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TOWARDS A WORLD CO_2 TAX?

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RESUME

Cet exposé offre un panorama de la taxe sur le CO_2, fait par de nombreux savants et politiciens, considéré comme instrument de lutte contre l'Effet de Serre et l'Echauffement Global. Les plus importants aspects sont considérés, comme la nécessité d'une taxe, sa nature, les difficultés d'introduction de la taxe, les alternatives et les questions qui appellent encore une réponse. Cet exposé présente un caractère économique net, c'est-à-dire que les aspects économiques de l'Echauffement Global et de la Taxe sur le CO_2 sont soulignés, plutôt que les aspects chimique et physique.

Le panorama est vite parcouru, les différents aspects ne sont que brièvement évoqués, des références à la littérature spécialisée sont ajoutées pour les lecteurs dont l'intérêt est suscité.

Mots clés : *échauffement global, effet de serre, taxe sur le CO_2, demande d'énergie.*

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INTRODUCTION

Global Warming, or the *Greenhouse Effect*, is not a new phenomenon. Almost exactly one hundred years ago, the Swedish Svante Arrhenius wrote a scientific article describing it[1]. However, it is only recently that it has become a widely discussed topic on the international scientific and political agenda.

The greenhouse effect can be attributed to a particular characteristic of water vapour and some gases known as greenhouse gases [GHGs] (CO_2, CFC, methane, NOx and ozone): these gases are transparent to short wave radiations, but are opaque to long waves. Hence they let short wave radiations of the Sun penetrate to the Earth's surface, but a certain proportion of the reflection of long wave radiation into space is trapped.

This is a perfectly 'natural' phenomenon, in the absence of which the average surface temperature of the Earth would be as low as -18° Centigrade rather than its current 15°. However, the greenhouse effect has become a problem since emissions resulting from *human* activities are substantially increasing the atmospheric concentrations of the greenhouse gases, thus *enhancing* the greenhouse effect. An important cause for the increase in the net emissions is the rapid deforestation (12%), but the predominant anthropogenic cause of the rise in the concentration of GHGs is the increase of the burning of fossil fuels for energy consumption (85%). The continuous increase of net GHG emissions as a result of economic growth is endangering the sustainability of Earth's society[2].

Some figures might illustrate what is going on.

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1 Arrhenius (1896)

2 One speaks of a sustainable development, when current actions are such that the potential well-being of future generations is at least as good as that of our generation: see e.g. Pearce (1994)

The atmospheric concentration of CO_2 has increased by about 27% since the Industrial Revolution. The International Panel on Climate Change (IPCC) estimates expected fossil fuel consumption to be doubled by the year 2050, causing an increase of average global temperature by 0.2 to 0.5% per decennium[3]. Temperature of this order of magnitude will have consequences on the climatic system of phenomenal proportion, certainly when the archaeologically minuscule time span is taken into consideration. A frequently heard effect will be felt in agriculture throughout large areas of the world (crops), another likely consequence will be a sea level rise of more than one meter. Estimates of the costs of coping with the damage due to the doubling of the CO_2 concentrations amount to 1.4% of GDP in OECD countries, and - more painful - 1.8% of GDP of non-OECD countries[4].

In this paper we are not going to discuss the physical or chemical aspects of the problem. Instead, we will concentrate on the economic aspect, for this is a new and intriguing one: Mankind is confronted with a *global* challenge, in this respect perhaps only comparable with the nuclear threat during the Cold War: "This greenhouse problem, if problem it proves to be, is truly one of the global common"[5]. How can Mankind respond to this challenge? Obviously, a global consensus is a prerequisite for a global policy. But such a consensus will be extremely difficult to attain, for there are many questions regarding for instance welfare distribution and economic development that must be addressed first. Managing the climate is not a question of cost-benefit analyses: the entire problem must be set within the broadest dynamic ecological-economic frame possible, if a consensus is to be achieved. In this paper we shall dwell on the pros and the cons of one instrument that could be used in this context: a worldwide CO_2 tax, briefly.

I. THE NECESSITY OF A WORLD CO_2 TAX

I.1. Why a tax?

The main idea is naturally that a tax would incite economic agents (producers and consumers) to reduce CO_2 emissions. But there is more to it than that: a tax will, at least in principle, address an equity problem by *internalizing* the intra-generational, inter-generational and inter-national externalities associated with pollution. A tax can make sure that the price of energy reflects the true integral costs, including the compensation for the negative side effects that the use of energy has, like pollution or a greenhouse effect, either harming current generations, or harming next generations. A tax can also play a *dynamic* role by stimulating investment in new techniques to abate GHG emissions. Furthermore, it can be regarded as a factor price for GHG emissions and for the use of natural services, or conversely as an artificial price for the natural assimilation of CO_2 and other GHGs. So a CO_2 tax has many aspects. It is this versatility that makes it suited to set the entire greenhouse effect problem within the broadest frame possible.

I.2. Conventions, treaties, agreements

The present conventions, treaties, agreements, etc., are not sufficient to bring about the desired changes in Man's use of energy. Let us take for example the Framework Convention on Climate Change, signed by 150 countries in Rio de Janeiro in 1992, and which came into force on March 21st 1994. Its requirements are not really demanding. The poorer countries are merely asked to make lists of sources of GHGs. The rich countries must draw up plans to show how, by the end of the century, they will return their GHGs output to 1990 levels. But they will quickly realise the difficulty of reaching such a goal without a steep rise in energy taxes, and that means introducing a CO_2 tax.

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3 IPCC
4 See Fankhauser and Pearce -1993), p. 9
5 Schelling (1992)

I.3. Why should the tax be world-wide?

To this day, much of the discussions regarding the greenhouse effect have only been heard in OECD countries being responsible for over 55% of global CO_2 emissions (USA alone: 25%). However, by 2050 the OECD will account for only one-quarter of the world's output of CO_2. Much more important in this respect will be the developing countries and the countries of Eastern Europe and the former Soviet Union[6]. So, the tax should be world-wide if it is to be efficient.

II. THE NATURE OF A CARBON TAX

A CO_2 tax is by definition a specific excise tax on the carbon content of fuels. In this respect it must be distinguished from generalised energy taxes such as VAT or a tax per Joule. The tax is levied on the use of fossil fuels only, thus not affecting the price of other energy carriers, like nuclear energy, or what is called renewable forms of energy (e.g. wind and solar energy).

A tax on energy raises the price of energy. The direct consequence of that is a fall in purchasing power of energy users: this is called the income effect. A somewhat more indirect effect is a fall in demand of the taxed energy carrier in favour of the non-taxed energy carriers, and in favour of the untaxed other production factors or consumer goods: this is known as the substitution effect. The extent to which the tax affects energy demand depends on the price elasticity of energy.

The tax does not affect everybody equally. Industrial sectors, groups of households, or entire nations that have a large price elasticity of energy will be able to cope with the tax somehow, others will have more difficulties. Thus some segments of society will shrink, while others can benefit from a relatively stronger position. Aspects of energy intensity, energy efficiency, efficiency improvement options, degree of competitiveness, and the characteristics of the product and financial markets all influence the ability to cope with the tax.

The energy user who is faced with an energy tax will exercise abatement efforts up to a point where the marginal costs of abatement efforts are surpassing the energy tax: after that it is cheaper to pay the energy tax, than to invest in additional energy efficiency improvement. The marginal costs of emission reduction tend to increase.

III. DIFFICULTIES IN INTRODUCING THE TAX

III.1. Uncertainty and irreversibility

Before a "traditional" politician accepts to consider ways to address the greenhouse effect problem, he will want clear scientific evidence that the accumulation of GHGs really changes the climate; next, he will want to know whether such a change carries economic costs. Both points are difficult to prove. Can we afford to wait until there is more certainty? Obviously not: global warming, if it takes place, would be irreversible. This is the reason why it is advocated that:

" damages ought therefore to attract a higher weighting than comparable costs, either:
(a) through the inclusion of damage costs over very long time horizons (technically, to infinity - in which case the issue of the choice of the appropriate discount rate arises, or

(b) through some premium on costs aversion to irreversible damage - reflecting some assessment of intertemporal equity"[7]

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6 IPCC (1990)
7 Pearce (1991)

This question of scientific uncertainty seems largely exaggerated. The majority of scientists, as represented by the Intergovernmental Panel on Climate Change (IPCC), believe that the greenhouse effect will indeed cause significant global warming by the middle of the next century in the absence of policy intervention. In view of the precautionary principle, it is unwise to wait, and a "non regret" policy is advocated widely.

Another type of uncertainty stems from the way to assess *ex-ante* the potential economic effects of the tax. One possibility is the use of models. A review of the main advances made in the past twenty years lies beyond the scope of this paper. However, one should be aware of the existence of two main schools, which usually attain conclusions: *Top-down* (or macro-economic) models generally foresee losses of economic growth accompanying CO_2 reduction strategies[8]. *Bottom-up* (or engineering) models stress the existence of cost-effective technologies, which can limit emissions without entailing additional costs for their users[9].

Needless to say, the very existence of two schools of thought adds to the uncertainty surrounding the economic impacts of a CO_2 tax.

III.2. Externalities and the 'free-rider' problem

The greenhouse effect can be seen as a text-book case of the economics of a public good, the atmosphere; externalities will occur, *in casu* caused by the emissions of greenhouse gases. "Free riders" can also appear if some countries refuse to introduce the tax: they will enjoy the effects of a better environment without contributing to it. CO_2 emissions are after all uniformly distributed in the atmosphere.

Moreover, the greenhouse effect is a very good example[10] of an externality which is *global* and *irreversible*. This make the problem more intricate: its global nature implies the recourse to something as elusive as International Law. Irreversibility means that one cannot wait until the free rider problem is solved.

III.3. Cooperation

The theoretical problems sketched above suggest that the implementation of a world CO_2 tax will require intense cooperation and control. To that effect, the United Nations established in 1988 a body called the I.P.C.C. (Intergovernmental Panel on Climate Change). It was asked to study the scientific basis of climate change, to assess its potential impacts, and to explore appropriate policy responses. This was the "first concrete step taken by the international community to address the effect of human activity on the atmosphere (...)"[11].

There is another reason for international cooperation. Recent research has shown that a *national* carbon tax would be lower than an optimal global tax[12]. Because of this sub-optimality, international cooperation and coordination is indispensable.

IV. ALTERNATIVES TO TAXATION

IV.1. Ending subsidies

As we already said, what happens in non-OECD countries will increasingly matter when it comes to world-wide CO_2 emissions. Indeed, the rapid disappearance of *energy subsidies* in the developing countries, the countries of Eastern Europe and the former Soviet Union should have a bigger impact on carbon-dioxide output than even the most draconian policies in the rich

8 Dean (1993); Nordhaus (1991); Jorgenson and Wilcoxen (1992)
9 Cline (1993)
10 The depletion of the ozone layer is another example
11 Jones (1993)
12 Van der Ploeg and De Zeeuw (1992)

countries. The OECD reckons that removing energy subsidies in non-OECD countries could cut their emissions in 2050 from 18.1 billion tonnes to 11.2 billion tonnes[13].

IV.2 Technical progress

Despite recent advances, technical progress often remains the least developed feature in macro-economic models. That explains why many forecast based on these models tend to give a gloomy picture when a shock is simulated: historically, technical progress has been considered as a 'residual', as something that cannot really be explained. So it is generally supposed to remain somehow constant in the future, or to grow at a constant rate. In both cases, it is disconnected from actual developments in the production sphere.

However, a sizeable CO_2 tax will certainly affect the investment behaviour of the firms, and thus accelerate R&D, innovation, and the diffusion of new techniques and processes[14]. The new endogenous growth theory could provide models that integrate endogenous technical progress[15]. An alternative is the vintage approach (*putty-clay* models), which we have used to model a CO_2 tax in Europe[16]. However, several uncertainties remain. If the expected rate of technical progress is less than the real one, the tax rate assessment will be too high, and *vice versa*.

To sum up, everything we have said about the magnitude of the CO_2 tax is subject to revision if some major technical advance, or a series of innovations in solar, wind, biomass or nuclear power permit to economically substitute coal and oil, the most commonly used fossil fuels.

IV.3. Tradeable Permits

An alternative economic instrument to reduce emissions is the so-called system of tradeable permits. Rights to emit are sold or given (grandfathered) to potential emitters, and at the same time the emitters are allowed to start trading the permits among each other. The amount of permits that the authorities issue is of course directly related to the total amount of emissions the authorities is prepared to allow. Energy users who are able to avoid emissions can sell permits to users who can not avoid emitting. The trading price reflects the scarcity of permits, and hence the strictness of the policy.

In theory the energy user will embark on energy efficiency improvement efforts, again up to the point where it starts to be more interesting to buy permits. In the optimum the energy user will purchase emission permits up to the point where its price equals marginal emission avoidance costs. Theoretically there is no difference between the trading price of a permit, corresponding to a certain 'bubble of emissions' allowed, and an energy tax that is just sufficient to achieve the same amount of emissions.

For unknown reasons the system of tradeable permits has become popular in the USA, and not (yet) in Europe, while for the energy tax the opposite is true[17].

V. FURTHER OPEN QUESTIONS

V.1. Tax and Development

Will a world-wide CO_2 tax hinder development? For some authors, the answer is clear: "(T)he developing world can not afford to incur economic penalties to slow the greenhouse effect"[18]. This is a much-heard objection to any grand scheme of world taxation. It gets sometimes a moral

13 Bohm (1993)
14 Velthuijsen (1994)
15 Rivera-Batiz and Romer (1991); Bovenberg and Smulders, (1993)
16 Laroui and Velthuijsen (1992a); (1992b)
17 See Cropper and Oates (1992)
18 Schelling (1992)

tint when formulated as follows: the developed countries have built their current prosperity on cheap, abundant energy sources. Why should Third-World countries not be allowed to do the same?

Our own position is that *global* economic growth is not necessarily impeded when steps are taken to protect our global environment. There could well be *local* impediments, but those could remedied via transfers between local entities.

V.2. The question of the "double dividend"

It is a well-known fact that present taxation systems bear heavily on labour. Therefore, many environmentalists suggest a shift in taxation: on energy and away from labour. This could in theory stimulate the quality of the environment and simultaneously boost employment. This 'double dividend' feature is of critical importance in the political debate about the carbon tax.

It must be noted that the 'double-dividend' argument is not universally accepted. A prominent economist writes: "[The double dividend] is a hoax. A pollution tax is as a matter of fact an implicit tax on labour. Conversely, a tax on labour hinders (polluting) production and consumption: therefore, it is an implicit pollution tax"[19].

The question of the double dividend is further complicated by the existence of distortions: "(...) Environmental policy typically exacerbates pre-existing tax distortions - even if environmental taxes are employed"[20].

V.3 Elasticities

A carbon tax will vary by carbon content of fuel; therefore we must know inter-fuel substitution elasticities as well as the standard income and price elasticities, in order to optimally calibrate the tax. There have been numerous studies into the energy price elasticities, ranging from cross sectional studies across households, industries, and countries, to time series studies, and from estimates based on stated reactions, to studies based on revealed observed reactions to price changes. All empirical evidence seems to be conclusive on the small sign of (at least the short run) elasticity, although estimates show a sizeable variation[21].

V.4. Environmental Accounting

To really assess the impacts of a carbon tax, one should use another framework than the traditional National Accounts that have been developed after World War II. In traditional National Accounting the value of the environment is not taken into account. According to supporters of so-called Green Accounting, the depletion of natural resources, or the deterioration of the productive and consumptive quality of air, water and soil that is caused during the generation of the national product should be subtracted somehow from the national income. A "*Green GDP*", i.e. a GDP that is corrected for the environmental damage, is a more proper indicator to measure the prosperity of a nation.

A lot of research has been done on this subject[22].

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19 Bovenberg and Van der Ploeg (1993)
20 Bovenberg and De Mooij (1993)
21 Central Planning Bureau (1990)
22 See, for instance: Lutz (1993) or Mäler (1991)

CONCLUSION

This paper contains a sightseeing tour through the CO_2 tax, by many scientists and politicians regarded as an instrument to counter the Greenhouse Effect and Global Warming. The tour stops at most of the important sites of interest, like the need of a tax, the nature of a tax, difficulties in introducing the tax, alternatives to the tax, and -scientific - questions that still need to be answered. The tour guide is an economist, the tour has a distinct economic flavour. That means that the economic aspects of Global Warming and a CO_2 tax are highlighted, rather than the chemical of physical aspects.

The tour is a very swift one: the various aspects are only briefly touched, references to relevant literature are added for the reader who's interest is aroused.

During the tour it is argued that despite several uncertainties and inconclusive argumentation by scientists, there seems to be a growing consensus about the need to counter the greenhouse effect, and the need to save energy. One of the most commonly heard-of instruments to attack energy consumption is the CO_2 tax. Perhaps more important than the scientific questions that have yet to be answered, laborious process of political consensus building seems to be the major obstacle blocking the introduction of a global CO_2 tax in the near future.

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