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Optimal tax rules and public sector efficiency with an externality in an overlapping generations model

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ABSTRACT

This paper examines optimal tax rules and public sector efficiency, integrating them in a second-best world with pollution by using an overlapping generations model. The second-best world is characterized by the comparative statics of green preferences. The main results obtained are as follows. First, the marginal cost of public funds may be reduced by the externalities, regardless of the choice of taxes. Second, optimal environmental and non-environmental tax rules are additively and directly affected by the dynamic efficiency of capital accumulation per unit labour (DECAL), and indirectly by it, through the efficiency of the public sector. Environmental taxes going beyond Pigovian ones may be welfare-improving if the DECAL is improved by the environmental tax. Even optimal non-environmental tax rules should additively and directly counter the dynamics of pollution to consider the income effects of the optimal tax system for the future. Third, the "additivity property," or the "principle of targeting," does not hold even in the absence of incentive compatibility constraints. The essential reasons for this are clarified as follows: distortions that should be countered by taxes; that is, the income effects of the optimal tax system and the DECAL in this model, break the equality between optimal environmental taxes and the externalities measured by governments. Finally, growing environmental concerns may, in fact, increase pollution. The inverse relationship between environmental and labour income taxes may not hold.

1. Introduction

This paper examines optimal tax rules and public sector efficiency, and integrates them in a second-best world with environmental externalities by using an overlapping generations model (OGM). The economy of the second-best world is characterized with the comparative statics of greater environmental concern, or greater green preferences.

Environmental taxes are known as incentive-based environmental policy instruments. The double dividend hypothesis of environmental taxes suggests that environmental taxes can be useful instruments for not only environmental policies but also tax policies in financing public expenditure; that is, environmental taxes may not only improve the environment but also alleviate the inefficiency of distortionary taxes if revenues from the former taxes are used to reduce the latter taxes (see Tullock 1967; Pearce 1991).[1] Therefore, it is necessary to examine optimal tax rules in a second-best world with the externalities from various perspectives to obtain an approximate criterion for testing the optimality of environmental tax policies.

The representative results concerning optimal environmental tax rules in a second-best world are provided by Sandmo (1975), Bovenberg and de Mooij (1994), and Bovenberg and van der Ploeg (1994). These works conclude that optimal tax rules additively consist of distortions covered by taxes, and that a distortion should be directly countered by a tax that acts on the distortion. This is called the "additivity property" by Sandmo (1975) and the "principle of targeting" by Dixit (1985). Bovenberg and de Mooij (1994) find that environmental taxes falling below Pigovian ones are welfare-improving.[2] Further, Bovenberg and van der Ploeg (1994) show that

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[1] Bovenberg and de Mooij (1994, 1997) and Assouline and Fodha (2006) use a static model, an endogenous growth model, and a Diamond OGM, respectively, to show that environmental taxes have double dividends under certain conditions. Although Bovenberg and Heijdra (1998) examine the transitional effects of environmental taxes on economies by using a Yaari-Blanchard OGM to tackle the intergenerational issues of environmental policies, lump-sum transfers on all generations are available.

[2] Schöb (1997) and Fullerton (1997) support this result of Bovenberg and de Mooij (1994). It has been shown that environmental taxes going beyond Pigovian ones are welfare-improving when non-environmental taxes are not labour income taxes but taxes on clean goods (Schöb 1997; Fullerton 1997) and production output (Bovenberg and de Mooij 1997).

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green preferences bring about a decline in employment, while they improve the environment, regardless of the labour supply curve.[3]

On the other hand, Cremer et al. (1998) show that the additivity property breaks down under incentive compatibility constraints owing to consumer heterogeneity, nonlinear income taxes, and public non-observability of the consumers' earning abilities. Moreover, Schöb (1997) mathematically indicates that non-environmental tax rules include externalities, but does not discuss the reasons for this and the economic implications. Schöb (1997) focuses on the normalization trap of taxes. Thus, these two studies do not clarify the essential reasons for and implications of the additivity property breaking down.

The abovementioned papers discuss the additivity property with static models. Discussions on pollution should not overlook the important fact that pollution is accumulative, and its dynamic aspects. Accumulative pollution affects not only the present but also the future. Its effects differ across generations, whose life spans differ from the life span of an economy. These implications are emphasized by Solow (1986) and Padilla (2002).

As Assouline and Fodha (2006) show, the double dividends of environmental taxes primarily depend on the dynamic efficiency of capital accumulation. Altonji et al. (1992) empirically reject the altruistic links of the distribution of income and consumption in infinitely lived agent models. Therefore, when analyzing optimal environmental tax rules in a second-best world, we need to consider the future effects of pollution and the differences in the life spans between an economy and consumers.

In analyzing optimal tax rules, the efficiency of the public sector should be considered, since, as Pigou (1947) states, the efficiency of the public sector reflects that of the tax system. Atkinson and Stern (1974) show that the effect described by Pigou (1947) is indicative of the growth of the public sector. Atkinson and Stern (1974), Batina (1990), and Sandmo (1998) examine the public sector in the absence of pollution. The main result of their studies is that whether the public sector grows or shrinks due to the distortionary nature of taxation depends on the marginal tax rate, or the choice of taxes and the income effects of taxed goods. Batina (1990) uses a Diamond OGM and shows that public sector efficiency depends not only on the marginal tax rate but also on the dynamic efficiency of capital accumulation per unit labour (DECAL). Batina discusses this in the context where the source for the DECAL is taxes on interest income, or the intertemporal allocation of a generation. Batina does not discuss all the sources for the DECAL, since it appears even without taxes on interest income.

The efficiency of the public sector under pollution is discussed by Bovenberg and de Mooij (1994) and Bovenberg and van der Ploeg (1994). They show that the marginal cost of public funds (MCPF) depends only on labour income tax rates and the own-price elasticity of labour supply through the additivity property under certain utility functions. However, these studies do not elaborate on the relationship between the efficiency of the public sector, the effect described by Pigou (1947), and pollution.

To incorporate the dynamic aspects of pollution and capital accumulation into the analyses of optimal environmental tax rules and public sector efficiency, we adopt a Diamond OGM under a system with environmental taxes and linear labour income taxes.[4] The latter are either proportional or progressive taxes, and their adoption facilitates the model and enables the clarification of the additivity property. From the ensuing analysis, we obtain four main results.

First, the externalities of pollution affect the efficiency of the public sector, regardless of the choice of taxes. This is because all available taxes should consider their effects on the externalities. By doing so, the public sector may optimally shrink, since the effect of the externalities may be opposite to the effect described by Pigou (1947). Moreover, it is shown that the inefficiency of intergenerations may result in the public sector shrinking optimally.

Second, the dynamics of capital accumulation and pollution affect optimal tax rules. Optimal environmental and non-environmental tax rules are additively and directly affected by the DECAL, since governments should consider the DECAL with all available taxes. Intergenerational allocation is considered by additively and directly controlling the value of consumption by the old generation, by imposing taxes on their consumption. This results in different optimal environmental tax rules across generations. Owing to the effect of the DECAL on welfare, it is ambiguous whether optimal environmental taxes lie above or below the marginal external cost of pollution (MECP). This suggests that environmental taxes going beyond Pigovian ones may be welfare-improving if the DECAL is improved by those environmental taxes. Not only optimal environmental tax rules but also optimal non-environmental ones should additively and directly counter the dynamics of pollution for the future. This is because all available taxes should consider the effects of income transfer from the taxes, including the externalities. In addition, the DECAL and the externalities indirectly affect all optimal tax rules through the efficiency of the public sector.

Third, the additivity property, or the principle of targeting, does not hold even without incentive compatibility constraints. This is evident in the appearance of externalities in optimal non-environmental tax rules. The essential reason for this is that all available taxes should consider the effects of the taxes that include the externalities. This depends on whether or not distortions hinder the equality between optimal environmental taxes and the MECP and which instruments counter the externalities. This is discussed by categorizing the additivity property into a “weak” and a “strong” additivity property. This discussion tells us whether or not non-environmental taxes should consider the externalities and under what conditions and with what instruments the externalities should be considered.

This third result means that the results obtained by Bovenberg and de Mooij (1994) and Bovenberg and van der Ploeg (1994) on the MCPF do not generally hold even under certain utility functions. This is because the DECAL breaks such equality between optimal environmental taxes and the MECP measured by the government. We show that their prior results hold only with the additional assumption that dynamically efficient capital accumulation per unit labour is achieved. This indicates that the main cause for the additivity property breaking down in this model is the inefficiency of either intergenerational allocation or the intertemporal allocation of a generation.

Finally, greater green preferences may aggravate pollution in an optimal tax system. This implies that neither of the two dividends of Bovenberg and van der Ploeg (1994) may be obtained. However, these dividends can be obtained under certain conditions. The inverse relationship between environmental and labour income taxes, which Bovenberg and van der Ploeg (1994) arrive at, does not hold. It is important that governments consider these conditions when undertaking activities to educate people on the environment.

This paper is organized as follows. Section 2 presents the model employed in this paper. Section 3 defines the market equilibrium. Section 4 analyzes the efficiency of the public sector and optimal tax rules, and integrates them in the second-best world. Section 5 performs the comparative statics of greater green preferences. Finally, Section 6 presents the conclusion.

[3] Bovenberg and van der Ploeg (1994) investigate whether or not greater green preferences improve the environment and employment. Note that while they call the two dividends by greater green preferences “the double dividend hypothesis,” this paper uses the term “the double dividend hypothesis of Bovenberg and van der Ploeg (1994)” to avoid confusion with the double dividend hypothesis of environmental taxes.

[4] Following Assouline and Fodha (2006), we adopt a Diamond OGM, because, unlike Bovenberg and Heijdra (1998), our focus is not the transitional effects of environmental taxes. Other papers on the environment that employ OGMs are those by Howarth and Norgaard (1992), John and Pecchenino (1994), John et al. (1995), Marini and Scaramozzino (1995), Guruswamy Babu et al. (1997), Howarth (1998), and Jouvet et al. (2000). These studies do not deal with optimal environmental tax rules in a second-best world.