Revisiting the Incidence of the Corporation Income Tax

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Abstract This paper argues that, in a theoretical framework for the competitive general equilibrium analysis of the corporation income tax, the result can be highly sensitive to the incorporation of inter-sector input-output links and the accompanied choice of production functions, in that varying input-output structures and technology specifications can change in a qualitative scale the tax burden distribution between capital and labor. I use a simple model to show that adding an input-output link to a two-sector model in Harberger (1962) could change the tax burden distribution qualitatively. Specifically, whether capital and labor equally bears the tax burden and which factor bears the weight of the tax burden could be changed by an input-output link. Consequently, in applied works, neglecting such links or assuming wrong technology for processing intermediate goods can give misleading estimation which will be nowhere close to the true distribution of tax burden - not even a good first-order approximation.

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I. Introduction

This paper argues that, in a theoretical framework for the competitive general equilibrium analysis of the corporation income tax, the result can be highly sensitive to the incorporation of inter-sector input-output links and the accompanied choice of production functions, in that varying input-output structures and technology specifications can change in a qualitative scale the tax burden distribution between capital and labor. Consequently, in applied works, neglecting such links or assuming wrong technology for processing intermediate goods can give misleading estimation which will be nowhere close to the true distribution of tax burden – not even a good first-order approximation. I notice that this caveat, though not explicitly warned of, is quite clear in Harberger (1962), but was more or less neglected in the subsequent literature.

Harberger (1962) marks the beginning date of modern tax incidence analysis (Metcalf and Fullerton 2002). In this seminal paper, Harberger examines two-sector competitive general equilibrium models, with both sectors employing mobile capital and labor and each sector producing a final consumption good. Harberger’s methodology have been extended ever since by, among others, McLure and Thirsk (1975), Vandendorpe and Friedlaender (1976), Feldstein (1977) and Bradford (1978) (Metcalf and Fullerton 2002). With the advancement of computing power, Shoven (1976) is able to analyze a twelve-sector computational general equilibrium model. In both Harberger’s and Shoven’s papers, the models only have parallel sectors; i.e., each sector takes capital and labor and produces one final good. Following works went beyond the parallel structure; Ballard, Fullerton, Shoven and Whalley(1985) writes a model with 19 producer goods and 15 consumer goods.

In this paper I discuss the importance of the input-output relationship among sectors, which are ignored in parallel sector models. In Section II, I use a simple model to show that adding an input-output link to a two-sector model in Harberger (1962) could change the tax burden distribution qualitatively. It is not surprising that adding an input-output link should result in a quantitative change because any variation to a model would do that; the significance of my model is that the larger picture of whether capital and labor equally bears the tax burden and which factor bears the weight of the tax burden could be changed by an input-output link. Harberger (1966) estimates the efficiency cost of the corporation income tax based on his 1962 model. From the example in Section II, it should be clear that the result of this type of estimation may be sensitive to assumed input-output relations. In Section III I point that how much input-output relation matters for incidence results depends qualitatively on the production technology.

II. A tale of two models: an input-output link makes a difference

I derive tax incidence results below for two models.

A. A Two-Sector Model without links

This is one of the models in Harberger (1962) with only minor changes in notation and scale. Sector 1 produces according to the production function \( y_1 = \min\{L_1, K_1\} \), in which \( y_1 \) is the amount of final good produced by Sector 1; \( L_1 \) and \( K_1 \) are amount of labor and capital employed, respectively, by Sector 1. Sector 2 produces according to \( y_2 = L_2^\frac{1}{2}K_2^\frac{1}{2} \). Both sectors are competitive. Both capital
and labor are mobile. Workers who are also consumers have Cobb-Douglas utility function and always spend equally on good 1 and good 2. The government imposes the tax schedule \((t_k, t_L, t_k, t_L)\) where \(t_k\) is the tax rate for capital in Sector \(i\) and \(t_L\) is the tax rate for labor in Sector \(i\). Let \(p_k\) and \(p_L\) denote, respectively, prices of capital and labor faced by the Sector \(i\) firm. Then in equilibrium four equations are satisfied: 
\[
K_1 + K_2 = 1; \\
L_1 + L_2 = 1; \\
p_k(1-t_k) = p_k(1-t_k); \\
p_L(1-t_L) = p_L(1-t_L).
\]

The change in the ratio \(\frac{\text{revenue of capital}}{\text{revenue of labor}}\) with respect to tax rate characterizes which factor, capital or labor, bears proportionally more tax burden. Simple algebra gives
\[
\frac{\text{revenue of capital}}{\text{revenue of labor}} = \frac{1 - t_{k2}}{1 - t_{L2}}.
\]

Each panel of Figure 1 plots the revenue ratio as a function of the rate of one type of tax, holding other tax rates 0. Notably, taxes levied on the fixed proportion sector (Sector 1) don’t affect the percentage shares of national revenue that go to capital and labor. The intuition is that, since the fixed proportion sector always employs capital and labor 1 to 1, in equilibrium the other sector will have to employ capital and labor at the ratio of 1 to 1, too. Since the other sector has Cobb-Douglas production function, this ratio alone determines the ratio of pre-tax capital price and pre-tax labor price. It follows that the ratio of after-tax capital price and after-tax labor price is determined only by taxes levied on the Cobb-Douglas production function sector (Sector 2).

B. A Two-sector Model with one input-output link

This model adds one intermediate output to the previous model. Sector 1 produces according to the production function \(y_1 = \text{Min}\{L_1, K_1^{\frac{1}{2}}y_2^{\frac{1}{2}}\}\), in which \(y_1\) is the amount of final good produced by Sector 1; \(L_1\) and \(K_1\) are amount of labor and capital employed, respectively, by Sector 1; \(y_2\) is the amount of intermediate goods produced by Sector 2 and employed by Sector 1. Workers derive utility from consuming good 1. Other set-up, including production functions in Sector 2, notations for tax rates, and equilibrium conditions are the same with the model in Part A. Simple algebra gives
\[
\frac{\text{revenue of capital}}{\text{revenue of labor}} = \frac{1 - t_{k2}}{r(1 - t_{L2})},
\]
in which \(r\) is the solution of the equation
\[
\left[\frac{1}{c^2} + \left(\frac{1}{c}\right)^{\frac{3}{2}}\right] r - r^{\frac{3}{4}} - \left(\frac{1}{c}\right)^{\frac{1}{2}} = 0, \text{ with } c = \frac{2(1 - t_{k1})}{1 - t_{k2}}.
\]

I calculated the \(K-L\)-revenue ratio for different tax rates with Mathematica and report the result in Figure 2.
Figure 1  incidence result for the no-link model
Panel A  revenue of capital vs. $I_{k1}$
Panel B  revenue of capital vs. $I_{L1}$
Panel C  revenue of capital vs. $I_{k2}$
Panel D  revenue of capital vs. $I_{L2}$

Figure 2  incidence result for the one-link model
Panel A  revenue of capital vs. $I_{k1}$
Panel B  revenue of capital vs. $I_{L1}$
Panel C  revenue of capital vs. $I_{k2}$
Panel D  revenue of capital vs. $I_{L2}$

A comparison of Figure 1 and Figure 2 shows that after one input-output link was added, the incidence of the corporation income tax on fixed-proportion sector was completely changed. In the parallel sector case, taxing the fixed coefficient Sector doesn’t affect the capital-labor-income-share
at all. However, in the model with one input-output link, this big result is completely changed; the corporation income tax now imposes burden disproportionally on capital owners. The key setup that drives this result is that the upstream sector produces an intermediate good that can substitute capital employed in the downstream sector.

Harberger (1962) derives a general formula for calculating the incidence of corporation income tax. The formula is based on the assumption that the corporate sector and the non-corporate sector separately take capital and labor. This formula is definitely valuable; but it may not give accurate estimate of the incidence of corporation income tax if the assumptions are not met.

III. Technology matters

As I showed in Section II, adding input-output links could bring qualitative change to tax incidence. However, these links alone don’t do the trick; assumptions for technology are also critical. In the model I presented in Section II-B, if I assume that the downstream sector produces according to $y_1 = \min\{L_1, K_1, y_2\}$ (i.e. $y_2$ is complement to both capital and labor; while in the Section II-B model I had $y_1 = \min\{L_1, K_1^{\frac{1}{2}}, y_2^{\frac{1}{2}}\}$ where $y_2$ is substitute to capital), then the tax incidence result will resemble the parallel-sector model for every type of tax. As no-link models in Harberger (1962) already suggest, whether factors are complements (as in fixed proportion production functions) or substitutes (as in Cobb-Douglas production functions) is very important.\(^1\) As my with-link models suggest, whether intermediate goods, capital and labor are complements or substitutes to each other matter a lot to who bear tax burden. In conclusion, when estimating incidence for an economy, one should not assume arbitrary functional forms for production functions or input-output links.

References


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\(^1\) For example, if both sectors are Cobb-Douglas, capital will bear the full burden of corporation income tax on one sector; however, as the model in Section II-A showed, if the taxed sector has a 1-1 fixed proportion technology, capital and labor will equally share the tax burden.