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TAX REFORMS AND ENVIRONMENTAL POLICIES FOR ITALY

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Abstract. This paper focuses on the relationship between tax reforms and environmental quality in Italy. First, we analyze some of the characteristics of the tax system. Within a dynamic model, we estimate the marginal distortion introduced by different taxes and show that the system is far from being optimal, at least in terms of efficiency. We then consider some possible tax reforms, keeping into account both the effect on utility and the impact on pollution. Finally, we design a tax reform with a specific environmental goal, i.e. the reduction of polluting emissions by 10%, and show the economic effects of this policy.

1. Introduction

Tax systems in real economies are typically non-optimal. Tax reforms can then be used in order to reduce the level of distortion of economic incentives introduced by the necessity of raising revenue. At the same time, however, tax reforms affect the level of pollution, as the composition of production and consumption change.

In this paper, we analyze the characteristics of the Italian tax system and study the effects of some possible tax reforms on tax distortions and polluting emissions.

By using a dynamic model, we estimate the marginal distortion caused by the different taxations of production, consumption and incomes. We find that these values are far from equal, hence they can be used in designing a policy aimed at reducing the distortion of economic incentives. Unfortunately, these policies are likely to determine an increase in the level of polluting emissions, as they reduce the tax burden bearing on goods with high polluting potential.

We then design a policy with the specific goal of reducing the level of polluting emissions by a predetermined percentage with respect to a business-as-usual scenario. While command-and-control policies set arbitrary standards for the reduction of pollution, environmental taxes guarantee that the marginal cost of reducing emissions is equalized across sectors. We allow the tax rate on households income to decrease in order to ensure revenue-neutrality. We find that welfare decreases, at least if the effect of environmental quality on consumer utility is not taken into

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account. Unfortunately, the total welfare effect of the reform cannot be determined without a careful evaluation of the environmental benefits of a reduction of pollution.

2. Tax distortions and environmental distortions

Taxes on production, consumption and income introduce a distortion of incentives as they break the equivalence between the price paid by the buyer and the price received by the producer of a good or service. Hence, each lira of revenue collected by the government costs society more than one lira. For every unit of revenue, distortionary taxation produces a loss of utility or welfare, which must be added to revenue in order to obtain the level of the marginal cost of public funds. If the marginal costs of the funds collected with different taxes are not equalized, then the tax system is suboptimal and there is space for obtaining an increase in welfare through a revenue-neutral tax reform[1]. By reducing the rate of the most distortionary tax and increasing the rate of the less distortionary one, welfare can be increased. In a few simple words, this is the theory of tax reforms.

However, traditional models of tax reform do not take into account pollution and the effect of environmental quality on utility and welfare. When a tax reform is implemented, the composition of production and consumption change, as the relative price of intermediate and final goods are affected. Hence, the level of polluting emissions changes. The recent literature on environmental tax reforms points out that the environmental effect of a reform must always be taken into account, even when the reform is not motivated by environmental goals.

Benefits and costs of a policy should be compared in order to take a welfare improving decision, but part of these benefits, i.e. the environmental ones, are difficult to evaluate. The problem could be avoided if we could design a policy that reduces tax distortions and polluting emissions at once. This is the double dividend hypothesis. If this hypothesis is verified, models which do not consider the relation between consumer utility and environmental quality could be used for the valuation of the total welfare effect of a tax reform.

The existence of a double dividend is an empirical matter. Even if the literature has shown that environmental taxes interact with preexisting distortionary taxes[2], we cannot exclude that a tax reform could reduce tax and environmental distortions. It essentially depends on the initial situation from which the reform is realized. We make reference to the Italian situation in 1992.

3. Commodity taxation

We consider two main groups of taxes: taxes on incomes and taxes on goods. The former can be divided in taxes on household incomes and taxes on company

[1] See A.B. Atkinson and J.E. Stiglitz, "The structure of indirect taxation and economic efficiency", Journal of Public Economics 1, 97-119 (1972). For a survey on the theory of tax reforms, see: F. Bulckaen, 'The Theory of Commodity Tax Reform: A Survey', in G. Galeotti and M. Marrelli, ed., Design and Reform of Taxation Policy, Dordrecht: Kluwer Academic Publishers (1992).

[2] See: A.L. Bovenberg and R.A. de Mooij, 'Environmental Levies and Distortionary Taxation', American Economic Review 94(4), 1085-1089 (1994); I.W.H. Parry, 'Pollution Taxes and Revenue Recycling', Journal of Environmental Economics and Management 29 (3), S64-S77 (1995).

incomes. The latter includes: sale or production taxes, net of subsidies, value added taxes[3] and tariffs.

In this section we focus on commodity taxation and on the distribution of the tax pressure among the different goods.

The revenue from commodity taxes in 1992 was 147039.8 billion lira, which represented about 5 percent of the total value of domestic production and imports (evaluated at before tax prices). However, the burden of taxation was not homogeneously distributed. We consider a comprehensive tax rate, which does not distinguish between sale taxes, value added tax and tariffs, but is calculated as the ratio between the sum of the revenues from all these taxes and the total value of production and imports. Tax rates differed a lot across sectors, varying between a subsidy of 6% to the 'transport' sector and a positive rate of more than 94% on 'coke and oil', which includes refined oil. Despite this last sector accounted for only 1.4% of the total value of production and imports, it provided almost 30% of the revenue from commodity taxation. The other sectors characterized by very high tax rates were 'gas' and 'electricity', respectively with 15 and 49%. As a whole, these three energy sectors provided almost 40% of the revenue, even if their weight in economic term was less than 3%.

Among the other sectors, we note that 'other extractions' (other with respect to oil extraction) and 'agriculture' were subsidized, while other tax rates varied between zero and 6%. Of course, public services were almost untaxed.

The whole picture is given in Appendix 2, table 1.

These tax rate differentials are probably due to the different elasticity of the demand for the various commodities, both when they are used as intermediate input and when they are destined to final consumption, and to equity considerations. As far as concerns the first point, which is related to efficiency considerations only, the work by Hatta[4] shows that the optimal structure of the tax on commodities is very close to uniformity. This is the reason why, at least in our model based on a single consumer, we should expect very high values for the marginal cost of public funds raised through the taxation of commodities. This entity is furthermore influenced by the co-existence with other taxes. In fact, the interaction with income taxation contributes to increase the size of the excess burden.

4. The marginal cost of public funds

Using a dynamic model for the Italian economy, we can estimate the marginal cost of the public funds raised through the different taxes on commodities and incomes. We increase each tax rate by 1 percent of its initial value and simulate the effect on the behavior of the economy.

The marginal cost of the funds obtained with a tax is given by the ratio between the variation of the money metric utility of consumers and the variation in the

[3] We model the value added tax as a consumption tax. In fact, as a consequence of the system of payments and credits, the burden of the tax bears on final consumers only. In the input-output table the value of the revenue from value added tax corresponds to the amount that the sector pays to the government, and is given by the difference between the tax earned on the sales and the tax paid on the purchase of intermediate inputs. This does not correspond to the tax paid by the consumers of the good produced by the sector. We have then calculated the implicit value added tax rate on the output of every sector and used this as the tax rate on final consumption.

[4] T. Hatta, 'Welfare Effects of Changing Commodity Tax Rates toward Uniformity', Journal of Public Economics 29, 99-112 (1986).

present value of future revenues, which is the marginal distortion, plus one. Hence, we have:

$$(4.1) \qquad MCF^i = 1 + \frac{\frac{1}{\lambda} \cdot \frac{\partial U}{\partial t^i}}{\frac{\partial R}{\partial t^i}};$$

where λ is the marginal utility of income, U is the utility of consumers, R is the revenue and t^i is the $i-$th tax. The variation in utility is calculated using the measure proposed by Jorgenson and Yun[5].

First, we calculate the value of the marginal cost of the funds raised through all taxes, by allowing all tax rates in the system to vary by the same proportion. We then repeat the experiment for the taxes on household incomes, for the tax on company incomes, for the taxes on sales and on consumption. For these last two groups of taxes, we assume that all tax rates vary by the same proportion (this implies that when tax rates increase the subsidized sectors experience an increase in the subsidy). Hence, we do not try to assess the marginal cost of the revenue for every single commodity tax, but only make a distinction between production and consumption taxes.

The results are summarized in the following table[6].

Tax	All taxes	Household income	Company inc.	Sales	Consumption
MCF	1.75620120	1.71927210	1.49716601	1.95627537	1.92393828

Table 1. Marginal cost of taxation.

Because of tax distortions, each unit of revenue collected through general taxation costs society 1.76[7]. Tax rate differentials makes sales and consumption taxation more distortionary than income taxation.

These values look high with respect to the estimates realized for the United States[8], but they are in the same range of the estimates for Sweden.

The differences in the marginal cost of the funds raised through the different taxes demostrate the possibility of realizing a tax reform that improves efficiency. Furthermore, the high cost of the revenue obtained with the taxation of production and consumption of commodities could probably be reduced by shifting to a more uniform structure of the tax rates.

[5] D.W. Jorgenson, Kun-Young Yun, "Tax Reform and U.S. Economic Growth", Journal of Political Economy, Vol. 98, No. 5, Part 2, S151-S193 (1990).

[6] Here are some of the parameter that influence the value of the MCF: compensated elasticity of labor supply = 0.25; uncompensated elasticity of labor supply = 0.06; intertemporal elasticity of substitution = 0.33.

[7] Public expenditure is worthwhile if the benefit overtakes the marginal cost of public funds. In this case, a project should be realized if its benefits are greater than 1.76 per unit of cost.

[8] C.L. Ballard, J.B. Shoven, J. Whalley, "General equilibrium computations of the marginal welfare costs of taxes in the United States", in American Economic Review, Vol. 75, n. 1, 128-138 (1985). This work estimates values which, for different hypothesis on uncompensated labor supply elasticity and on uncompensated saving elasticity, never overtake 0.5 for any taxes in the United States. In particular, see table 4.

5. The model

By the way, the structure of our model influences these estimates. Our simulations are based on a Ramsey model of economic growth for the Italian economy, in which perfect foresight and infinite time horizon are assumed. Growth is driven by a aggregate household[9].

In every period, the household decides the level of full consumption maximizing a utility function with constant intertemporal elasticity of substitution. Full consumption is then allocated between leisure and consumption goods on the basis of a utility function with constant elasticity of substitution. Finally, commodity demand derive from a Cobb-Douglas subutility function. Savings are endogenously derived as the result of the intertemporal optimization process. Environmental quality does not influence consumer utility.

In the model, thirteen commodities or activities are identified. We do not make a real distinction between industries and commodities, hence every good is produced by one sector. Output is produced using a constant returns to scale technology. Technological progress is labor augmenting[10]. Labor force and capital are mobile across sectors.

As far as concerns imports, we make the Armington assumption. Domestic output is combined with imports to produce a composite consumption supply using a CES function. Exports are price sensitive.

The current account balance and world prices are set exogenously. Also the public deficit is exogenous. Hence, as tax rates are fixed, public expenditure in commodities is determined endogenously.

We assume intertemporal consistency in the accumulation of government deficit and of current account balances into new domestic or foreign debt.

The model is calibrated on the base of a social accounting matrix for Italy for 1992.

The primary statistical source is the input-output table for the same year released by the Italian national institute of statistic (ISTAT)[11]. Transfers among institutional sectors (households, companies, government and rest of the world) are evaluated on the basis of the SAM provided by ISTAT for 1990. Public sector deficit, private savings and current account deficit are taken directly from the national accounts. Company savings are then calculated as a residual, given the value of investment.

6. The base case scenario (business-as-usual)

The use of a Ramsey model of economic growth implies some assumptions on the state of the economy in the base year, for which data are available. Does the picture represented by the SAM correspond to a steady state or should we suppose that Italy is far from this stage and will converge to it through time? A simple example can explain the problem. If we are in a steady state, investments must guarantee that the stock of capital increases at the rate of growth of labor,

[9] A detailed explaination of the model and its equations can be found in "IT_ENV: A dynamic CGE model of economy and environmental pollution for Italy", a technical note which can be requested to the author.

[10] If technological progress were not labor augmenting, it would not be possible to reach a steady state in which the ratio of labor to capital is constant.

[11] Some modifications have been necessary in order to obtain the data set used to calibrate the model. These are explained in Appendix 1.

which is given by the sum of the population growth rate plus the rate of labor augmenting technical progress. We assume population to be constant and fix the rate of technical progress to 0.75 percent. Given the estimate of the capital stock, this implies a value of the rate of depreciation of capital. If we think that this value is not acceptable, then we must assume that the economy is not in a steady state and will reach it only in the future. However, this implies that the model is not able to replicate perfectly the base year case, as the assumption of perfect foresight typical of the Ramsey model implies that economic agents anticipate the adjustment process and smooth the behavior of all economic variables. For this reason, we try to limit the assumptions of divergence from an initial steady state. However, the particular situation of the Italian economy in 1992 as far as concerns public debt and current account balance and the need to consider intertemporal consistency in the dynamic of public and current account balance suggest to accept some deviations from an initial equilibrium.

In 1992, Italy had a very high level of public debt, above 100 percent of GDP. In the following years, the situation worsened further, and the ratio between debt and national product rose until a maximum level of 1.25. Only recently the economic reforms started in order to accomplish the standards imposed for the participation to the European Monetary Union have given some results in this field and the trend has been reversed. We then assume a pattern of public deficit which implies a former increase in the ratio between debt and GDP, then a decrease of the same ratio until a level of about 65 percent in 25 years.

The current account deficit in 1992 was unusually high for Italy. In fact, in the same year a strong devaluation brought the exchange rate to its natural value, after a long period in which it had been defended on values that were inconsistent with the different level of inflation rate with respect to other countries and in particular to other members of the European Community. We then assume that the current account deficit decreases and that in the following years Italy runs some surpluses that allow it to pay the debt toward foreign countries.

All other variables and parameters are assumed to be consistent with an initial steady state.

7. Possible reforms

In this section, we simulate the effects of reforms aimed at reducing the level of tax distortions.

We consider a revenue-neutral reform, which keeps the real value of the public expenditure in commodities in every year at the same level as in the base case. This definition of revenue neutrality allows us to ignore the effect of this expenditure on consumer welfare, as the reform does not affect the path of the variable. Alternatively, we could have used a definition of revenue-neutrality based on the present value of future real public expenditures. This would have allowed us to keep the value of the tax rates affected by the reform constant throughout time. However, the path of public expenditure in commodities would have been influenced and the impact on welfare should have been evaluated.

We suppose that sale tax rates are decreased by 5 percent with respect to their initial value and the tax rate on company incomes is allowed to vary in order to ensure revenue-neutrality.

The figures in Appendix 3 show the effect of the reform on the level of full consumption, labor supply, real GDP and capital stock[12]. The solid line represents the base case, the dashed one the counterfactual simulation corresponding to the reform.

The reform produces an increase in utility of 0.07 percent. We observe that the level of full consumption is constantly higher than in the base case, even if it tends to converge to the same steady state value. Labor supply increases slightly, then the consumption of leisure decreases. Hence, utility increases because of the positive variation in the real value of commodity consumption. The effect of the reform on real GDP is small, but in the reform case the value is slightly lower than in the base case. Finally, the capital stock converges to a value that is lower than in the base case.

Despite having increased the tax with the lowest marginal distortion and decreased the one with the highest distortion, the effect on welfare is very small. The size of the variation in the tax rate on company incomes necessary in order to guarantee revenue-neutrality may help to explain this result. In fact, we see that this tax rate must be increased by more than 40 percent: in the steady state, its value is 53 percent higher than in the base case, 24.16 against 15.78 percent. This is a big change, more than marginal by far. It is then possible that the dimension of the reform that we have simulated brings the tax on company incomes to a high level of distortion, reducing the welfare benefit.

We now simulate a more fundamental tax reform. We eliminate the differentials in the taxation of sales and consumption, fixing a uniform sale tax rate of 10 percent and abolishing the consumption tax. In order to achieve revenue-neutrality, we leave the tax rate on household incomes free to change in every period. In this case, the gain in utility is more consistent and amounts to 1.09 percent. The tax rate on income decreases by more than 25 percent, from 28 to 20 percent. This means that we have actually increased the revenue raised through commodity taxation, which we had seen to be more distortionary than income taxation. The positive effect of the reform is due to the elimination of the differentials in commodity tax rates and to the transition to an uniform system. As we can see in the figures in Appendix 4, full consumption increases in every period. As in the previous reform, labor supply increases and the capital stock decreases. In this case we have a remarkable reduction in the level of real GDP. The contrast with the result in term of utility shows how the index of production is an imperfect measure of welfare.

8. Environmental effects

So far, pollution has been left to the margin of our simulations. The level of emissions is endogenous, but calculated only when the solution of the problem is obtained. Now, in order to understand the environmental effects of the policies that we have considered, it is necessary to explain how production, consumption and polluting emissions are related in our model.

We consider three kinds of emissions: sulphur oxides, nitrogen oxides and carbon dioxides.

[12] The level of the variables in the figures depend on the normalization used in the calibration of the model. Full consumption is represented by an index, labor supply is expressed as a linear transormation of hours supplied, real GDP and the capital stock are in trillion lira.

Both producers and consumers produce emissions, when they use raw oil, refined oil[13] and natural gas. The following equation shows how emissions are determined in the model:

$$E_{xtr} = \sum_i \left[\sum_j \left(\alpha_{i;j;xtr} \cdot Q_{i;j} \right) \right] + \sum_j \left(\beta_{j;xtr} \cdot C_j \right) \tag{8.1}$$

where E is the level of emission, α is the level of emission per unit of input, β is the level of emission per unit of consumption, and:

xtr = polluting emission: NOX, SOX, CO2;
i = sector of production;
j = good used as intermediate input or consumed by households;
Q = quantity of intermediate input;
C = quantity of private consumption.

We derive our coefficients α and β from the of NAMEA for Italy for 1990. The data on pollution coming from production sectors and consumption are reported in Appendix 2, table 2.

The coefficients α and β are allowed to change throughout time. In particular, we suppose that the trend observed in real data in the late eighties and in the early nineties continue in the future. According to this trend, the emissions of sulphur oxides decline by a rate of more than 6% per year, nitrogen oxides emissions decrease by more than 2% per year and carbon dioxide emissions slowly grow.

Both reforms introduced in the previous section have the effect of reducing the taxation of energy sources (the second one reduces also the taxation of energy in consumption). The relative price of oil and gas decreases, hence these commodities are used more intensively from producers and consumers. The figures in Appendix 3 and 4 show that polluting emissions increase. In the second case, the uniform taxation of sales and the cancelation of the taxation of consumption eliminates the strong pressure on the sectors of oil and gas that we had pointed out above.

As full consumption increases and environmental quality worsens, a valuation of the loss of environmental quality would be necessary in order to determine the net welfare effect of the reforms.

9. Environmental tax reform

This section considers tax reforms for the control of the level of polluting emissions. The policy-maker uses tax instruments in order to obtain a predetermined environmental goal.

We assume that this goal is the reduction of the level of emissions to 90% of the base case for every pollutant in every period. In order to achieve this reduction, a tax on each pollutant is introduced, both for domestic production and for consumption. Environmental taxes do not bear on imports[14], as the relative production does not generate pollution within the country. This makes imports more competitive

[13] Coal cannot be distinguished in the model, but we can think of 'coke and oil' as a composition of refined oil and coal.

[14] The burden of the taxation of consumption bears also on the part of the supply which comes from abroad.

with respect to the domestic production and raises the problem of coordinating environmental policies, an issue that we do not address here. Revenue-neutrality is achieved through the reduction of the tax rate on household incomes.

The taxation of pollution necessary to achieve the desired reduction of emissions generates a considerable revenue, which allows a decrease in the tax rate on household income by more than four percent. However, the net impact on welfare, if the influence of environmental quality on utility is not taken into account, is negative. Full consumption and utility decrease (utility decreases by 0.3%). The figures in Appendix 5 show the effect on full consumption, labor supply, real GDP, capital stock and polluting emissions throughout time.

The taxes per unit of pollutant change every year in order to guarantee the achievement of the emission goal. We show the results for period 1 and 60 only:

Tax on:	SOX	NOX	CO2
Period 1	-0.024	0.051	0.051
Period 60	-0.032	0.043	0.137

Table 2. Tax per unit of pollutant.

We note that the tax on one of the three pollutants is negative, while we usually expect this value to be positive if we want a reduction in the level of emissions. In general equilibrium, when we deal with the contemporary reduction in the level of more pollutants, it is possible that the emission of one of the pollutants must be subsidized. The total effect of the three taxes guarantees a reduction of all pollutants, included the one whose tax is negative.

It is interesting to analyze the effect of the tax reform on prices and quantities.

First, we consider the tax on every unit of commodity produced by the domestic activities in the hypothesis that no adjustment is realized in the choice of the inputs (see Appendix 2, table 3).

With no behavioral responses from producers, the highest increase in the price of domestic production should be expected for gas (21%), electricity (17%) and transportation services (15%). Unexpectedly, the price of refined oil (coke and oil sector) would fall (-6%). For consumption, the price of refined oil and gas used for transportation and heating would increase sensitively (by 46% and 23% respectively).

However, producers and consumers react to the taxation and to the consequent change in prices. Hence, the general equilibrium results are different. For example, the price of domestic extracted oil, which would have risen negligibly with no behavioral response, decreases by 4%. The price of refined oil decreases, but only by less than 1%. Also the effect on the price of gas is reduced, from a 21% to a 6% increase. The most remarkable increases are still in the price of electricity and transportation (13% and 16% respectively). The increase in the prices of the commodities produced by the manufacturing industry is in the range of 5-6%, while services are less affected, with an increase in price limited to less than 2%.

If we analyze the variation in the quantities produced by the domestic activities, we note that almost all decrease, with the exception of the sectors which supply services, whose expansion is however negligible. The most remarkable reduction in production regards refined oil, electricity, gas and transportation (all more than 10%).

Environmental taxes also bear on consumption. Consumption prices are affected both by the change in the price of domestic production and by the taxation of polluting emissions. Hence, consumption prices increase, especially for refined oil (42%), electricity (13%), gas (27%) and transportation services (15%). This determines a reduction in the quantities consumed (26%, 6%, 17% and 8% respectively).

It is now interesting to analyze the measure in which every sector has contributed to the reduction of the level of pollution. In fact, environmental taxes are an efficient way of achieving a reduction of polluting emissions, because they do not set an arbitrary standard that every activity must comply with. Taxation allows for adjustments and guarantees that the marginal cost of the reduction of pollution is equalized among producers.

Oil extraction, refined oil, electricity, gas and transportation give the major relative contribution to the reduction of all pollutants (12%, 10%, 11%, 20% and 14% of the previous level of emissions). A great contribution comes from the households consumption of refined oil, with a reduction of emissions of more than 20%.

In Appendix 2, table 3 gives the complete picture.

Once again, environmental quality and tax distortions move in opposite directions and the total welfare effect of the reform cannot be determined without a careful evaluation of the benefits from the reduction of polluting emissions.

10. Conclusions

Tax reforms and the quality of environment are related and both the effect on tax distortions and the effect on polluting emission must be taken into account when evaluating a policy.

We begun by showing that the marginal cost of the public funds collected with different taxes on commodities and incomes in Italy are far from being equalized, so there is space for a welfare improving tax reform, at least in regards to efficiency, as far as environmental quality is not taken into account. Our estimates are obtained within an intertemporally consisted dynamic model.

We simulate two reforms aimed at reducing tax distortions. As expected, these policies increase consumer utility. However, they have a negative effect on environment, as the level of polluting emissions increases. Tax distortions and environmental quality change in opposite directions.

We then design a policy with the specific purpose of reducing emissions by 10% with respect to the base case scenario. Production, consumption and utility decrease. Once again, there is a trade off between environmental goals and the reduction of tax distortions.

We must conclude that, for a correct evaluation of the welfare effect of tax reforms, the process of evaluation of the environmental effect cannot be avoided.

11. Appendix 1 - From the input-output table to the base of the SAM

The first change regards the inputted credit services, given by the difference between the capital return to the credit sector and the interests that this sector pays on deposits. The national accounts do not integrate this value with the input of production sectors, as if it was not possible to say how much of it is paid by every sector on the base of their level of indebtedness. A distribution based on the size of the production would underestimate the costs of sectors with a high indebtedness (like electricity and public administration) and would overestimate the costs of the other sectors. We refer to the work of Bianchi[15], which estimates the degree of indebtedness of the different activities. Bianchi states that the margin for inputted credit services must be broken in two parts: 213% of it must be distributed among the production sectors, while 113% must be returned to consumers, who have a net credit toward banks and insurance companies. This is like saying that, once the redistribution has been made, the credit sector is the mean through which the interests paid by the companies on their indebtedness is distributed to the consumers, who actually provide the funds. We do not proceed in this way and chose to scale all the coefficients in order for them sum up to one. We then chose to let consumers get the money directly from the companies through higher gross management results.

Agriculture	0.008918
Oil extraction	0.000782
Other extractions	0.001623
Food industry	0.017556
Textile	0.023953
Paper and wood	0.014561
Coke and oil	0.005322
Chemical	0.038779
Building materials	0.013514
Mechanical	0.113506
Other manufacturing	0.005751
Electricity	0.024674
Gas	0.010553
Water	0.003766
Constructions	0.068815
Trade	0.065548
Transport	0.063684
Communications	0.034619
Credit and insurance	0.032736
Services to firms	0.038897
Public services	0.412444
Other services	0.000000

Table 1 - Coefficient used for the distribution of the inputted credit services.

[15] C. Bianchi, "Servizi bancari imputati e interdipendenze settoriali: un'analisi strutturale del ruolo del credito nel sistema economico.", Moneta e Credito, vol. 38, n. 150, 183-217 (1985).

The second change regards the remuneration of the labor of independent workers. In the original input output table, this is part of the return to capital. The national accounts report the value of the income withdrawn by these workers, but do not specify which part is related to their labor input and which part must be considered return to capital. We reduce the share of value added attributed to capital and increase the part to labor, assuming that the share to capital should be expected to be between 35 and 40 percent. This is not made for all sectors, as in some the weight of independent workers and individual firms is negligible.

12. Appendix 2 - Tables

Sector / Commodity	Value of domestic production*	Imports*	Share of total production (domestic + imports)	Compre-hensive revenue*	Share of revenue	Comprehensive tax rate
Agriculture	96498.6	12732.5	0.0329	-2130.6	-0.0145	-0.0195
Oil extraction	5196.9	17395.1	0.0068	38.8	0.0003	0.0017
Other extractions	8075.9	2125.5	0.0031	-68.3	-0.0005	-0.0067
Coke and oil	40467.0	6066.2	0.0140	43944.1	0.2989	0.9444
Non durable goods	605270.5	80481.1	0.2066	25125.7	0.1709	0.0366
Durable goods	557769.8	114404.2	0.2025	10183.6	0.0693	0.0152
Electricity	35215.0	1800.9	0.0112	5621.7	0.0382	0.1519
Gas	15060.2	0.0	0.0045	7392.6	0.0503	0.4909
Constructions	197942.8	173.9	0.0597	11486.2	0.0781	0.0580
Trade	390614.4	6730.4	0.1197	22444	0.1526	0.0565
Transport	154248.4	6144.5	0.0483	-8908.1	-0.0606	-0.0555
Public services	368006.7	184.5	0.1109	368.2	0.0025	0.0010
Other services	574381.0	22050.4	0.1797	31541.9	0.2145	0.0529
Total	2741553.8	270289.2	1.0000	147039.8	1.0000	0.0488

*** billion lira**

Table 1 - Commodity taxation in Italy (1992).

PRODUCTION

Sector / Commodity	SOX(a)	NOX(b)	CO2(c)
Agriculture	21239.65	125468.76	19806.19
Oil extraction	32.39	2029.25	1021.91
Other extractions	2780.71	2162.24	609.69
Coke and oil	291151.39	54510.95	37187.68
Non durable goods	217908.89	148384.38	48359.91
Durable goods	143815.46	215650.61	70205.63
Electricity	554375.61	297343.31	78817.42
Gas	290093.05	155593.48	41243.49
Constructions	3565.22	30294.17	2534.45
Trade	21149.90	166120.11	24085.62
Transport	175712.23	473002.31	49392.33
Public services	49044.23	101539.45	15767.98
Other services	8305.93	46371.05	6312.33
Total	1779174.66	1818470.06	395344.64

CONSUMPTION

Sector / Commodity	SOX(a)	NOX(b)	CO2(c)
Coke and oil	69589.59	252311.41	54064.82
Gas	0.00	38183.18	16592.39
Total	69589.59	290494.60	70657.21

(a) tons
(b) tons
(c) thousand of tons

Table 2 - Air emissions from production and consumption (1992).

Domestic production: quantity

	Base case	After the reform	Percentual variation
Agriculture	93.3582	87.7914	-0.0596
Oil extraction	5.2440	4.8981	-0.0660
Other extractions	7.8201	7.5240	-0.0379
Coke and oil	83.0125	73.6492	-0.1128
Non durable goods	609.6110	599.1599	-0.0171
Durable goods	548.7225	529.2812	-0.0354
Electricity	40.6249	36.2650	-0.1073
Gas	21.9218	19.1888	-0.1247
Constructions	198.0265	196.6970	-0.0067
Trade	406.2966	398.6830	-0.0187
Transport	144.4267	122.7574	-0.1500
Public services	367.4752	368.0478	0.0016
Other services	602.7777	603.9845	0.0020

Domestic production: price

	Base case	After the reform	Percentual variation	Percentual variation with no general equlibrium adjustments
Agriculture	1.0039	1.0979	0.0936	0.0715
Oil extraction	1.0025	0.9606	-0.0418	0.0298
Other extractions	0.9951	1.0413	0.0465	0.0093
Coke and oil	0.9990	0.9874	-0.0116	-0.0555
Non durable goods	1.0011	1.0510	0.0498	0.0080
Durable goods	0.9963	1.0540	0.0580	0.0200
Electricity	1.0007	1.1312	0.1303	0.1703
Gas	1.0032	1.0603	0.0569	0.2083
Constructions	0.9817	1.0183	0.0373	0.0080
Trade	1.0006	1.0384	0.0378	0.0235
Transport	0.9992	1.1580	0.1590	0.1455
Public services	0.9995	1.0274	0.0279	0.0131
Other services	1.0001	1.0188	0.0187	0.0043

Table 3 - Effects of the environmental tax reform.

Private consumption: quantity

	Base case	After the reform	Percentual variation
Agriculture	42.9577	41.9707	-0.0230
Oil extraction	0.0083	0.0087	0.0503
Other extractions	0.0673	0.0684	0.0170
Coke and oil	31.1222	22.9244	-0.2634
Non durable goods	293.6205	297.2118	0.0122
Durable goods	119.8388	120.6827	0.0070
Electricity	12.4805	11.7486	-0.0586
Gas	12.3778	10.2939	-0.1684
Constructions	1.6068	1.6413	0.0215
Trade	100.7766	102.9081	0.0212
Transport	25.0438	23.0129	-0.0811
Public services	37.0018	38.1398	0.0308
Other services	195.7956	203.6118	0.0399

Private consumption: price

	Base case	After the reform	Percentual variation	Percentual variation with no general equlibrium adjustments
Agriculture	1.0297	1.1167	0.0845	0.0000
Oil extraction	0.9968	1.0056	0.0088	0.0000
Other extractions	1.0067	1.0488	0.0418	0.0000
Coke and oil	1.0297	1.4812	0.4385	0.4605
Non durable goods	1.0862	1.1370	0.0468	0.0000
Durable goods	1.0393	1.0935	0.0521	0.0000
Electricity	1.0304	1.1597	0.1256	0.0000
Gas	1.0623	1.3534	0.2741	0.2307
Constructions	0.9951	1.0322	0.0373	0.0000
Trade	1.0794	1.1200	0.0376	0.0000
Transport	1.0394	1.1985	0.1531	0.0000
Public services	1.0147	1.0431	0.0279	0.0000
Other services	1.0215	1.0408	0.0189	0.0000

Table 3 - Effects of the environmental tax reform

PERCENTUAL VARIATION IN EMISSIONS AND TAX REVENUE

	FROM PRODUCTION			
	SOX	NOX	CO2	Revenue from environmental taxes (trillion lira)
Agriculture	-0.0352	-0.0356	-0.0359	6.7549
Oil extraction	-0.1233	-0.1233	-0.1233	0.1366
Other extractions	0.0062	0.0045	0.0028	0.0734
Coke and oil	-0.1026	-0.1027	-0.1028	-2.0357
Non durable goods	0.0326	0.0214	0.0134	4.9209
Durable goods	0.0079	-0.0024	-0.0099	10.7853
Electricity	-0.1133	-0.1188	-0.1234	5.2131
Gas	-0.1978	-0.1979	-0.1980	2.5537
Constructions	0.0315	0.0309	0.0304	1.5218
Trade	0.0044	0.0033	0.0022	9.2611
Transport	-0.1411	-0.1412	-0.1413	19.2942
Public services	0.0252	0.0180	0.0121	4.8828
Other services	0.0255	0.0232	0.0210	2.5517

	FROM CONSUMPTION			
	SOX	NOX	CO2	Revenue from environmental taxes (trillion lira)
Agriculture	-	-	-	0.0000
Oil extraction	-	-	-	0.0000
Other extractions	-	-	-	0.0000
Coke and oil	-0.2634	-0.2634	-0.2634	10.5570
Non durable goods	-	-	-	0.0000
Durable goods	-	-	-	0.0000
Electricity	-	-	-	0.0000
Gas	-	-0.1684	-0.1684	2.3749
Constructions	-	-	-	0.0000
Trade	-	-	-	0.0000
Transport	-	-	-	0.0000
Public services	-	-	-	0.0000
Other services	-	-	-	0.0000

Table 3 - Effects of the environmental tax reform.

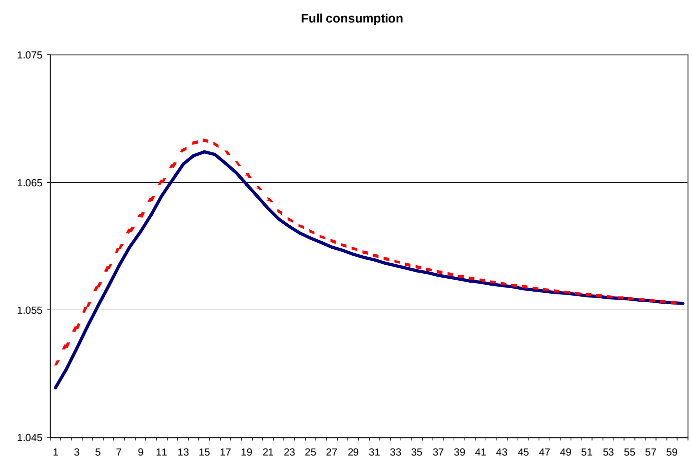
13. Appendix 3 - First tax reform

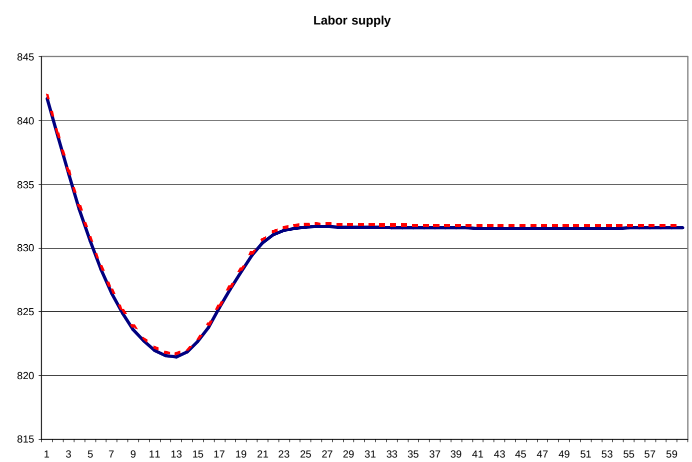
Reform which reduces sale tax rates by 5% of their initial values and allows company incomes tax rate to change in order to guarantee revenue-neutrality.

Effect on full consumption (index), labor supply (transformation of hours), real GDP and capital stock (trillion lira) and on emissions of sulfur oxides, nitro-oxides (tons) and carbon dioxide (thousand tons), for 60 periods.

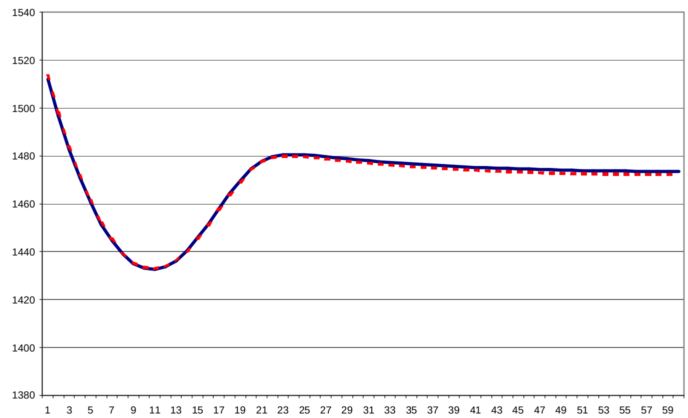
The solid line refers to the base case scenario, while the dotted one represents the reform.

Full consumption, labor supply, real GDP and capital stock are expressend in units per unit of efficiency of labor (net of growth rate). Emissions are instead expressed in real quantities.

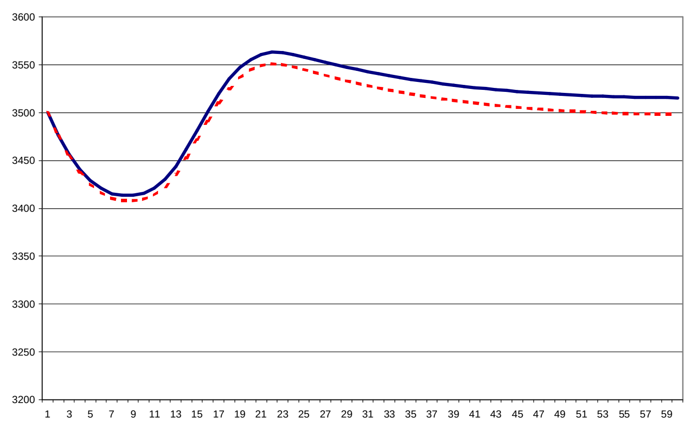




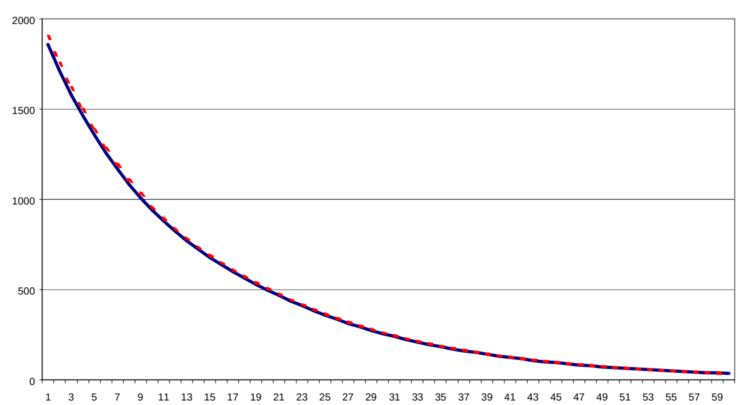
Real GDP (trillions of lira)



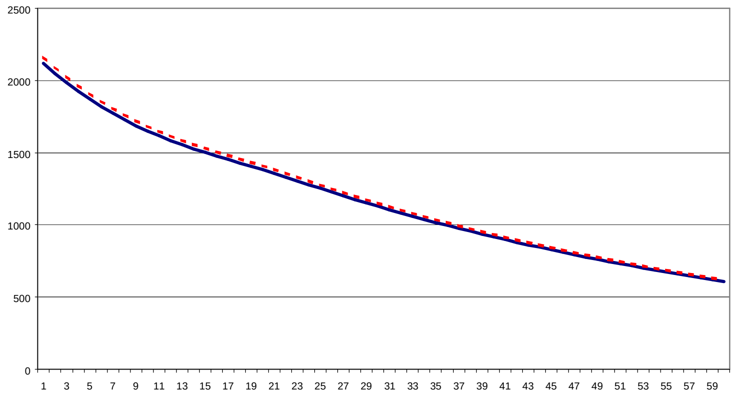
Capital stock



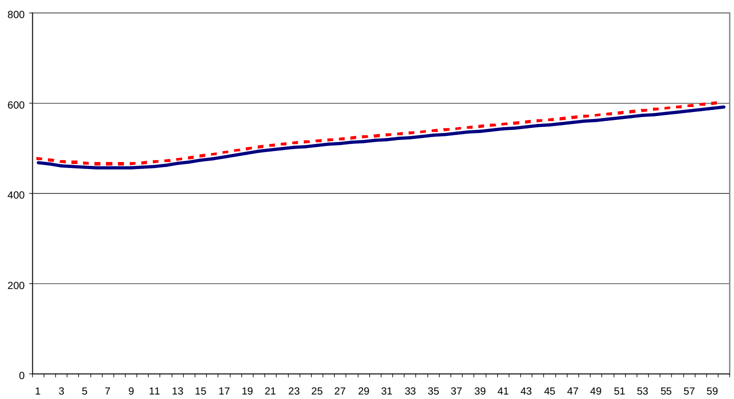
SOX EMISSIONS (tons)



NOX EMISSIONS (tons)



CO2 EMISSIONS (thousand of tons)



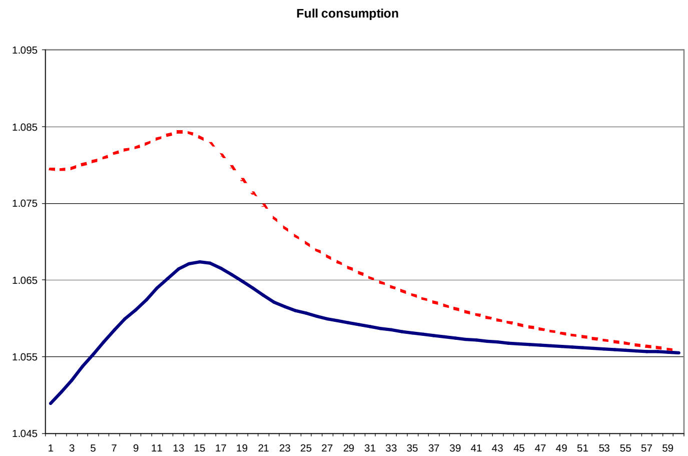
14. Appendix 4 - Second tax reform

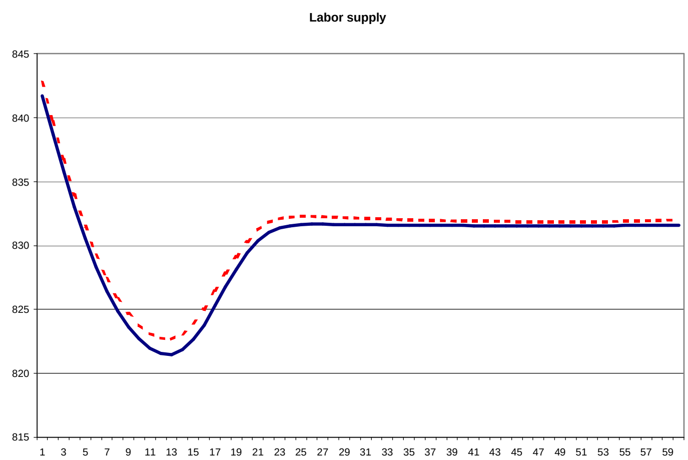
Reform which sets a uniform sale tax rate of 10%, sets consumption taxes to zero and allows household income tax rate to change in order to guarantee revenue-neutrality.

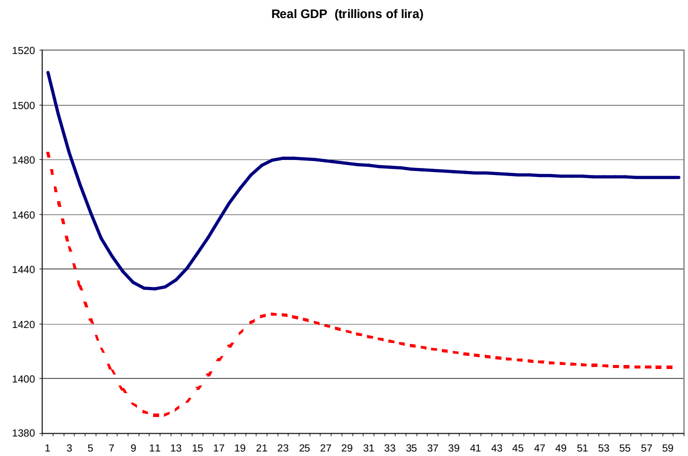
E¤ect on full consumption (index), labor supply (transformation of hours), real GDP and capital stock (trillion lira) and on emissions of sulfur oxides, nitro-oxides (tons) and carbon dioxide (thousand tons), for 60 periods.

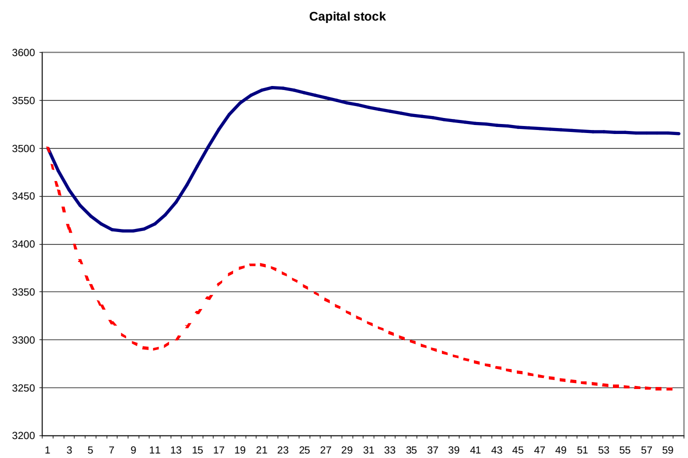
The solid line refers to the base case scenario, while the dotted one represents the reform.

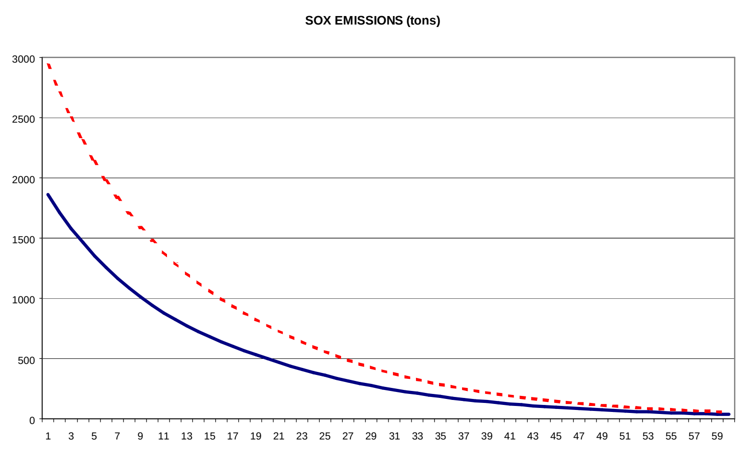
Full consumption, labor supply, real GDP and capital stock are expressend in units per unit of e¢ ciency of labor (net of growth rate). Emissions are instead expressed in real quantities.



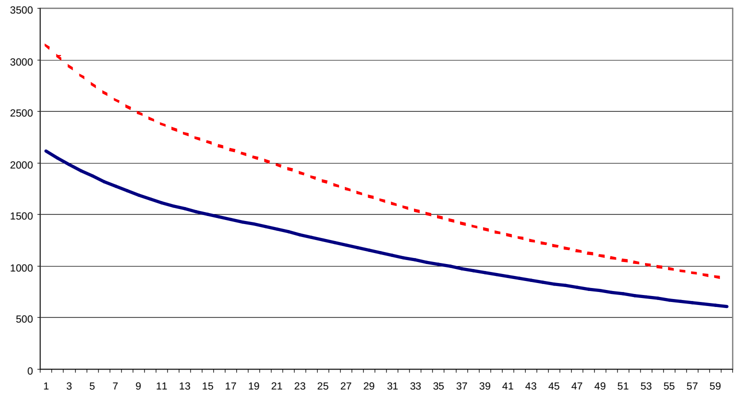



Real GDP (trillions of lira)
1520
1500
1480
1460
1440
1420
1400
1380
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59

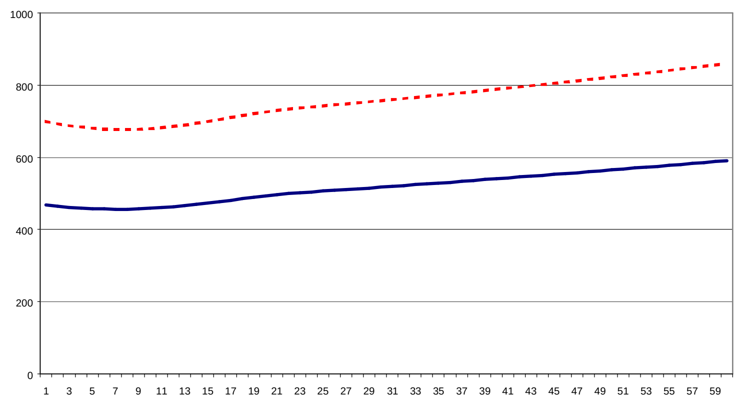

Capital stock
3600
3550
3500
3450
3400
3350
3300
3250
3200
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59


SOX EMISSIONS (tons)
3000
2500
2000
1500
1000
500
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59

NOX EMISSIONS (tons)



CO2 EMISSIONS (thousand of tons)



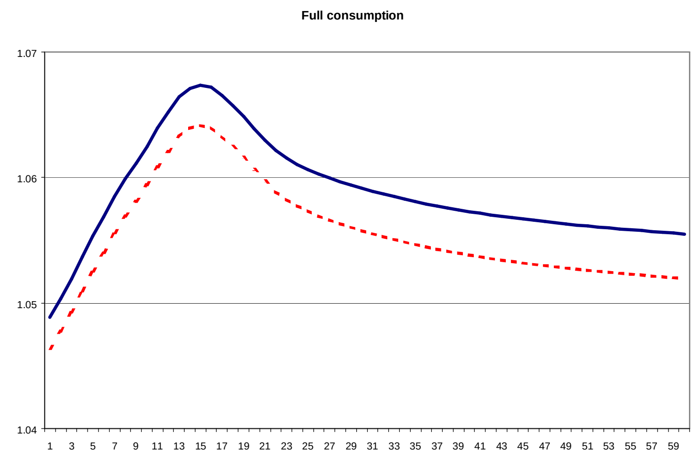
15. Appendix 5 - Environmental tax reform

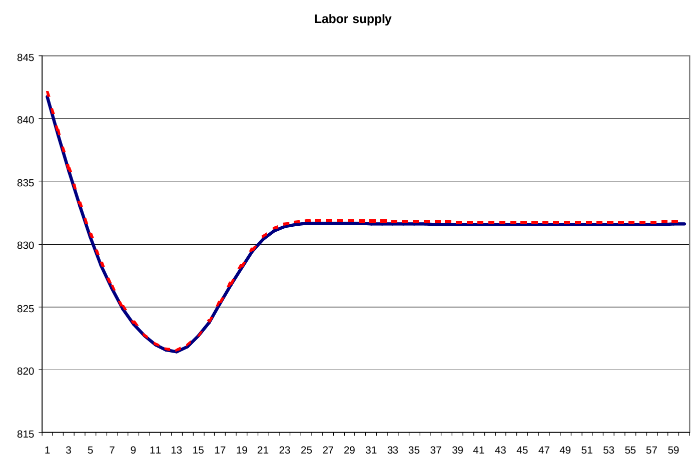
Reform which intruduces taxes on emissions for the reduction of their level to 90% of the base case in each period and allow household income tax rate to change in order to guarantee revenue-neutrality.

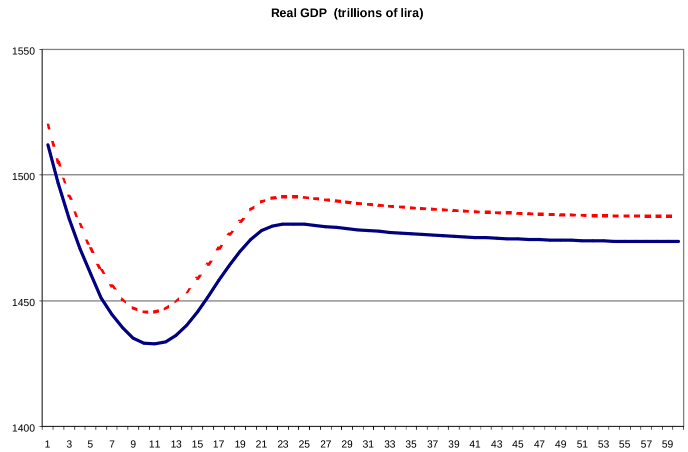
Effect on full consumption (index), labor supply (transformation of hours), real GDP and capital stock (trillion lira) and on emissions of sulfur oxides, nitro-oxides (tons) and carbon dioxide (thousand tons), for 60 periods.

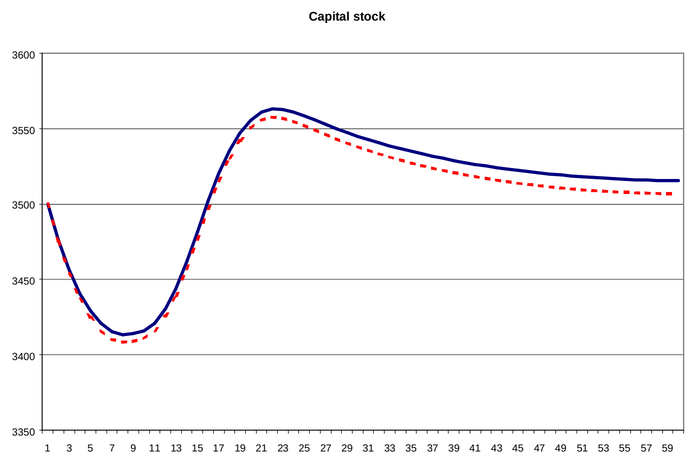
The solid line refers to the base case scenario, while the dotted one represents the reform.

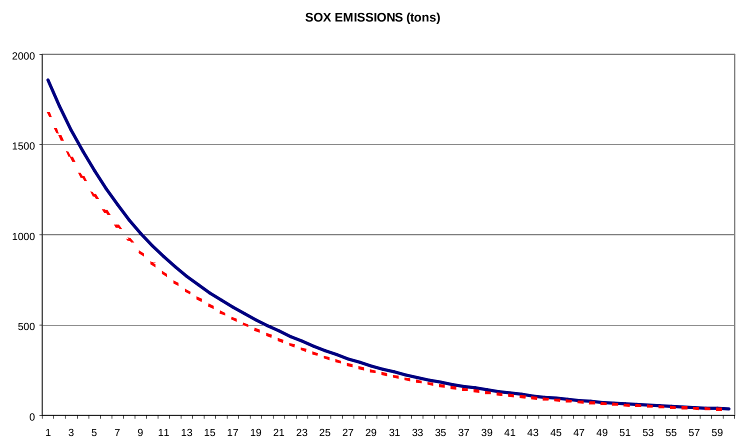
Full consumption, labor supply, real GDP and capital stock are expressend in units per unit of efficiency of labor (net of growth rate). Emissions are instead expressed in real quantities.



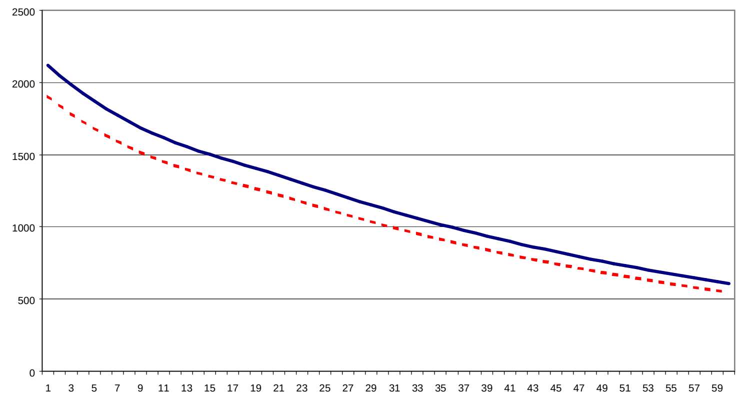



Real GDP (trillions of lira)
1550
1500
1450
1400
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59


Capital stock
3600
3550
3500
3450
3400
3350
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59


SOX EMISSIONS (tons)
2000
1500
1000
500
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59

NOX EMISSIONS (tons)



CO2 EMISSIONS (thousand of tons)