Negative Production Externalities and Efficacy of the Pigouvian Tax Policy in a Developing Economy: A Pure Economic Argument

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Abstract: This theoretical note examines the usefulness of the Pigouvian tax policy in dealing with negative production externalities and in improving social welfare in a small developing economy. A two-sector, full-employment general equilibrium model with exogenous labour market imperfection is used for the analytical purpose where the sector that faces an imperfect labour market creates pollution through its production and lowers the efficiency of workers. The analysis finds that the socially optimal Pigouvian tax rate may not necessarily be positive and that it crucially hinges both on the degree of labour market imperfection and the scale of negative externalities that production of the dirty commodity generates.

Keywords: Negative production externality; pollution; efficiency of labour; Pigouvian tax; social welfare; general equilibrium.

JEL codes: D58; D62; H23; Q52; Q58.

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1. Introduction and motivation

A standard welfare result in the small open economy literature is that a Pigouvian production tax is an effective instrument to take care of negative externalities emanated through production of a commodity. There are no other distortions in the economy and commodity prices are given internationally. The simple economic argument is that such a tax on producers would lower production of the dirty commodity and divert economic resources towards production of good commodities. The tax does not affect consumer prices and the amount of excess demand for the commodity by the consumers can easily be met through import of the good from the international market at a given price. The tax revenue collected by the government is transferred to consumers in a lump-sum fashion. Hence, the socially optimal tax rate in a small open economy is unambiguously positive. We here set aside the problems relating to measurement and implementation of the tax mechanism and other alternatives to deal with negative production externalities and concentrate on Pigouvian tax principle solely from the perspective of social welfare.[1]

Two pertinent questions at this juncture are as follows. (i) Is the optimal Pigouvian tax in a small open economy in the presence of other distortion(s) e.g. labour market distortion also necessarily positive?; and, (ii) does the sign of the optimal tax anyhow

[1] For issues relating to measurement and implementation problems of the tax principle and its alternatives one may go through Baumol (1972), Boettke (2012), Vaughn (1980), Barthold (1994), Coase (1960), Carlton and Loury (1980), Kohn (1986), Fullerton (1997), Fullerton and Metcalf (1998), Bovenberg and Mooij (1994), Goulder, Parry and Burtraw (1997), Sandmo (2008) etc.

depend on the magnitude of negative externalities that the production of the dirty good generates?

This theoretical note attempts to provide answers to the above questions in terms of a 2×2 full-employment small open economy model with exogenous labour market imperfection. The import-competing sector (sector 2) produces a manufacturing commodity that causes health hazards; thereby lowering the efficiency of the workers. In sector 2, workers receive an exogenously given higher wage than their counterparts in sector 1.€[2] Thus, we have exogenous labour market imperfection. There is a Pigouvian production tax on sector 2 in the scenario, which aims at tackling negative externalities, generated by production of commodity 2. In this setting, we have shown that the socially optimal Pigouvian tax although lowers the degree of labour market distortion may not necessarily be positive and crucially hinges both on the degree of labour market imperfection and the scale of negative externalities that production of the dirty commodity generates. We also point out that if the degree of dirtiness of the commodity is sufficiently high there may arise a perverse case where the socially optimal Pigouvian tax rate could be negative even in the absence of any labour market imperfection.

2. The Model

A small, open economy is considered with two sectors: agriculture (sector 1) and manufacturing (sector 2). Sector 1 is an informal sector that produces an agricultural commodity, X_1 by means of labour (L) and capital of type K. Sector 2 is the formal sector producing a final manufacturing commodity, X_2 using the same two homogeneous inputs. Both the inputs are perfectly mobile across sectors. Sector 2

[2] Implementation of the minimum wage law, trade unionism etc. could be the reason.

faces an imperfect, labour market where workers receive an exogenously given wage, W^* while the wage rate in the informal sector, W, is market determined with $W^* > W$. The labour allocation mechanism is as follows. Workers first compete for getting jobs in sector 2 where the wage rate is high. However, those who cannot get employment in that sector are automatically absorbed in sector 1 providing the competitive and low wage. Hence, we have exogenous labour market distortion.

Sector 1 is assumed to be non-polluting[3], but the production of commodity 2 generates pollution that affects the efficiency of workers. It is assumed that the efficiency of a representative worker, h, is inversely related to the level of pollution in the economy. Environmental pollution leads to health hazards[4], thus adversely affecting the worker's efficiency. Although in this model the manufacturing sector creates pollution, it is assumed that pollution affects the efficiency of not only those workers engaged in sector 2 but the entire workforce. This is because both the sectors operate at close vicinity so that environmental degradation affects the entire working population equally. Thus, the average efficiency of the workers, h, is considered to be a positive function of the total amount of production of commodity 2 and is given by

$$h = h(X_2); h'(.) < 0 \qquad (1)$$

Since the production of the manufacturing commodity creates external diseconomies its free market production is not optimal and therefore, there should be a Pigouvian

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[3] This is a simplifying assumption. A typical agricultural sector also vitiates the environment through use of chemical fertilizers and pesticides. However, the amount of pollution generated by the agricultural sector is insignificant relative to that produced by the manufacturing sector.

[4] For example, air pollution can lead to irritation, breathing problems and lung diseases; water pollution causes contaminated drinking water; improper waste disposal management involves significant human pathogens. All these contribute directly to reduce productive efficiency of workers.

production tax from the perspective of social welfare. The producers have to pay a production tax at the ad-valorem rate, z for the production of commodity 2. Hence, the effective price of commodity 2 received by its producers is $P_2^* = P_2(1-z)$.

Sector 1 is the export sector while sector 2 is the import-competing sector. Commodities prices are given by the small open economy assumption. We assume sector 2 to be capital-intensive in value sense which in turn implies that $\frac{a_{K2}}{W^* a_{L2}} > \frac{a_{K1}}{W a_{L1}}$. Here a_{ji} denotes requirement of the j th input required to produce 1 unit of output of the i th sector for $j = L, K$ and $i = 1, 2$. All other assumptions of the Heckscher-Ohlin-Samuelson model including CRS with positive but diminishing marginal productivity to each input holds. Labour is measured in efficiency unit. Finally, commodity 1 is taken to be the numeraire.

It should be pointed out at this stage that sector 2 uses $a_{L2}X_2$ efficiency units of labour apart from capital in its production to produce X_2 units of commodity 2. The production of commodity 2, lowers the average efficiency of the workers through generation of pollution. If X_2 rises by one per cent, sector 2 employs λ_{L2} per cent of the labour force additionally while it lowers the labour force in efficiency unit by ε_h per cent at the margin, where $\varepsilon_h = (\frac{dh(.)}{dX_2}.\frac{X_2}{h(.)}) < 0$ is the elasticity of the labour efficiency function, $h(X_2)$, with respect to X_2 and λ_{L2} is the proportion of effective labour endowment (measured in efficiency unit) employed in sector2. Hence, effectively sector 2 utilizes $(\lambda_{L2} + |\varepsilon_h|)$ proportion of the total labour force of the economy measured in efficiency unit. Hence, sector 2 in effect uses more labour vis-à-vis what it directly requires in production. This gives rise to the necessity of classifying sectors in terms of ***efficiency adjusted physical sense***.

Because $W^* > W$, our assumption that sector 2 is more capital-intensive relative to sector 1 in value sense automatically implies that sector 2 is capital-intensive in physical sense as well i.e. $\frac{\lambda_{K2}}{\lambda_{L2}} > \frac{\lambda_{K1}}{\lambda_{L1}}$. However, here only direct labour uses in production are taken into consideration. We concentrate on the case where sector 2 is more capital-intensive than sector 1 even in ***efficiency-adjusted physical sense*** i.e. $(\frac{\lambda_{K2}}{\lambda_{L2} + |\varepsilon_h|}) > (\frac{\lambda_{K1}}{\lambda_{L1}})$. It is not problematic to assume sector 2 to be capital-intensive in both value sense and efficiency-adjusted physical sense so long as $|\varepsilon_h|$ is low. Problems arise when $|\varepsilon_h|$ is sufficiently high so that sector 2 becomes labour-intensive in ***efficiency-adjusted physical sense***. It is not difficult to check intuitively that the results get altered in this peculiar case.

2.1 The general equilibrium structure

3. Comparative statics

Totally, differentiating equations (2) – (5) the following proposition can easily be derived.

Proposition 1: A Pigouvian production tax on commodity 2 leads to: (i) a decrease in the return to capital, r; (ii) an increase in the competitive wage, W; (iii) a reduction in intersectoral wage differential; (iv) increases in wage-rental ratios; (v) an expansion (a contraction) of sector 1 (sector 2); and, (vi) a decrease in the number of workers employed in sector 2, $L_2 (= a_{L2} X_2)$.

Proposition 2: An increase in the ad-valorem rate of production tax on commodity 2 worsens welfare if $zP_2X_2 \geq Wh(.)L|\varepsilon_h|$.

Proposition 3: The socially optimal Pigouvian tax is negative (zero) (positive) iff $(W^* - W)L_2 > (=)(<)WhL|\varepsilon_h|$.

Proposition 4: The probability, that the Pigouvian tax policy would be effective in addressing the problem of negative externalities and improve social welfare, increases with an increase in the degree of dirtiness of the commodity. This possibility also increases if the tax policy is accompanied by a policy of labour market reform.

4. Concluding remarks

In this theoretical note, we have shown that in a small developing economy with labour market imperfection the socially optimal pigouvian tax may not necessarily be positive. We have used a two-sector, full-employment model with exogenous labour market imperfection for analytical purpose. The import-competing sector (sector 2) produces a commodity that causes health hazards and lowers the efficiency of workers in the economy. In sector 2 workers receive a fixed wage which is greater than the competitive wage in sector 1. Hence, there are two distortions in our model: labour market distortion reflected in intersectoral wage differential and negative externalities generated from production of commodity 2. In this setting, we have shown that a Pigouvian production tax may not be the right instrument to deal with negative externalities and improve social welfare. The socially optimal tax rate can indeed be negative depending on relative strengths of two opposite effects. Most importantly, the degree of dirtiness of the commodity, whose production emanates negative externalities, plays a very crucial role in determining the sign of the socially optimal tax rate.

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