Technical Progress and the Incidence of the Corporation Income Tax

Raveendra Batra
Kul B. Bhatia

Citation of this paper:

Follow this and additional works at: https://ir.lib.uwo.ca/economicsresrpt
Part of the Economics Commons
RESEARCH REPORT 7034

Technical Progress and the Incidence of
the Corporation Income Tax

by

Raveendra Batra and Kul B. Bhatia
Technical Progress and the Incidence of the Corporation Income Tax

by

Raveendra Batra and Kul B. Bhatia*

I. Introduction

The role of technical progress in determining the incidence of the corporation income tax has been recognized in a number of empirical studies. In fact, in some cases, variables representing changes in productivity and shifts in production function have been specifically included in the analysis [e.g. Gordon (1967), Hall (1964)], but somehow technical progress has been completely ignored in the theoretical literature on the problem of tax-incidence. Recent econometric studies of the aggregate production function show that substantial technical progress has been taking place in the manufacturing sector of the U.S. economy [for example, Solow (1957) and Sato (1970)]. Since corporations form a sizable component of this sector, it is important to examine the theoretical and empirical implications of technical progress for the question of the incidence of the corporation income tax. In this paper, we incorporate technical progress into a general-equilibrium model of tax-incidence and analyze several cases of neutral and biased technical progress in the corporate and non-corporate sectors of the economy.

The starting point of our analysis is the well-known two-factor two-commodity model which was first applied by Harberger (1962) to analyze the incidence of the corporation income tax. In the absence of technical progress, the burden of the tax depends mainly on relative factor intensities and the

*Assistant Professors of Economics, University of Western Ontario.

1See for example, Harberger, Cragg and Mieszkowski (1968).
elasticities of substitution between labor and capital in the two industries. When technical progress is considered, many of the results derived in earlier studies are modified. The most important conclusion to emerge, however, is that demand conditions (especially the elasticity of demand in the taxed industry) now play a crucial role in determining the tax-incidence.

The basic theoretical model is presented in Section II and the subsequent sections deal with technical progress in the taxed industry, the untaxed industry, and in both industries.

II. The Model and Some Key Relations

The model to be presented in this section follows a comparative static approach and estimates how the burden of the tax would be shared when the economy attains a new equilibrium after the tax is imposed. It is assumed that the economy consists of two sectors of production, the corporate sector (X) and the non-corporate sector (Y), which utilize capital (K) and labor (L) in the process of production, and that per-unit net of tax earnings of each productive factor are equalized between sectors. Perfect competition, constant returns to scale, diminishing returns to variable proportions, full employment of factors, inelastic factor supplies and perfect factor mobility are also assumed. The product and factor prices are initially taken to be unity.\(^2\)

The corporate income tax can be viewed as a fixed tax per unit of capital employed in industry X. When the tax is levied, the output of X declines, both capital and labor are ejected from industry X and have to be absorbed by industry Y (because we assume full employment). The incidence of the tax depends on how the relative factor shares change as a result of

\(^2\)This assumption is made for the sake of simplicity of calculations and does not restrict our results in any way.
the tax. If the earnings of capital decline by just the amount of the tax revenue (or equivalently, the share of labor in national income remains unchanged), capital bears the entire burden of the tax. The change in relative shares depends on the terms on which the untaxed industry absorbs the "rejects" of the taxed industry. Consequently, variables like the elasticity of demand for $X$ (which determines the extent of the decline in the output of $X$), the initial factor proportions and the elasticity of factor substitution in the two industries will have to be included in our model.

Following Harberger, we assume that demand for each commodity is a function of the relative product prices alone, i.e., $D_i = D_i(p_x/p_y)$ where $p$ stands for price, $D$ for demand and the subscript $i$ denotes the two commodities $X$ and $Y$. The demand functions can be specified in this manner if we assume that when the government spends the tax proceeds, the initial commodity prices do not change, and that the redistribution of income among consumers resulting from the corporate income tax does not change the pattern of demand. Since factors are assumed to be fully employed, the demand functions for $X$ and $Y$ are interdependent. Once the demand function for one commodity is specified, for given prices and full employment income, the demand function for the other commodity can be derived without any additional information. The demand conditions in our model may then be represented by a single equation, namely,

$$X = D_X = D_X(p_x/p_y).$$

Differentiating this equation and remembering that $p_x = p_y = 1$ initially, we obtain

$$\frac{dx}{x} = E(dp_x - dp_y),$$  \hspace{1cm} (1)
where $E$ is the price elasticity of demand for $X$. The two production functions are given by

\[ X = F_X(K_X, L_X, t) \quad (2*) \]
\[ Y = F_Y(K_Y, L_Y, t) \quad (3*) \]

where $K_i$ and $L_i$ are the capital and labor inputs in the $i^{th}$ industry ($i = x, y$), and $t$ is a shift parameter representing the technological level in each sector. Differentiation of (2*) yields:

\[ \frac{dX}{X} = f_L \frac{dL}{L_X} + f_K \frac{dK}{K_X} + \alpha_x \quad (2) \]

where $f_L$ and $f_K$ are the initial shares of labor and capital, respectively, in industry $X$, and $\alpha_x$ denotes the rate of growth of output of $X$. When the factor-inputs in $X$ are kept constant,

\[ \alpha_x = \frac{1}{X} \frac{\partial X}{\partial t} \, dt > 0 \]

In an industry characterized by perfect competition and a production function homogeneous of degree one, the capital-labor ratio is determined by the factor-price ratio and any bias that may be created by technical progress. Therefore, for industry $Y$,

\[ \frac{K_Y}{L_Y} = \frac{K_Y}{L_Y} \frac{P_K}{P_L} \quad (4*) \]

where $P_K$ and $P_L$ are the price of capital and labor, respectively. Differentiating (4*) and remembering that initially $P_K = P_L = 1$, we obtain:

\[ \frac{dK_Y}{K_Y} - \frac{dL_X}{L_X} = S_y (dP_K - dP_L) + \lambda_y \quad (3) \]

where $S_y$ is the elasticity of factor substitution in industry $Y$, and $\lambda_y$ is the relative rate of change in the capital-labor ratio in $Y$ if only the shift parameter changed, i.e.,

\[ \lambda_y = \frac{1}{(K_y/L_y)} \cdot \frac{\partial (K_y/L_y)}{\partial t} \, dt. \]
The partial derivative notation in the above expression implies that factor prices are being held constant. In other words, $\lambda$ is the Hicks-measure of technical progress. Its sign indicates the nature of Hicks-technical progress. If $\lambda=0$, technical progress is neutral; if $\lambda > 0$, it is capital-using; if $\lambda < 0$, it is capital-saving.

The same procedure can be followed to derive a factor response equation in industry $X$, but here it must be noted that the return to capital is subject to a tax in $X$, and not in $Y$. Let $T$ denote the amount of tax per unit of capital. Then the change in the price of capital including the tax will be $(dp_K + T)$. The change in the price of capital relevant for decision making in industry $Y$, therefore, is $dp_K$, i.e., the change in price of capital net of tax. The equation for $X$ corresponding to (3) will, therefore, be

$$\frac{dK_X}{K_X} - \frac{dL_X}{L_X} = S_x(dp_K + T - dp_L) + \lambda_x$$

(4)

where

$$\lambda_x = \frac{1}{(K_x/L_x)} \frac{\partial (K_x/L_x)}{\partial t}$$

With full employment of capital and labor

$$K_x + K_y = \bar{K}$$

(5*)

and

$$L_x + L_y = \bar{L},$$

(6*)

where $\bar{K}$ and $\bar{L}$ are given constants. It follows then, that

$$dK_y = -dK_x$$

(5)

and

$$dL_y = -dL_x.$$ 

(6)

---

3Hicks originally defined the nature of technical progress in terms of the change in the marginal rate of substitution at the old capital/labor ratio. It is well known that this definition is equivalent to that given in the text. This is also the classification used by Takayama (1965) and Amano (1964) among others.
Additionally, we have:

\[ dp_x = f_L dp_L + f_K dp_K + T - \alpha_x \]  
\[ dp_y = g_L dp_L + g_K dp_K - \alpha_y \]  
\[ dp_L = 0 \]

where \( g_L \) and \( g_K \) are respectively the relative shares of labor and capital in industry \( Y \).

Substituting equations (5) - (9) into equations (1) - (4), we obtain the following system of equations:

\[ \frac{dx}{X} = E[f_K(dp_K + T) - g_K dp_K + (\alpha_y - \alpha_x)] \]  
\[ \frac{dx}{X} = f_L \frac{L_x}{L_x} + f_K \frac{K_x}{K_x} + \alpha_x \]  
\[ \frac{K_x(-dK_x)}{K_y x} - \frac{L_x(-dL_x)}{L_y x} = S_x dp_K + \lambda_y \]  
\[ \frac{dK_x}{K_x} - \frac{dL_x}{L_x} = S_x(dp_K + T) + \lambda_x \]

Equating (1') and (2) and rearranging terms in (3') and (4'), we obtain:

\[ E(f_K dp_K + \alpha_y) - \alpha_x (1 + E) = E(g_K dp_K + f_L \frac{L_x}{L_x} + f_K \frac{K_x}{K_x} \]  

---

4 Applying the Euler theorem to a linear homogeneous production function we have

\[ p_X X = p_L L_x + p_K K_x \]

Differentiating (9*) and noting that \( p_X = p_L = p_K = 1 \) initially, we obtain:

\[ dp_x + \frac{dx}{X} = f_L (dp_L + \frac{dL_x}{L_x}) + f_K (dp_K + T + \frac{dK_x}{K_x}) \]

Substituting for \( \frac{dx}{X} \) from (2) in (9') then gives us equation (7). Equation (8) can be derived in a similar manner, except that the return to capital in \( Y \) is untaxed and the change in the price of capital is given by \( dp_K \).

5 This equation shows that \( p_L \) has been chosen to be the numeraire. Cf. Harberger (1962). Again it may be noted that our results are in no way dependent on the choice of \( p_L \) as the numeraire.
\[- \lambda_y = S_y dp_K - \frac{L_x}{L_y} \frac{dL_x}{L_x} + \frac{K_x}{K_y} \frac{dK_x}{K_x} \]  

\[S_x T + \lambda_x = -S_x dp_K - \frac{dL_x}{L_x} + \frac{dK_x}{K_x}. \]  

The specification of the model is now complete. The government's tax revenue always amounts to $K_x T$. The change in national income, caused by the tax, and measured in terms of $p_L$, the price of labor, is $K_x T + (K_x + K_y) dp_K$. If $dp_K$ is zero, the decline in real national income equals the tax revenue; the prices of labor and capital (net of tax) as also their relative factor shares do not change, hence capital and labor bear the tax in proportion to their initial factor shares. Labor's tax-burden exceeds this if the price of capital (net of tax) rises in the new equilibrium position after the tax ($dp_K > 0$), and if $dp_K = -TK_x / (K_x + K_y)$, the earnings of capital fall by the amount of the tax revenue and the entire burden of the tax is on capital. The incidence of the tax thus, depends crucially on $dp_K$.

The solution for $dp_K$ is

\[
dp_K = \begin{vmatrix} 
E(f_K T + \alpha_y) - \alpha_x (1 + E) & \frac{f_L}{f_K} & \frac{L_x}{L_y} \frac{K_x}{K_y} \\
-\lambda_y & -\frac{L_x}{L_y} & \frac{K_x}{K_y} \\
S_x T + \lambda_x & -1 & 1 \\
\frac{dL_x}{L_x} & \frac{dK_x}{K_x} & \frac{f_L}{f_K} \\
S_y & -\frac{L_x}{L_y} & \frac{K_x}{K_y} \\
-S_x & -1 & 1 \\
\end{vmatrix}. \]  

(11)

Expansion of (11) furnishes us with:
\[
\frac{E(f_K + \alpha_K) - \alpha_X (1 + E) \left( \frac{K}{K} - \frac{L}{L} \right) + \lambda_y + (S_X T + \lambda_x) \left( \frac{K}{K} + \frac{L}{L} \right)}{E(g_K - f_K) \left( \frac{K}{K} - \frac{L}{L} \right) - S_X - S_y \left( \frac{K}{K} + \frac{L}{L} \right)}
\]

(12)

In solving the determinants in the denominator as well as the numerator of (11), we have made use of the fact that \((f_L + f_K) = 1\).

Since we have closely followed Harberger's model, it is interesting to compare (12) with Harberger's general solution. The only difference between the two is in the numerator of (12) where \(\lambda_X, \lambda_Y, \alpha_X, \text{ and } \alpha_Y\) appear and represent technical progress. Because the sign of \(d_{pK}\) determines the incidence of the corporate income-tax, we must decide whether the numerator and the denominator of the general solution would be positive or negative.

The denominator of (12) is necessarily positive because, \((-S_X\) and \((-S_Y)\) are positive, \(E\) is negative but, as Harberger shows, \((g_K - f_K)\) and \(\left( \frac{K}{K} - \frac{L}{L} \right)\)

always have opposite signs (e.g. when \(g_K\) is less than \(f_K\), industry \(X\) is more capital intensive than industry \(Y\); so that, \(\left( \frac{K}{K} - \frac{L}{L} \right)\) is positive), \(E(g_K - f_K) \left( \frac{K}{K} - \frac{L}{L} \right)\), therefore, must be positive (or, in the limiting case, zero). Consequently, the denominator of (12) has to be positive.\(^6\)

No such definite conclusions can, however, be reached about the numerator of (12). Its sign depends inter alia on the elasticity of demand for \(X\), the elasticity of factor substitution in \(X\), the initial capital-labor ratio and technical progress in the two industries.

We now turn to some general conclusions that can be derived from (12). We shall consider the cases of technical progress in industry \(X\), and in industry \(Y\). As discussed above, \(d_{pK}\) holds the key to the problem of tax-

incidence. Therefore, in each case, we shall examine the factors that determine the sign of \( dp_K \).

III. Technical Progress in the Taxed Industry

Neutral Technical Progress

If technical progress takes place only in industry \( X \), \( \alpha_y = \lambda_y = 0 \).

If technical progress is neutral, \( \Lambda_x \) is also zero and (12) simplifies to

\[
\frac{dL_K}{dL_K} = \frac{\frac{K}{K} \left( x - \frac{L}{L} \right) + S_x}{\lambda_x \left( \frac{K}{K} - \frac{L}{L} \right) + S_x} \cdot \frac{f L K}{L} + \frac{f L K}{L} - \frac{\alpha_x \left[ \frac{K}{K} - \frac{L}{L} \right] \left( 1 + E \right)}{1}
\]

(13)

The only term reflecting technical progress is \( \alpha_x \left[ \frac{K}{K} - \frac{L}{L} \right] \left( 1 + E \right) \) which appears in the numerator of (13). It is obvious that when \( |E| = 1 \) or \( \frac{K}{K} = \frac{L}{L} \), the term disappears. This leads to a key conclusion that whenever the demand for the product of the taxed industry is unit elastic, or factor proportions are initially the same in the two industries, technical progress does not affect the problem of tax-incidence.\(^7\)

Many other results can be derived by examining the general solution (13):

1. When factor proportions are initially the same in the two industries, capital's share of the tax burden must exceed its initial contribution to national income. In this case \( \left( \frac{K}{K} / \frac{L}{L} \right) = \left( \frac{L}{L} / \frac{L}{L} \right) \), second term alone remains in the numerator of (13) and the first term in the denominator also disappears.

\(^7\) It is easy to explain this rather sweeping conclusion. Within the framework of our model, the incidence of the tax depends on its effect on the output of the two industries and relative factor prices. When \( |E| = 1 \), the proportion of national income spent on the taxed industry remains constant regardless of the level of output; technical progress, therefore, does not matter. Again, when factor proportions are the same, the untaxed industry can absorb labor and capital in the same proportion in which they are released by the taxed industry. Neutral technical progress, by definition, does not alter capital-labor ratio; therefore, it does not affect relative factor prices in this case.
The solution simplifies to \( dp_K = -TS_K x / (S_K x y + S_K x x) \) which is negative because \( S_K x \) and \( S_K y \) are negative but \( K_K x \), and \( T \) are positive.\(^8\)

2. When the two industries use capital and labor in the same proportion, demand conditions do not affect the problem of tax-incidence at all.

The elasticity of demand for \( X \) determines the proportion of national income spent on it in the new equilibrium. Consequently, \( E \) also affects the output of \( X \). However, these considerations per se are immaterial as long as the untaxed industry uses labor and capital in the same proportion as the taxed industry. The result is obvious from the general solution (13) because whenever \( (K_K x / K_K y) = (L_K x / L_K y) \), all terms containing \( E \) disappear from both the numerator and the denominator.

3. When the taxed industry is capital intensive and the demand for its product inelastic, capital's share of the tax burden exceeds its initial contribution to national income. In this case, \( |E| < 1, K_K x / K_K y \) is greater than \( L_K x / L_K y \), and all the terms in the numerator are negative; hence \( dp_K \) must be negative. Q.E.D. When \( |E| = 1 \), the result still holds: the third term in the numerator of (13) vanishes but the other terms are negative, hence \( dp_K < 0 \).

4. When labor and capital are used in the fixed proportions in both industries, the incidence of the tax depends on the elasticity of demand for the taxed commodity and the relative capital-labor ratios in \( X \) and \( Y \).

In this case, \( S_K x = S_K y = 0 \) and (13) reduces to

\[
dp_K = \frac{f_K T}{(e_K - f_K)} - \frac{\alpha_K x (1 + E)}{E(e_K - f_K)}
\]

(15)

When \( |E| = 1 \), the expression simplifies further to \( dp_K = \frac{f_K T}{(e_K - f_K)} \), which is negative when the taxed industry is relatively capital-intensive.

---

\(^8\)If additionally, \( S_K x = S_K y \), \( dp_K = -TK x / (K_K y + K_K x) \) which implies that capital bears exactly the full burden of the tax. Cf. Harberger (1962), p. 228.
(g_K < f_K), and conversely.\footnote{However, when the taxed industry is relatively capital intensive, the assumption of fixed proportions is redundant, because, as long as |E| ≤ 1 and S_y is not infinity, dp_K < 0. (See points 3 and 6 above).} This conclusion is reinforced when |E| < 1, because the second term in (15) will have the same sign as the first. The sign of dp_K, however, could be reversed if |E| > 1.\footnote{Equation (15) can be rewritten as dp_K = \frac{1}{g_K - f_K} \left[ f_K T - \frac{\alpha_x (1+E)}{E} \right]. As long as |E| ≤ 1, the term within brackets is positive and the sign of dp_K depends on the sign of (g_K - f_K). If |E| > 1, - \frac{\alpha_x (1+E)}{E} would be negative and if it is greater than f_K T, dp_K will change signs.}

5. When elasticity of demand is unity, capital bears more of the tax than labor relative to their initial factor shares if |S_x| ≥ |E|. In this case \( S_x f_K (L_x/L_y) \) and other negative terms dominate the only positive term in the numerator, namely \( E f_K (-L_x/L_y) \), and dp_K < 0. However, when |E| ≠ 1, this is not a sufficient condition for dp_K < 0; now \( (-\alpha_x) E \frac{K}{K} \) and \( \alpha_x \frac{L_x}{L_y} \) are additional positive terms in the numerator of (1) and the sign of dp_K is not independent of the factor proportions in the two industries.

6. In the absence of technical progress, labor can bear more of the tax than its initial share in national income, only if the taxed industry is relatively labor intensive. When technical progress is taking place, this is a necessary condition only if the demand is unit elastic or inelastic.

The above result holds if dp_K > 0. The denominator of (13) is positive, the second term in the numerator is negative, the entire numerator can be positive only if the first and/or the third terms are positive.

\[
E f_K \left( \frac{X}{K} - \frac{L_Y}{L_Y} \right) T > 0 \text { if } \frac{K}{K_Y} < \frac{L_X}{L_Y} \text{ i.e., } X \text{ is labor-intensive.}
\]

When |E| < 1, this also ensures that

\[
\alpha_x \left( \frac{X}{K_Y} - \frac{L_X}{L_Y} \right) (1+E) > 0.
\]
When $|E| = 1$, the third term in the numerator of (13) disappears and the first term is positive only if $X$ is labor-intensive. When there is no technical progress $\alpha_x = 0$ and the same result follows. Q.E.D.

A corollary of the above result is that when technical progress occurs at sufficiently rapid rate ($\alpha_x$ substantially greater than zero), and demand for $X$ is elastic ($|E| > 1$), $dp_K$ can be positive even if the taxed industry is relatively capital-intensive.

**Biased Technical Progress**

If technical progress is not neutral, $\lambda_x \left( f_L \frac{K_x}{K} + f_L \frac{K_x}{L} \right)$ is added to the numerator of (13). This term is positive if technical progress is capital-using, and negative if it is labor-using (or capital-saving). On **a priori** grounds, it is clear that capital-saving technical progress would tend to increase the burden of tax on capital: for a given reduction in the output of the taxed industry, more capital would now be released and other things equal, in the new equilibrium, the untaxed industry would be able to absorb it only at a lower relative price of capital.

Many conclusions derived above are altered by the introduction of bias in technical progress. The first one to change is the general result stated earlier, i.e., when the elasticity of demand for the taxed commodity is unity, or the factor-ratios in the two industries are equal, technical progress does not affect the incidence of the tax. Now, even if $|E| = 1$ and $\frac{K_x}{L_x} = \frac{K_y}{L_y}$, $\lambda_x \left( f_L \frac{K_x}{K} + f_L \frac{K_x}{L} \right)$ will appear in the numerator of (13) and affect $dp_K$. If technical progress is capital saving, it reinforces all cases in which $dp_K$ tends to be negative. When $\lambda_x > 0$, things are different but this case can be analyzed easily by comparing $\lambda_x$ with $S_x$.

In the numerator of (12), $\lambda_x$ and $S_x$ appear as follows:
\[
(S_x T + \lambda) \left[ \frac{f_L K_x}{K_y} + \frac{f_K L_x}{L_y} \right]
\]

If other terms in (12) lead to the conclusion that \(dp_K < 0\), and \(\lambda_x > 0\) but \(< |S_x T|\), this conclusion still holds and capital's burden of the tax would be greater than its initial contribution to national income.

IV. Technical Progress in the Untaxed Industry

When technical Progress occurs only in industry Y and is neutral, \(\lambda_x = \alpha_x = \lambda_y = 0\), and the general solution (12) simplifies to

\[
dp_K = \frac{E(f_K T + \alpha_y) \left( \frac{K_x}{K_y} - \frac{L_x}{L_y} \right) + S_x T \left( \frac{f_K}{K_y} + \frac{f_L}{L_y} \right)}{E(s_K - f_K) \left( \frac{K_x}{K_y} - \frac{L_x}{L_y} - S_y - S_x \left( \frac{f_K}{K_y} + \frac{f_L}{L_y} \right) \right)} \tag{16}
\]

When factor proportions are the same in the two industries, (16) is a special case of (13) which has been discussed in detail in the preceding section. However, when the two industries do not use labor and capital in the same ratio initially, the results are different. Elasticity of demand for the taxed commodity (especially its absolute value) does not play an important role in determining the incidence of the tax any more. Many conclusions presented in the preceding section will now hold under much weaker conditions. For example, the first point in that section states that \(dp_K < 0\) if \(|E| \leq 1\) and the taxed industry is relatively capital intensive. In the present case, the latter condition would be sufficient because when industry X is relatively capital intensive, \(K_x/K_y > L_x/L_y\); E and \(S_x\) are negative; hence, all the terms in the numerator of (16) are negative and \(dp_K < 0\).

When \(|E| = 1\), (13) reduces to (16) except for an additional term in the numerator, i.e., \(E_{yr} \left( \frac{K_x}{K_y} - \frac{L_x}{L_y} \right)\). The additional term, however, always
has the same sign as the first term in the numerator of (13) (because \( \alpha_y > 0 \)); therefore, it affects only the magnitude and not the sign of \( dp_K \). For example, to continue with the case of the taxed industry being capital intensive, when \(|E| = 1\), neutral technical progress in industry \( X \) does not affect the tax-burden on capital, but when technical progress happens in industry \( Y \), \( dp_K \) is more negative and capital suffers more.

When technical progress is not neutral, \( \lambda_y \) is added to the numerator of (16) with a positive or a negative sign. In the above example of a capital intensive taxed industry, capital would bear a still greater burden of the tax if technical progress in industry \( Y \) is capital-saving (\( \lambda_y < 0 \)) and vice versa. Barring extreme (and extremely unlikely) values of \( \lambda_y \), the results would not change much and mutatis mutandis, the remarks made above apply.

V. Technical Progress in Both Industries

Assuming that technical progress is neutral, (12) can be rewritten as follows:

\[
dp_K = \frac{Ef(T(x_K - x_L) + St(x_L + x_K) + \lambda_K + \lambda_L)}{E(g_L - f_K) - x_K \lambda_L - (1 + E)\alpha_y}
\]

The above expression is a combination of (13) and (16) and some special cases can be observed readily. When \(|E| = 1\), (17) reduces to (16) and all the results of the preceding section hold. Similarly, when factor proportions are initially the same in the two industries, (17) becomes the special case of (13) that was discussed above, i.e., neutral technical progress in one or both industries does not affect the incidence of the corporate income tax. Some new results, however, do emerge:

1. When the taxed industry is relatively capital intensive, simultaneous
technical progress in both industries increases capital's share of the tax burden if the taxed industry has an inelastic or unit elastic demand. It was proved earlier [section III, result (3)] that whenever neutral technical progress takes place in the untaxed industry also, a new term $E \alpha_y (K_x/K_y - L_x/L_y)$ is added to the numerator of $dp_K$. This term is negative whenever the taxed industry is capital-intensive; therefore capital's share of the tax burden goes up.

2. When technical progress in the untaxed industry occurs at a rate faster than or equal to that in the taxed industry, the above result holds regardless of the magnitude of $E$. The third term in the numerator of (17) can be rewritten as

$$\left[ E(\alpha_y - \alpha_x) - \alpha_x \right] \frac{K_x}{K_y} - \frac{L_x}{L_y}$$

(18)

When $\alpha_y \geq \alpha_x$, and $(K_x/K_y) > (L_x/L_y)$, (18) is unambiguously negative, whatever the level of $E$; this negative term results in a further rise in capital's share of the tax burden.

None of the above results, however, may hold if $|E| > 1$ and $\alpha_x < \alpha_y$.

When technical progress is non-neutral, the general solution is given by (12) and two new terms, $\lambda_y$ and $\lambda_x (\frac{f_x}{K_y} + \frac{f_L}{L_y})$, are added to the numerator of (17). These terms measure the bias in technical progress. Recall that when $\lambda_x$ and $\lambda_y$ are negative, technical progress is capital-saving. Consequently, to ensure full employment of capital in the new equilibrium after tax, the price of capital would have to decline more; hence, ceteris paribus, the tax burden of capital increases. Capital would bear a smaller burden if technical progress is capital-using.

VI. Conclusion

The model analyzed in this paper shows that in general, neutral
technical progress in the untaxed industry tends to increase the burden of
the corporation income tax on capital. This tendency would be mitigated
if technical progress in either industry happens to be capital using. If
technical progress is confined to the taxed industry, the elasticity of
demand for its products plays a critical role in determining the tax
burden. If the demand curve is inelastic, other things being equal, capi-
tal's share of the tax would rise and vice versa. The demand for the
products of the corporate sector in the United States is believed to be
inelastic. In some cases the price elasticity (E) has been estimated to
be as low as -0.14.\footnote{Harberger (1962), p. 233.} If our analysis of tax incidence is correct, the
corporation income tax provides the corporate sector with a strong induce-
ment to introduce capita-using innovations. In this context, it is inter-
esting to note that Sato's recent work supports the hypothesis that technical
progress in the manufacturing sector of the U.S. economy has been of the
capital-using type.\footnote{Cf. Sato (1970), p. 200.} Our results suggest that the bias in technical
progress might be explained, at least partially, by efforts of corporations
to escape the burden of the corporation income tax.

Our analysis, thus, has some interesting implications for the theory
of induced inventions which suggests that when the price of a factor rises,
the producers have an incentive to introduce innovations which economize on
the use of that factor (see Hicks 1932 and Ahmad 1966). Since the corpora-
tion income tax, in effect, raises the price of capital to the taxed indus-
try, this argument implies that producers in the taxed industry would be
induced to introduce capital-saving technical progress. However, this a
priori conclusion is modified when other variables suggested by the general
equilibrium approach presented in our paper are taken into account, and, as shown before, capital owners (or producers), ceteris paribus, tend to benefit from the introduction of capital-using technical progress.

In the absence of technical progress, capital could benefit from the corporation income tax only if the corporate sector is labor-intensive. When technical progress is introduced, it ceases to be a necessary condition if the corporate sector faces an elastic demand curve; capital can gain (labor's share exceeding its initial contribution to national income) even if the taxed industry is capital intensive. Relative factor intensities alone, however, are not sufficient to determine the incidence of the corporate income tax.
References


