Optimal Taxation and Externalities: Literature Reviews

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Abstract

This paper has two purposes. The first is to analyze the first-best and second-best settings concerning optimal environmental taxation. The second is to analyze, compare and contrast related literatures on optimal taxation with the presence of externalities, focusing on how to set the optimal tax and at what level the optimal tax should be, when compared to the Pigouvian tax. The analysis reveals that for the first-best setting, the optimal tax in general equals the Pigouvian tax. For the second-best setting, the optimal taxation can be higher, equal or lower than the Pigouvian tax rates, depending on various factors, including the type of utility functions, assumptions and relationships among variables.

Introduction

The well-known Pigouvian tax suggests that the optimal tax should be where the marginal social cost, which takes damages into consideration, equals marginal social benefit. This will lead to the efficient level of output. In order to achieve this equilibrium, however, we have to know which activities cause negative externalities, who the pollutants are and the values of damages they cause. Although the Pigouvian tax framework provides us an efficient way to determine the optimal tax level, it suffers from its limitations. Scholars, consequently, have been attempting to indentify and measure the optimal taxation in other ways when the externality is present.

With the presence of externalities, the market system in determining prices and quantities fails and this situation leads to inefficiency. Therefore, it is the task of the government to sanction the market and set the optimal tax to guarantee the efficient level of output. There are several ways to arrive at the optimal tax level.

One way is that the government might regulate the environmental pollutants by setting regulatory standards. Another way is to give incentives to the market through taxes. This method has been preferred to the regulatory method by economists because

the tax method will cause the pollutants to internalize their external pollution cost and give them incentives to search for alternative forms of abatement. Moreover, the double dividend hypothesis might be a form of justifying the pollution taxes over controlling pollution standards in terms of efficiency.

Double dividend hypothesis emerges from the notion that environmental taxes not only lead to a cleaner environment but provide the government an alternative way to raise revenues from pollution taxes to decrease other tax distortions as well. That is, the double dividend would result in a better environment and a less distortionary tax system.

Although there are diverse issues concerning externality taxes, double dividend hypothesis, and Pigouvian tax, this paper will primarily attempt to answer the following question. Should the optimal tax rate lie above or below the rate suggested by Pigouvian tax? Moreover, I will compare similarities and dissimilarities among related literatures and when applicable pinpoint these article's findings to the Pigouvian tax scheme.

The organization of this paper is straightforward. I will begin with rationales for environmental taxation both in the first-best and the second-best settings. Next, I will summarize, compare and contrast related studies. The last section is the conclusions.

Optimal Environmental Taxation in the First-best and Second-best Settings

The fact that natural environment has been deteriorating makes the government of every nation pay more attention to the public policy. However, implementing the public policy is not an easy task because it involves the conflicting interests among several parties in the society. Environmental groups insist that a decent environmental policy

does not need large economic cost but rather, provides better environmental quality with higher economic benefits. The subsequent question is how to achieve both lowest cost and efficient outcome with better environmental quality. The answer relies on what the primary goals of the government are and how in practice the policy can be implemented. In theory, the first-best setting suggests an efficient way to optimal taxation but it is difficult to estimate while the second-best setting suggests a more realistic way in practice but the results from policy implementation is still controversial. Some studies show that it is beneficial to other sectors, thus achieving the double dividend hypothesis whereas others suggests that except for better environmental quality, environmental taxation does harm other sectors such as a reduction in employment or a lower level of output.

- ***The first-best setting***

Natural environment like air or water can be perceived as public goods because they are shared among people with properties of non rivalry and non excludability. Also, who owns the property rights is not clearly defined. This implies that the market in which commodities are produced and consumed do not work properly. Another implication is the excess demand for environmental goods, so the government should interfere the market to improve the optimality. In so doing, command-and-control approach over the agents concerning environment can be employed. Although this approach has been successful and the environment has been improved, it also suffers from some disadvantages. For example, there has been too many unnecessary frustrated and so many innovations for environmental protection. In addition, economists insist that this method causes dramatically welfare losses. This is because the environment laws have indirectly

predetermined the technological standards which can be achieved only by some groups. The government did not take into account the difference of local environmental conditions as well as the marginal cost of pollution abatements among different firms. These bring about an inefficient outcome from environmental regulation.

Alternatively, environmental taxes have been selected as an efficient way to better the environment. Theoretically, pollution taxes are used to improve economic efficiency by charging polluters for the opportunity cost of resources being polluted. According to Pigou, the pollution tax is used to correct environmental problems and the new level of production that is already adjusted by costs will be the efficient level. Nonetheless, in practice, Pigouvian tax is difficult to implement since we have to know the marginal damage in each pollution level in which it is complicated to estimate. Also, it is assumed that we know who the pollutants are and how much they pollute. The lack of information on these factors makes the optimal taxation to the externality almost improbable.

- ***The second-best setting***

Even though the Pigouvian taxation is optimal in the first-best setting, in reality, there are pre-existing tax distortions and incomplete information about cost-benefit analysis that might make Pigouvian tax no longer desirable in terms of efficient outcome. This is because in Pigouvian world, it does not take these factors, in particular with the presence of other distortionary taxes, into account. The net effect of environmental taxes depends upon the level of other pre-existing taxes such as labor income and commodity taxes. Thereby, general equilibrium models are typically used to analyze the impact of environmental tax instead since it allows us to identify the secondary effects of the policy given other distorted markets. Yet there are no clear-cut findings that using this general

setting would yield better outcomes to non-environmental sectors other than environment improvement. Higher environmental tax obviously can improve the environmental quality but it is not clear that other non-environmental sectors would be improved. If so, we can claim that the double dividend hypothesis holds but if not, increasing the tax on environment might hurt others and as well lead to inefficient outcomes.

Literature Summary and Comparisons

One of the pioneers in analyzing the general equilibrium models with the presence of externality is Sandmo. His study in 1975 was based on a simple model with n consumers, m+1 consumer goods including one good creating negative externalities, a public good and leisure in the utility function. Also, he assumes that consumers have identical preferences, so that the redistribution problem can be ignored. For the first best setting, the optimal tax should be where the producer and consumer prices are equaled for the first m-1 goods. This is equivalent to the marginal rate of substitution between good i and leisure equals the marginal rate of transformation between good i and leisure. However, for the good that generates negative externalities, the optimal tax should reflect the sum of the marginal rates of substitution between polluting good and public good or its marginal social damage cost. This is simply the Pigouvian tax. For the second-best setting, he assumes one of the key factors called “additive tax structure” that determines the level of the optimal tax and a number of studies afterwards follow his assumption. This additive property enters the tax structure additively, so that an externality-creating good does not interfere with other goods and they should not be taxed according to this

argument. His results reveal that the optimal tax for clean goods should follow the Ramsey rule where the tax rate is inversely related to the elasticity of its own goods and the tax rate for polluting good should be the weighted average between the Ramsey rule rate and the Pigouvian tax rate. Moreover, when the assumption that individuals have the same productivity is relaxed, the Pigouvian tax is still applicable.

With the assumption that environment is a public consumption good, a cleaner environment can be regarded as a public production input as well. By this way of thinking, Bovenberg and van der Pleog (1994) extends Sandmo's (1975) study in a significant way by adding the natural environment as a public good into the utility function. They derive the optimal labor and dirt taxes when environmental externalities are present in the consumption. Similarly, their result coincides with Sandmo's (1975) work in that the optimal tax in the second-best world can be characterized by Ramsey rule plus Pigouvian tax. Further, an implication of this study is that the government should impose a dirt tax but cut the labor tax if the goal is to achieve a better environmental quality. A decline in employment is a necessity with better environment because the effect from a labor tax reduction cannot be offset by an effect from employment fall. This case indicates that double dividend does not hold because non-environment sector cannot be improved. In sum, this paper implies that the second-best world taxation with the presence of negative externality and environmental quality, the labor income tax is not changed by imposing tax on the polluting good and this study coincides with Sandmo' assumption that the tax on the polluting good enters the tax structure additively.

In the same year, a study by Bovenberg and Mooij (1994) was done in a similar fashion as B&P (1994). Basically, they use a similar utility function as the previous study but investigate the optimal taxation when the tax distortions pre-exist. Having set this framework, they are able to examine the interaction between the environment and the labor market distortions. Also, the utility is separable between private and public goods. For the first-best setting, we do not have to finance public spending through distortionary tax and the optimal tax on dirty good is equivalent to the Pigouvian tax. With the presence of preexisting distortionary taxes, the optimal pollution tax lies below the Pigouvian tax in the second-best framework. The reason behind this is that higher environmental tax induces households to change from dirty to clean consumption goods. This implies a reduction in their real income, thus lowering income from an additional unit of work, so that it undermines the individual's incentives to supply their labor. As such, in general environmental taxes worsen rather than better the preexisting tax distortions. This conclusion is consistent with that of B&P (1994) when they have preexisting taxes but the results indicate that the optimal environmental tax lies below the Pigouvian tax. In other words, environmental tax policy betters the environment but worsens non-environmental sectors.

However, this conclusion does not apply to the case of industrial pollution. As analyzed by Ballard and Medema (1993), they embedded the environmental factor into the production function by assuming that a better environment can be regarded both as a public consumption and a public production input. Employing the concept of producer-producer externalities is typical for production externality and the damages done to the structure of production are due to industrial pollution. Nevertheless, they add a parameter

showing the positive relationship between a unit of the output of the polluting sector and production cost in the polluted sector. They further assume that the polluted sector needs to use more input of the third-party sector to produce its output. Environmental benefits are part of the non-environmental dividend. For instance, agricultural productions would benefit from a better soil and air quality if the soil can give more produces with the same amount of inputs. This is because better air quality can make individuals healthier, thus resulting in higher productivity. Thereby, imposing a pollution tax not only can improve the environment but boost labor productivity as well. Clearly, this yields double dividend in terms of non-environmental benefits. As such, when labor productivity is boosted by environmental quality improvement, the costs and the benefits of a cleaner environment would benefit those with the highest amount of labor supply. Consequently, the internalizing environmental externalities would be less costly in worsening the distortions in the labor market.

Another study that is different from previous studies is done by Bovenberg and Goulder (1996). One of their innovative contributions is adding intermediate inputs into the model and imposing a tax on the intermediate inputs. Other than this, they follow the same analytical setting as B&P (1994). The government has to decide how and how much to tax on clean and dirty intermediate inputs as well as clean and dirty consumption goods. Using the general equilibrium models, they conclude that the clean intermediate input should not be taxed but the dirty input tax rate should be at the marginal environmental damage from this input divided by the marginal cost of public funds. By the same token, the dirty consumption good tax should be at the marginal environmental damage from the consumption of this good divided by the marginal cost of public funds.

The other innovative part of their paper that is different from others is that they use a numerical method to investigate and confirm the results they derive from theoretical framework. For this type of analysis, they focus on carbon tax. Basically, they compare the taxes that the government would receive if it follows the real tax structure and the taxes from simulation compared to those with the Pigouvian tax concept. The results show that with certain values of parameters, the optimal carbon tax rates are below the marginal environmental damages or the Pigouvian tax. Their results strengthen the conclusions by others claiming that the optimal tax rate should lie below the Pigouvian tax rate as suggested by B&M (1994) even if the settings of those models are different.

When comparing leisure with environmental quality, we may expect that they are substitutable since cleaner environment can enter the utility function positively and so does leisure. Individuals are likely to purchase leisure or environment to higher their utility level. As environment can substitute for leisure, the rise in demand for environment means the reduction of leisure, thus boosting labor supply or employment. So, more consumption of environmental quality implies a higher level of employment in the economy. This conclusion holds when environmental quality is a very close substitute for leisure. An implication from this is that it can alleviate the labor market distortions on the basis of distortionary tax. This can be said that the introduction of an environment tax is able to yield a form of double dividend but this does not always hold, especially when a better environment is not a substitute for leisure.

If ordinary goods consumption defined as clean consumption is a better substitute for leisure, do the environmental taxes still provide us a favorable double dividend outcome? In contrast, what if the polluting good is a substitute for leisure, will the

outcome still be desirable? There are a number of economists who investigate these types of questions.

Having analyzed the effects of environmental taxes on final goods, Parry (1995) demonstrates that when polluting good like energy is sufficiently substitute for leisure, revenue-recycling effect can overshadow tax interaction effect, as such double dividend hypothesis holds in this scenario. By contrast, if energy consumption is a better substitute for leisure than ordinary goods consumption, the environmental tax can worsen the distortion caused by labor income tax, thus resulting in a less chance of double dividend case. As the utility function is assumed to be separable between goods and leisure, but not homothetic due to a minimum consumption requirement, it is possible that the double dividend hypothesis would hold. Analyzing environmental taxes on non-environmental outcome in the case of non-homothetic preferences, Ballard, Goddeeris, and Kim (2000) shows that the cases for parameter combination leading to double dividend are equivalent to the case when the optimal environmental tax rate is higher than that of the Pigouvian hypothesis. They use generalized CES utility function that is valid only when each of consumption is above the pre-specified level. They find that the optimal environmental tax rate is much higher than the Pigouvian tax rate. That is, under the non-homothetic preferences, the double dividend hypothesis is likely to hold.

Their results coincide with a number of studies saying that with the second-best setting, the optimal environmental tax rate is higher than that of the first-best setting or the Pigouvian optimality. Also, a conclusion that is consistent with this is proposed by Cremer, Gahvari and Ladoux (2001). They have investigated the optimal tax problem in a classical Ramsey setting. By allowing for *m* nonpolluting goods with only one polluting

good, they come up with the notion that the optimal environmental tax should represent both "optimal tax" and Pigouvian tax. The "optimal tax" in this context is one that is derived from the Ramsey conditions and the Pigouvian tax is one that suggested by Pigou, which aims at correcting for the externalities. That is, the environmental optimal tax is the "optimal tax" plus the "Pigouvian tax." As such, the optimal tax rate is higher than the Pigouvian tax.

In sum, Ballard, Goddeeris, and Kim (2000) and Cremer, Gahvari and Ladoux (2001) arrive at the same conclusion that the optimal tax rate should lie above the Pigouvian tax even though their assumptions are not identical. In contrast, the optimal tax rate should be less than the Pigouvian tax according to the analysis of B&M (1994) and B&G (1996). Other than these results, Sandmo (1975) and B&P (1994) emphasize that with externalities in the second-best world, the Pigouvian tax is still applicable. The question that naturally follows is why some suggest higher tax rates when compared to the Pigouvian tax while others suggest the opposite. By utilizing general equilibrium models, it allows us to assume and analyze the interactions among variables in the models. The effect of some variables can be boosted by others while some effects are weakened, so that the optimal tax rates are dependent partly on this way of setting. An implication from this literature survey is that the policy makers should be aware of setting the optimal tax rates because different settings might give different optimal taxes. The trade-off between environmental quality and some losses to other parts of the society sometimes cannot be avoided.

Conclusions

In the first-best world, the aim of environmental taxation is to correct for the externalities, so that the optimal tax rate is equivalent to the Pigouvian tax. However, dealing with the second-best world with the presence of externalities is much more complicated. There is no consensus on the optimal tax rates. They could be higher, equal or lower than the Pigouvian tax rate, depending upon various factors. Nonetheless, with the assumption that the tax formula is additively separable, it is likely to yield a tax rate consistent with the Pigouvian tax. When one assumes that the environment enters not only as a public consumption good but as an intermediate input as well, it is likely that the optimal tax rate lies below the Pigouvian tax. According to studies, nevertheless, when allowing several polluting goods enters the utility function or the utility function is not assumed to be homothetic, the optimal tax lies above the Pigouvian tax rate. As such, an environmental improvement through taxes might come with an extra cost to the society, so that pros and cons should be carefully pondered when implementing the environmental tax policies.

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