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Optimal Indirect Taxation under Imperfect Competition[*]

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Abstract: This paper considers a simple general equilibrium model of indirect taxation under imperfect competition. Tax revenue is viewed as the rent of government coercion power and gross profit is viewed as the rent of market power. A government maximizes consumer surplus conditional on a certain amount of rent being collected. In contrast with many models in the literature, this model assumes that the government and consumers make their decisions simultaneously, which means the government cannot commit to a tax structure through its "first-mover advantage". It is found that when all commodities are taxable, the optimal indirect taxes should equalize the after-tax Lerner indexes of all commodities. When consumers' labor supplies are sufficiently inelastic, the optimal taxes generally lead to social welfare gain rather than deadweight loss.

Keywords: Indirect tax, Deadweight loss, Excess burden, Imperfect competition, Lerner index

JEL classification: D59, H21, L16

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1. Introduction

It is often suggested that indirect or commodity taxes lead to deadweight loss or excess burden. It is also suggested that an optimal indirect tax structure should prescribe higher tax rates for commodities that have lower demand or supply elasticities, especially when the demand functions are independent from each other (Ramsey, 1927; Hotelling, 1938; Baumol and Bradford, 1970; Diamond, 1975; Myles, 1989; and others). Nevertheless Dixit (1970) and Lerner (1970) suggest that when all goods are taxable, a uniform tax rate on all commodities is social optimal.

Atkinson and Stiglitz (1972) argue that the conventional theories of optimal indirect taxation are based on restrictive assumptions, like the absence of income effects and the independence of demand functions. They consider a general equilibrium model of indirect taxation. All commodities are taxable but leisure is not. A government maximizes consumer surplus conditional on collecting a certain amount of tax revenue. Consumers choose their optimal consumption bundles and labor supplies after observing the tax rates. The paper characterizes the conditions that an optimal tax structure should satisfy. One of the main results is that with additive utility functions, the government should tax more heavily the goods that have low income elasticities of demand. As suggested by Slemrod (1990) (p. 159), "*why the apparently benign rule of uniform taxation is generally not optimal should become clear once the second-best nature of the problem is understood … the optimal tax pattern should take advantage of commodities' relative substitutability or complementarity with leisure. A complement to leisure, such as skis, should be taxed relatively heavily and a substitute for leisure, such as work uniforms, should be taxed* *relatively lightly*."

The studies of indirect taxation under imperfect competition can be divided into two branches, which are partial equilibrium approach and general equilibrium approach. The partial equilibrium approach considers the optimal taxes for a small set of industries rather than the whole economy. Anderson, Palma and Kreider (2001) consider the relative efficiency of *ad valorem* and unit (or specific) taxes in imperfectly competitive markets. They find that cost asymmetry, strategic value, market entry, and other factors may affect the relative efficiency. Auerbach and Hines (2001) suggest that governments with perfect information and access to lump-sum taxes can provide corrective subsidies that render outcomes efficient in the presence of imperfect competition, while relaxing either of these two conditions removes the government's ability to support efficient resource allocation and changes the perfect policy response. In the general equilibrium approach, firms may engage in Cournot-Nash games (Gabszewicz and Vial, 1972) or Bertrand-Nash games (Marschak and Selten, 1974; Benassy, 1988; Guesnerie and Laffont, 1978; Dillén, 1995). One of the key issues is how indirect taxes help correcting the distortion caused by market powers. For example, Dillén (1995) shows that under a set of conditions, a budget constrained tax and subsidy system can correct the market inefficiency caused by imperfect price competition.

The model of the current paper follows Atkinson and Stiglitz (1972). It assumes that all commodities are taxable but leisure is not. The product markets are imperfectly competitive, which means producer surpluses have to be taken into account in the welfare analyses. In the model, tax revenue is viewed as the rent of government coercion power and gross profit is viewed as the rent of market power. A government can freely divide the total rent between itself and firms, through corporate income taxes for instance. The government maximizes consumer surplus conditional on a certain amount of rent being collected. Consumers maximize their utilities by choosing their consumption bundles and labor supplies. The consumers and government make decisions simultaneously. This paper avoids modeling the specific games played in the various industries, but assumes that stable equilibria prices always exist.[1]

A critical assumption of the model is that the government and consumers make their decisions simultaneously. In contrast, Atkinson and Stiglitz (1972) and many other papers implicitly assume that a government can commit to a tax structure through its first-mover advantage. This timing allows the government to "strategically" influence consumer choices. Just like a typical model that has a monopolistic first-mover, the government has incentive to further adjust the tax rates after consumers make their decisions. Hence the models also implicitly assume that the game is played for one round only. In the current model, the government has no incentive to further adjust the tax rates at the equilibrium even if it were allowed to do so.

This paper suggests that when all commodities are taxable, the optimal indirect tax structure should equalize the after-tax Lerner indexes of all commodities.[2] Hence the firms with less market powers should be taxed more heavily and *vice versa*. Such a tax pattern corrects the price distortion caused by market powers. This finding is in contrast with

[1] In particular this paper does not explicitly define the objective of a firm. As suggested by Kreps (1990, pp. 727), Dierker and Dierker (2006), and others, it might be inappropriate to assume that firms simply maximize their profits in a general equilibrium model with imperfectly competition.

[2] In the case of perfect competition, this tax rule is what Slemrod (1990) suggested "*the apparently benign rule of uniform taxation*".

Ramsey (1927)'s inverse price elasticity rule or Atkinson and Stiglitz (1972)'s inverse income elasticity rule. The differences are due to the assumptions that all commodities are taxable and the government does not have first-mover advantage. It is also shown that when consumers' labor supplies are sufficiently inelastic, the optimal indirect tax structure generally leads to social welfare gain rather than deadweight loss. This is also in contrast with the conventional view about indirect taxation.

The rest of this paper is organized as follows. Section 2 gives a review of the conventional wisdom about the deadweight loss or excess burden caused by market power or indirect taxation. Section 3 presents a simple model of indirect taxation under imperfect competition. It characterizes the optimal indirect tax structure and analyzes its social welfare effects. Section 4 concludes this paper.

2. Conventional wisdom about deadweight loss

In textbook presentations, the deadweight losses caused by market power and indirect tax are pretty similar. In an imperfect competitive market like monopoly, oligopoly, or monopolistic competition, firms are capable of setting producer prices above their marginal costs. The resulted gross profits can be viewed as the rents of market powers. Deadweight loss occurs when the firms' rent from market power is less than consumers' loss from it, compared to the resource allocation under perfect competition. More accurately, we say deadweight loss occurs if consumers are unable to attain the utility level under perfect competition even if the firms' rent were transferred to the consumers.

In economic textbooks the deadweight loss caused by market power is often illustrated by Figure 1. The argument is as follows. Starting from the equilibrium output level Q^*, if the economy can manage to produce one more unit of the product at the marginal cost (which is slightly higher than the MC^* in the figure) and sell it to the consumer who is willing to pay the highest price (which is slightly lower than the p^* in the figure), the total social welfare would be improved (by an amount slightly less than $p^* - MC^*$). Therefore the market power leads to inefficiently low output. The resulted welfare loss can be represented by the area of triangle *DL*.

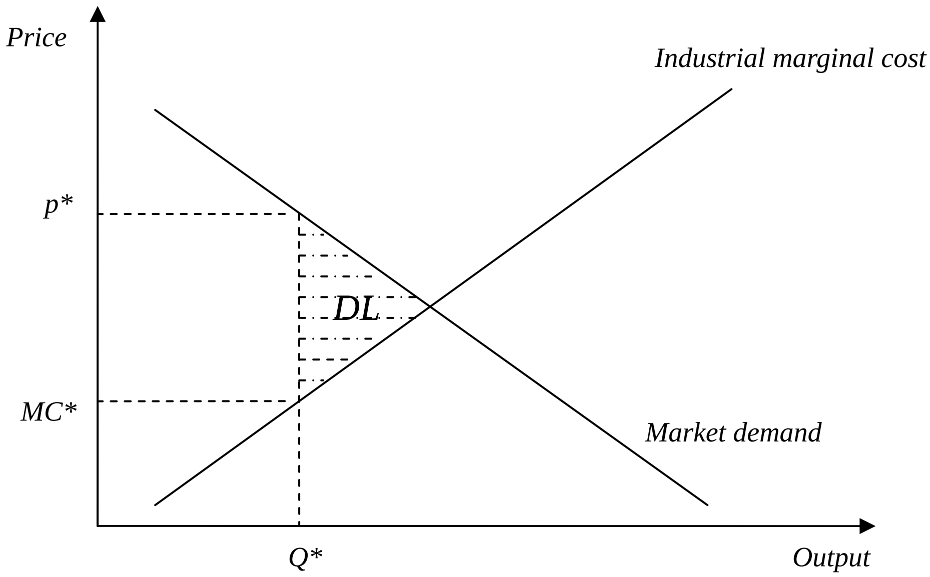

Figure 1: Deadweight loss and market power

This argument implicitly assumes that all other commodity markets are perfectly competitive. It ignores the fact that if a consumer spends more on the good in consideration, the consumer may spend less on some other goods. If those markets are imperfectly competitive and the commodities are priced above their marginal production costs, spending less on those commodities would reduce the producer surplus there. This is a welfare loss that must be accounted. It may offset the suggested welfare gain $p^* - MC^*$.

Hence the argument fails.

Market powers cause social welfare loss when the "degree" of competition differs across industries. In that case the relative prices cannot fully reflect the relative scarcities of the commodities. Therefore the consumers' choices are distorted, since the choices are based on the relative prices. The market powers in different markets actually cancel out with each other to some extent. In particular, if all commodities had the same proportional markups, the price distortion would completely disappear. Hence the conventional view generally overestimates the damage of market powers.[3]

The conventional wisdom about deadweight loss caused by indirect taxes is similar to that caused by market power. The welfare loss is also represented by a triangle in a demand-supply diagram, often referred as Harberger triangle in memory of Harberger's empirical work in estimating the losses (Harberger, 1964). We can similarly show that when all commodities are taxable, the Harberger triangles may overestimate the welfare loss caused by indirect taxation.

In Ramsey (1927), the society's objective function is the "net utility" of production and consumption. This approach is suitable in a partial equilibrium analysis, but might be problematic in a general equilibrium analysis. Production costs are expressed in monetary units, which are cardinal, but the utility from consumption is usually expressed ordinally. Hence it might be problematic to use the arithmetic "net utility" as the society's objective function in a general equilibrium analysis. Therefore it should be implicitly assumed in Ramsey (1927) that the analyses are conducted in a partial equilibrium framework rather

[3] Market power may also cause welfare loss by distorting consumers' labor supply, since it lowers the return from working.

than a general equilibrium one. The Ramsey tax rule should be more sensible when many commodities of the economy are not taxable.

3. The model

3.1 An imperfectly competitive economy

Consider a market economy with *n* commodities, denoted as 1, 2, …, *n* respectively. The marginal production costs are assumed to be constant for simplicity, which are $c_1,...,c_n$.[4] The marginal costs are strictly positive. Define the "gross profit" of a firm with marginal cost *c* and producer price *p* as $x(p-c)$, where *x* is the quantity of output.[5] Consumers are identical. A representative consumer's labor supply is denoted by *L* and his consumption bundle is denoted by vector $x=(x_1,...,x_n)$, which are non-negative. The consumer's utility function is $u(x_1,...,x_n;L)$, which satisfies

$$\frac{\partial u}{\partial x_i}>0\,,\quad \frac{\partial^2 u}{\partial x_i^2}<0\,,\quad \frac{\partial u}{\partial L}<0\,,\quad \frac{\partial^2 u}{\partial L^2}<0\,. \tag{1}$$

Hence the marginal utility from consumption is positive and decreasing, and the marginal "disutility" from working is positive and increasing. The income from labor supply is not taxed and the wage rate is unity. All commodities are taxable. Denote the specific tax rate on commodity i as t_i and denote $t\equiv(t_1,...,t_n)$. A tax rate could be negative, which represents a subsidy. For any given tax structure, all industries are assumed to have stable equilibrium prices. Denote the after-tax equilibrium price of commodity *i* as

[4] The production costs of this paper refer to the "social production costs". Hence the possible issues of externality or transaction cost are taken into account.

[5] This should be the definition of "gross profit" when the model is extended to the case where firms have increasing marginal costs. In that case *c* represents the equilibrium marginal cost. Note that the "gross profit" of this paper differs from that in accounting.

$p_i(t) = p_i(t_1,...,t_n)$. Assume that for any relevant commodity bundle $x = (x_1,...,x_n)$, the market value of the bundle increase with each tax rate, *i.e.*,

$$\frac{\partial[p(t)\cdot x]}{\partial t_i} = x_1\frac{\partial p_1}{\partial t_i} + ... + x_n\frac{\partial p_n}{\partial t_i} > 0\,,\quad i \in \{1,...,n\}\,. \tag{2}$$

If the markets are perfectly competitive, we have $p_i(t) = c_i + t_i$. Hence the model has perfect competition as a special case.

A benevolent government seeks to maximize the social welfare under two constraints. First, it has to collect a certain amount of revenue to finance public services. Second, it has to allow a certain amount of gross profits for firms to promote entrepreneurship and investment. Define the total rent of the economy as the sum of tax revenue and gross profits. Suppose that the government can figure out the optimal amount of total rent, and can freely decide how to allocate the rent between firms and itself, through corporate income taxes for instance. Hence the government seeks to maximize consumer surplus conditional on a certain amount of rent being collected.

3.2 The optimal indirect taxes

Since consumers are identical, we only consider the behavior of a representative individual. Denote the gross after-tax profit of the firms from each consumer as

$$\pi^t = x_1(p_1(t) - t_1 - c_1) + ... + x_n(p_n(t) - t_n - c_n)\,, \tag{3}$$

And denote the tax revenue of the government as

$$T = x_1 t_1 + ... + x_n t_n\,. \tag{4}$$

The sum $\pi^t + T$ is the rent from each consumer. A representative consumer's available resource for consumption includes wage L and the dividend he obtains from the firms, which is π^t. The dividend is viewed as a lump sum income by the consumer. Given a tax structure $(t_1,...,t_n)$, the consumer solves utility-maximization problem

$$\underset{x,L\geq 0}{\text{Max}} \quad u(x_1,...,x_n;L), \tag{5}$$

$$\text{s.t.} \quad x_1 p_1(t) + ... + x_n p_n(t) \leq L + \pi^t. \tag{6}$$

The Lagrangian of this problem can be written as

$$\mathrm{L}(x,t;\lambda) = u(x_1,...,x_n;L) - \lambda(x_1 p_1 + ... + x_n p_n - L - \pi^t). \tag{7}$$

The Lagrangian coefficient λ (*i.e.*, the "shadow price" of wealth) is non-negative since budget constraint (6) must be binding. Suppose there is an interior solution. Under certain regularity conditions, say, $u(\cdot)$ is quasi-concave in $(x_1,...,x_n;-L)$, the consumer's optimal choice is characterized by following first order conditions.

$$x_i: \ \frac{\partial u}{\partial x_i} = \lambda p_i(t), \quad i \in \{1,...,n\}, \tag{8}$$

$$L: \ \frac{\partial u}{\partial L} = -\lambda, \tag{9}$$

$$\lambda: \ x_1 p_1(t) + ... + x_n p_n(t) = L + \pi^t. \tag{10}$$

From (8) we have following conditions for the utility maximization

$$\frac{\partial u / \partial x_i}{\partial u / \partial x_j} = \frac{p_i(t)}{p_j(t)}, \text{ for any } i, j \in \{1,...,n\}, \ i \neq j, \tag{11}$$

On the other hand, given the consumer's choice $(x_1,...,x_n;L)$, the government chooses $(t_1,...,t_n)$ to maximize consumer surplus conditional on a certain amount of rent being collected. The government also understands that the consumer's choice must satisfy a budget constraint, which is (6). Hence it solves problem

$$\underset{x,L\geq 0,t}{\text{Max}} \quad u(x_1,...,x_n;L), \tag{12}$$

$$\text{s.t.} \quad x_1 p_1(t) + \ldots + x_n p_n(t) \le L + \pi^t , \tag{13}$$

$$x_1(p_1(t) - c_1) + \ldots + x_n(p_n(t) - c_n) \ge \pi^t + T \ . \tag{14}$$

Note that π^t and T are exogenously determined.

The modeling of the government's maximization problem is critical in characterizing the optimal tax structure. There is a subtle difference between the model of Atkinson and Stiglitz (1972) and the current one. Atkinson and Stiglitz substitute the first order conditions of consumer's utility-maximization problem into the government's problem. This approach implicitly assumes that the government chooses a tax structure first, and consumers make their decisions after observing the tax rates. This timing allows the government to "strategically" commit to a tax structure before consumers move. Therefore at the end of the game the government wishes to adjust the tax rates further. In contrast, the current paper does not allow the first-mover advantage of the government. The consumers and government are assumed to move simultaneously. Technically, we will not substitute conditions (8) into constraint (13) when we solve the government's problem.

The Lagrangian of the government's problem is

$$\begin{aligned} \mathrm{L}(x,t;\gamma,\mu) = u(x_1,\ldots,x_n;L) - \gamma(x_1 p_1 + \ldots + x_n p_n - L - \pi^t) \\ + \mu[x_1(p_1 - c_1) + \ldots + x_n(p_n - c_n) - \pi^t - T]. \end{aligned} \tag{15}$$

Suppose there is an interior solution. The optimal tax rates satisfy following first order conditions, which can be the sufficient conditions of the optimality under certain regularity conditions.

$$x_i: \ \frac{\partial u}{\partial x_i} = \gamma p_i - \mu(p_i - c_i), \quad i \in \{1,\ldots,n\}, \tag{16}$$

$$t_i:\quad \gamma(x_1\frac{\partial p_1}{\partial t_i}+\dots+x_n\frac{\partial p_n}{\partial t_i})=\mu(x_1\frac{\partial p_1}{\partial t_i}+\dots+x_n\frac{\partial p_n}{\partial t_i}),\quad i\in\{1,\dots,n\},\tag{17}$$

$$L:\quad \frac{\partial u}{\partial L}=-\gamma\tag{18}$$

$$\gamma:\quad x_1p_1+\dots+x_np_n=L+\pi^t,\tag{19}$$

$$\mu:\quad x_1(p_1-c_1)+\dots+x_n(p_n-c_n)=\pi^t+T.\tag{20}$$

From (2) and (17) we have $\gamma=\mu$, which means the social optimal tax structure entails equal "shadow prices" of the two budget constraints. From (16) and $\gamma=\mu$, we have

$$\frac{\partial u/\partial x_i}{\partial u/\partial x_j}=\frac{c_i}{c_j}\text{, for any } i,j\in\{1,\dots,n\},\quad i\neq j.\tag{21}$$

Note that a consumer's choice rule under perfect competition without tax also takes the form of (21). From the choice rule of the representative consumer (11) and that of the government (21), we see the social optimal tax structure $(t_1,\dots,t_n)$ satisfies

$$\frac{p_i(t)}{p_j(t)}=\frac{c_i}{c_j}\text{, for any } i,j\in\{1,\dots,n\},\quad i\neq j,\tag{22}$$

Or equivalently we can write these equations in term of Lerner index, *i.e.*,

$$\exists\,\eta>0\text{, such that }\frac{p_i(t)-c_i}{p_i(t)}=\eta,\quad i\in\{1,\dots,n\}.\tag{23}$$

This tax rule suggests that the optimal indirect taxes should correct the price distortions caused by market power. From (19) and (20) we have

$$\eta=\frac{T+\pi^t}{L+\pi^t}.\tag{24}$$

This is the ratio between the total rent and private consumption. Under the optimal indirect taxes, ratio η represents the optimal markup of the economy. Hence it might be a useful benchmark in welfare studies.

As long as the government is able to use the *n* tax variables to control the *n* prices of the commodities such that (22) or (23) holds, we have following result.

Proposition 1: *An optimal indirect tax structure should equalize the after-tax Lerner index of all commodities.*

In order to correct the price distortion caused by market powers, the optimal taxes should be discriminating across industries. Governments should tax more heavily the industries that are more competitive. Lower tax rates or even subsidies should be imposed on monopoly, oligopoly, or monopolistic competitive industries, especially those with very low marginal costs. The optimal indirect taxation may lead to fairness problems because it prescribes lower tax rates for firms with larger market powers. A well-designed corporate income tax structure could be used to solve this problem. Of course at the aggregate level, corporate income taxes also play the role of allocating the total rent between governments and firms.

3.3 Do indirect taxes cause deadweight loss?

To consider the social welfare effect of the optimal indirect taxes, we need to compare three market outcomes: the first-best outcome where all commodities are priced at their marginal costs, the imperfectly competitive outcome without tax, and the imperfectly competitive outcome with the optimal indirect taxes. It is helpful to introduce a notation before the discussion. If a consumer faces price vector $p = (p_1, ..., p_n)$ and receives a lump sum transfer *H*, he solves problem

$$\underset{x,L\geq 0}{\text{Max}} \quad u(x_1,...,x_n;L)\,, \tag{25}$$

$$\text{s.t.} \quad x_1 p_1 + ... + x_n p_n \leq L + H\,. \tag{26}$$

We denote the optimum value of the problem as

$$U(p_1,...,p_n;H) = u(x_1(p;L+H),...x_L(p;L+H);L(p,H))\,. \tag{27}$$

This function is similar to the "indirect utility function" of consumers.

In the first-best outcome, the social welfare is simply the consumer surplus. Such a resource allocation is characterized by problem

$$\underset{x,L\geq 0}{\text{Max}} \quad u(x_1,...,x_n;L)\,, \tag{28}$$

$$\text{s.t.} \quad x_1 c_1 + ... + x_n c_n \leq L\,. \tag{29}$$

Using the notation of (27), the first-best social welfare can be represented by $U(c_1,...,c_n;0)$ for each consumer.

In a general equilibrium model with imperfect competition, the social welfare includes consumer surplus, producer surplus and tax revenue, which are expressed differently. Producer surplus and tax revenue are usually expressed in monetary units, but consumer surplus is expressed in "utility". Hence the arithmetic sum of them is not relevant. One approach to evaluate the social welfare effect of indirect taxes is measuring the variation of consumer welfare in term of a suitable price vector and then comparing that with the tax revenue. If the measuring is based on the *ex post* price vector, the welfare change is called "compensating variation". If the measuring is based on the *ex ante* price vector, it is called "equivalent variation" (Hicks, 1939). In the current model, since the after-tax (*ex post*) prices are not distorted, it should be reasonable to use the compensating variation approach to evaluate the social welfare effect of the taxes.

We will hypothetically transfer the total rent of the firms and government back to the consumers at the after-tax prices, and then compare the consumers' wellbeing with that without tax. The taxes are said to cause deadweight loss if the compensated wellbeing is less than that without tax. It should be noted that when consumers are compensated at the after-tax prices, they would necessarily consume more commodities and thus generate more rents for the firms and government. The extra rents also have to be transferred to the consumers. In other words, the amount of transfer is determined by the after-compensation consumption. It is also important to realize that an individual consumer views the compensation as a lump-sum transfer.

If there were no tax, the total gross profit of the firms is

$$\pi^0 = x_1(p_1(0) - c_1) + ... + x_n(p_n(0) - c_n) . \tag{30}$$

When the equilibrium without tax is not Pareto efficient, transferring π^0 to consumers is insufficient to "compensate" them back to the first-best situation. Hence the compensated social welfare $U(p_1(0),..., p_n(0); \pi^0)$ satisfies

$$U(p_1(0),..., p_n(0); \pi^0) \le U(c_1,...,c_n; 0) . \tag{31}$$

It is theoretically possible for (31) to hold in equality, which happens when the market powers do not distort the relative prices of commodities and the labor supply is perfectly inelastic. If

$$U(p_1(0),..., p_n(0); \pi^0 + \Delta) = U(c_1,...,c_n; 0) , \tag{32}$$

we say Δ is the excess burden caused by market powers.

Now we consider the social welfare effect of the optimal indirect taxes. The total rent collected from each consumer is

$$\pi^t + T = x_1(p_1(t) - c_1) + ... + x_n(p_n(t) - c_n)$$
$$= \eta x_1 p_1(t) + ... + \eta x_n p_n(t). \quad (33)$$

A representative consumer's utility-maximization problem with the compensation is

$$\underset{x,L\geq 0}{\text{Max}} \quad u(x_1,...,x_n;L)\,, \quad (34)$$

$$\text{s.t.} \quad x_1 p_1(t) + ... + x_n p_n(t) \leq L + \pi^t + T\,. \quad (35)$$

Hence the consumer's utility with the compensation is $U(p_1(t),..., p_n(t);\pi^t + T)$. Denote the solution to the problem as $(\tilde{x}_1,...,\tilde{x}_n;\tilde{L})$. Note that $\tilde{L}$ is the consumer's labor supply when the consumer faces the after-tax prices and compensated income. Both the substitute effect and income effect of labor supply suggest that $\tilde{L}$ might be less than the first-best level. Consumption bundle $(\tilde{x}_1,...,\tilde{x}_n)$ is also the solution to problem

$$\underset{x\geq 0}{\text{Max}} \quad u(x_1,...,x_n;\tilde{L})\,, \quad (36)$$

$$\text{s.t.} \quad x_1 p_1(t) + ... + x_n p_n(t) \leq \tilde{L} + \pi^t + T\,. \quad (37)$$

Since rent $\pi^t + T$ is determined by the after-compensation consumption, we can substitute (33) and $p_i(t) = \dfrac{c_i}{1-\eta}$ into constraint (37). It becomes

$$x_1 c_1 + ... + x_n c_n \leq \tilde{L}\,. \quad (38)$$

Note that the transformation of (37) into (38) does not change the relative prices faced by the consumer.

Since the indirect taxes may distort the labor supply, the consumer's compensated utility should be lower than that of the first-best. However, if consumers have perfectly inelastic labor supplies,[6] which means L is exogenously given, problem (36) with constraint (38)

[6] The condition can be slightly weaker. What we really need is that the labor supply satisfies $L(p) = L(kp)$ for any relevant $k > 0$. This condition means that consumers' labor supplies do not change with the real wage rate.

becomes identical to problem (28). Hence the outcome with the compensation is a first-best one, *i.e.*,

$$U(p_1(t),...,p_n(t);\pi^t + T) = U(c_1,...,c_n;0)\,. \tag{39}$$

From (31) and (39) we have

$$U(p_1(t),...,p_n(t);\pi^t + T) \geq U(p_1(0),...,p_n(0);\pi^0)\,. \tag{40}$$

We write this result as following proposition.

Proposition 2: *When consumers have perfectly inelastic labor supplies, the optimal indirect tax structure generates potential Pareto improvement for the society.*

Since function $U(.)$ is typically continuous, Proposition 2 suggests that when the market outcome without tax is not Pareto optimal and consumers' labor supplies are sufficiently inelastic, the optimal tax structure leads to welfare gain rather than deadweight loss. Therefore if indirect taxes cause excess burden, it should be due to the suboptimality of the tax structure or elastic labor supply. This finding is in contrast with the conventional view about indirect taxation.

A change of wage rate leads to income effect and substitute effect on labor supply. The two effects are often in opposite directions. Hence the elasticity of labor supply is an empirical issue. Kosters (1967) finds very weak tax effects for male hours-of-work equations for those who are working and somewhat stronger but still small effects on participation. The findings are confirmed by MaCurdy, Green and Paarsch (1990). Mroz (1987) finds similar weak tax effects on female hours of work for working women. See

Slemrod (1990) and Heckman (1993) for reviews of the literature. Proposition 2 suggests that with the optimal indirect taxes and an appropriate transfer payment system, it is possible for a government to make all parties better off.

4. Concluding Remarks

This paper considers the optimal indirect taxation when a government cannot strategically commit to a tax structure before consumers make their decisions. The model suggests that when all commodities are taxable, an optimal indirect tax structure should equalize the after-tax Lerner indexes of all commodities. This is true even when the commodities have different relative substitutability or complementarity with leisure. Such a tax structure corrects the price distortion caused by market powers. According to the model, the highly competitive industries, like automobile, agriculture products, and base metals, which have relatively low Lerner indices in the absence of taxes, should be taxed more heavily. Other industries like software, communication services, and toll roads, should enjoy low indirect tax rates. Another contribution of this paper is finding that when consumers' labor supplies are sufficiently inelastic, the optimal tax structure leads to potential Pareto improvement rather than deadweight loss for the society. Therefore from the perspective of economic efficiency, indirect taxation could be more preferable than direct taxation in collecting revenue for governments.

This paper invokes some restrictive assumptions, for instances, the game is static, all commodities are taxable, consumers are identical, information is perfect, market structures are fixed, and stable equilibria always exist. It is left for future studies to observe what if some of the assumptions are not satisfied. The results of the current paper may serve as a benchmark for more sophisticated studies.

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