1986

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Kul B. Bhatia

ISSN 0228-4235
ISBN 0-7714-0799-8

THE CENTRE FOR THE STUDY OF INTERNATIONAL ECONOMIC RELATIONS

WORKING PAPER NO. 8626C

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Kul B. Bhatia

This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

DEPARTMENT OF ECONOMICS
THE UNIVERSITY OF WESTERN ONTARIO
LONDON, CANADA
N6A 5C2

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by

Kul B. Bhatia*
Department of Economics
University of Western Ontario
London, Canada
N6A 5C2

September 1986

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Abstract

Many definitions of short run and long run, ranging from zero elasticities of substitution and demand to unchanged factor prices, exist in the tax-incidence literature. This paper emphasizes the Marshallian approach incorporating specific and mobile factors. In the short run, labor is mobile but capital is sector-specific. In the long run, capital becomes quasi-fixed and then perfectly mobile. Problems inherent in other specifications are illustrated by taxing one good in a two-sector general equilibrium model with endogenous demand. Several results on tax-incidence in the short run and the long run are also derived.

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One of the best known results of general equilibrium analysis of taxes is that a commodity tax will affect the functional distribution of income. The result, formally derived by Mieszkowski (1967) from a static two-sector Harberger model of tax incidence, states that the incidence of such a tax depends on comparative factor intensities: the tax burden falls more heavily on the factor used relatively intensively in the taxed industry.[1] Accordingly, if an excise tax has to be levied on one of two industries - say, steel which is relatively capital intensive and shoe manufacturing which is labor intensive - workers in general would choose steel whereas owners of capital would rather see a tax levied on shoes. Magnitudes of change in factor incomes of course will depend on elasticities of demand and substitution besides the capital labor ratios in the two industries.

Most public finance experts will consider this to be a long run result as it emanates from a model in which factors of production move freely and costlessly between the two sectors of the economy. From the same model, there is the Stolper-Samuelson theorem in international trade theory which deals with a slight variation of the tax problem, namely, the effects of commercial policy on the distribution of income, and it focusses on only relative factor intensities. As Mussa (1974, p. 1201) emphasizes, "In the long run... the magnitudes of factor income changes are independent of the degree of substitutability between capital and labor in either industry." Thus we have two candidates for the long run - one in which various elasticities matter, and the second in which relative factor intensities alone determine changes in factor incomes.

Turning to the short run, at least in the tax literature, one comes across a confusing array of things - from imperfect factor mobility (McLure (1969, 1971)) to fixed productive capacity (Asimakopulos and Burbidge (1974)), to constant factor prices, fixed production coefficients and more (Melvin (1979)). With such diverse terminology, how can there be a clear-cut analysis of the short run incidence of any tax? For example, if short run refers to immobile labor in a two good world with mobile capital (McLure (1974)), a commodity tax will reduce the rental on capital, lower the wage rate in the taxed industry and raise it in the other. If factor proportions are fixed, however, factor prices will not change, and a zero elasticity of substitution in either industry will eliminate any role for demand factors, as the analysis later will show. These "short run" results contrast rather sharply with each other and with the "long run" Mieszkowski result mentioned above.

The main objective of this paper is to suggest that much needless confusion can be avoided by adopting the Marshallian distinction between the short run and the long run based on specific and mobile factors of production. In the short run, the emphasis is on specific factors and their interaction with mobile factors whereas in the long run, the specific factors become quasi-fixed and then fully mobile as they move to alternative uses throughout the economy in response to differentials in their rewards.[2] Restrictions on elasticity of factor substitution or elasticity of demand can still be imposed, but that can be done in the short run or the long run, with rather different consequences as we shall see.

The approach being proposed here has numerous advantages over conventional analysis. Firstly, most commodity taxes are levied on firms for whom short run is invariably characterized by specific factors, usually capital. This approach puts tax analysis on the same footing as the theory of the firm. Secondly, the effect of factor specificity can be isolated from everything else that has been assumed for the short run in existing studies, especially the assumptions of fixed production coefficients or constant factor prices. Thirdly, some light can be shed on how an economy moves from the short run to the long run when a tax is levied. Earlier work on tax incidence has concentrated on one or the other.[3]

McLure has solved the short run model in a series of papers (1969, 1971, 1974), and Jones (1965) and Mieszkowski (1969) have derived the key result in the long run model which relates tax incidence to relative factor intensities. These authors, however, use somewhat different approaches and notation and they do not consider any linkage between the short run and the long run. Transition from the short run to the long run is an integral part of the anlaysis in this paper. We shall recast the two models into a common theoretical framework and highlight several results which have not been brought out in earlier studies.

The short run model is set out in the next section and Section III deals with transition to the long run. Results from the two models are compared and contrasted in Section IV. In Section V the relationship between the tax problem and the Stolper-Samuelson theorem is taken up, and Section VI contains some concluding remarks.

II. THE SHORT RUN MODEL

There are two commodities X_1 and X_2 and three factors of production: two types of capital K_1 and K_2 are specific to X_1 and X_2 respectively, and labor, L, is perfectly mobile between the two industries. Aggregate factor supplies are fixed, all factors are fully employed, and the two production functions are linear homogeneous with positive and diminishing marginal physical products for each input. If a_{ij} represents the use of input i per unit of output j, we can write the full employment conditions as:

$$a_{L1}X_1 + a_{L2}X_2 = L \qquad (1)$$

$$a_{K1}X_1 = K_1 \qquad (2)$$

$$a_{K2}X_2 = K_2 \qquad (3)$$

Or, by substituting for X_1 and X_2 from (2) and (3) into (1), we get after total differentiation:

$$\lambda_{L1}(\overset{*}{a}_{L1} - \overset{*}{a}_{K1}) + \lambda_{L2}(\overset{*}{a}_{L2} - \overset{*}{a}_{K2}) = \overset{*}{L} \qquad (4)$$

where λ_{L1} and λ_{L2} are the proportion of labor used in each industry and the asterisks represent proportional changes. For example, $\overset{*}{a}_{L1} = da_{L1}/a_{L1}$, etc. Firms minimize unit costs, and the zero-profit conditions are:

$$\theta_{L1}\overset{*}{w} + \theta_{K1}\overset{*}{r}_1 = \overset{*}{p}_1 \qquad (5)$$

and

$$\theta_{L2w}{}^{*} + \theta_{k2}\overset{*}{r}_2 = \overset{*}{p}_2 \qquad (6)$$

where p_1 and p_2 are the two commodity prices and θ's represent factor shares, e.g., $\theta_{L1} = wL_1/p_1X_1$, etc.[4] For given output prices, equations (4)-(6) can be used to determine changes in the three factor rewards w, r_1, and r_2. If relative output prices have to be determined endogenously, a demand function of course will be needed to close the model.

<u>Commodity Tax and Factor Income Changes</u>

When a tax is levied on the output of X_1, the direction of change in factor incomes (as opposed to its magnitude) can be determined without solving the full model. A simple diagram, Figure 1, often used in one-factor models and adapted from Mussa (1974) will suffice. The horizontal axis represents the total endowment of labor. O_1 is the origin for X_1 and O_2 for X_2. Each value of marginal produce curve is drawn with reference to the corresponding origin, for a given relative output price $p^0(= p_1/p_2)$, and the intersection of the two curves at E determines the wage rate (in terms of units of X_2) and the allocation of labor between the two industries at L_o. O_1L_o labor is employed in X_1, and the remainder, O_2L_o will be used in X_2. The earnings of labor in each industry can be computed by multiplying the wage rate w_0 by the number of workers employed there (the rectangular areas under the w^0 line), and the triangular areas between the w^0 line and the value of marginal product curves denote the incomes of K_1 and K_2, the two types of capital. These incomes are in the nature of rent because K_1 and K_2 are specific to X_1 and X_2, so they have no alternative use in the short run.

A tax per unit of output on X_1, for a given p^0, will shift the $VMPL_1$ curve proportionately downward. $VMPL_2$, being independent of the commodity-price ratio, will not move. The new equilibrium will be at F, with a lower wage rate w^1. Notice that the wage rate has fallen by less than the

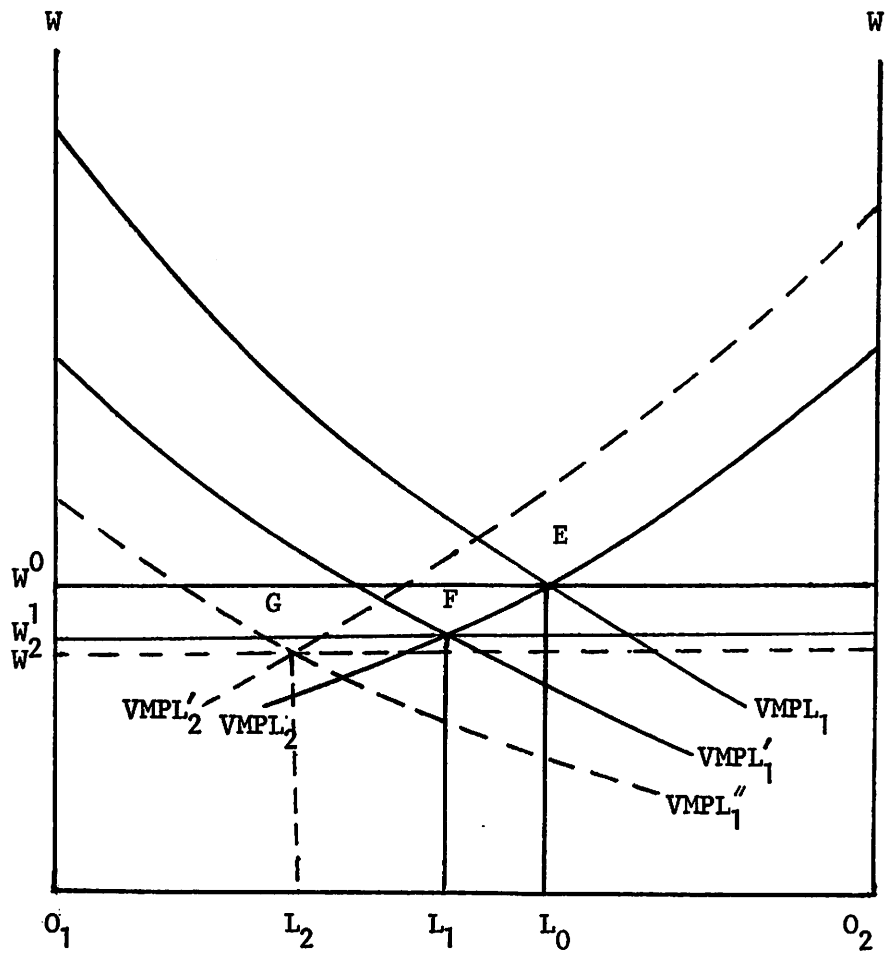

Figure 1: Labor Allocation in the Short Run and the Long Run

amount of the tax per unit of output. Capital in X_2 gains but that in X_1 loses. The gain to capital in X_2 is visible in the larger triangular area under the $VMPL_2$ curve. The loss to owners of capital in X_1 arises because L_0L_1 workers who previously contributed some "surplus" have moved to X_2. Moreover, the wage rate has not fallen by the full amount of the tax, so a portion of the tax has to come out of the earnings of capital in X_1.

The direction of change in factor incomes due to the commodity tax, thus, is completely determined by the assumptions of sector-specific capital and mobile labor. That, however, is not the complete picture because Figure 1 has been drawn for a given output-price ratio which, ordinarily, will change when an excise tax is levied. This result, however, will continue to hold, as will become apparent momentarily, even after an endogenous demand function is specified which will allow output prices to vary. The full model then will have to be solved to determine the magnitude of changes in factor incomes.

The Demand Side of the Model

For simplicity, it is assumed that the government spends the tax revenue exactly as private individuals would have, and that consumer preferences are homothetic so that redistribution of income will not change the pattern of demand. Changes in demand thus depend on changes in relative output price alone. Moreover, since full employment is also assumed, only one of the demand functions is independent. Demand conditions in the model can then be summarized by noting that the quantity demanded of X_1 depends only on p_1/p_2. Differentiating this function we obtain:

$$X_1^* = \varepsilon(p_2^* - p_1^*) \quad (7)$$

where ε is the price elasticity of demand defined to be positive.[5]

Commodity Tax and the Distribution of Factor Incomes

The model has to be solved for changes in relative factor rewards w/r_1 and w/r_2 to determine how the distribution of factor incomes will be affected. Clearly, if w/r_1 and w/r_2 do not change, relative factor shares cannot change because of the assumptions of fixed factor endowments and full employment. The solution of the model can be greatly simplified by setting all initial prices to unity by suitable choice of units and by choosing the wage rate w as the numeraire, so $w^* = 0$ everywhere.[6] L^*, K_1^* and K_2^* will be zero because of the assumption of fixed factor supplies.

If T_1^* denotes the proportional rate of change in the tax rate, the zero-profit conditions are reduced to $\theta_{K1}r_1^* + T_1^* = p_1^*$ and $\theta_{K2}r_2^* = p_2^*$, and the demand function, after substituting for p_1^* and p_2^*, can be written as:

$$X_1^* = \varepsilon(\theta_{K2}r_2^* - \theta_{K1}r_1^*) - \varepsilon T_1^* \quad (8)$$

The next step is to determine the proportionate change in the supply of X_1 and equate it to the corresponding change in demand for equilibrium in the goods market. That and the full employment condition for labor will then lead to a solution for r_1^* and r_2^* from which the zero profit conditions can be used to solve for p_1^* and p_2^*.

Totally differentiating (2) yields $a^*_{K1} + X^*_1 = 0$, and using the definition of elasticity of substitution (σ^1) we get:[7]

$$X^*_1 = \sigma^1_{KL}\theta_{L1}r^*_1 \tag{9}$$

Since the only elasticities of substitution throughout the paper are those involving labor and capital, we shall drop the subscripts K and L, and use superscripts 1 and 2 to refer to X_1 and X_2 respectively.

Equating (8) and (9) yields (10), the equilibrium condition in the goods market:

$$\epsilon\theta_{K2}r^*_2 - (\epsilon\theta_{K1} + \sigma^1\theta_{L1})r^*_1 = \epsilon T^*_1 \tag{10}$$

By substituting for a^*_{L1}, a^*_{K1}, etc. in (4), the full employment condition for labor can be rewritten as:

$$\lambda_{L1}\sigma^1 r^*_1 + \lambda_{L2}\sigma^2 r^*_2 = 0 \tag{11}$$

Now, from equations (10) and (11), we get by using Cramer's rule:

$$r^*_1 = -\epsilon\ \lambda_{L2}\sigma^2 T^*_1/\Delta, \text{ and} \qquad (12)$$
$$r^*_2 = \epsilon\ \lambda_{L1}\sigma^1 T^*_1/\Delta$$

where $\Delta = \epsilon(\theta_{K2}\lambda_{L1}\sigma^1 + \lambda_{L2}\theta_{K1}\sigma^2) + \lambda_{L2}\theta_{L1}\sigma^1\sigma^2$ which is positive because ϵ, σ^1, σ^2, λ's and θ's are all positive.

Since the wage rate, w, is the numeraire, r_1^* and r_2^* in expression (12) really indicate changes in relative factor rewards. They confirm the result derived above from Figure 1 that the tax will hurt owners of capital in the taxed industry and benefit those in the untaxed industry.[8] The result holds even when output prices are endogenously determined. It is worth noting that unless ε, σ^1 or σ^2 are zero, the signs of r_1^* and r_2^* do not depend on any parameters of the model: $r_1^* < 0$ and $r_2^* > 0$ solely because capital has been assumed to be sector-specific and labor is mobile. The solutions for r_1^* and r_2^* also clearly show how important factor substitution (via σ^1 and σ^2) and factor intensities (via factor shares, the θ's) are in determining the magnitude of changes in the distribution of factor incomes even though they do not affect the direction of income changes.

Incidentally, r_1^* and r_2^* also hold the key to the incidence of the commodity tax in this model because how the burden of the tax is ultimately borne depends on what happens to factor shares. If r_1^* and r_2^* turn out to be zero, factor shares will not alter, so the three factors will share the burden of the tax in proportion to their initial contribution to national income. The factor whose relative reward falls (K_1 in the present case) will suffer more. We can now state a number of results about tax incidence based on the solutions in (12).

<u>Result 1</u>. <u>If the elasticity of demand for the taxed good is zero, the three factors of production will bear the burden of the tax in proportion to their initial contribution to national income</u>.

In this case, $r_1^* = r_2^* = 0$. When a commodity tax is levied, factor prices change because of alterations in the levels of output. If demand is completely inelastic, the goods market can be in equilibrium at only one level of relative outputs. Since all factors have to be fully employed, it follows that there will be no change in relative factor rewards or factor intensities.

Result 2. If elasticity of substitution between labor and capital is zero in either industry, demand conditions will have no bearing on the incidence of the commodity tax.[9]

If σ^1 or σ^2 is zero in (12), the elasticity of demand, ε, simply cancels out (assuming $\varepsilon \neq 0$). This result can be easily explained by noting that if labor cannot be substituted for capital in one industry, a given number of workers will be needed to ensure full employment of capital which is specific to that industry. Output levels, thus, will be supply determined, independently of demand conditions.

Result 3. If demand is not completely inelastic, but the elasticity of substitution in the taxed industry is zero, the tax will be borne entirely by the specific factor in that industry.

In this case $r_2^* = 0$ and $r_1^* = -1/\theta_{K1}$. Since capital must be fully employed, and there are fixed proportions in the taxed industry, labor cannot be released. Therefore, there is no change in the capital-labor ratio in either industry. Relative return to capital in the untaxed industry does not change, and K_1 suffers the entire burden of the tax.

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A corollary of this result is that larger values of σ^1, other things being equal, will benefit both specific factors of production. From (12), $\partial r_1^*/\partial\sigma^1 > 0$, which implies that the decline in r_1 will be smaller the greater is σ^1. Since σ^1 appears only in the denominator of r_1^*, in the limit, as $\sigma^1 \to \infty$, $r_1^* \to 0$. In the other industry, differentiating r_2^* partially w.r.t. σ^1 we get:

$$\partial r_2^*/\partial\sigma^1 = \epsilon^2 \lambda_{L1}\lambda_{L2}\theta_{K1}\sigma^2 T_1^*/\Delta^2.$$

which is positive because none of the terms is negative.

To understand this corollary, note that when σ^1 is zero, there is no reallocation of labor in the economy when the tax is levied on X_1. Therefore, there is no change in w or r_2. Now, if capital can be substituted for labor in the taxed industry, some labor will be released from X_1. For a given σ^2, thus, there will be some excess supply of labor, and wage rate will fall benefitting both specific factors because their rents are determined as a residual. The "effective protection" to specific capital in both sectors is enhanced by a decline in the wage rate.

Result 4. If demand is not completely inelastic, but elasticity of substitution is zero in the untaxed industry, the tax is borne by all labor, and by capital in the taxed industry.

In fact, in this situation, the tax ends up benefitting capital in the untaxed industry because when $\sigma^2 = 0$, $r_1^* = 0$, and $r_2^* = 1/\theta_{K2}$. This curious result can be explained by noting that because of the tax, labor will be released from the X_1 industry, but it cannot be absorbed in the other industry because of the assumption of fixed proportions. Therefore, at the initial relative factor prices, there will be excess supply of labor, so labor must become relatively cheaper. In X_1, r_1 must also fall proportionately with w to restore the original capital-labor ratio. In X_2, because of the lower wage, the wage bill (wL_2) will be lower; therefore, capital in that sector will benefit. Reduction in wages increases the "effective protection" afforded to specific capital used in producing X_2.

As in the case of Result 3, an analogous corollary can be stated here as well: the greater is the elasticity of factor substitution in the untaxed industry, <u>ceteris paribus</u>, the worse it will be for both specific factors. Partial differentiation of (12) shows that both $\partial r_1^*/\partial\sigma^2$ and $\partial r_2^*/\partial\sigma^2$ are negative. In the case of r_2^*, since σ^2 appears only in the denominator, as $\sigma^2 \to \infty$, $r_2^* \to 0$. The elasticity of substitution in the untaxed industry determines how easily it can absorb the labor released from the taxed industry. A higher value of this elasticity implies that, other things being equal, there will be a smaller decline in the wage rate, so the rents of the specific factors will be lower.

<u>Effect on Commodity Prices</u>

By substituting the solutions for r_1^* and r_2^* into the two price equations we get:

$$p_1^* = (\epsilon\theta_{K2}\lambda_{L1}\sigma^1 + \lambda_{L2}\theta_{L1}\sigma^1\sigma^2)T_1^*/\Delta$$
$$p_2^* = \epsilon\theta_{K2}\lambda_{L1}\sigma^1 T_1^*/\Delta$$

These lead to several interesting results about output prices.

Result 5. If demand is inelastic, the price of the taxed good will rise by the full amount of the tax, but the price of the untaxed good will remain unchanged.

This essentially follows from Result 1. When $\epsilon = 0$, relative factor rewards do not change, there is no alteration in factor ratios or the production cost of each good, so p_2 is unaffected and p_1 will rise by the full amount of the tax.

Result 6. The relative output price (p_1/p_2) will remain unchanged so long as there are fixed proportions in either industry.

Change in relative output price $(p_1^* - p_2^*)$ is given by $\lambda_{L2}\theta_{L1}\sigma^1\sigma^2T_1^*/\Delta$, and that will be zero if either σ^1 or σ^2 is zero. It is worth noting that if only the taxed industry has fixed factor ratios, neither output price will change and the entire tax will come out of the earnings of the specific factor in the taxed industry, which corresponds to Result 3 above. If σ^2 alone is zero, however, both p_1 and p_2 will increase equally, although by less than the amount of the tax. As Result 4 points out, in this case both w and r_1 decline equally while r_2 rises. In the taxed industry, the tax exceeds the reduction in factor cost whereas in X_2, increase in r_2 relative to the wage rate ensures that p_2 also goes up.

Tax Incidence and Specification of the Short Run

The results and the equations in this section illustrate the pitfalls inherent in murky specifications of the short run. If it merely implies fixed productive capacity in the economy, it is compatible with all the above results and also with the ones to follow in the next section because we have assumed fixed factor endowments for the economy, and there are no other capacity expanding devices such as technical progress in the model. Fixed capacity in each sector, inasmuch as it implies a given quantity of specific capital, of course will support everything in this section. If short run is characterized by constant relative factor rewards, as has been assumed in some existing studies (e.g. Melvin (1979)), that can come about in this model through inelastic demand ($\epsilon = 0$), or if some demand response is possible, fixed proportions in one industry will ensure an unchanged ratio of factor rewards in the other. For instance, in Result 3, with $\sigma^1 = 0$, $r_2^* = 0$ whereas in Result 4, when $\sigma^2 = 0$, $r_1^* = 0$. It is important to recognize that the distribution of factor incomes will be affected quite differently in these two cases. When Result 3 holds, neither r_2 nor the wage rate changes, and the entire tax revenue comes out of the earnings of capital in X_1. In case of Result 4, however, the wage rate falls pari passu with r_1, and r_2 actually increases so that labor throughout the economy and capital in X_1 suffer an income loss while owners of capital in X_2 gain.

The arguments in the above paragraph carry over to estimating changes in commodity prices as well, so no further elaboration is needed here. The specific-factor model shows that of all the assumptions that have been used to "define" the short run, the one about constant relative factor prices is the most slippery, and as the model in the next Section will show, unchanged factor prices can come about in several different ways even when no specific factors are present. Merely assuming unchanged factor rewards, therefore, can conceal a lot about the underlying structure and parameters of the economy.

<u>Which Industry to Tax?</u>

The model in this section recognizes that a shoe factory cannot be instantaneously and costlessly converted into a steel mill although a shoe maker can easily become a steel worker. Armed with the analysis in this section, who will support a tax on which industry? Clearly, if demand is inelastic, the three factors will be indifferent between the two industries because they will all suffer according to their initial factor shares. But if demand is not completely inelastic, and factor proportions are fixed in the steel industry, stockholders in that industry will staunchly oppose any excise tax on steel. On the other hand, if capital and labor must be used in a fixed ratio for making shoes, all workers will join the stockholders in the steel industry in staving off a commodity tax on steel, to be opposed, of course, by owners of capital in the shoe industry who will stand to gain by a tax on steel.

III. FROM SHORT RUN TO LONG RUN

The essence of the Marshallian approach to the short and the long run is that capital is a quasi-fixed factor. It is specific in the short run, but over time it moves in response to differentials in rates of return so that in the long run there is only one rental for capital throughout the economy. The question to consider, therefore, is: "How do rewards of factors and their distributive shares alter when capital moves from one sector to the other?"

Once again we can begin with Figure 1. The initial intersection of $VMPL_1$, and $VMPL_2$ at E can be viewed as a long run equilibrium whereas F is the short run equilibrium after the excise tax on X_1 has been levied, with $r_1 < r_2$. When capital is free to move, it will go from X_1 to X_2. For a given allocation of labor at L_1, the capital-labor ratio falls in X_1 and rises in X_2 which implies that $VMPL_1$ shifts further down to $VMPL_1''$ while $VMPL_2$ shifts up to $VMPL_2'$. What happens to the wage rate and to other factor rewards when a unit of capital moves from X_1 to X_2 depends on the horizontal shift in the two VMPL curves and that, in turn, depends on the long run relative capital-labor ratios in the two industries because the two production functions are assumed to be linear and homogeneous. If the taxed industry is relatively labor intensive, the wage rate will fall and vice versa.

In order to see this result more clearly, equations (2) and (3) are added together to form a full employment condition for capital analogous to equation (1) for labor. By totally differentiating the two full employment conditions then we get the following equations of change:

$$\lambda_{L1}X_1^* + \lambda_{L2}X_2^* = -\delta_L r^* \qquad (13)$$

$$\lambda_{K1}X_1^* + \lambda_{K2}X_2^* = \delta_K r^* \qquad (14)$$

where $\delta_L = \lambda_{L1}\theta_{K1}\sigma^1 + \lambda_{L2}\theta_{K2}\sigma^2$ and $\delta_K = \lambda_{K1}\theta_{L1}\sigma^1 + \lambda_{K2}\theta_{L2}\sigma^2$. As before, L^*, K^* and $w^* = 0$ because of factor endowments and the choice of wage rate as the numeraire. Notice that δ_L and δ_K will be zero whenever $\sigma^1 = \sigma^2 = 0$.[10] From (13) and (14) we obtain by Cramer's rule:

$$X_1^* = -[\lambda_{K2}\delta_L r^* + \lambda_{L2}\delta_K r^*]/|\lambda| \qquad (15)$$

where $|\lambda|$ is the determinant of λ_{L1}, λ_{L2}, λ_{K1} and λ_{K2}, and it is positive or negative as X_1 is relatively labor or capital intensive.[10] Equating change in the supply of X_1 (equation (15)) to the corresponding change in its demand (equation (8)), we obtain:

$$r^* = |\lambda| \; \varepsilon \; T_1^*/D \qquad (16)$$

where $D = \varepsilon(\theta_{K2} - \theta_{K1})(\lambda_{L1} - \lambda_{K1}) + \lambda_{K2}\delta_L + \lambda_{L2}\delta_K$.

All three terms in D are positive: the second and third terms are simply products of λ's, θ's and σ's which are all non-negative by definition. In the first term, ε is positive and $(\theta_{K2} - \theta_{K1})$ and $(\lambda_{L1} - \lambda_{K1})$ always have the same sign. If X_1 is relatively labor intensive, $\lambda_{L1} > \lambda_{K1}$ and $\theta_{K2} > \theta_{K1}$, and vice versa. The sign of r^*, therefore, depends on the numerator of (16) or on $|\lambda|$ since ε is defined to be positve. When $|\lambda| > 0$, which implies that X_1 is relatively labor intensive, $r^* > 0$, i.e. the wage-rental ratio in the economy falls (because w is the numeraire), and the opposite will hold when X_1 is relatively capital intensive. This is what was suggested above by Figure 1 when $VMPL_1$ and $VMPL_2$ were shifted due to movement of capital from X_1 to X_2.

The results derived so far show that in the short run, assumptions about factor mobility determine the direction of change in factor incomes even when commodity prices are allowed to change. Unless some restrictions are placed on elasticites of substitution and demand, a commodity tax will hurt the specific factor in the taxed industry and benefit the factor which is immobile in the other industry. During the transition to the long run, directions of income change depend only on the capital labor ratios in the two industries. Magnitudes of changes in factor incomes, of course, will also depend on elasticity of demand and the two elasticities of factor substitution.

IV. COMPARISONS WITH THE SHORT RUN MODEL

In the short run model, the direction of change in factor incomes as a result of the commodity tax was determined by the assumption about factor mobility. Here that role is played by relative capital labor ratios in the two industries. Magnitudes of changes in factor incomes, of course, depend on elasticities of substitution and demand, factor shares, etc. Another similarity between the two models is that Result 1 will hold whenever demand is completely inelastic. With $\epsilon = 0$, regardless of factor mobility assumptions, relative factor rewards will not change: r_1^* and r_2^* in equation (12) and r^* in (16) will be zero when $\epsilon = 0$. A few more general results of this type will further help in comparing and contrasting the two models.

Result 7. If elasticity of substitution between labor and capital in both industries is zero, demand conditions will not affect the incidence of the commodity tax.

When $\sigma^1 = \sigma^2 = 0$, as noted above, δ_L and δ_K will be zero. In (16), $r^* = T_1^*/(\theta_{K2} - \theta_{K1})$ which is entirely independent of ϵ (assuming $\epsilon \neq 0$). In the short run model, this result came about when either σ^1 or σ^2 was zero. The more stringent requirement in the present case is needed precisely because capital is also mobile. With immobile capital, fixed proportions in one industry were sufficient to maintain the initial factor allocation in the two industries which determined the two output levels independently of demand. That, in the present case, requires that factor proportions be fixed in both industries.

One aspect of this result has a direct bearing on Results 3 and 4 derived above. Since $r^* = T_1^*/(\theta_{K2} - \theta_{K1})$, it is positive or negative as $\theta_{K2} \gtrless \theta_{K1}$. In other words, if the share of capital in the taxed industry is less than that in the other industry, capital will tend to benefit from a commodity tax in industry X_1. In Results 3 and 4, although elasticity of demand was irrelevant, share of capital in either industry did not affect the direction of income change as a result of the tax. Moreover, unlike the present case, the relative magnitudes of θ_{K2} and θ_{K1} did not matter because capital in one industry had nothing to do with capital in the other industry.

Result 8. The higher is the elasticity of substitution between labor and capital in either industry, the greater will be the tendency for capital and labor to bear the tax in proportion to their initial income shares.

The two elasticities of substitution appear only in the denominator of r^* in (16). As either σ becomes larger and larger, r^* gets smaller and smaller, approaching zero in the limit. Both σ's together have an important role to play in determining the excess demand or supply of labor and capital due to the commodity tax and in restoring equilibrium in the factor markets, and the two elasticities of substitution affect relative factor rewards in a symmetrical fashion. By contrast, in the short run model, as the corollaries to Results 3 and 4 showed, larger values of σ^1 were beneficial to capital whereas higher σ^2 hurt capital in both industries.

Result 9. If the two industries have the same capital-labor ratio, labor and capital will bear the burden of the tax in proportion to their initial contribution to national income.

If $K_1/L_1 = K_2/L_2$, $|\lambda| = 0$, and $r^* = 0$ in equation (16), so the wage-rental ratio does not change. As the taxed industry contracts in response to the tax, capital and labor released from it are absorbed in exactly the same ratio in the other industry. So far as the production side of the economy is concerned, the two industries thus can be regarded as one. There is no excess demand or supply for either factor of production. The short run model attached no special significance to relative factor intensities as such.

These results carry over to commodity prices as well. When demand is completely inelastic, $r^* = 0$, p_1 will rise by the full amount of the tax while p_2 will remain unchanged as in Result 5. Relative output price $(p_1 - p_2)$ will not change if there are fixed proportions in both industries, not in just one industry as required by Result 6. This is a reflection of Result 7 presented above.

The Question of Unchanged Factor Prices

In the specific factor model, relative factor prices could remain unchanged only if the taxed good had a completely inelastic demand. That outcome will obtain in the present model under two other conditions as well: when the two industries have the same capital-labor ratio or when one of the two elasticities of substitution is quite large. Constant factor prices thus can occur both in the short run and the long run, in fact in more ways in the latter than in the former. Following the Marshallian approach, there is no need to apply this or any other restriction on factor prices or on elasticities of substitution to define short run or long run. Rather, one can examine the implications of such restrictions for incidence or other effects of a given tax. The same parameter could play a very different role in the short run and the long run. For example, a large elasticity of substitution in the untaxed industry will hurt capital in the short run (corollary, Result 4), but in the long run it will affect both labor and capital equally.

Which Industry to Tax?

Possible short-run responses to this question were considered above. How will it be answered in the long run? As noted at the outset of the paper, the answer basically depends on relative factor intensities. In our example, workers will not favor a tax on shoes, nor will owners of capital support a tax on steel. In the short run, some capital owners (in the shoe industry) could benefit from a tax on steel (Result 4). In this context, a number of other points are worth noting. Firstly, in the long run, all capital stands to gain or lose together. Because of the assumption of perfect mobility, there can be no conflict of interest between the owners of capital in the two industries. Secondly, when demand is inelastic, all factors of production will be indifferent between the two industries, both in the short run and the long run because relative factor rewards will remain unchanged. Thirdly, in choosing the taxable industry in the short run, workers will switch sides depending on which industry has fixed production coefficients. A comparison of Results 3 and 4 suggests that if $\sigma^1 = 0$, workers will favor an excise tax on X_1, but not so if $\sigma^2 = 0$. In the long run, elasticities of substitution have no such role because zero values of σ^1 and/or σ^2 will not lead to an unchanged wage-rental ratio. It is interesting to observe that in the long run, large, not small values of σ, will make a bigger difference. Workers will never support a tax on the labor intensive shoe industry, but they will not care when either σ^1 or σ^2 is very large. Fixed proportions in one or both industries will not alter the basic long-run conclusion based on relative factor intensities.

V. THE STOLPER-SAMUELSON THEOREM AND LONG RUN TAX INCIDENCE

Now we can address the issue raised in the Introduction as to whether there is a long run in tax-incidence analysis, analogous to the famous theorem in international trade, in which changes in factor incomes on account of an excise tax depend only on relative factor intensities, independently of the elasticity of substitution between labor and capital in either industry.

Well, there is Result 7 in which $r^* = T_1^*/(\theta_{K2} - \theta_{K1})$, so changes in factor incomes depend only on relative factor intensities in X_1 and X_2, as measured by the difference in factor shares, exactly as in the Stolper-Samuelson theorem.[11] But that really is not very satisfactory because of the required assumptions, $\sigma^1 = \sigma^2 = 0$, and $\epsilon \neq 0$. The tax model and the Stolper-Samuelson model are really referring to the same long run. The only difference is that the latter assumes commodity prices to be exogenous while they are endogenous in the tax model. In fact, with fixed commodity prices, changes in factor prices due to a commodity tax could be determined from the zero-profit conditions independently of elasticities of substitution and demand, and as Jones (1965) shows, even the Stolper-Samuelson long run result will be affected by these elasticities once the production model is closed with endogenous demand.

VI. CONCLUSIONS

This paper has emphasized the Marshallian distinction between the short run and the long run, based on mobile and specific factors of production, as a way of clarifying a number of issues in tax-incidence analysis. The results illustrate the problems that can arise when short and long run are defined by restrictions on factor proportions or on changes in factor prices rather than by assumptions about factor mobility. When all is said and done, even the "long run model" in this paper falls short of the long run in growth theory which invariably entails capital accumulation and population growth. Marshall was right. "Of course there is no hard and sharp line of division between 'long' and 'short' periods." (Principles, V, v. 8). One distinguishes between them for analytical purposes, for highlighting specific issues. When a sharp division between the two periods is necessary, Marshall recommended the use of a special interpretation clause," ... but the occasions on which this is necessary are neither frequent nor important," he wrote (ibid.). In analysing taxes, numerous such occasions arise, with rather important implications, as the case of a commodity tax considered here has shown. The Marshallian distinction stressed in this paper can stand us in good stead, by at least saving a lot of interpretation clauses.

FOOTNOTES

[1]Jones (1965) derives a similar result for output subsidies in the two sectors.

[2]That still leaves the anamoly of a specific factor in the long run (Ratti and Shome (1977)), but that can be ignored in the present context.

[3]The parallel literature on international trade seems to be remarkably free from the problems that have crept into the tax field. Haberler (1936) made a distinction between the short and the long run along the lines of this paper. Jones (1971) has a lucid explanation of the specific-factor model. Mayer (1974) and Mussa (1974) deal with both short run and long run equilibria, focussing on trade-policy issues. In keeping with much of trade theory, they do not consider demand factors. Atsumi (1971) develops a dynamic trade model with capital accumulation and growth.

[4]For details of the derivation of equations (4), (5), and (6), see Jones (1971) pp. 6,7.

[5]This is the demand function commonly employed in the Harberger model. It also requires the assumption that there are no taxes in the initial situation.

[6]Figure 1, in effect, used p_2 as the numeraire which is also used by McLure (1969, 1971, 1974). The choice of a numeraire is essentially arbitrary although it does change the form of certain expressions. We have chosen w as the numeraire because that has been the common choice in long run incidence models. While we cannot solve for w^* explicitly, we can examine changes in commodity prices rather clearly, and that is of considerable interest in a tax-incidence context.

[7]The elasticity of substitution between capital and labor in X_1, $\sigma^1_{KL} = \frac{a^*_{K1} - a^*_{L1}}{w^* - r^*_1}$. Also if a_{K1} and a_{L1} are chosen so as to minimize unit cost, $\theta_{K1}a^*_{K1} + \theta_{L1}a^*_{L1} = 0$. Expression (9) is easily derived from these after setting $w^* = 0$.

[8]In Figure 1, both w and r_1 declined. Since w is the numeraire here, $r^*_1 < 0$ implies that r_1 falls proportionately more than w. The model of course can be solved for w^*, r^*_1 and r^*_2 by selecting another numeraire, say, p_2, which was used in Figure 1.

[9]We rule out the case in which both σ^1 and σ^2 are zero or in which ϵ also is zero to avoid dividing zero by zero.

[10]The two full employment conditions and the two production functions summarize the production side of this model. For a derivation of (13) and (14), see Atkinson and Stiglitz (1980) pp. 169,170 where an elaboration of $|\lambda|$ and the corresponding matrix of factor shares $|\theta|$ can also be found. These are also given in Jones (1965).

[11]Formally, the theorem can be proved by solving for w^* and r^* from the zero-profit conditions (5) and (6), and the solutions will be independent of ϵ_1, σ^1_1 and σ^2.

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