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Energy taxation and the double dividend effect in Taiwan's energy conservation policy—an empirical study using a computable general equilibrium model

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ABSTRACT

Faced with pressure from greenhouse gas reductions and energy price hikes, the Taiwan government is in the process of developing an energy tax regime to reflect environmental external costs and effectively curb energy consumption, as well as mitigate CO_2 emissions through an adequate pricing system. This study utilizes a CGE model to simulate and analyze the economic impacts of the draft Energy Tax Bill and its complementary fiscal measures. Under the assumption of tax revenue neutrality, the use of energy tax revenue generated for the purpose of reducing income tax is the best choice with double dividend effects since it will effectively stimulate domestic consumption and investment, and, consequently, mitigate the negative impacts of the distortionary tax regime. The double dividend effect is less significant, however, when the supplementary measures being used are for government expenditure. Nevertheless, all supplementary measures have effectively reduced energy consumption, which means they have delivered at least the first dividend—in the sense of CO_2 emissions control. It has been verified in this study that having adequate public-finance policy measures is the key to realizing the double dividend effect.

1. Introduction

Sustainable development as an ideal has been highly valued by many countries, as noted in the Environmental Basic Law in Taiwan: "Sustainable development refers to development that meets the needs of the current generation without damaging those of the future generations". Consequently, developing energy policies requires vigorous assessment and considerations and must strive for a sound balance between the three dimensions of economic development, energy saving, and environmental protection.

Pigou (1932) was the first to propose levying taxes (i.e., a Pigouvian tax; see below for an illustration) to redress market inefficiency created by negative externalities by suggesting that polluters should be accordingly taxed to offset their under-estimated input prices. However, Pigou's study did not elaborate on uses of such environmental taxes, but assumed that such taxes would be fed back into the economy in a lump-sum fashion. Tullock (1967) argued that a Pigouvian tax could create a double dividend by internalizing external costs. In other words, by means of levying Pigouvian taxes, the issue of external costs would be redressed and tax revenue thus collected could be used to reduce other distortionary tax revenues to eventually improve economic efficiency.

The notion of a double dividend originally came from Tullock (1967) but was first proposed by Pearce (1991), who maintained that the government should adopt a revenue neutrality approach to levying carbon taxes and use such revenues to reduce other distortionary taxes, which would curtail environmental pollution and reduce the distortionary costs of taxation. Furthermore, the costs derived from levying a new environmental tax would be offset by the benefit from reducing the costs of other distortionary taxes, thus creating the double dividend effect. According to environmental economics, green tax reform delivers a double dividend mainly through two types of effect:

1. Pigouvian effect (first dividend): this effect uses economic incentives as a tool to reduce pollutants produced by the polluter until the marginal external cost is equal to the pollution tax rate. This is the primary objective when levying pollution/environmental taxes.
2. Revenue effect (second dividend): the revenue collected from levying environmental taxes could reduce the inefficiency of distortionary taxes (such as an income tax or social welfare tax) on the market so as to increase household income.

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According to Goulder (1995a), a double dividend can be verified as long as the revenue effect exists. It does not matter whether the costs of levying a new environmental tax are positive (they must be less than the transaction cost of redirecting the lump-sum tax revenue back into the economic system) or negative (they must effectively reduce the total social cost). After the mid-1990s, however, the second effect of the double dividend was questioned by some economists, such as Bovenberg, Goulder, and Parry. Bovenberg and de Mooij (1994a) claimed that an environmental tax often worsened the problem of tax distortion even when such revenues were used to reduce other distortionary tax revenues. Parry (1995) identified the "interdependency effect" out of the second dividend effect to emphasize that the benefit derived from replacing the environmental tax with the labor income tax was no match for the deteriorating effect of the environmental tax on the current distortion. Oates (1995) maintained that most measures for increasing the polluters' production costs might have certain unevaluated major negative impacts, and, therefore, the double dividend hypothesis was considered to be quite unreliable. Parry and Oates (1998) even argued that the double dividend hypothesis should be rejected since their model indicated that the distortionary effect of environmental taxes exceeded the tax reduction effect of labor income taxes. Parry et al. (1999) further summarized the above arguments as referring to the so-called 'tax interaction effect', which dictates that levying environmental taxes results in increases in the production costs of the industries concerned and subsequently leads to higher product prices, lower real income, and reduced labor supply. This means that the double dividend effect disappears when the welfare decreases due to the tax interaction effect exceeding the benefit created through the revenue cycling effect. Lomborg (2001) pointed out that the double dividend hypothesis was incorrect and that carbon taxes should be charged at a level lower than the Pigouvian tax. He went further to suggest that an adequate pollution tax be even lower unless it was used to reduce taxes with a great distortionary effect.

Bovenberg and de Mooij (1994b) came up with another contentious analysis on the reasons why the interaction effect had influenced the second dividend, and maintained that levying the environmental tax lowered the real labor income, thus affecting the employment level. However, since the environmental tax has a smaller tax base than the labor income tax, the tax reduction benefit for labor income cannot fully offset the negative impact of the environmental tax on employment. Consequently, using the environmental tax to reduce other distortionary tax revenues has effectively aggravated the distortion in the tax regime rather than reducing the excessive burden. Goulder (1995b) pointed out that although substitution between taxes might be able to reduce the social cost of the environmental tax, it would not be effective in improving the overall economic efficiency, the reason for this being that the environmental tax as an indirect tax for intermediate goods has a stronger distortionary effect on the market. Hence the revenue effect of the environmental tax is above zero. In further analyzing the second dividend, Goulder et al. (1999) maintained that the second dividend was decomposed into three effects: the revenue recycling effect, the tax interaction effect, and the tax shifting effect. The second dividend might exist if the benefit to employment generated by the tax shifting effect is higher than the negative effect of the revenue recycling effect and tax interaction effect combined.

The above discussions in the literature were heated but unsubstantiated since they included only those theoretical assumptions that were over simplified and did not offer any empirical evidence (e.g., the positive external effect of the mitigation of pollution on society and the bio-system, which was indeed a fundamental issue related to the environmental problem) to support their arguments. On the other hand, many empirical studies in the literature have adopted a more positive view, and they differ in the ways in which they design complementary measures for the green tax regime. Terkla (1984) maintained that the pollution tax was an efficient tax regime and that using tax revenue to reduce other distortionary tax revenues could improve welfare. Based on the US-EPA data in 1970s, the simulation analyses performed in his study indicated that the value created by replacing an individual income tax with a pollution tax ranged from US$630 million to US$3.05 billion at the 1992 level, and the amount would be increased by between US$1 billion and US$4.87 billion when a pollution tax was used to replace the business income tax.

Repetto et al. (1992) believed that the environmental tax, when used prudently as a substitute for all kinds of distortionary taxes, could offset most losses of national income due to the levying of an environmental tax. Shah and Larsen (1992) used a static partial equilibrium model for their stimulation study. By assuming that a carbon tax of US$10 per ton was imposed in both developed countries (the US and Japan) and in developing countries (India, Pakistan, and Indonesia) with a concurrent reduction in the capital income tax, the results showed that the welfare level improved in most countries, with more significant improvements in developing countries where profit tax rates were already high. Barker et al. (1993) used a multi-sector model to study the effects of levying a carbon tax (with the target of a 15% reduction in CO_2 emissions by 2005) in the UK and Europe. The research findings showed that gross domestic product (GDP) decreased by 0.4% against the base-year when the revenue was used to reduce the deficit; it increased by 0.1% when used to offset the income tax; and it also increased by 0.2% when used to offset the value-added tax.

Jorgenson and Wilcoxen (1993) used an MF-12 (Energy Modeling Forum 12) dynamic general equilibrium model to examine the effects of a carbon tax on energy and an environmental economy, and their findings indicated that higher carbon taxes would be required to reduce CO_2 emissions by large margins. Furthermore, higher carbon taxes, while significantly boosting tax revenue, also resulted in GDP losses, but such a negative impact could be mitigated if the carbon tax revenue was used to offset other distortionary taxes. Mckitrick (1997) adopted a static CGE model to empirically verify if the carbon tax regime in Canada gave rise to a double dividend effect. The research findings showed that, assuming that CO_2 emissions in 2000 were to be turned back to their 1990 levels, using a carbon tax to reduce other distortionary taxes would lead to a significant drop in CO_2 emissions as well as offset a drop in output and a welfare loss in all sectors. The conclusion was that it was likely that a double dividend did exist, and that a carbon tax would reduce the welfare level by 0.3% and GNP by 0.8% when its lump-sum revenue was channeled back into the economic system, but that the welfare level would remain unchanged and GNP would increase by 0.6% when the carbon tax was used to offset the payroll tax. Bye and Bruvoll (2008) pointed out that, in general, the effect of an instrument depends heavily upon the elasticities of the demand and the supply sides of the markets. The sequence of the introduction of the instruments changes the effect of the instrument itself. This increasing complexity calls for theoretical and empirical research on efficiency over several simultaneous instruments of energy taxes/subsidies.

In spite of the double dividend of green tax reform remaining a contentious issue, as indicated by the literature review in this study, European countries, including Denmark, Finland, the Netherlands, Norway, and Sweden, as early as the 1990s launched