Taxes versus permits as incentive for the intertemporal supply of a clean technology by a monopoly☆

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ABSTRACT

This paper investigates the intertemporal monopolistic supply of a clean technology and addresses the following questions: How does the lack of governments to commit restrict the incentives and thereby the supply of clean technologies? Are either emission taxes or emission permits better suited in such a dynamic setting? Although the monopoly can be forced to price taking behaviour, the inability of governments to commit leads to too slow and to too little expansion. Prices and quantities are equivalent for different kinds of government's objectives. An (important) exception is the case of non-competitive supply of the dirty input: taxes dominate from a welfare perspective however due to the additional scope to accrue rents and not due to an improvement of incentives for the development of clean technologies. Permits eliminate pollution entirely, which fosters the expansion of the clean technology.

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1. Introduction

This paper investigates simultaneous intertemporal decisions of a monopoly to invest into improving/expanding clean technology and of a government. The government can choose either to tax pollution or to issue permits but it cannot commit to their future levels, which determine the incentives

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for the clean technology firm. An obvious motive of this investigation is to consider Weitzman's (1974) famous question in a dynamic setting. Another is that getting the incentives right for the development of clean technologies seems of utmost importance in the global warming debate according to a special issue of *Energy Economics* (33/4, edited by Nordhaus and Nakicenovic (2011) about the economics of technologies to combat global warming documents). Acemoglu et al. (2012) study directed technical change and find that subsidies are needed for new products like renewable energy (or the electric car) in order to compensate for the positive feedback loops that old products (like the combustion engine) enjoy from past experience and expertise. Sinn's (2008) 'green paradox' is more pessimistic about the consequences of future environmental policies including the availability of alternative energy because they will increase today's extraction and thus pollution, at least transiently; recent variations of this theme are Gerlach (2009), Smulders (2010), van der Ploeg and Withagen (2009) the latter also ignoring the exhaustibility constraint. The following model is complementary since it is the provider of the clean technology who holds the monopoly. The assumption that clean technology supply will be noncompetitive is a sensible one given that such a much sought technology will be patented. Closest and in fact motivating is Montero (2011) following Laffont and Tirole (1996), which is here extended for (richer) dynamics; Karp and Zhang (2010) consider (implicitly) the competitive supply of abatement and account for uncertainty and time consistency. A dynamic setting raises the issue of time consistent policies that Karp and Livernois (1992) address to subsidizing/taxing a nonrenewable resource monopolist and Maskin and Newbery (1990) for an oil importing economy. More recently, Hörner and Kamien (2004) show for commitment strategies the formal equivalence between an oil importing economy with the durable good monopoly while Liski and Montero (2009) elaborate the difference if requiring a subgame perfect equilibrium.

This impossibility to commit holds in particular for government policies, as Kydland and Prescott (1977) stressed a long time ago. The inability of the European Union to stick to the no-bail out commitment when facing the insolvency of Greece is a topical confirmation. Recent examples from energy markets are the cancellation of renewable energy subsidies by the new government of Mariano Rajoy in Spain (FAZ, February 2nd, 2012), a discussion of a reduction of the 'sacred' feed in tariffs in Germany (NZZ, February 14th, 2012) and other examples are: the forced renegotiations of electricity price contracts in the UK (even by the same Conservative government and its chief regulator Stephen Littlechild) followed by an ex-post windfall profit tax (by the following Labour government of Tony Blair), and of oil and gas contracts, recently in Venezuela, Peru and Russia.

The development of future clean energy can be divided into two phases. First, into a competitive phase in which many firms try to find the technological clue(s). This competitive phase is followed by a non-competitive one in which the owners of the basic technologies are protected by patents and decide how far to improve the technologies and how to expand capacities. The analysis in this paper is restricted to this second non-competitive phase, and it is assumed that a monopoly supplies the clean technology in line with the motivating paper of Montero (2011) and admittedly also for reasons of simplicity. Of course, the outcome of this second stage has crucial implications on the efforts of competitive firms in the first phase such that the impact due to the lack of commitment is even larger than revealed in the analysis of this second stage only.

The objective of this paper is to determine how far the lack of commitment is an obstacle for the provision of clean energy and which of the two instruments, taxes or permits, is better suited. More precisely, the government can choose either the tax or the permit policy forever, but cannot commit to the future tax level or the volume of permits. The levels of these policies determine the price for pollution (tax or permit price) and thus the profitability of investments into clean technologies. It turns out that prices and quantities are equivalent in most cases if the players employ Markov strategies, which are chosen because they are self-enforcing over the entire state space (sub game perfect) and thus account for the lack of commitment. The economic reason for equivalence is that the market distortion due to a monopoly supplying the clean technology is not relevant for the choice of either taxes or permits, because the marginal damage determines the marginal production costs independent of the monopoly's markup (since that is bounded by either the pollution tax or the permit price). That is, the monopoly can charge at maximum this 'choke' price. However, this ex-post efficient choice of either permits or taxes leads to suboptimal long run supply of the clean technology by a monopoly, i.e., the distortion due to a monopoly is intertemporal rather than within periods (perfect competition