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Environmental taxation and the double dividend

I. INTRODUCTION

"Environmental taxation" refers to an emissions charge or fee collected by government and levied per unit of pollution emitted into the air or water. As a policy instrument for the control of pollution, emissions charges will reduce pollution because firms or individuals will reduce emissions in order to avoid paying the tax. Under a range of market conditions, a pollution tax will generally be more cost-effective at reducing pollution than regulations: the total abatement cost of achieving a specified level of pollution reduction will generally be lower under a pollution tax than for a regulatory "command-and-control" approach that achieves the same reduction in pollution. This social cost advantage, well-established in both theory and empirical study, is largely due to the flexible way in which environmental taxes allow for decentralized decisions at the firm or household level about how, and how much, to reduce pollution given their firm-specific or household-specific costs and opportunities for doing so. Each firm or individual decides whether or not to lower their emissions in order to avoid being taxed. The same general ideas can apply to other situations such as congestion highway fees.

The idea that taxation can be used to correct or internalize externalities was first introduced by A.C. Pigou in 1920 and has been generally accepted by economists as an efficient means to remedy inefficiencies in the allocation of resources. Other market-based policy instruments such as tradable emissions rights can achieve similar efficiencies; and it is understood that other social considerations such as equity, rights, political considerations and enforcement costs may tip the balance toward a preference for other policy instruments despite being less cost-effective. Pigou concluded that an environmental tax will be optimal when it is raised until the per-unit fee is just equal to the "marginal social damage" (MSD) from the pollution. Intuitively this result suggests that abatement should be pursued up to the point where the marginal cost of further abatement (reflected in the emissions fee) is just equal to the marginal benefit from reducing pollution. This optimal pollution tax is widely referred to as the "Pigouvian rate."

Of course, the most common motivation for taxation is to raise revenues necessary to finance the provision of public goods such as national defense, public safety, transportation infrastructure, education or basic research. It is recognized that these "collective consumption" or public goods would not be provided at optimal levels in private markets due to "free riding" behavior when goods are non-rival (when an individual's consumption of the good does not subtract from its availability for others to consume). This fact underlies the rationale, established by P. Samuelson in 1954, for government provision of public goods, and thus the need to raise revenues in order to finance public expenditures.

One additional element from public economics that is important for our present discussion is the notion of "optimal taxation" in the sense of raising the revenues necessary to finance public expenditures in the most efficient way. Other dimensions of tax policy such as their distributional impact across income groups are also important to consider, but to a considerable degree the two sets of issues can be explored separately. The problem addressed in optimal taxation stems from the recognition that taxes distort behavior and, as a result, they introduce inefficiencies in the allocation of resources and, hence, a decline in social welfare compared to the (undistorted) optimum. The basic question addressed in optimal tax theory is, how can the inefficiency, or "excess burden," of revenue-raising taxes be kept to a minimum?

Non-distortionary taxes do exist, at least hypothetically. A "head tax" or a tax on pure land rents would be non-distortionary, but these face political constraints. A uniform (proportional) tax on all goods would also be non-distortionary because the relative prices of all goods would remain unchanged, and thus behavior would be unaffected. Unfortunately this possibility is precluded by the presence of goods which cannot be directly taxed. Leisure is the standard example recognized in the economics literature as a good which cannot be directly taxed. As a result, the taxation of income or consumption will distort behavior by encouraging individuals to consume more leisure in the face of taxes on their expenditures or income.

Given that distortionary taxes are unavoidable, Ramsey (1927) solved the optimal tax problem which minimizes tax distortions in its basic form. The results establish that it is best to introduce a tax system that is broadly-based, taxing all goods at low levels rather than a narrowly-based tax system with high tax rates on a few goods. In a world of identical demands for all goods, equal taxes on all goods would be optimal. Where demands differ but are independent of one another, the "inverse elasticity rule" holds stating that higher taxes should be applied to goods with inelastic demands and low tax rates applied to goods where

demand is elastic. The objective is to minimize the extent to which the overall set of taxes will cause individuals to shift from consumption of taxed commodities toward greater consumption of the un-taxable good, leisure. It's useful to note also that a tax on income can be thought of as being equivalent to a uniform tax on all expenditures.

These theoretical developments have been carried out in the economics literature with strong assumptions about the workings of the economy including competitive markets, profit-maximizing firms, rational consumers, and, in mathematical terms, "well-behaved" preferences and technologies for production. Thus, it should be understood that relaxing one of these assumptions can alter the conclusions reached in this standard analysis, and thus the results and interpretations must be understood to reflect a base-case from which modifications can be, and in many cases have been, introduced and evaluated.

The two main strands of tax theory just described, one to raise revenue and the other to correct externalities, have until recently been approached independently. Ramsey's optimal revenue-raising taxes ignore the possibility of externalities; and Pigou's optimal corrective tax assumes there are no revenue-raising taxes in the economy, and that the revenues generated by the environmental tax are simply returned to the economy in a "lump-sum" fashion (distributed as payments in a way that will not distort behavior). Although the integration of the two optimal tax problems was solved formally by Sandmo in 1975, his conclusions received little attention until recently in part because his mathematical expressions are difficult to interpret.

Indeed, this integration of revenue-raising taxation and corrective taxation underlies the set of issues surrounding the "double dividend hypothesis." At one level the double dividend idea asks; if corrective taxes raise revenue and revenue-raising taxes discourage pollution, aren't these two policy objectives complementary? A tax that reduced pollution and raises revenue would be serving both environmental and public expenditure goals and, intuitively, would seem to produce a second benefit, or "double dividend" when the revenues generated also contribute to financing the provision of public goods. Moreover, wouldn't an integrated tax program which serves both public expenditure and environmental goals make it possible to achieve more on both fronts, at a lower cost, than when each goal is considered separately? Since the early 1990s, there has been debate and controversy surrounding aspects of these questions, and the next two sections address these.

II. THE DOUBLE DIVIDEND

The basic hypothesis of the double dividend, that a revenue-neutral substitution of environmental taxes for revenue-raising taxes might offer a second benefit, was first advanced by Tullock (1967) in a paper titled "Excess benefit." The first benefit or dividend is an improvement in the environment, and the second benefit is a reduction in the distortions of the revenue-raising tax system. This idea received scant attention until the early 1990s when climate change policy attracted economists' attention to the topic, and the idea also attracted popular attention following publications such as Repetto et al. (1992). The term "double dividend" became widely used following its use by Pearce (1991). Based on estimates of the marginal excess burden (marginal distortionary cost) of taxation for the U.S. economy of between 20 and 50 cents of added distortionary cost per dollar of revenue collected, Pearce suggests that for every dollar of revenue raised with a carbon tax, a revenue-neutral carbon tax would amount to an effective tax of only 50 to 80 cents, since the revenues would be "recycled" into the distortionary revenue-raising tax system, allowing the distortions inherent in the revenue-raising tax system to be reduced.

The implications, and indeed the validity, of the double dividend hypothesis are more complicated, however. Views differ on what the double dividend hypothesis implies, and there is no consensus on any single test or experiment that would validate or repudiate it. Four main questions appear to form the core questions at issue, and each of these is addressed below. The four questions are:

1. Does "revenue-recycling" (the use of environmental tax revenues to finance reductions in distortionary revenue-raising taxes) produce a higher social benefit relative to when those revenues are simply returned, lump-sum to the economy?

2. Is the optimal level of pollution lower when environmental taxes are introduced optimally alongside revenue-raising taxes, compared to a situation in which revenue raising taxes are absent?

3. Does the extra social benefit from revenue-recycling lead to a situation were the optimal environmental tax will be generally higher than the Pigouvian rate (the marginal social damage from pollution)?

4. Does the optimal environmental tax rise or fall with an increase in the level of revenue-raising taxes.

(Several permutations on these questions have also been devised employing distinctions between "strong" versus "weak" forms of the double dividend, or by defining "gross cost" to be distinguished from more standard notions of overall welfare changes. Some of these other formulations are discussed below in section III.)

On the first question above, there is general agreement in the affirmative. Environmental taxation with "revenue-recycling" does, indeed, produce a higher welfare gain than would be the case if those revenues were simply returned, lump-sum to the economy (or equivalently if tradable emissions rights were given away rather than auctioned off). A simple thought experiment involving two different policies can demonstrate this intuitively. If the revenues from a Pigouvian tax were just equal to the total revenues required by government, then revenue-recycling would completely eliminate the need for any distortionary revenue taxes, so there would be no distortions at all in the economy. If, however, the revenues from the environmental tax were simply returned lump-sum to the economy, then distortionary revenue-raising taxes would be necessary to raise revenue and welfare would be lowered due to the distortions or "excess burden" attributable to the tax system. Both situations can achieve an optimal environmental outcome, but only with revenue-recycling do we eliminate the distortions from revenue-raising taxation.

On the second question about the optimal level of environmental quality, a clear result has also emerged from the theoretical economics literature. This result was demonstrated by Gaube (1998). Intuitively revenue raising taxes are assumed to discourage consumption of goods and services generally, including those goods that harm the environment when produced or consumed. An increase in taxation, therefore, will often lower the level of pollution in the economy generally. When an optimal environmental tax is introduced along side higher revenue-raising taxes, the combined effect of the two taxes will generally lower the level of pollution compared to a situation without revenue-raising taxes. This result is based on some standard theoretical models used in public economics which can be interpreted as reflecting a neutral base case. For other models or differing circumstances with peculiar properties, results can surely differ.

Much of the debate surrounding the validity of the double dividend hypothesis has hinged largely on evaluation of the third question, whether the optimal environmental tax will

be higher or lower than the Pigouvian rate when revenue-raising taxes are also present. Indeed, it was the appearance of an incongruous theoretical result on this point that attracted the attention of many economists in the early 1990s, and which also generated confusion and controversy. A detailed discussion of those incongruous results is presented separately in the next section along with a discussion of their interpretations.

There is general agreement that under specific circumstances (ones involving the demand for goods which are environmentally harmful as compared to demand for other goods), that the optimal environmental tax with revenue-recycling could be higher than MSD. For example, Schwartz and Repetto (2000) demonstrate that when labor supply is affected positively by improved environmental quality that the optimal environmental tax may increase in the presence of revenue-raising taxes. Other circumstances could produce similar, or opposite results. However, much of the theoretical debate has centered on models which are "neutral" in the sense that demands for environmentally benign and environmentally-harmful goods are assumed to be the same.

At the core of the theoretical analysis is a comparison between the optimal environmental tax and MSD — also identified as "the Pigouvian rate" – the tax that will achieve optimality in the absence of revenue-raising taxes. Since it is well-established since Pigou that, at the optimum, the environmental tax will equal MSD in the absence of revenue-motivated taxes, the question of whether this optimal environmental tax rises or falls relative to MSD when revenue-raising taxes are present, is understood to be an indirect test of whether there is an extra benefit (a double dividend) when revenues from the pollution tax are used to meet government's revenue requirements. Logically, if the trade-off between the environmental benefits and costs of pollution abatement can justify a tax equal to MSD (at the optimum) in the absence of revenue-raising taxes, then the added benefit from revenue-recycling should make it possible to justify an environmental tax higher than MSD.

Confirmation of this intuitive link between question 1 and question 3 comes in the form of both theoretical and numerical models indicating the optimal environmental tax may be more than 50 percent higher than MSD for an economy like the US economy (Jaeger 2002). Earlier "partial equilibrium" analyses suggested much higher increases (e.g., Nordhaus 1993), but these have been largely discounted as incorrect because they were not based on integrated general equilibrium models of the economy.

A number of qualifications are needed for those wanting to explore some of the technical and analytical details surrounding the debate on these results. First, we are not talking here about the "total tax" on a good that causes pollution since that tax can be thought of as including both a revenue-raising and an environmental component. The theoretical debates have focused only on the environmental component of the tax system. One way to separate the two taxes in a theoretical or numerical model is to use a tax on income (or labor supply) to raise revenue and then have a separate tax on emissions or a "dirty good" as the environmental tax. Second, it is understood that depending on the demand for a specific good, the optimal tax may be higher or lower than for an "average" or typical good. The results discussed here are based on models where all goods are assumed to have similar, or average, demand relationships. This makes it possible to interpret the differential between the optimal tax on polluting and non-polluting goods as the environmental component of the optimal tax. Third, there are different kinds of externalities which can produce somewhat different results, and this point, in particular, is relevant to the conflicting results discussed in the next section. Environmental externalities which degrade an amenity such as air visibility will have a different impact on the economy than one which degrades productive assets such as capital stocks, labor supply, or labor productivity.

An affirmative answer to the fourth question above follows directly from the answer to the third question. If we move from a situation with zero revenue-raising taxes to one with positive revenue-raising taxes we found above that the optimal environmental tax changes from one equal to MSD to one higher than MSD. This result suggests that as the revenue requirement is raised, the optimal environmental tax rises as well. Indeed, results for a model of the US economy and carbon taxation (Jaeger 2002) confirm this. This does not suggest, however, that this will always be the case for other economies or for very high levels of revenue-requirements. Indeed, we can anticipate a point above which a "Laffer curve" phenomenon takes hold, and the optimal environmental tax will begin to decline. Such a point, however, does not appear to be near the current realistic range for public finances.

III. INCONGRUOUS RESULTS AND "TAX INTERACTIONS"

The validity of the double dividend hypothesis has been challenged by a set of theoretical papers which appeared to show that, despite the presence of a positive "revenue-recycling effect," the optimal environmental tax would actually be *lower* than the Pigouvian

rate when revenue-raising taxes were present (Bovenberg and de Mooij 1994; Parry 1995; Bovenberg and Goulder 1996). These results caught the authors, and many others, by surprise because they are logically incongruous: they are at odds with the intuitive reasoning that the addition of a "revenue-recycling effect" would increase the benefits of green tax reform so that the optimal environmental tax would rise above the Pigouvian rate. In explaining their result, the authors of these papers argued it was due to the presence of a previously unknown distortionary cost, which they dubbed the "tax interaction effect." This effect, they argued, was negative and large enough that it would generally offset the positive "revenue recycling effect." As a result of this, not only would the optimal environmental tax be lower than MSD, but the welfare gains from revenue-neutral green tax reform would be lower than expected, the justification for environmental improvement would be diminished, and government's goals of providing public goods with tax revenues were found to be in conflict with the goal of protecting the environment (Bovenberg and Goulder 1996). A number of additional papers have been published which elaborate on these same general points.

The results from this "tax interaction literature," however, are due directly to their use of a definition of marginal social damage (the "Pigouvian rate") which differs from the precise definition that would produce consistent optimal tax results for all kinds of externalities, and both in situations with and without revenue-raising taxes (Jaeger 2002). The differences between the two definitions involve the distinction between valuing environmental damage and money income from society's perspective (as Jaeger has done), versus summing the private valuation of environmental damages across individuals (as the authors of the tax interaction literature have done – we'll refer to this definition as marginal private damage or MPD). For example, in the case of an externality which lowers labor productivity (e.g., adverse health effects), the "tax interaction" literature defines the marginal social damage in terms of the decline in consumption for households. Jaeger's definition, based on the definition of the social marginal value of income established by Diamond (1985), includes both the decline in consumption for households and the loss in tax revenues associated with that decline in income and consumption.

One implication is that the definition of marginal damages used in the tax interaction literature, MPD, is distorted when revenue-raising taxes are introduced, making their definition an inconsistent benchmark against which to gauge whether the optimal environmental tax is rising or declining. As a result, when revenue-raising taxes are increased in their basic "amenity" model, the tax interaction approach appears to detect a decline in the

optimal environmental tax (when in fact the optimal environmental tax is rising). But because MPD is also being altered by the introduction of revenue-raising taxes, it is also rising, and rising faster than the optimal environmental tax. As a result, the optimal environmental tax appears to be below MPD, and this has led to the conclusion that it was declining. Had they used a definition of marginal damages reflecting society's valuation of pollution damages, they would have concluded that the optimal environmental tax was rising above MSD.

The opposite pattern occurs when a productivity externality is considered. In this case, MPD is lower than MSD (the definition reflecting society's value of the environment and income). As a result, the tax interaction literature finds that, in this case, the optimal environmental tax is higher than marginal damages. In order to explain these results, which contradict their earlier findings for the amenity case, the authors of the tax interaction literature provide a different explanation and introduce yet another previously unrecognized phenomenon, the "benefit-side tax interaction effect" (Williams 2003; Parry and Bento 2001). By contrast, when marginal social damage (MSD) is used as a benchmark, the results are identical for all kind of externalities, indicating that the optimal environmental tax rises above the Pigouvian rate when revenue-raising taxes are present (Jaeger 2002).

In an effort to reconcile the tax interaction findings with economic intuition, explanations have been formulated which introduce distinctions between "weak" and "strong" forms of the double dividend hypothesis—a distinction which itself further requires the introduction of a concept of "gross cost" (Goulder 1995). The "weak form" of the double dividend simply answers question 1 above in the affirmative. The strong form is more stringent and requires a reduction in "gross cost," where gross cost has been defined by Goulder to include only changes in utility from consumption of ordinary goods and services (and also leisure), but not changes in welfare related to the environment or public goods. Not only is there no apparent theoretical basis for a "gross cost" criterion rather than measuring overall welfare changes, but gross cost is problematic because it cannot be defined or interpreted except in models where the welfare gains from environmental quality are completely independent (separable in the utility function) from consumption, leisure or public goods.

In addition to these shortcomings, the real world relevance of the tax interaction results has also been called into question by Goodstein (2002) given the assumption in their models that labor supply declines with a rise in the general price level. The authors of the tax

interaction literature concede that their results are dependent on having labor supply decrease when pollution taxes raise the general price level. Although empirical evidence tends to support the assumption that labor supply declines when wages decline, Goodstein points out that a household's labor supply response to a change in the price level will differ from its response to a change in wages. This being the case, empirical estimates of labor's responsiveness to price level changes do not support the assumption that labor supply will decline with a rise in the overall price level. Hence, a necessary assumption underlying the tax interaction results is without solid empirical basis and thus should be viewed as a special case with questionable applicability.

IV. CONCLUSIONS

The double dividend idea—despite a debate that has been played out on the basis of technical details in theoretical models—fits well into the ecological economics framework which emphasizes placing economic models and analyses within the larger natural systems on which they depend. Previously the economics of optimal taxation has only recognized one untaxable endowment, leisure. Now we can recognize that environmental quality is clearly another such untaxable "good", the consumption (enjoyment) of which cannot be directly taxed. We understand that revenue-raising taxes on income and expenditures are distortionary precisely because they discourage labor supply and encourage greater consumption of untaxed leisure; the double dividend can be seen as pointing out that, in a parallel fashion, optimal taxation will discourage pollution and encourage greater "consumption" of untaxed environmental quality. To the extent that higher revenue requirements mean higher taxes, they are also likely to mean greater consumption of both leisure and environmental quality.

The intuition that an optimal revenue-raising tax program should be as broadly-based as possible is also consistent with the systems approach emphasized in ecological economics. Environmental goods and services, like other goods in the economy, should be priced at their social cost in a "first-best" world without distortionary taxes (the Pigouvian rate in the case of emissions), and in a "second-best world" where distortionary taxes are necessary to finance public expenditures, a broadly based revenue-raising tax should be added to all goods, raising their prices above their social cost – above the Pigouvian rate in the case of emissions.

Despite recent controversy and confusion on this topic, the conclusions one can draw are in keeping with economic intuition: environmental and revenue-raising taxes are complementary tools for achieving two different kinds of government goals: the provision of public goods with revenue motivated taxes and the protection of environmental quality with corrective taxes. Indeed, the joint pursuit of both goals using taxation can enable government to justify doing more of both by making the optimal environmental tax higher than it otherwise would be, and by lowering the distortionary cost of financing the provision of public goods.

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