E c o n o m i c s B u l l e t i n

The time-inconsistency of alternative energy policy

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Abstract

Time-inconsistency can arise when a government attempts to convince private sector to use a particular alternative energy (gas, green electricity...) rather than petroleum products. By introducing taxes and feed-in prices, a government would encourage firms and households to switch to an alternative energy rather than use petroleum products. However, even if a government is in favor of increasing alternative energy consumption, it can benefit from considerable financial resources resulting from petroleum product consumption. As a result of these conflicting issues, the private sector may not find the alternative energy policy credible, which prevents the government to implement a socially efficient policy.

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1 Introduction

Over the last 25 years, various predictions have been made about crude oil supply. It seems obvious that there is an increasing shortage of fossil fuels and, at the same time, governments are faced with more demanding energy users with respect to environmental protection. To deal with these crucial issues, governments have to implement incentive tax policies in order to encourage firms and households to switch to alternative energy sources (natural gas, wind or solar photovoltaic energy or nuclear power). However, when government benefits from considerable proceeds from petroleum product taxes (which is the case for most European countries[1]), implementing time-consistent policies remains a difficult task.

A certain amount of time-inconsistency-related literature[2] focuses on environmental issues in order to define the credibility of coercive policies which are imposed on firms for making less polluting technology investments (Helm, Hepburn and Mash (2004), Abrego and Perroni (2002), Marsiliani and Renström (2000)). For instance, Abrego and Perroni (2002) consider environmental taxes aiming to reduce pollution and related changing production methods which involve more research and development work as well as new investments. However, these taxes can generate unwanted distributional effects and, in the future, taxes may be reduced by the government to minimize these impacts.

The present paper is related to the time inconsistency problem stemming from incentive measures, such as tax credits, subsidies or feed-in prices, implemented for supporting alternative energy instead of petroleum products consumption. Our aim is not to emphasize the credibility of coercive measures. It is rather to understand the difficulty for final users to consider the government as a credible authority when it promotes alternative energy. This situation is due to the government's dilemma: supporting alternative energies based on incentive policies or receiving large proceeds from base energy taxes (mainly petroleum products). Even if the government prefers to promote the use of alternative energies, it also considers the implications due to the income loss resulting from a decreasing consumption of the base energy.

We develop a simple model of time-inconsistency in which only two sources of energy are available to final users: a base energy (petroleum) and an alternative energy. A government implements an energy policy using taxes or subsidies in order to increase the public's energy consumption of alternative energy. In this context, we show that such a policy is time-consistent provided that the tax differential between the two energy sources is equal to the government preference for alternative energy. As a result, when the government's preference for alternative energy is lower than its base energy tax, the only way to be credible consists in setting a positive tax on alternative energy, but not giving subsidies. However, this situation involves a reduction in the tax differential which may prevent an incentive from existing at all.

The remainder of the paper is organized as follows. Section 2 presents a model of time-inconsistent alternative energy policy. Section 3 firstly determines how the government's energy policy is an incentive policy, and then provides equilibrium conditions under which this policy is time-consistent. Section 4 includes a discussion of results when fixing energy base tax. Section 5 concludes the paper.

[1] See International Energy Agency, 2000.

[2] Based on the founding works of Barro and Gordon (1983) and Kydland and Prescott (1977).

2 A model of time-inconsistent alternative energy policy

We consider an economy with two types of energy consumption, a base energy (petroleum) and an alternative energy (as for instance wind turbine), respectively denoted B and S. We develop a repeated game between the government (also called G or policymaker), which applies energy taxes, and the private sector (called P or public) which determines its energy consumption according to its expectations for government energy policy.

Let $E = (E_b, E_s)$ be energy consumption variations with restrictions $E_b, E_s \in [0;1]$ and $E_b + E_s = 1$. This means that, at each stage of the analysis, there is a positive variation in the overall energy consumption.[3] We first define the government's preferences and then we consider those of the private sector.

2.1 The government's energy preferences

The government implements its energy policy using taxes (or subsidies when taxes are negative). We consider that the government's policy is represented by couple $T = (T_b, T_s)$, where T_b and T_s represent taxes or subsidies on energy's consumptions, $T_b, T_s \in [-1, 1]$.

For the moment, we assume that T_b and T_s are the only policy instrument that G can use to influence public consumption choices. By using its energy policy, G can draw resources from energy consumptions. The revenue of G from energy consumptions is assumed to be linear and represented by $R = T_bE_b + T_sE_s$. By substituting E_b by $1 - E_s$, we obtain:

$$R = T_b + E_s(T_s - T_b). \quad (1)$$

We assume that the government wishes to increase E_s without R being below $\bar{R} > 0$. Formally, G's energy preferences can be represented by the following objective function:

$$u_G = R - \lambda_G(1 - E_s), \quad (2)$$

in which constant $\lambda_G \geq 0$ represents the priority that G gives to the alternative energy with respect to energy taxation revenues. The government's program is then

$$Max_{(T_b,T_s)} \ R - \lambda_G(1 - E_s), \ \ s.c \ \ R \geq \bar{R}.$$

By substituting (1) in (2), we can rewrite the government's objective function as follows:

$$u_G = E_sT_s + (T_b - \lambda_G)(1 - E_s). \quad (3)$$

In Equation 3, the first member represents the revenue from alternative energy consumption. The second member refers to the base energy's revenue which depends not only on T_b but also on λ_G, the government's preference for alternative energy.

2.2 The public's energy preferences

The public utility function includes the public's preference for alternative energy and the expected overall cost related to energy consumption:

$$u_P = \lambda_P E_s - c_P. \quad (4)$$

[3] This amounts to assume that the public has increasing needs in energy at the moment of the analysis.

in which constant $\lambda_P \geq 0$ represents the weight that P gives to alternative energy consumption. The cost function is formalized as follows:

$$c_P = (p_s(1+\alpha) + T_s^e)E_s + (p_b + T_b^e)E_b, \tag{5}$$

in which p_b and $p_s(1+\alpha)$ refer to energy prices, and (T_s^e, T_b^e) the government's policy expected by the public. Parameter $\alpha \geq 0$ represents the potential monetary contribution (switching cost) to be made by the public for alternative energy consumption.[4] In order to simplify our calculations , we assume that $p_b = p_s$ and prices are normalized to one so that $p_b = p_s = 1$. By substituting E_b by $1 - E_s$, the public's cost function becomes

$$c_P = [E_s(\alpha + T_s^e - T_b^e) + 1 + T_b^e]. \tag{6}$$

The public's program can then be written as follows:

$$Max_{E_s} \;\; E_s[\lambda_P - (\alpha + T_s^e - T_b^e)] - (1 + T_b^e). \tag{7}$$

3 Equilibrium policy

In this section, we determine time-consistent policies which constitute a Nash equilibrium of the game described above. A Nash equilibrium includes the government's policy and the public's energy consumption. Formally, a Nash equilibrium is a couple (T, E), in which $T = (T_b, T_s)$ is the government's strategy (taxes) and $E = (E_b, E_s)$ is the public's strategy (energy consumptions).

An (expected) incentive government's policy is a policy which increases alternative energy consumption, i.e. a policy involving $E_s > 0$.[5] Denote by $\hat{T}^e = (\hat{T}_b^e, \hat{T}_s^e)$ an incentive policy and by $\hat{E} = (\hat{E}_b, \hat{E}_s)$ the related energy consumption.

Proposition 1 *$\hat{T}^e = (\hat{T}_b^e, \hat{T}_s^e)$ is an incentive for consuming the alternative energy if*

$$\alpha - \lambda_P \leq \hat{T}_b^e - \hat{T}_s^e. \tag{8}$$

Proof: We must determine the set of $T^e = (T_b^e, T_s^e)$ such as $E_s > 0$, i.e. the set of (expected) incentive policies. Notice first that with $E_s = 0$ (the alternative energy consumption is equal to zero), $U_p = -(1 + T_b^e)$. As a result, an incentive policy is such as $E_s > 0$ involves $U_p \geq -(1 + T_b^e)$. The last inequality holds if $\lambda_P - (\alpha + T_s^e - T_b^e) \geq 0$, i.e. if $\alpha - \lambda_P \leq T_b^e - T_s^e$. □

According to Condition (8) in Proposition 1, an incentive policy is such as the tax differential $(T_b^e - T_s^e)$ is higher or equal to the energy switching cost $(\alpha - \lambda_P)$. Furthermore, by considering that $\alpha - \lambda_P > 0$ represents the most interesting and relevant case, an incentive policy must verify $T_s^e < T_b^e$, as illustrated in Figure 1.

We turn now to the determination of credible energy policies. Such policies consist in a subset of incentive policies. They are consistent with the government's objective function such as defined in Eq. 3, meaning that they constitute a Nash equilibrium. Credible policies are given by the inequality defined in the following proposition.

Proposition 2 *Let $T^* = (T_b^*, T_s^*)$ be an incentive policy for consuming the alternative energy. Then $T^* = (T_b^*, T_s^*)$ is a time-consistent policy if $T_b^* - T_s^* = \lambda_G$.*

[4]For instance a more costly standing charge in order to use green electricity.

[5] It should be underlined that the degree of substitutability between the two energies does not modify our final results, even if it clearly changes the magnitude of the consumption variation of each energy. For instance, in case of perfectly substitute energy sources, an incentive policy involves $E_s = 1$.

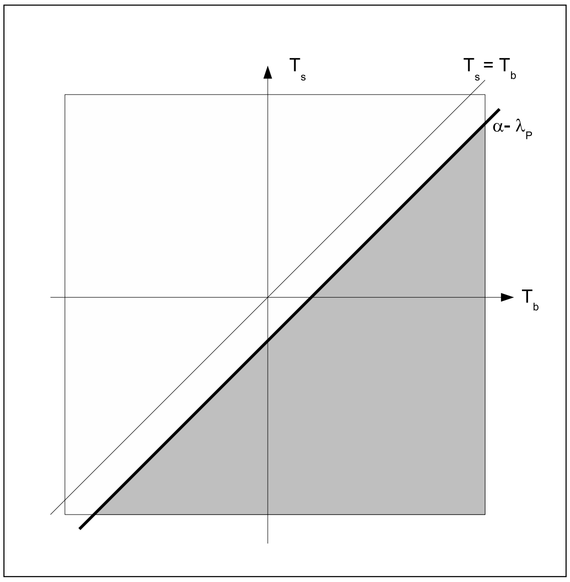

Figure 1: Incentive policies

Proof: We know that $T^* = (T_b^*, T_s^*)$ is an incentive policy if it satisfies condition (8) in proposition 1, that is $\alpha - \lambda_P \leq T^{*e}_b - T^{*e}_s$. For such a policy to be time-consistent it has also to maximize $u_G = E_s T_s + (T_b - \lambda_G)(1 - E_s)$. u_G can be increased by means of $E_s > 0$ whenever we have $T_b - \lambda_G \leq T_s$, i.e., $T_b - T_s \leq \lambda_G$ (as assumed for the public, government prefers alternative energy whenever indifferent). However, G attempts to maximize its utility function and consequently it will restrict the last condition so as $T_b - T_s = \lambda_G$. □

Based on Proposition 2, a credible policy is defined as an incentive policy for both the public (refer to Condition (8)) and the government. The last condition is fulfilled when the tax differential ($T_b^* - T_s^*$) is equal to the government's preference for alternative energy (λ_G). Otherwise, there is an incentive for the government to deviate from its early energy policy over time. Notice also that a credible policy may fail to exist. This occurs when the switching cost is high enough to overcome the government's preference for alternative energy.

Consider now the interesting case in which the base energy tax has been previously fixed, and denoted by $\bar{T}_b$. This means that government may only use alternative energy tax as a policy tool. Then, from Proposition 2, we can draw the following result.

Corollary 1 *Whenever $\bar{T}_b > \lambda_G$, a credible policy implies $T_s > 0$.*

Corollary 1 informs us that when the government's preference for alternative energy is lower than its base energy tax, then the only way to be credible implies setting a positive tax on alternative energy, but not giving subsidies. This counter-intuitive result will be illustrated in the next section.

4 Discussion

As described above, one interesting result that can be drawn from Proposition 2 (Corollary 1) relates to the impact of implementing T_s once determined T_b. As a

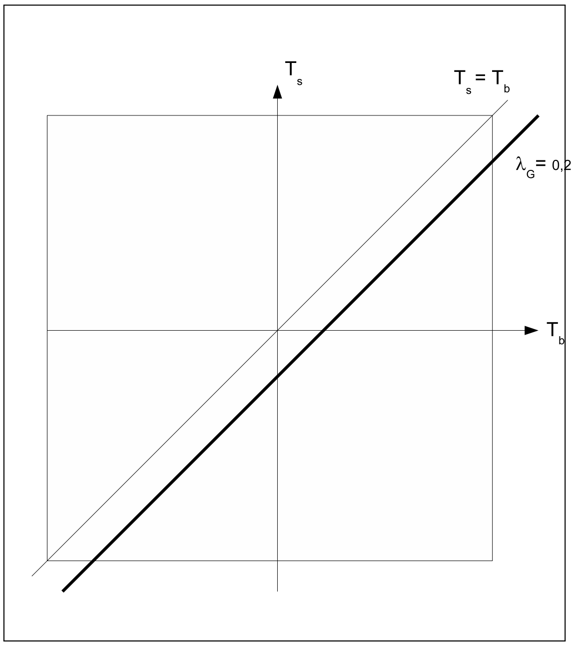

Figure 2: Credible policies with $\alpha - \lambda_P = 0$ and $\lambda_G = 0.2$

result, we may compare situations in which the government draws different proceeds from base energy. As expected, some aspects of the credible policy may be counter-intuitive. In particular, when T_b exceeds λ_G, then all credible policies must apply a positive T_s, meaning that an efficient policy consists in taxing the alternative energy instead of giving subsidies.

Consider the following example which is illustrated in Figure 2. We set $\alpha - \lambda_P = 0$ and $\lambda_G = 0.2$. In such a case, we know that credible policies are located along straight line $\lambda_G = 0.2$, which allows us to distinguish two subsets of credible policies: on the up-side and down-side of λ_G. Regarding the first one, a credible policy will consist in fixing a negative T_s (subsidies). For example, when $T_b = 0.1$, setting $T_s = -0.1$ is a credible policy. On the contrary, in the second subset, all subsidies to alternative energy will be considered as a time-inconsistent policy. For example, with $T_b = 0.5$ the alternative energy tax must be fixed at 0.3.

5 Conclusion

This paper has examined the credibility issue for a government aiming at promoting alternative energy. We have considered two sources of energy available to final users: a base energy (petroleum) and an alternative energy. We have shown that a credible policy is such that (1) the switching cost for users is lower than the tax differential between the two energy sources, and (2) this tax differential is equal to the government preference for alternative energy. As a result, a government, which has previously fixed a high base energy tax related to its preference for alternative energy, will be credible by setting positive tax on alternative energy rather than subsidizing it.

At this stage of the analysis, it would be interesting to discuss the relationships between credibility and energy vulnerability. Investments made for diversifying sources of energy allow a government to reduce its energy vulnerability. As opposed to the intuitive result that reducing energy vulnerability could improve the credibility of the government policy, the paper shows that developing alternative sources of energy is not necessarily a credible approach for private agents. This result depends on strategic interactions between the public and the government which are opponent for financing energy investments.

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