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34

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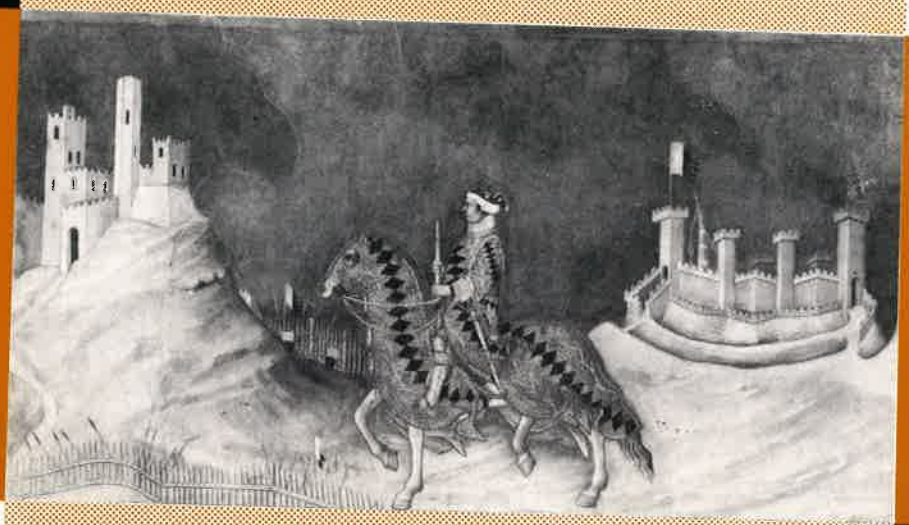
PRODUCED INPUTS AND TAX INCIDENCE THEORY



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Ian Steedman è professore presso l'Università di Manchester. Questo quaderno è stato presentato in un seminario tenuto presso l'Istituto di Economia dell'Università di Siena in data 6 marzo 1985.

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*I. Introduction**

It will perhaps be generally agreed that the theory of tax incidence has been greatly strengthened by the widespread adoption of the two-commodity, two-factor general equilibrium framework and that 'The single most important step forward in applying a general equilibrium approach to public finance questions came with Harberger's adaption of the two-sector competitive equilibrium model in his analysis of the incidence of corporation tax (1962)' (Atkinson and Stiglitz, 1980, p. 163). Since then, 'The simple competitive general equilibrium model...has been widely used in public economics' (*ibid.*, p. 197). Of course, "the study of public policy can be no more firmly based than the economic theory on which it draws" (*ibid.*,p. 13) and, in particular, "the study of taxation can be no more soundly based than the models that are employed (explicity or implicity)" (*ibid.*, p. 226). It follows, then, that it is important for tax incidence theorists to give careful consideration both to the various aspects of the familiar 2 x 2 model which may be open to objection and to the implications for incidence theory of meeting those objections.

Throughout this paper we shall accept the common framework of a perfectly competitive, closed economy, in which markets clear, there are constant-returns-to-scale in production and there are fixed supplies of the factors, which are fully mobile between the two industries. Moreover, we shall ignore joint production, assume that no taxes lead to any vertical integration between the industries, and give demand side complications short shrift by supposing that all households *and* the government share a common, homothetic preference map which determines their respective consumptions of the two produced commodities. These various assumptions are made not on the grounds that they are self-evidently reasonable but because we wish to focus all our attention

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on just one set of issues: the role of produced means of production and of the factor 'capital'. There will be no need to demonstrate here the very great importance of produced inputs in every modern economy but it may be useful, before we begin our own analysis, to consider briefly the way in which capital goods and 'capital' *sans phrase* have been treated in the tax incidence literature.

II. References to the literature

The many aspects and connotations of 'capital' notwithstanding, the term has, traditionally, always referred to produced means of production, by contrast with either labour or (non-produced aspects of) land. The long-run, similarly, has always referred to that period in which capital goods can be reproduced and can be replaced - or not, according to the capitalists' profit maximising plans. Correspondingly, since the amounts of specific capital goods are endogenously chosen, the "return to capital" takes the form of a uniform rate on the value of capital goods (and no simply that of a specific quasi-rent on each particular produced input). Since general equilibrium tax incidence theory typically deals with long-run analysis of a system employing capital, one might expect then always to find both a clear emphasis on the *rate* of return and a clear statement of the relationship between the stock of capital and the output of the industry or industries producing capital goods. That obvious expectation, unfortunately, is not always satisfied.

Harberger (1962) states at the outset of his oft-cited paper that he is concerned with long-run analysis (p. 215) and that rates of return, net of risk premia, are equalised (pp. 215, 217). The aggregate supplies of both capital and labour are taken as given (p. 216). On p. 224 it is then said that units of measurement will be so chosen that both the products, X and Y, and capital and labour have initial prices of *unity*. (This is partially repeated on p. 225 - 'we choose units of labor and capital so that their initial prices are equal to unity'.) The 'price of labour' here can, of course, only mean the price of a unit of labour service, since there are no slaves, but what is meant by the

'price of capital'? It cannot mean the *rate* of return, for that cannot be made unity by any choice of measurement units. Nor, apparently, can it mean the price of a single capital goods, for it is not supposed in Harberger's analysis either that $p_k = p_x$ or that $p_k = p_y$ and one of the these relations would have to hold under such an interpretation. Is p_k the price of one unit of capital service? In this case one might expect to find within Harberger's argument some explicit discussion of the relationship between the rate of return, p_k and p_x and/or p_y (depending on whether X and/or Y is a capital good as well as a consumer good) but any such discussion is, at the very least, kept well-hidden. Harberger makes clear neither what his given amount of capital consists of, and is measured in terms of, nor what relations are supposed to hold between p_k, p_x, p_y and the rate of return, even though his analysis is avowedly conducted in long-run terms. Indeed, were is not for his preliminary remarks concerning the equalisation of rates of return, one might well think that his 'capital' is merely an unfortunate name for *land*, a non-labour, primary input which is qualitatively distinct from each of the produced outputs, X and Y! This interpretation would immediately dispel any uncertainties about Harberger', treatment of produced inputs - there just would not be any - albeit at the cost of leaving wide-open the question whether his conclusions also apply to a modern industrial economy.

Mieszkowski (1967) takes up the Harberger analysis, with fixed supplies of 'K and L' and production of 'X and Y' but says rather more about the concept of capital. "Capital goods are durable producers' goods...the rate of depreciation of capital is the same in both industries" (p. 250). Since this common rate of depreciation is not, in general, zero, while 'The *total* supplies of each of the two factors (K and L) are assumed to be fixed' (p. 250), it follows that capital goods are being produced to make good the depreciation. Indeed Mieszkowski explicitly refers to 'the production of consumption and capital goods' (p. 251). Since X and Y are the only commodities produced, capital must consist, in physical terms, of quantities of X and/or Y. And yet Mieszkowski's analysis

involves no apparent reference to any necessary relationship(s) between the 'price of capital', on the one hand, and p_x and/or p_y, on the other. In his 1969 paper, Mieszkowski is a little more explicit. After stating that 'In contrast with Austrian capital theory that viewed capital as goods in process, modern distribution theory emphasizes capital as durable producers' good' (p. 1104), he goes on to state that competition would lead to a 'single rate of return on real capital (the rate of interest) which would equate the present value of the rentals (gross profits) on a particular asset to its cost of production' *(ibid.)*. New production of capital goods is again referred to quite explicitly on pp. 1104 and 1105. Even in this paper, however, the relationship(s) between the 'price of capital' and p_x and/or p_y play(s) no central role. Mieszkowski's references to 'dynamic incidence theory' (pp. 1103, 1113) and to the effects of taxation on positive net savings, nevertheless seem to suggest two possible interpretations of his treatment of capital in 'static' incidence theory: either it is a physically homogeneous stock of *one* of the produced commodities (X or Y) or it is the *value* of a heterogeneous stock, expressed in terms of some standard of value (presumably the same standard as is used to measure net savings).

Johnson and Mieszkowski (1970), after introducing the usual assumption of given supplies of mobile, homogeneous labour and capital, assert that their 'assumptions beg certain questions in capital theory, but the questions are not crucial for the present purpose' (p. 540). In more expansive mood a year later, Johnson (1971) suggested that Shove was quite right to reject any concept of capital as an original factor of production but went on, 'I shall, however, ignore this problem for the time being, a procedure that can be rationalized by identifying "capital" with a stock of perfectly malleable equipment used in the production process, in combination with labour' (p. 13). The phrase 'for the time being' appears to refer only to the fact that, later on in the book, Johnson interpreted his two-sector model as a one consumer good, one capital good growth model; certainly the suggested malleability interpretation appears

still to be employed when Johnson presents what is, in effect, Johnson and Mieszkowski (1970, referred to immediately above). Once again one can only remark that *either* this perfectly malleable capital is really land passing under a misnomer or one is entitled to be told far more about the physical and price relationships between this capital, on the one hand, and the two produced commodities, on the other. (It is to be noted that, while Johnson and Mieszkowki's 1970 paper is centred on the effects of labour unionisation, the authors point out that 'Our characterization of the impact of unions has been formulated in such a way that the unionization of an industry is equivalent to a tax on labor in a particular sector of the economy' (p. 559).)

In 1975, McLure presented a very long survey discussing the logic of the Harberger analysis, subsequent developments, possible further extensions and a number of inadequacies, yet at no point did it seem important to him to consider the treatment of the factor 'capital' or its relation to the two produced commodities. (Even though he touched, in his § 7.2, on savings as leading to changes in 'K'.) Even more pointedly, Vandendorpe and Friedlaender (1976) summarised their work by saying that 'This paper has extended the standard two-sector, two-factor, general-equilibrium model...' (p. 225), when there appears to be absolutely nothing in their analysis to distinguish 'capital' from non-produced *land*. Their 'capital' does not seem to depreciate or to have any connection with either produced commodity (other than being used in their production). That Vandendorpe and Friedlaender could see their analysis as an extension of the normal one, shows very clearly that 'capital' in the normal framework is not treated really seriously.

In introducing the static, two-sector tax incidence analysis, Atkinson and Stiglitz (1980, p. 165) state that the two factors, capital and labour, are given in quantity but mobile between sectors and continue, 'In this sense it is neither a short-run nor a long-run model; and the assumptions are probably better seen as a useful analytical device...than as corresponding to any actual time period'. Most readers have, presumably, always thought that, since Marshall

at least, the long-run/short-run distinction hase never been anything other than an analytical device, having little or nothing to do with any specific length of time. But it seems that in their (solecistic?) usage, Atkinson and Stiglitz use 'long-run' to refer to a period of time in which a non negligible amount of capital accumulation can take place and *not* with reference to fully endogenous choice of the physical *composition* of the capital stock, with a consequent tendency to a uniform rate of return on their value. By contrast, of course, Robbins (1930) described as a long-run, static analysis precisely one in which the total value of capital is given, the rate of interest is uniform, and the composition of the capital stock is endogenous. To raise this terminological matter might seem pedantic were it not for the fact that Atkinson and Stiglitz go straight on (*ibid.*) to refer to 'the rate of return (rental price of capital)', which leaves the reader uncertain whether it is indeed a rate or a rental that is referred to. The later statement (p. 167) that 'The cost function is homogeneous of degree one in factor prices' naturally suggests that a rental is intended - but why then was a 'rate of return' referred to, with all the strong associations that term has with an analysis of the long-run (as traditionally understood)? And why, only three pages later, is there then a reference to 'the wage relative to the *rate* of profit' (emphasis added)? Perhaps because the authors feel uneasy about their treatment of 'capital' in a way which makes it very hard to distinguish from non-produced land and thus waiver between 'rental' language and 'rate of return' language. Be that as it may, their general equilibrium analysis shows no more concern for any physical or price relations between 'capital' and the produced commodities than does that of the writers cited above.

It is not implied above - and is not true - that writers on tax incidence have never been seriously concerned with produced inputs. Friedlaender (1967), for example, discusses at length the effects of various taxes within an explicit input-output framework. (But note that she begins by stating both that intermediate goods are typically ignored and that this leads to too simple an analysis.) Again, Atkinson and Stiglitz's Lecture Seven, which deals with extensions to the standard tax incidence analysis, includes a section on the structure of production, which they open by stating that 'The assumptions made so far about the input-output relations of the economy have been simplistic in the extreme. Each sector has been assumed to produce its final output using only capital and labour. A lot of the debate about tax incidence is however concerned with the inter-industry structure' (1980, p. 217). At last, one feels, the precise relationship between 'capital' and produced commodities is about to be revealed. But it is not! First, a two-commodity input-output model is presented in which 'there is only one basic factor, labour' (p. 217). The adjective 'basic' is, presumably, intended to *suggest* why there are not said to be *three* factors of production in each industry (labour and two produced inputs), though it can hardly be said to provide a full explanation. Then, on p. 218, one finds that 'we now treat the commodity inputs as circulating capital, on which there is a required rate of return r' and finally, again on p. 218, that 'we [now] revert to the assumption of a single factor, labour', with $r = 0$. That is, if two commodities are produced by means of labour and the commodities themselves, there are two (basic?) factors when $r > 0$ but only one when $r = 0$. Absolutely no guidance is given as to how this view of capital as a (basic?) factor of production is to be interpreted or to how this analysis relates to the earlier one with a given stock of (non-produced?) capital. Since Atkinson and Stiglitz's *Lectures* are generally both explicit and beautifully lucid, this strongly suggests that all is not crystal-clear in the treatment of capital within the 2 x 2 general equilibrium analysis of tax incidence. That suggestion is confirmed by our brief consideration of the work by Harberger, Mieszkowski and Johnson - hardly unimportant contributors to the analysis in question! - so that it is necessary to attempt to render the required treatment of capital more transparent.

III. Introduction to the analysis

There can be no doubt about the validity of the familiar tax incidence

theorems in the context of a 2 x 2 general equilibrium model in which the two factors are homogeneous land and homogeneous labour and in which no produced inputs are used. In order to study the effects (if any) of introducing 'capital' into the model, we shall proceed in three stages. In the first, land and labour will be used in production, along with inputs of the two produced commodities; the rate of interest (profit) on the value of the circulating capital will be zero. In the second stage, that rate of interest will be taken to be exogenously given at some positive level. In the final stage of the analysis, the given supply of homogeneous land will be *replaced* by an exogenously given total value of capital. As stated earlier, we shall make most of the usual simplifying assumptions of 2 x 2 theory throughout. It is to be noted that only circulating capital will be dealt with, in order that the complexities of joint production may be avoided, and that a *uniform* rate of interest on the value of the circulating capital will be assumed in all three stages of the discussion; we deal only with long-run positions (in the traditional sense). There will, of course, be no suggestion that the three cases considered are the *only* proper ways to deal with 'capital' in tax incidence theory but, in line with the argument of the preceding section, it will indeed be implied that, whichever particular representation of 'capital' be used, it should be quite explicit and shoud treat 'capital' quite distinctly from 'land', giving full recognition to the produced nature of capital goods.

Some more particular assumptions about production which will be used throughout are, first, that the number of alternative techniques is finite and, second, that no taxes will be sufficiently large to provoke a difference between factor-intensity rankings in 'value' terms and those in 'physical' terms. Thus none of our results will derive from such intensity ranking discrepancies. It will also be assumed that both commodities are used as inputs in both sectors (simply in order to avoid any need for irritating qualifications about special cases). It follows that, when excise taxes are considered, we have to assume either that industries pay such taxes on their use of their own products as

inputs, or that they do not; we make the former assumption but the reader is welcome to adjust the analysis to deal with the alternative case. (See Friedlander, 1967). Of course, by letting each 'own use' coefficient tend to zero, one can make the difference between the two cases vanishingly small. (It may be noted here that our excise taxes will always be ad-valorem taxes, not specific taxes).

Our general approach will be an 'expenditure-incidence' one, full employment of the two factors being maintained throughout, with the government spending all its revenue for 'consumption' purposes, in proportions defined by the same common, homothetic preference map as is shared by all households. One, small tax will be considered at a time, the with-tax position being compared with the corresponding no-tax position. In each case, taxes will be represented in the form of a 'tax coefficient' (≥ 1) multiplying the corresponding wage rate, commodity price, etc. which obtains in the presence of the tax. (There will thus be no need to say whether tax *rates* are defined relative to pre-tax or post-tax price, etc.) It will be clear in each case that the analysis of the effects of taxes is strictly related to that of the effects of technical regress; the analogy will not be mentioned again but the reader might care to keep it in mind throughout.

IV. Land, labour and produced inputs

Consider first a one technique, two product economy in which (a_{1j}, a_{2j}, a_j, A_j) units of product 1, product 2, labour and land, respectively, are used to produce a gross output of one unit of j. Using commodity 2 as the standard of value, let p be the with-tax relative price of commodity 1, w be the real after-tax wage rate an W be the real after-tax rent rate. Then

$$p = \tau_1(a_{11}p + a_{21} + wa_1t_1 + WA_1T_1)$$

$$1 = \tau_2(a_{12}p + a_{22} + wa_2t_2 + WA_2T_2),$$

where, for industry j, τ_j is the excise tax-coefficient, t_j is the wages tax-coefficient and T_j is the rent tax-coefficient. We suppose that commodity 1 is the (unambiguously) land-intensive commodity and that the relative supplies of land and labour are such that simultaneous full employment of both is possible.

It follows from (1) and (2) that the relative commodity price, p, is related to the relative factor price, z = (W/w), by

$$p = \left[\frac{a_{21} + (\tau_2^{-1} - a_{22})\pi}{(\tau_1^{-1} - a_{11}) + a_{12}\pi}\right] \qquad (3)$$

where

$$\pi = \left(\frac{a_1 t_1 + A_1 T_1 z}{a_2 t_2 + A_2 T_2 z}\right). \qquad (4)$$

The 'real factor price frontier' is given by

$$w = \left[\frac{(\tau_1^{-1} - a_{11})(\tau_2^{-1} - a_{22}) - a_{12}a_{21}}{a_2 t_2(\tau_1^{-1} - a_{11}) + a_1 a_{12} t_1}\right] - \left[\frac{A_2 T_2(\tau_1^{-1} - a_{11}) + A_1 a_{12} T_1}{a_2 t_2(\tau_1^{-1} - a_{11}) + a_1 a_{12} t_1}\right] W \qquad (5)$$

The effects of the various taxes on the (p/z) relation and on the factor price frontier are readily seen from (3), (4) and (5).

Denote by α the technique described by (1) and (2) and suppose now that there exists an alternative process in one of the industries which, together with the single process in the other industry, constitutes a second viable technique, β. Let β be such that 1 is again the land-intensive commodity and that each commodity is more land-intensive in α than it is in β. If β allows simultaneous full employment of both land and labour, we now have an economy with

a convex production possibility frontier along which the output of 1 rises and that of 2 falls as p and z increase together, technique α being used at 'low' p and z and technique β at 'high' p and z. This is represented in Figure 1, in which y is the output of commodity 1 *relative* to that of 2, y^S is the relative supply curve (in the absence of taxes) and y^D is the relative demand curve implied by the common, homothetic preference map: on the section marked α (β) only that technique is used, while on the vertical section in between all three processes are operated in suitable proportions. The choice of technique can also, of course, be (partially) represented as in Figure 2, which shows the intersecting wage-rent frontiers for techniques α and β in the absence of taxes; at any given p and z competition will push the economy to the outermost part of the overall frontier. (For a more detailed presentation, see Metcalfe and Steedman, 1972).

In order to study the incidence of a tax, then, 'all' one need do is to consider equations (1)-(5), together with the corresponding equations for technique , and Figures 1 and 2 as modified by the presence of the tax in question. In order to save space, it will simply be asserted here that the presence of the produced inputs ($a_{ij} > 0$) makes *no* difference to the standard results concerning factor taxes. If $t_1 = t_2 = t$ and/or $T_1 = T_2 = T$ then equilibrium outputs and commodity prices are unchanged, while tw = the no-tax wage and TW = the no-tax rent; if only $T_1 > 1$, then output of 1 'falls', that of 2 'rises', p 'rises' and real rents 'fall'; if only $t_1 > 1$, then outputs (and p) change as with $T_1 > 1$ but little can be said about changes in wages and rents. ('Fall' here means 'falls or remains unchanged', etc.).

When we turn our attention to excise taxes, however, the presence of produced inputs does indeed become important. It will be perfectly obvious from (1)-(5) that a uniform excise tax ($\tau_1 = \tau_2 = \tau$) is by no means equivalent to a uniform factor tax ($t_1 = t_2 = T_1 = T_2 = t$); it changes the (p/z) relationship, (3)-(4) - while a uniform factor tax would not affect it - and it has a qualitatively different kind of effect on the wage-rent frontier, (5). Indeed if we set

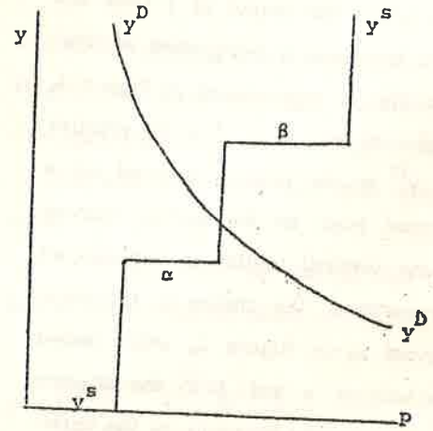


Figure 1

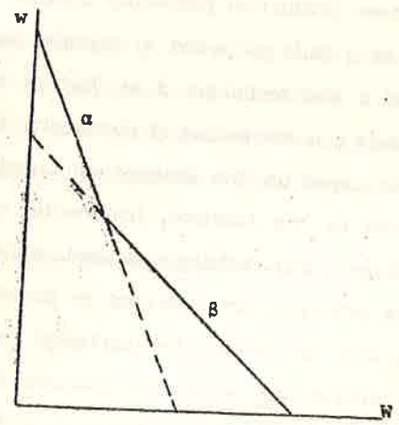


Figure 2

$t_1=t_2=T_1=T_2=1$ and $\tau_1=\tau_2=\tau>1$ we see at once that (1) and (2) are, in effect, the price equations of a *no*-tax economy in which wages and rents are paid in advance and there is a *positive* rate of interest, implying an interest *factor* of τ. A uniform excise tax is not equivalent to a uniform factor tax but it is equivalent to a uniform factor tax but it is equivalent to a uniform, positive rate of interest (Cf. Samuelson, 1975, pp. 317-8). Similarly, an excise tax on one industry alone is not equivalent to a factor tax in that industry alone, although it is equivalent to a positive rate of return in that industry alone.

Consider first the uniform excise tax, with tax-coefficient $\tau>1$. It is known that the introduction of a positive rate of interest into the present model of production can have a pronounced effect on Figure 1; the relative supply curve need no longer be monotonically non-decreasing, since technique β may now be used at 'low' p and z and α at 'high' p and z (Cf. Metcalfe and Steedman, 1972, and Montet, 1979; it is not important that wages and rents were assumed to be paid *ex post* in these articles, by contrast with our above interpretation of (1) and (2) with $\tau>1$). In Figure 3, y^Sy^S is simply the no-tax relati-

ve supply curve of Figure 1, while y^Ty^T is a possible relative supply curve in the presence of a uniform excise tax; $y^{D_1}y^{D_1}$ and $y^{D_2}y^{D_2}$ are two *alternative* possible relative demand curves. It will be seen that it is by no means necessary that the uniform excise tax will leave y and p unchanged. Moreover, the directions of change in y and p are not known *a priori*; with relative demand curve D_1 y rises and p falls with the tax, while with curve D_2 y falls and p rises with the tax. It is not clear that *anything* useful can be said about how the post-tax real wage and real rent rates compare with the no-tax rates (by contrast with the uniform factor tax case), since even the direction of movement of the (p/z) relation, as τ rises from unity, is not known *a priori*. The mere recognition of the presence of produced inputs is here sufficient to destroy the familiar incidence propositions concerning a uniform excise tax.

Suppose now that only industry 1, the land-intensive industry, is subject to an excise tax ($\tau_1>1=\tau_2$). The standard prediction is that y will fall, p rise, z fall and both W and (W/p) fall. Suppose first that the choice of process is in industry 2 and that a_{21} is 'large' in technique α but 'very small' in technique β. As τ_1 'rises' above unity the (w/W) frontier for α will contract 'rapidly' towards the origin but that for β will contract only 'very slowly'. Hence at some $\tau_1>1$, β may come to be the only technique ever used, whatever the value of z. As may be seen from Figure 4, the result could be that the with-tax economy has a *higher* y and a *lower* p than the no-tax economy. On the other hand, it can be shown that the value of z at which a switch takes places between α and β (when there *is* such a switch) may rise or fall as τ_1 rises. If the relative demand curve is such as to imply a 'switchpoint' equilibrium in both the no-tax and the with-tax economies, therefore, it can occur that equilibrium z is *higher* in the with-tax economy. (I have not yet been able to establish whether it is or is not possible for W to be higher in the with-tax economy than in the no-tax one).

(It cannot, however, occur *both* that p falls and that z rises, for the pre-

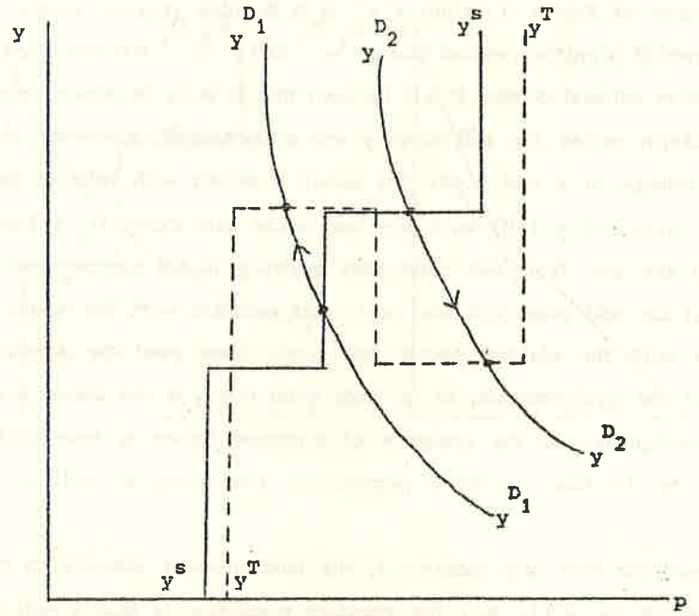


Figure 3

sence of $\tau_1 > 1 = \tau_2$ ensures that the whole (p/z) relation lies above the corresponding no-tax relation. It may be of interest to note here that, in $\tau_1 > \tau_2 > 1$, it is *not* certain that the value of p implied by a given z is greater then the corresponding no-tax value of p - as it would be, of course, in the case of $a_{ij} = 0$. This follows at once from the fact that the sign of $(\partial_p/\partial\tau)$ is not known in the uniform excise tax case; increase $\tau_1 = \tau_2$ together in a case in which $(\partial p/\partial\tau) < 0$ and then raise τ_1 alone very slightly. Cf. Metcalfe and Steedman, 1971, for a similar result in a different distributional framework).

Even when there is no positive rate of interest on their value, then, produced inputs make a considerable difference to the incidence of an excise tax, whether it be uniform or not. Since produced inputs are of great importance empirically, of what value are the familiar excise tax incidence propositions which depend upon the absence of such inputs?

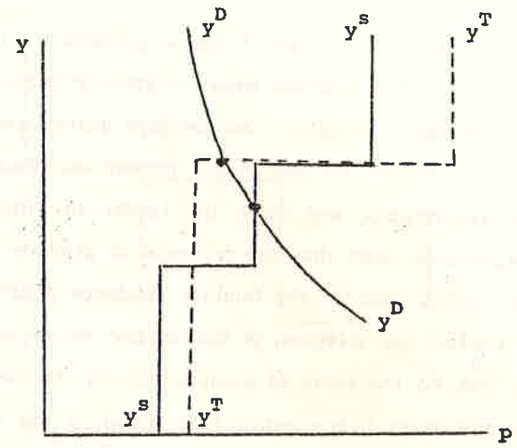


Figure 4

V. A positive interest rate

We now maintain the assumptions of the previous section, except that we suppose a given, positive (and untaxed) rate of interest on the value of the circulating capital. The given interest rate may be thought os as resulting from a given rate of time preference in an analysis which is stationary (not static) in the sense of Robbins (1930); or as being imposed by international conditions in a small economy which is open to financial capital movements but not to trade flows; or as being given parametrically for unspecified reasons. All that will matter here is that it is given and positive. Before turning to our analysis, however, we should perhaps anticipate the objection that 'If you have land, labour and a positive rate of interest you have *three* factors and two commodities, so that you have stepped outside the familiar general equilibrium tax incidence framework'. In response one might cite Hicks, for example, to the effect that 'In an "Austrian' theory, the rate of interest is not the price of a "factor"' (1973, p. 39, n. 1); or Bliss's discussion of the procedure

of supposing a given interest rate (1975, pp. 71-2); or Samuelson's use of such a supposition (1975). It is clear then that the objection itself is open to question but rather than enter here into a complex - and perhaps inconclusive - discussion about the concept of a 'factor', we shall simply present our results, derived from the above-stated assumptions, and leave the reader to interpret them.

Since it has already been seen that the presence of produced inputs *per se* is sufficient to cause difficulties for the familiar incidence results regarding excise taxes, we shall confine our attention in this section to the consequences of a positive interest rate, on the value of produced inputs, for the incidence theorems concerning factor taxes (wage and/or rent taxes). It was noted above that, in the presence of a positive interest rate, the relative supply curve is not necessarily monotonically non-decreasing; that result will be central throughout this section.

Suppose then that there is a positive rate of interest $r > 0$; if both wages and rents are paid *ex post*, equations (1) and (5) will still hold good provided that every a_{ij} is replaced by $[(1+r)a_{ij}]$. Consider the case $t_1=t_2= t>1$ and/or $T_1=T_2=T>1$; it is readily shown that the relative supply curve is unaffected by such taxes but, of course, the unchanged $y^S y^S$ curve may be as shown in Figure 5. If the relative demand curve should be $y^{D_1} y^{D_1}$, for example, equilibrium will be unique, so that both y and p are the same in the with-tax economy as in the no-tax economy. Consequently tw = the no-tax wage rate and TW = the no-tax rent rate, as in the standard incidence literature. But the relative demand curve could be $y^{D_2} y^{D_2}$, yielding multiple (stable) equilibria, so that both y and p could differ as between the with-tax and no-tax economies. Moreover, the relative demand curve could be such that the no-tax equilibrium involves *zero* rents (on the first vertical section of $y^S y^S$), while the with-tax equilibrium involves positive rents. Since the latter equilibrium could be that of an economy in which the only tax is a uniform rents tax, the with-rent-tax economy could have *higher* (post-tax) rents than the no-tax economy, contrary to standard incidence theory.

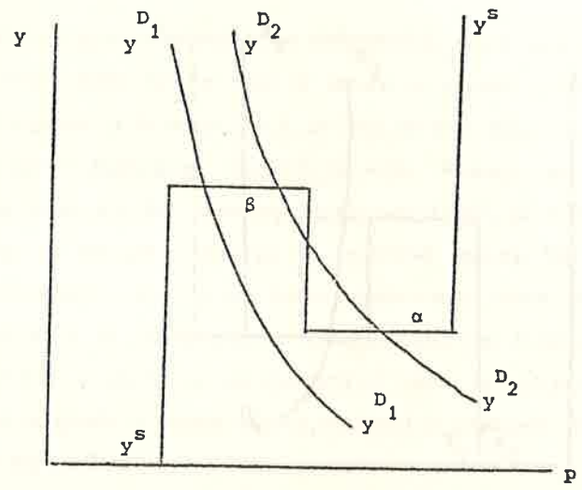


Figure 5

It might be said, in response to the above, that multiplie equilibria are always liable to create difficulties for comparative statics results and that this is in no way peculiar to tax incidence theory. The observation is, of course, perfectly sound but it does nothing whatever to alter the fact that, under our assumptions, real rents might be higher in a with-rent-tax economy than in a no-tax economy and says nothing which constitutes a defence of the (contrary) standard proposition. It is up to those who ignore possible multiple equilibria to justify their doing so. (Similar remarks are in order below).

Suppose now that the only tax is a rent tax in the land-intensive industry ($T_1 > 1$); in this case the relative supply curve is affected. Figure 6 shows a case in which the no-tax economy has a unique equilibrium, as does the with-tax economy, which has the *higher* y and the *lower* p, contrary to the standard incidence theorems. As in those theorems, however, z will be lower in the with-tax economy. The reader may pursue other possible cases - and the strongly inconclusive case of a *wage* tax in the land-intensive industry ($t_1 > 1$).

It can be suggested then that in an economy using land, labour and produced inputs, in which there is a positive rate of interest on the value of the circula-

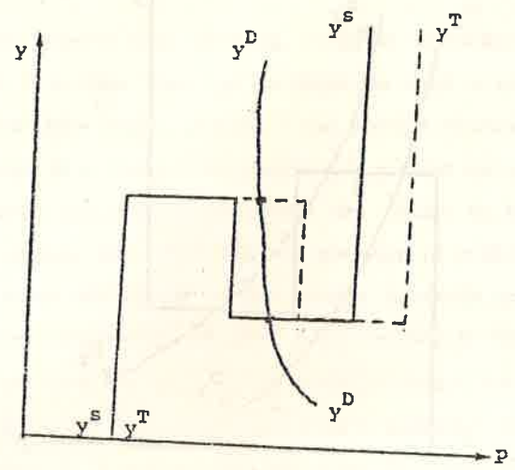


Figure 6

ting capital, the familiar results concerning the incidence of excise and factor taxes are in need of considerable modification.

VI. A given value of capital

We turn now to a different possible representation of 'capital' within the 2 x 2 model. Two commodities are produced by means of labour and the commodities themselves. There is no land and outputs are constrained by a given labour supply and by the requirement that the *total value* of the capital goods employed is given exogenously. The uniform wage rate and the uniform rate of interest are now both determined endogenously, in what Robbins (1930) called a static (not stationary) analysis. It will be assumed that commodity 1 is (unambiguously) the capital- intensive commodity, so that $(\partial p/\partial r) > 0$ always holds; the real wage rate, w, is of course inversely related to the interest rate r.

Whilst it often appears that the assumption of a 'given supply of capital' is intended to mean that the total value of capital goods is always equal to

(or, at least, not greater than) some exogenously given quantity, particularly in analyses which refer to the rate of return to capital and/or to savings as additions to capital, it is often the case that neither this nor any other interpretation is given explicitly. Yet this is what Wicksell, for example, most certainly did mean by the 'quantity of capital' (1967, p. 204) and it is the meaning given in the great majority of empirical studies. Yet the conceptual basis for this interpretation is far from crystal-clear. Since the relative commodity price, p, is to be determined endogenously, the total value of capital *can be* given only in terms of one standard of value. And to say that aggregate capital value is given in terms of one standard is precisely to say that it is *not given* in the infinitely-many other possible standards! How is this assumption to be understood? What is the economic meaning of supposing that this aggregate value is fixed exogenously in terms of one standard yet unfixed in terms of others? Hayek has suggested that any 'homogeneous fund' concept of capital is simply 'pure mysticism' and stated that he could not 'attach any meaning to this mystical "fund"' (1941, pp. 93-4). If others can give it more meaning, they should explain clearly how they do so; here we simply accept the assumption - without pretending to understand it any more than Hayek could - and examine its consequences for tax incidence theory.

For the moment, let us think of the interest rate, r, as a parameter. For a given technique, at a given value of r the price ratio p is determined and thus the outputs which will fully employ the fixed amounts of labour and capital can be calculated, just as in a labour and land model. As we vary r - and thus p - however, the 'full employment of capital' constraint *itself changes* just because we are dealing with a value 'constraint'. It is not to be expected, then, that the relative supply curve, in the present labour and capital case, will be as straightforward as it was in the labour and land case discussed above. Even for a given technique, y will now vary as p varies. A full discussion of how the relative supply curve is to be derived in a two-technique economy would take up much space and has, in any case, been presented in detail in

Metcalfe and Steedman (1981, § III). Figure 7 encapsulates the results needed here. In Figures 7a and 7b the total value of capital is given *in terms of commodity 1* (the capital-intensive commodity), while in Figure 7c and 7d it is given *in terms of commodity 2*. In Figures 7a and 7c there is a single switch-point between the two techniques (at the price above which $y^s y^s$ is vertical), while in Figures 7b and 7d there is double-switching between the two techniques. (It need hardly be added that many other standards of value could be considered, in terms of which 'K' could be given, and that each standard would yield a *different* relative supply curve). It will be noted at once that, in Figure 7, only 7a presents a 'conventional' relative supply response ad that, in all the other three cases, the possibilities for multiple equilibria are rife. This warns us at once that tax incidence theorems, like any other comparative statics results, are likely to be hard to come by. Since this paper is already becoming rather long, and since it might well be thought tedious to show in detail how each standard incidence theorem is liable to be undermined by multiple equilibria, we shall attempt just to say enough to enable the interested reader to pursue any particular case -thereby ensuring that some readers will think we say too little and others that we say too much!

Consider a given tecnique whose price equations may be written as

$$p = \tau_1 \ (a_{11}p+a_{21}) \ (1+r\vartheta_1) + wa_1t_1$$

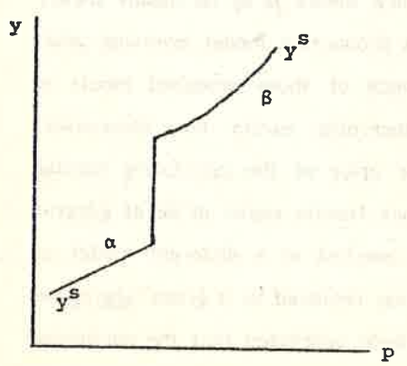
$$1 = \tau_2 \ (a_{12}p+a_{22}) \ (1+r\vartheta_2) + wa_2t_2 \ ,$$

where ϑ_j is the profits tax coefficient (≥ 1) in industry j but the notation is otherwise that adopted above. (Of course, r is now the after-tax interest rate). Denote this technique by α and suppose that it is used at r = 0; in Figures 7 it is thus the tecniques used at 'low' values of p. Now suppose that there is an alternative process in one of the industries which, together with the one process in the other industry, forms a second technique, β, which is less

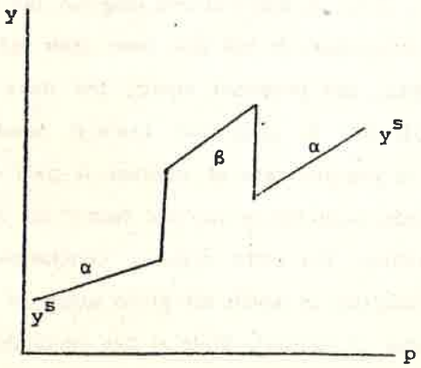
capital-intensive than α. It is readily deduced how, for each technique, p and w vary with r, for any given set of taxes.

If $\tau_1=\tau_2=1$, while $t_1=t_2=t$ and/or $\vartheta_1=\vartheta_2=0$, the with-tax relative supply curve is identical to the no-tax relative supply curve. Thus if equilibrium is unique, the conventional results concerning uniform factor taxes are obtained. If equilibrium is not unique, however, there is probably not much useful to be said. (Except that, as above, those who assume uniqueness should show why they do so). In all other cases, taxes will *change* the value(s) of p at which a switch of techniques place (but will not change the trajectories of the non-vertical parts of $y^s y^s$ in Figures 7). Definite results are not to be expected, other than such negative ones as 'A uniform excise tax $\tau_1=\tau_2=\tau$ is evidently *not* equivalent to a uniform factor tax $t_1=t_2=\vartheta_1=\vartheta_2=\vartheta$; nor is a one industry excise tax equivalent to a uniform factor tax in that industry alone'. Or 'The levying of a wages tax may lead to the adoption of a more capital-intensive technique or to that of a more labour-intensive technique' (Cf. Pedone, 1966, and Metcalfe and Steedman, 1971, p. 182).

Even if some plausible interpretation can be given to the assumption of a given aggregate value of capital - which is at least open to reasonable doubt - the 2 x 2 general equilibrium model with given supplies of labour and 'capital' will not yield the standard set of tax incidence theorems.



7a



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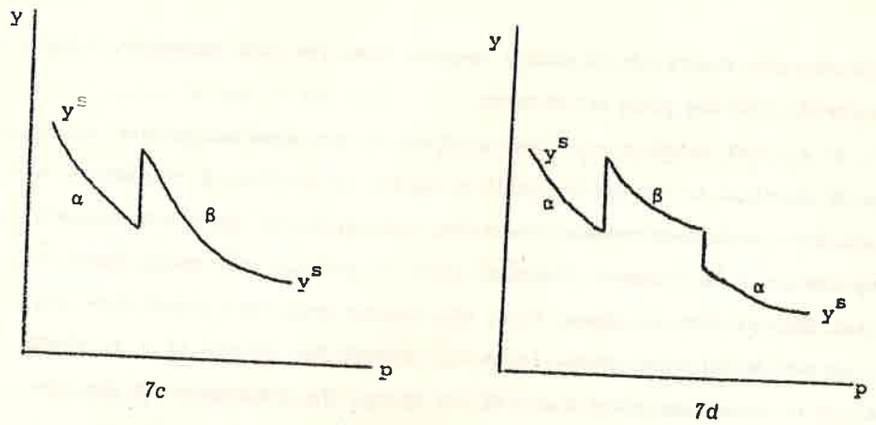

Figure 7

VII. Summary and conclusion

Produced inputs play a major role in all modern economies and tax incidence theory is intended to throw light, albeit at a high level of abstraction, on the effects of taxes in such economies. It follows, presumably, that the role of capital goods should be taken seriously, and analysed carefully, in general equilibrium tax incidence writings. Yet a brief survey of the relevant literature suggests that, on the contrary, the treatment of capital and of the return to capital in (Marshallian) long-run tax incidence theory is by no means always crystal-clear. It has also been seen that in a production model involving land, labour and produced inputs, the mere presence of those produced inputs is sufficient to undermine familiar results concerning excise tax. Morevover, if a positive rate of interest is paid on the value of the circulating capital goods, both excise tax and factor tax incidence results cease to be of general validity. The same negative conclusion was reached in a different model of production in which the given supply of land was replaced by a given 'aggregate value of capital'. While it has certainly not been suggested that the particular models of production considered here are the only possible - or even the best - explicit representations of capital within the 2 x 2 framework, it can reasonably be urged that, whichever model of production is employed in incidence theory, it should give a perfectly clear and generalisable treatment of produced inputs. (A 'one physical capital good' model is *not* a serious contender, for its generalisations are either a (Marshallian) short-run analysis with given stocks of many different capital goods, or the 'given capital value' analysis discussed above). It may perhaps be concluded that all is not well in general equilibrium tax incidence theory and that much remains to be done if a useful theory is to be constructed.

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