), 1527-44.

BUCHANAN, J.M. (1969), "External Economies, Corrective Taxes and Market Structure", *The American Economic Review*, 59, 174-7.

BUCHANAN, J. and TULLOCK, G. (1975), "Polluters' Profit and Political Response: Direct Controls versus Taxes", *The American Economic Review*, 65(1), 139-47.

ÇAPOĞLU, G. (1992), *Türkiye İstikrar İçinde Nasıl Kalkınır?* (How Can Turkey Develop Under Stability?), Ankara: Adım Yayıncılık.

DERVİŞ, K., de MELO, J. and ROBINSON, S. (1982), *General Equilibrium Models for Development Policy*, New York: Cambridge University Press.

ESKELAND, G. and JIMENEZ, E. (1992), "Policy Instruments for Pollution Control in Developing Countries", *The World Bank Research Observer*, 7(2), 145-69.

GIBSON, B., LUSTIG, N. and TAYLOR, L. (1986), "Terms of Trade and Class Conflict in a Computable General Equilibrium Model", *Journal of Development Studies*, October, 23(1), 40-59.

GUNTER, S., van NIEWKOOP, R. and WIEDMAR, T. (1992), "Social Incidence and Economic Costs of Carbon Limits, A Computable General Equilibrium Analysis for Switzerland", *Environmental and Resource Economics*, 2, 569-91.

KARAASLAN, M. (1989), "Pricing in the Turkish Non-Agricultural Sector", *Journal of Contemporary Management*, 3, 42-57.

KAYTAZ, M., ALTIN, S. and GÜNEŞ, M. (1993), "Türkiye İmalat Sanayiinde Yoğunlaşma: 1990" (Concentration in the Turkish Manufacturing Industry: 1990), *Proceedings of the TMMOB 1993 Industrial Congress, Vol. 1*. No. 160, Ankara: TMMOB.

KRUEGER, A. O. (1974), "The Political Economy of the Rent-Seeking Society", *The American Economic Review*, 64(3), 291-303.

MISIOLEK, W.S. (1980), "Effluent Taxation in Monopoly Markets", *Journal of Environmental Economics and Management*, 7, 103-7.

——— (1988), "Pollution Control through Price Incentives: The Role of Rent-Seeking Costs in Monopoly Markets", *Journal of Environmental Economics and Management*, 15, 1-8.

NORDHAUS, W. (1993), "Optimal Greenhouse-Gas Reductions and Tax Policy in the "DICE" Model", *The American Economic Review*, 83(2), 313-7.

OATES, W. (1992), "Pollution Charges as a Source of Public Revenues", *Resources for the Future*, Discussion Paper No. QE92-05.

OECD (1991), *Environmental Indicators*, Paris: OECD.

ÖNİŞ, Z. (1992), "Organization of Export Oriented Industrialization: The Turkish Foreign Trade Companies in a Comparative Perspective", in T. Nas and M. Odekon (eds.) *Economics and Politics of Turkish Liberalization,* Bethlehem: Lehigh University Press.

ÖZMUCUR, S. (1986), "Türkiye'de Gelir Dağılımı, 1963-85" (Income Distribution in Turkey, 1963-85), *İktisat Dergisi*, 258, 13-26.

RESOURCES FOR THE FUTURE (1994), *World Resources, 1992-93: A Guide for the Global Environment*, Washington, D.C.

ROBINSON, S., SUBRAMANIAN, S. and GEOGHEGIAN, J. (1993), "A Regional, Environmental Computable General Equilibrium Model of the Los Angeles Basin", University of California, Berkeley, Giannini Foundation Paper, No.646, April.

ROE, T. and YELDAN, E. (1993), "The Interface of Industrialization and Environmental Policies in A CGE Model for Turkey", Bilkent University Department of Economics, Discussion Paper, No. 93-11.

——— (1991), "The Political Economy of Rent Seeking Under Alternative Trade Regimes", *Weltwirtschaftliches Archiv*, 127(3), 563-83.

ŞAHİNKAYA, S. (1993), "İmalat Sanayiinde Sektörel İşgücü Verimliliği, Reel Ücretler ve Gayri Safi Kârlar veya Mark-up Oranları" (Sectoral Labor Productivity, Real Wages and Gross Profits or Mark-up Ratios in Manufacturing Industry), *Toplum ve Ekonomi*, April, 4, 27-51.

ŞENSES, F. (1989), "Turkey's Labor Market Policies in the 1980's Against the Background of Her Stabilization Program", Middle East Technical University, Working Paper No.ERC/1989-10, August.

TAYLOR, L. (1991), "Structuralist CGE Models", in L. Taylor (ed.), *Socially Relevant Policy Analysis*, Cambridge: The MIT Press, Ch.1, 1-69.

WHALLEY, J. (1991), "The Interface Between Environmental and Trade Policies", *The Economic Journal*, March, 101, 180-91.

WHALLEY, J. and WIGLE, R. (1992), "The International Incidence of Carbon Taxes", in R. Dornbusch and J. Poterba (eds.), *Economic Policy Responses to Global Warming,* Cambridge: The MIT Press.

YELDAN, E. (1994), "The Economic Structure of Power Under Turkish Structural Adjustment: Prices, Growth and Accumulation", in F. Şenses (ed.), *Industrialization Experience of Turkey in a Global Context*, Westport, CT.: Greenwood Press.

——— (1993), "Conflicting Interests and Structural Inflation: Turkey, 1980-1991", *Pakistan Development Review*, Autumn, 32(3), 303-27.

YELDAN, E. and BAKAN, G. (1993), "Industrialization, Energy Demand and Environmental Pollution under Turkish Structural Adjustment: A Case Study with Implications to Other Countries", Bilkent University, Department of Economics Discussion Paper, No.93-11, January.

Özet

Doktor reçeteleri ne zaman işe yaramaz?
Değişik piyasa yapılarında çevre politikaları

CO_2 emisyonlarını azaltmayı amaçlayan karbon tüketim vergisi senaryolarının uygulamalı modellemesi çoğunlukla tam rekabetçi piyasalar varsayımı üzerine kuruludur. Bu yazıda savunulan görüş şudur: Modellenen ekonomide rekabetçi olmayan üretici davranışlarının egemen olduğu ölçüde, çevre politikaları amaçlarını gerçekleştiremeyebilir. Bu görüş Türkiye ekonomisine uygulanan bir hesaplanabilir genel denge modeli çerçevesinde somutlaştırılmış, alternatif fiyatlama davranışları varsayılarak çevresel kirlilik gideriminin değişik piyasa yapılarına duyarlılığı sınanmıştır.