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The Incidence and Efficiency Effects of Taxes on Income from Capital

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This article reexamines the incidence and efficiency cost of the discriminatory taxation of capital income in the United States. It is argued that Harberger's 1966 estimates of the static welfare loss were subject to two important mistakes. Their correction lowers the efficiency cost estimates approximately 38 percent. The paper also compares the corrected results of the Harberger model with those achieved with an algorithmic solution procedure for a general equilibrium model. When the latter approach is used with the same two-sector division of production, the results are very similar to those of Harberger's model. With disaggregation to 12 production sectors, however, the loss estimates increase by an average of 40 percent.

I. Introduction

There has developed over the past 15 years or so a very extensive literature regarding the taxation of income from capital, particularly the corporation income tax. On issues regarding the distributional incidence and inefficiency of these capital income levies, the works of Arnold Harberger (1959, 1962, 1966) have been particularly influential and important. His models and results often serve as a reference with which other approaches to these questions are compared. The 1959 and 1966 articles by Harberger deal with estimating the efficiency cost or dead-weight loss of these taxes resulting from the misallocation of resources. The latter of these pieces is somewhat more complete, in that it attempts to include all taxes on capital income rather than just the corporation income tax. Harberger's 1962 article describes his theoretical framework and addresses the question

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of the incidence of the corporation income tax on the functional distribution of income. On this issue, Harberger concludes that capital bears close to the full burden of the tax for realistic estimates of the elasticity parameters of his model.

Despite the attention economists have given the corporation income tax and other capital income taxes, nothing near a consensus has emerged regarding their economic impact. The importance of the subject is often rejuvenated by suggestions that the corporation income tax be integrated into the personal income tax structure.

This article has two primary purposes with respect to capital income taxation. The first of these is to correct two serious flaws in Harberger's 1966 article. One error is purely arithmetic, while the other is conceptual; but they both significantly affect his widely referred to inefficiency estimates. In the second section of this paper, I briefly describe the Harberger model,[1] comment on its shortcomings, illustrate the sources of the two mistakes, and present the corrected results for the Harberger approach. The importance of this section derives from the fact that the corrected inefficiency estimates of Harberger's model amount to only 32–63 percent of the published figures for the same elasticity parameterizations. On the other hand, it will be argued that the usual reporting of these dead-weight loss results as a trivial fraction of GNP is misleading. The section is also of value in displaying how important consistent units definitions are in applying data to the Harberger model.

The second purpose of this paper is to compare the corrected results of the Harberger model with those derived from an algorithmic solution of a general equilibrium model. One advantage of such an approach is that, in not using calculus, the changes which one is trying to gauge need not be assumed small in the model itself. The task of comparing the results of such a procedure with those of the Harberger model was undertaken in an earlier work (Shoven and Whalley 1972), but a recalculation is now in order, for several reasons. First, the earlier article used the data and the results of the Harberger 1966 article in evaluating the two techniques. However, the data and therefore the results were incorrect (as shown here in Sec. II). Second, the algorithmic approach has been greatly improved in the interim, as is detailed in Shoven and Whalley (1973) and Shoven (1976). And finally, third, another advantage of the algorithmic approach is that it is capable of evaluating an *n* sector rather than a two-sector model. Therefore, in order to provide a feel for the effects of aggregated analysis, the impact of the uneven capital income tax levies is estimated for a 12- as well as a two-sector breakdown of the production side of the U.S. economy. With the algorithmic approach, the flat tax rate necessary to generate the same real yield as the current system is calculated.

[1] The model has been elaborately specified several times in the literature. See, e.g., Harberger (1962); appendix B of Shoven and Whalley (1972); McLure (1974); or McLure (1975).

II. Harberger Model, Data, and Results

The Harberger model, as detailed in his 1962 article and in several subsequent studies, is sufficiently well known and documented that it need not be completely specified here. However, since a primary purpose of this section is to correct the results of his 1966 paper concerning the efficiency losses of the taxes, it is appropriate that we review the approach of that study.

In his model, Harberger makes an empirical distinction between a heavily and lightly taxed sector. These sectors are sometimes referred to as the "corporate" and "non-corporate" sectors, due to the major role played by the corporation income tax in causing the differential rates, although the sectoral division does not exactly correspond to the legal distinction between incorporated and unincorporated enterprises. Harberger assumes that each sector employs two factors, capital services and labor, in the production of homogeneous outputs.

In order to estimate the efficiency loss due to the differential taxation of the return to capital, Harberger applies a form of welfare analysis in the tradition of Marshallian producer surplus. It is assumed that the marginal product of capital schedules for each sector are linear, as drawn in figure 1. Output units are chosen so that both commodity prices are unity, and therefore the schedules in figure 1 can be thought of as marginal revenue product schedules. The total quantity of both capital and labor in the economy is assumed fixed and always fully employed. With these assumptions, the changes in the capital allocation can be used to generate a measure of the social waste imposed by the distortion. In the absence of any taxes, capital will allocate itself in a market economy such that the rate of return $\bar{r}$ is equal for the two sectors and the capital endowment is fully employed. Upon the imposition of a tax on capital income in sector X, the gross rate of return r_g in that sector must be such that the net rate of return r_n is equalized across the sectors and capital is again fully employed. The difference between r_g and r_n is by definition the tax T per unit of capital utilized in sector X.

Referring to figure 1, the area $ABEF$ can be interpreted as the value of the lost output in sector X when K_X decreases from K_{X0} to K_{X1} upon the imposition of the tax. Analogously, $GHIJ$ is the value of increase in output in sector Y. Since we know that capital is fully employed both in the presence and absence of the tax, it must be true that $K_{X0} - K_{X1} = K_{Y1} - K_{Y0}$. The area $FECD$ represents the social loss of the tax in the producer surplus sense (it is simply $ABEF - GHIJ$) and is given by

$$\tfrac{1}{2}(r_g - \bar{r})(K_{X0} - K_{X1}) + \tfrac{1}{2}(\bar{r} - r_n)(K_{Y1} - K_{Y0}) = -\tfrac{1}{2}T\Delta K_X, \qquad (1)$$

where $\Delta K_X = K_{X1} - K_{X0} = K_{Y0} - K_{Y1}$ and $T = r_g - r_n$.

Now, in order to estimate the magnitude of the social efficiency loss, an expression for ΔK_X is required. In order to obtain such a solution,

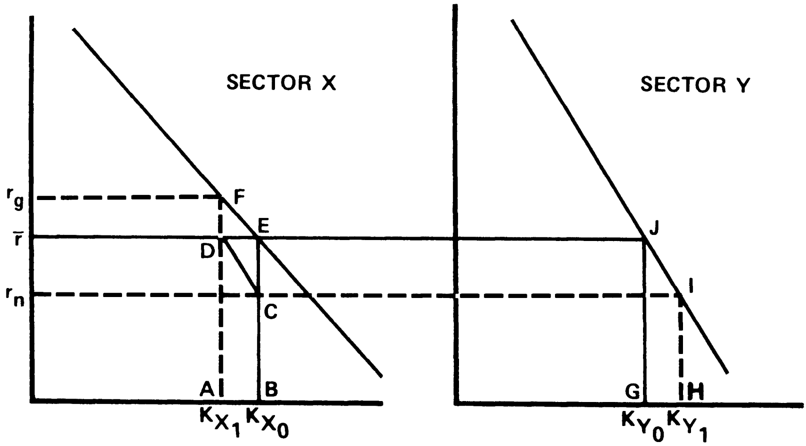

Fig. 1

Harberger calls upon the static two-sector, two-factor, general equilibrium model of his 1962 paper. The use of this model in conjunction with the Marshallian approach above has several shortcomings, particularly if the purpose involves measurement of economic changes. The primary problem is that local or "small change" assumptions are made repeatedly in the analysis. For example, in solving for the efficiency loss formula (eq. [1]), it has been assumed that the marginal product of capital varies linearly with the amount of capital for each of the sectors. In addition, either the labor allocation must be assumed to be unaltered, or the marginal product of capital must be taken as independent of the amount of labor employed in each sector. Without either of these conditions, the marginal product curves themselves will not be stationary. At the same time, in the model used to solve for the capital shift, ΔK_X, constant returns to scale in production is assumed. The joint assumptions of linear marginal product schedules, constant returns to scale, and separable marginal products (or an unchanged labor allocation) are inconsistent for large changes. Given that the purpose of the analysis is to determine the magnitude of the effects of distortionary taxation, assumptions such as these which are consistent only locally are undesirable.

Solving through the equations of the Harberger (1962) model, the following solution for ΔK_X is obtained:

$$\Delta K_X = \frac{K_X T\,\{-E[g_K S_X(L_X/L_Y) + f_K S_Y] - S_X S_Y f_L\}}{E(g_K - f_K)[(K_X/K_Y) - (L_X/L_Y)] - S_Y - S_X[f_L(K_X/K_Y) + f_K(L_X/L_Y)]}, \tag{2}$$

where E = compensated price elasticity of demand for X; $S_X(S_Y)$ = elasticity of factor substitution in sector $X(Y)$; $f_K(g_K)$ = share of capital in sector $X(Y)$; and $f_L(g_L)$ = share of labor in sector $X(Y)$. So, as one would expect, the capital shift depends on the various elasticities and factor intensities and is also proportional to T. This last point is emphasized, as it later becomes important in that it, along with equation (1), implies that the social cost varies with the square of the tax rate.

Harberger similarly solves this system of equations for the change in the net price of capital (i.e., $\Delta P_K = r_n - \bar{r}$) and obtains

$$\Delta P_K = \frac{T\{Ef_K[(K_X/K_Y) - (L_X/L_Y)] + S_X[f_L(K_X/K_Y) + f_K(L_X/L_Y)]\}}{E(g_K - f_K)[(K_X/K_Y) - (L_X/L_Y)] - S_Y - S_X[f_L(K_X/K_Y) + f_K(L_X/L_Y)]}. \tag{3}$$

He uses this figure to evaluate the incidence of the burden, reasoning that, if $\Delta P_K = -(TK_X)/(K_X + K_Y)$, capital could be said to bear the full burden of the tax in that its gross return would be unchanged, while if $\Delta P_K = 0$ both net input prices would be unaffected, and thus the share of national income going to capital and labor would remain constant.

In order to evaluate expressions (2) and (3) for the 1953–59 U.S. economy, Harberger uses and supplements the data of Rosenberg (1969). However, in carrying this out, two mistakes are made. Estimates of K_X, K_Y, and T are drawn from table 1, reproduced from Harberger (1966). Columns 1 and 2 are derived from Rosenberg's disaggregated study, while column 3 is meant to reflect the personal income taxes on capital income. Appealing to columns 4 and 5, Harberger notes that total taxes on net income in the "non-corporate" and "corporate" sectors average, respectively, 45 percent and 168 percent.[2] Thus he asserts that the taxation of income from capital in the United States during this period may be approximated by a general tax of 45 percent on all net income from capital and an 85 percent surtax on the net income from capital originating in the heavily taxed sector ($1.45 \times 1.85 = 2.68$).

The first flaw in Harberger's 1966 application of this data to his model is an inconsistency between the calculation of tax rates above and the units of measurement of capital chosen in the study. Harberger takes as one unit of capital that amount which earned an average annual flow of $1.00 net of all taxes. Thus, appealing to column 5 of table 1, he sets K_Y as 18,510 million and K_X as 19,547 million. In models such as this, with a fixed quantity of aggregate capital, a general tax on all capital income is nondistortionary. Therefore Harberger proceeds to evaluate only the 85 percent surtax applying to the capital income of the "cor-

[2] The use of average tax data to evaluate distortions has been questioned by Stiglitz (1975). The implied assumption that the marginal gross cost of capital equals the average gross cost can be defended on the grounds that investment decisions are often made using average capital costs (see, e.g., Van Horne 1971).

TABLE 1

Taxes on Income from Capital, by Major Sectors
(Annual Averages, 1953–59, in $ Millions)
(Reproduced from Harberger 1966, p. 110)

	Total Income* from Capital (1)	Property & Corp. Income Taxes (2)	Other Tax Adjustments (3)	Total Tax on Income from Capital (4)	Net Income from Capital (5)
"Non-corporate" sector	26,873	6,639	1,724	8,363	18,510
Agriculture	7,481	1,302	927[a]	2,229	5,252
Housing	18,429	5,140	797[b]	5,937	12,492
Crude Oil and Gas	963	197	...[c]	197	766
"Corporate" sector..	52,399	22,907	9,945[d]	32,852	19,547
Total.........	79,272	29,546	11,669	41,215	38,057

* "Income" (Rosenberg 1969, p. 125) is defined as income from capital for nonfinancial industry and includes
(1) Corporate sector net income before corporate profits tax liability and property tax payments.
(2) For the unincorporated sector, the portion of the total income of the unincorporated enterprise that is a return on equity capital, plus property tax payments.
(3) Net monetary interest paid by businesses on borrowed capital in the form of debt obligations.
(4) Net rent paid by an industry to persons for the use of physical capital.
(5) Net realized capital gains by the corporate sector that are considered as income to an industry.

[a] Assumes a 15% effective tax on income from capital in agriculture after payment of property and corporate income taxes (i.e., [3][a] = 15% of [1] − [2]).

[b] Assumes that 70% of income from capital in the housing sector is generated by owner-occupied housing, on which no personal income tax liability is incurred. It is assumed that the remaining 30% of capital income from housing is subjected to a 20% income tax rate after the deduction of property and corporate income taxes incurred (i.e., [3][b] = 6% of [1] − [2]).

[c] Assumes personal tax offsets on account of oil depletion allowances and similar privileges offset any taxes on dividends and capital gains in this sector.

[d] Assumes a 50% dividend distribution rate and a "typical" effective tax rate of 40% on dividend income (i.e., [3][d] = 20% of [1] − [2]).

porate" sector (i.e., he set $T = 0.85$ in equations (1), (2), and (3)). The problem is that the surtax is in fact applied not to the net capital income of the heavily taxed sector (indicated in table 1 to be 19,547 million) but to the capital income in that sector gross of the neutral 45 percent tax ($28,379 million). Harberger is thus evaluating a smaller tax than his data reveals! The social marginal product of each of Harberger's units of capital is $1.45, not the $1.00 he recognizes. In order to rectify this problem, one either has to evaluate *both* the 45 percent and 168 percent taxes simultaneously or to evaluate only the surtax and take as a unit of capital that amount which earns $1.00 net of the surtax but gross of the neutral tax. The dead-weight loss estimates are identical with either convention, and I have chosen the latter simply because the previous figure and equations have been for the surtax case. Under this approach, table 1 shows $K_Y = 26{,}873$ million and $K_X = 28{,}379$ million. As the estimate of the capital shift and the dead-weight loss are proportional to K_X, this correction alone would increase Harberger's inefficiency results 45 percent.

Unfortunately, the problem with units above is not the most serious error related to the data of Harberger (1966). They contain a simple arithmetic mistake, which also greatly affects his results. The entry superscripted *d* in column 3 should be 5,898 rather than 9,945, and, with this correction, the net income from capital in the "corporate" sector becomes \$23,589 rather than \$19,547 million. The total tax on capital income in the "corporate" sector should be \$28,805 million. The source of the error is obvious. In determining the column 3 entry for the "corporate" sector, the arithmetic was mistakenly done on the first two entries in the total row. Note that 9,945 is 20 percent of 79,272 less 29,546.[3]

Table 2 contains the corrected factor input and capital tax data for both a two- and a 12-sector level of aggregation for averaged data for the same 1953–59 period. The capital income and tax data are again drawn from Rosenberg (1969), and the "Other Capital Tax Adjustments" column was constructed upon the assumptions listed in the footnotes to table 1. The labor data are derived from National Income and Product Accounts. At the two-sector level of aggregation, the main difference between the two tables is caused, of course, by the arithmetic mistake just noted. The surtax rate, which Harberger figures as 85 percent, is, according to table 2, only 53 percent ($1.45 \times 1.53 = 2.22$). The effect of this error is magnified, since, as was pointed out earlier, the loss estimate varies as the square of the rate of distortionary taxation. The capital data, using the consistent definition of units mentioned above, now indicates that $K_Y = 26{,}878$ million and $K_X = 34{,}244$ million.

Subject to these two mistakes, Harberger uses the data of table 1 augmented with labor data[4] to estimate ΔK_X and $-(1/2)T\Delta K_X$ for several different elasticities of factor substitution (S_X and S_Y) and for two different compensated elasticities of demand for the "corporate" product X. The two demand elasticities E are based on the elasticity of substitution between X and Y, which is labeled V, being assigned values of 1 and $\frac{1}{2}$. The relationship between V and the compensated demand for X is

$$E = Vr_Y, \tag{4}$$

where r_Y is the share of national income spent on Y. Thus the $V = 1$ case is consistent with demands derived from a Cobb-Douglas–type utility function. Harberger takes r_Y as 0.17, although my revised data (col. 3, table 2) suggests that r_Y is just slightly under 0.15.

Many different estimates have been made of the elasticities of substitution between labor and capital for various sectors, often concluding with contradictory results. Most of the work based on cross-section data

[3] There are two other errors in table 1. The total income figure from capital in the noncorporate sector should be 26,878 rather than 26,873, and in the corporate sector the figure should be 52,394 rather than 52,399. The total of the two is correct in table 1.

[4] Harberger takes L_X to be \$200 billion and L_Y to be \$20 billion. Col. 1 of table 2 agrees very closely with his L_X figure but shows L_Y to be only \$17,471 billion (or units).

TABLE 2

FACTOR PAYMENTS AND CAPITAL INCOME TAXES, BY MAJOR SECTORS
(Annual Averages, 1953–59, in $ Million)

Sector	Total Return to Labor (1)	Total Return to Capital (2)	Total Factor Return (1) + (2) (3)	Property and Corporate Income Tax (4)	Other Capital Tax Adjustments (5)	Total Capital Tax (4) + (5) (6)	Net Return to Capital (2) − (6) (7)	Capital Tax as a Fraction of Total Return to Capital (6)/(2) (8)	Capital Tax as a Fraction of Net Return to Capital (6)/(7) (9)
"Non-corporate"	17,471	26,878	44,349	6,639	1,724	8,363	18,515	0.3111466	0.4516878
Agriculture	8,800	7,481	16,281	1,302	927	2,229	5,252	0.2979548	0.4244097
Real estate	6,869	18,429	25,298	5,140	797	5,937	12,492	0.3221552	0.4752641
Crude oil and gas	1,802	968	2,770	197	...	197	771	0.2035123	0.2555123
"Corporate"	199,871	52,394	252,265	22,907	5,898	28,805	23,589	0.5497766	1.2211220
Mining*	2,528	688	3,216	305	77	382	306	0.5552325	1.2483660
Contract construction	16,670	1,195	17,865	435	152	587	608	0.4912133	0.9654605
Manufacturing†	79,626	24,665	104,291	12,488	2,435	14,923	9,742	0.6050273	1.5318209
Lumber and wood products	2,426	718	3,144	206	102	308	410	0.4289693	0.7512195
Petroleum and coal products	1,846	3,028	4,874	770	452	1,222	1,806	0.4035667	0.6766334
Trade	43,590	10,897	54,487	3,493	1,481	4,974	5,923	0.4564559	0.8397771
Transportation	14,078	2,683	16,761	1,230	291	1,521	1,162	0.5669027	1.3089500
Communication and public utilities	7,394	6,489	13,883	3,290	640	3,930	2,559	0.6056403	1.5357561
Services	31,713	2,031	33,744	690	268	958	1,073	0.4716888	0.8928238
Total	217,342	79,272	296,614	29,546	7,622	37,168	42,104	0.4688666	0.8827664

* Other than crude oil and gas.
† Other than lumber and wood products and petroleum and coal products.

suggests that, for most two-digit manufacturing industries, S is not significantly different from 1 (see, e.g., Solow 1964 and Minasian 1961). On the other hand, time-series studies yield estimates significantly less than 1 (see Lucas 1969). Given this situation, Harberger looks at several combinations of S_X and S_Y.

Table 3 contains Harberger's published results, appropriately qualified as only rough estimates, and the impact on them of the two errors just discussed. Their importance is readily apparent, although the net effect is somewhat reduced, as they cut in opposing directions. The 45 percent increase in the inefficiency estimates due to the units-definition problem is apparent in comparing column 7 with column 5. The independent effect of the arithmetic mistake and Harberger's use of other data which are only roughly correct is seen by contrasting columns 9 and 7. The range of the estimates is lowered from the published \$1.0 billion–\$2.9 billion to the \$0.625 billion–\$1.79 billion shown in column 9 of table 3 and based on the data of table 2. Surprisingly, Harberger's numerical estimates of the outflow of capital from the "corporate" sector due to the discriminatory taxation shown in column 4 are almost identical with the corrected figures given in column 8 except in case 11, where he has made a serious computational error. The equivalency is less comforting and more coincidental, however, when it is recalled that each of Harberger's units of capital is equivalent to 1.45 units under the revised system of accounts.

It may be claimed that all that has been done is to lower further Harberger's already small loss estimates, widely reported as between 0.5 and 1 percent of GNP (or NNP). This presentation of the results as a percentage of national product seems misleading, however. Perhaps a more natural benchmark is the net revenue yield of the surtax. This alternative, also not without some interpretational difficulties, suggests a "coefficient of inefficiency" which can be defined as the ratio of the deadweight loss of the surtax (in this case the 53% additional tax paid by sector X) to the net surtax revenue. This additional revenue due to the presence of the surtax amounts to between \$9.3 billion and \$13.9 billion, depending on the factor-elasticity assumptions. The yield of a flat 45 percent tax on net income depends upon the net price of capital in the nondistortionary situation. For the revised results of column 9, table 3, the coefficient of inefficiency ranges from 0.06 to 0.15. Column 10 of table 3 records the values for ΔP_K, the change in the price of capital in moving from the nondistortionary to the distortionary situation. This variable sheds some light on the functional incidence of the taxation, particularly when it is noted that $-TK_X/(K_X + K_Y) = -0.297$. This is the value of ΔP_K at which capital can be said to bear the entire tax, as its net return is reduced by the amount of the tax proceeds. For those cases in which the price falls by more than this figure, capital can be said to be bearing more than 100 percent of the tax burden.

TABLE 3

ESTIMATES OF EFFICIENCY COST OF EXISTING TAXES ON INCOME FROM CAPITAL (1953–59), USING HARBERGER'S MODEL

				HARBERGER'S ESTIMATES*		ESTIMATES WITH REVISED UNITS†		ESTIMATES WITH REVISED UNITS AND REVISED DATA‡		
CASE	S_X (1)	S_Y (2)	V (3)	ΔK_X (4) §	$-(1/2)T\Delta K_X$ (5) ‖	$\Delta K'_X$ (6) §	$-(1/2)T\Delta K'_X$ (7) ‖	$\Delta K''_X$ (8) §	$-(1/2)T\Delta K''_X$ (9) ‖	ΔP_K (10)
1	−1.0	−1.0	−1.0	−6.9	2.9	−9.7	4.1	−6.76	1.79	−0.326
2	−1.0	−0.5	−1.0	−5.9	2.5	−8.4	3.6	−5.85	1.55	−0.362
3	−0.5	−1.0	−1.0	−5.2	2.2	−7.4	3.1	−5.20	1.38	−0.221
4	−0.5	−0.5	−1.0	−4.8	2.0	−6.7	2.9	−4.75	1.26	−0.261
5	−1.0	0.0	−1.0	−4.7	2.0	−6.6	2.8	−4.71	1.25	−0.408
6	−0.5	0.0	−1.0	−3.9	1.7	−5.7	2.4	−4.09	1.08	−0.318
7	−1.0	−1.0	−0.5	−5.3	2.3	−7 5	3.2	−5.13	1.36	−0.365
8	−1.0	−0.5	−0.5	−4.2	1.8	−5.8	2.5	−4.00	1.06	−0.408
9	−0.5	−1.0	−0.5	−4.1	1.7	−5.8	2.5	−4.06	1.08	−0.272
10	−0.5	−0.5	−0.5	−3.5	1.5	−4.9	2.1	−3.38	0.896	−0.326
11	−1.0	0.0	−0.5	−5.0	2.1	−3.6	1.5	−2.55	0.676	−0.464
12	−0.5	0.0	−0.5	−2.4	1.0	−3.3	1.4	−2.36	0.625	−0.408

NOTE.—$S_X (S_Y)$ = elasticity of factor substitution in "corporate" ("non-corporate") sector; V = elasticity of substitution between products X and Y.

* Based on $K_X = 20$, $K_Y = 20$, $L_X = 200$, $L_Y = 20$, $f_K = 0.2$, $f_L = 0.8$, $g_K = 0.54$, $r_Y = 0.17$, $T = 0.85$. Harberger made a computational error in case 11, where he should have gotten $\Delta K_X = -2.5$ and $-(1/2)T\Delta K_X = 1.1$.

† Based on $K_X = 28.5$, $K_Y = 27.0$, $L_X = 200$, $L_Y = 20$, $f_K = 0.2$, $f_L = 0.8$, $g_K = 0.54$, $r_Y = 0.17$, $T = 0.85$.

‡ Based on $K_X = 34.244$, $K_Y = 26.878$, $L_X = 199.871$, $L_Y = 17.471$, $f_K = 0.20769$, $f_L = 0.79231$, $g_K = 0.60606$, $r_y = 0.14952$, $T = 0.53003$.

§ In billions.

‖ In $ billion.

III. Results of the Algorithmic Approach

Using the revised data of table 2, the efficiency cost of the distortionary taxation of capital income has been recomputed using a solution algorithm for a general equilibrium model. It is, of course, the corrected results of columns 9 and 10 of table 3 which will serve as a basis for comparison. Such additional questions as the impact of the taxes on the supply of labor, on the functional and personal distribution of income, and the flat capital income tax rate which would be required to generate the same real revenue as the existing taxes can be addressed using the algorithmic approach. In most cases the assumptions of Harberger have been followed, although the models of course are not strictly comparable. Production functions are assumed to be of the CES form, while both CES and Cobb-Douglas utility functions were analyzed for consumers. Two classes of consumers were incorporated, one representing the top 10 percent of the income recipients in the United States, the other the bottom 90 percent. The model was solved both with and without the inclusion of a labor-leisure choice, although detailed results will be presented only for the fixed-labor-supply case.

Just as there is no need to respecify the Harberger model completely each time it is employed, it is likewise unnecessary to review fully the Scarf (1973) general equilibrium algorithm utilized here to derive the results of this section. For that reason, only a brief sketch of the mechanics of the approach is presented.

The basic idea of the algorithmic approach of this section is to specify an Arrow-Debreu general equilibrium model with and without taxes. The existence of an equilibrium for a model with such ad valorem taxes is assured in Shoven (1974). In order to parameterize the model, some extraneous estimates are required. These are the same factor substitution and demand elasticities which must be specified in the Harberger approach described in the last section. Given these estimates, which comprise perhaps one-third of the total number of parameters, the model is solved "backward" to determine the values that the remaining variables must take in order to replicate exactly the prechange economy. The technique of carrying out this parameterization approach is more fully described in Shoven (1973) and Whalley (1973). Once all the parameters are set, the model is solved "forward" for a new equilibrium in the presence of the new tax environment. In the case of this study, the new system involves the removal of the surtax on capital income in the heavily taxed sector (or sectors with the 12-sector level of aggregation). The solution technique is a version of Scarf's algorithm modified to include taxes and continuous production functions. This method is detailed in Shoven (1973) and Shoven and Whalley (1973). The degree of approximation is greatly improved with a Newton-type termination routine similar to that described in appendix A of Shoven and Whalley (1972). The advantages of this general approach over that of Section II are that (1) no localization assumptions are required; (2) it is simple to incorporate many commodities and several classes of consumers; and (3) it is unnecessary to assume fixed factor supplies. A more abstract advantage is that the model need not be kept sufficiently simple so as to be analytically tractable.

On the production side of the economy, each sector's technological production possibilities are characterized by a CES production function such as

$$Q_i = \gamma_i[\alpha_i L_i^{-\rho_i} + (1 - \alpha_i)K_i^{-\rho_i}]^{-1/\rho_i}. \tag{5}$$

Noting the discussion in the previous section of plausible estimates of the elasticity of substitution (in this case $S_i = -1/[1 + \rho_i]$), seven cases were considered: three in line with Harberger, and four others. They may be listed as

Case	S_X	S_Y
1	−1.00	−1.00
2	−1.00	−0.50
3	−1.00	−0.25
4	−0.75	−0.25
5	−0.50	−0.50
6	−0.50	−0.25
7	−0.25	−0.25

As previously mentioned, two consumers were considered; the first heuristically represents the upper 10 percent of the income recipients, while the second represents the lower 90 percent. The first is endowed with approximately 23 percent of the economy's labor (corresponding to the observed share of labor income going to the top decile of income receivers) and 40 percent of total stock of capital (both figures from Projector and Weiss 1966). This latter figure roughly corresponds to the share of capital income going to the top 10 percent of the income receivers, although it is much lower than the share of capital income going to the top 10 percent of wealth holders. Endowing the high-income receivers with more than 10 percent of the labor appeals to an equal endowment of labor in natural units but a disproportionate endowment in efficiency units.

Each consumer's demand functions are of the form

$$x_{ij} = \frac{I_j}{\sum_{i=1}^{n} a_{ij} P_i^{(1-V_j)}} \frac{a_{ij}}{P_i^{V_j}}, \qquad i = 1, \ldots, n; j = 1, 2, \tag{6}$$

where x_{ij} is consumer j's demand for commodity i, a_{ij} measures the intensity of his desire for commodity i, P_i is the price of the ith good, V_j

is individual j's elasticity of substitution between commodities, and I_j is his income given by

$$I_j = \sum_{i=1}^{n} P_i w_{ij}, \tag{7}$$

where the w_{ij} are his initial asset holdings, including labor.

In the recomputations, two values for the consumer's elasticities of substitution (i.e., the V_j's) are examined: 1.0 and 0.5. With V_j equal to 1.0, the demand functions (6) are of the familiar Cobb-Douglas type.

Using the demand functions (6) permits one to impose the observed aggregate 5.69–1.0 expenditure ratio for the outputs of the heavily and lightly taxed sectors. Approximately \$252 billion a year was spent on "corporate" products, while only \$44 billion was spent on the output of the "non-corporate" sector. If each individual's tastes were such that $a_{ij} = 5.69a_{2j}$, $j = 1, 2$, where the "corporate" product is labeled commodity 1 and the "non-corporate" product commodity 2, the expenditure ratios of the model would exactly correspond to the 5.69–1.00 figure with unitary prices. However, in the examples investigated here, lower-income individuals are taken to place a relatively higher weight on the output of the lightly taxed sector than higher-income individuals. This is consistent with observed higher budget shares allocated to food expenditures (agricultural output) by lower-income people. The ratios a_{1j}/a_{2j} used are 7.00 for the higher-income consumer and 5.30 for the lower-income consumer.

The total endowments of the economy are taken from table 2 of the last section. Again, we need to clarify units conventions. The approach taken in this section is to analyze all capital income taxes, and not simply the surtax. This implies taking as a unit of capital that amount which earns \$1.00 net of all taxes, Harberger's original units. The advantage of this convention here is that it readily permits disaggregation, and it explicitly recognizes that the government's tax collections rise (even from neutral taxes) when the net price of capital services increase. It is a perfectly acceptable units convention, provided all taxes are incorporated into the model. Relative price changes and real output effects are independent of which of the two consistent units definitions is chosen. Only in comparing absolute quantities of capital must the appropriate conversion (1.45) be applied. With this settled and in the absence of a labor-leisure choice, the total labor endowment is taken to be 217.342 billion units, while the capital-services endowment is 42.104 billion units. In the presence of the surtax, 23.589 billion units of capital and 199.871 billion units of labor are allocated to the "corporate" sector (from table 2, columns 1 and 7). To focus solely on the impact of the tax, the fraction of government tax proceeds returned to each consumption class is assumed equal to that class's fraction of the total capital endowment.

Thus the potential redistributionary effects of the expenditure of the tax proceeds are not considered here.

Table 4 contains a summary of the efficiency loss and incidence results for the two production-sector cases. What is compared in this table is the observed equilibrium (the equilibrium in the presence of distortionary capital income taxes) with the equilibrium which would prevail in the absence of the distortionary taxes (i.e., in the absence of what Harberger refers to as the surtax). Also reported are the equilibrium prices and the tax rate (on net income) which would prevail if the replacement were a flat tax designed to have the same real yield as is realized in the distortionary situation. A Paasche price index is used in determining real rather than nominal revenue equivalency. The technique of determining this equal-yield tax rate is described in Shoven and Whalley (1975). The entry termed the "shift factor" is presented to give some insight into the incidence of the distortionary capital taxation with respect to the functional distribution of income.[5] The definition of the term is shift factor $= 1 + (\Delta P_K K)/(\Delta R)$, where K is the total endowment of capital, ΔP_K is the change in the net price of capital in moving from the nondistortionary to the distortionary tax regime (thus this term is negative in all cases), and ΔR is the change in nominal government revenue (which is of course positive). If this shift factor is zero, the decrease in the net return to capital is equal to the increase in government revenue due to the distortionary surtax, and in this sense capital may be said to bear the full burden. A negative value for this shift factor would indicate that capital bears more than 100 percent of the burden of the surtax, while a positive value would reflect the fact that labor is sharing in its costs.

Table 4, part A, presents the results for the cases in which both consumer classes have demand elasticities of substitution (V_j's) equal to 1. As one would expect, the removal of the surtax involves a decrease in the price of X, the "corporate" output, and an increase in the price of Y (due to the increase in the net price of capital). It might be noted that these price changes tend to benefit the higher-income consumer class more than the lower-income class, as the former spends a larger fraction of its income on products which decrease in price (i.e., X). As is done in Harberger's work, labor is taken as the numéraire commodity and thus always has a price of unity. The "X" and "Y" rows show that the output of sector X increases by 2–3 percent, while the output of sector Y decreases by as much as 15 percent. Factor substitution occurs, and the "corporate" sector switches to a more capital-intensive technology with the removal of the surtax, while the lightly taxed sector becomes more labor intensive. One interesting aspect of this particular problem is that the sector whose capital income is currently heavily taxed is relatively

[5] Of course the reader also can compute ΔP_K from the tables.

labor intensive. This fact opens the possibility that labor may bear a large fraction of the burden of the surtax, particularly in cases with low elasticities of factor substitution. Indeed, the "shift factor" row of this section shows that, in cases 5, 6, and 7, labor's share of the burden is significant. In fact, in case 7 the relative share of the rich consumer class (whose assets are capital intensive) is 0.4 percent higher in the presence of the distortionary tax than in its absence. The efficiency loss estimates are shown to be sensitive to the specification of the production parameters and range between \$0.435 billion and \$2.344 billion. These figures amount to 2.8–18.7 percent of the revenue generated by the surtax. For each parameterization, two loss estimates (or changes in NNP)[6] are given: one evaluated at the observed prices and one at the new, nondistortionary prices. As is known from index number theory, under "reasonable" assumptions it can be shown that the estimate based on the new prices gives by a lower bound for welfare losses, while that based on the old, observed prices provides an upper bound.

As capital services are fixed in aggregate supply by assumption, any flat-rate tax on capital income is nondistortionary. Further, since the tax proceeds are distributed according to one's ownership of capital, the distribution of income is unaffected by flat-rate capital income taxes. It is for these reasons that the only price which changes in moving from a flat 45.16878 percent tax (the surtax-removal cases) to a flat tax at an equal-yield rate is the net price of capital. For each of the seven production parameterizations, the new net price of capital and the equal-yield tax rate applying to net capital income are shown in the "P_K" and "tax rate" rows, respectively.

Part B of table 4 presents the same seven factor-elasticity cases where the consumers' elasticities of substitution are now specified as 0.5. As is shown, the efficiency loss estimates are reduced by 10–40 percent, and the shift factors are substantially lower, indicating that labor bears a smaller share of the burden of the surtax. The sensitivity of this incidence of the distortion on the functional distribution of income to different parameterizations seems to be far greater than expected or indicated by Harberger.

In comparing the estimates of the two parts of table 4 with Harberger's corrected results, one arrives at the general conclusion that the magnitudes are similar. The capital reallocation caused by the discriminatory capital income taxation is estimated to be smaller with the algorithmic approach of this section. Recalling the inequality of the units of measurement, the figures can best be interpreted by comparing the percentage increase in the amount of capital allocated to sector X which would occur in moving from the distortionary to a neutral tax situation. The six comparable

[6] What is referred to here as NNP is the value of the product of the two (or 12) sectors. The efficiency loss is the value of the change in production.

TABLE 4

SUMMARY OF TWO-SECTOR RESULTS

Case	Observed Equilibrium	1	2	3	4	5	6	7
		A. Consumer Demand Elasticities = 1; Fixed Factor Supplies						
S_X	...	−1.0	−1.0	−1.0	−0.75	−0.5	−0.5	−0.25
S_Y	...	−1.0	−0.5	−0.25	−0.25	−0.5	−0.25	−0.25
Surtax removal:								
P_X	1.00000	0.96626	0.97136	0.97419	0.96834	0.95607	0.95921	0.94337
P_Y	1.00000	1.17068	1.19455	1.20842	1.18378	1.13088	1.14478	1.07529
P_L	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
P_K	1.00000	1.29695	1.33027	1.34900	1.30727	1.22027	1.24145	1.12495
R	37.168	24.665	25.299	25.655	24.861	23.207	23.610	21.394
X^*	252.265	261.074	261.495	261.741	261.070	259.666	259.971	257.884
Y^*	44.349	37.883	37.374	37.082	37.541	38.614	38.310	39.624
K_X^*	23.589	27.828	27.318	27.043	26.815	26.585	26.431	25.665
K_Y^*	18.515	14.276	14.786	15.061	15.289	15.519	15.673	16.439
L_X^*	199.871	199.871	201.250	202.026	201.916	201.165	201.731	201.366
L_Y^*	17.471	17.471	16.092	15.316	15.426	16.177	15.611	15.976
Shift factor	...	0.00000	−0.17158	−0.27634	−0.05125	0.33570	0.25018	0.66648
Relative share of rich	0.273	0.273	0.274	0.275	0.274	0.271	0.272	0.269
ΔNNP†	...	0.943	0.633	0.450	0.467	0.591	0.477	0.435
ΔNNP‡	...	2.344	2.255	2.209	1.997	1.666	1.666	1.094
Equal yield replacement:								
P_X	1.00000	0.96626	0.97136	0.97419	0.96834	0.95607	0.95921	0.94337
P_Y	1.00000	1.17068	1.19455	1.20842	1.18378	1.13088	1.14478	1.07529
P_L	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
P_K	1.00000	1.00692	1.04901	1.07269	1.01902	0.90749	0.93441	0.78472
R	37.168	36.877	37.141	37.289	36.998	36.376	36.538	35.719
Tax rate	1.22112/0.45169	0.86983	0.84091	0.82795	0.86232	0.95204	0.92871	1.08108

TABLE 4 (*Continued*)

	B. Consumer Demand Elasticities = 0.5; Fixed Factor Supplies							
S_X	...	−1.0	−1.0	−1.0	−0.75	−0.5	−0.5	−0.25
S_Y	...	−1.0	−0.5	−0.25	−0.25	−0.5	−0.25	−0.25
Surtax removal:								
P_X	1.00000	0.97166	0.97842	0.98230	0.97781	0.96531	0.97032	0.95551
P_Y	1.00000	1.18989	1.22155	1.24078	1.22182	1.16734	1.18994	1.12585
P_L	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
P_K	1.00000	1.33226	1.37745	1.40398	1.37175	1.28306	1.31769	1.20961
R	37.168	25.337	26.196	26.701	26.088	24.401	25.060	23.004
X*	252.265	257.426	257.618	257.740	257.460	256.760	256.979	255.969
Y*	44.349	40.879	40.502	40.279	40.462	41.044	40.783	41.470
K_X*	23.589	26.862	26.180	25.800	25.693	25.760	25.506	25.096
K_Y*	18.515	15.242	15.924	16.304	16.411	16.344	16.598	17.007
L_X*	199.871	198.180	199.707	200.595	200.583	199.872	200.562	200.511
L_Y*	17.471	19.162	17.635	16.747	16.759	17.470	16.780	16.830
Shift factor	...	−0.18240	−0.44843	−0.62499	−0.41262	0.06652	−0.10472	0.37689
Relative share of rich	0.273	0.274	0.276	0.276	0.275	0.273	0.274	0.271
ΔNNP†	...	0.885	0.539	0.328	0.331	0.481	0.330	0.305
ΔNNP‡	...	1.690	1.507	1.405	1.308	1.190	1.148	0.831
Equal yield replacement:								
P_X	1.00000	0.97166	0.97842	0.98230	0.97781	0.96531	0.97032	0.95551
P_Y	1.00000	1.18989	1.22155	1.24078	1.22182	1.16734	1.18994	1.12585
P_L	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
P_K	1.00000	1.04987	1.10675	1.14016	1.09892	0.98588	1.02976	0.89152
R	37.168	37.039	37.594	37.809	37.575	36.913	37.183	36.397
Tax rate	1.221122/0.45169	0.84215	0.80675	0.78759	0.81211	0.88928	0.85760	0.96964

* Billions of units.
† $ billion. Calculated at new (i.e., nondistortionary) prices.
‡ $ billion. Calculated at old (i.e., observed) prices.

TABLE 5

% Increase in Capital Allocated to "Corporate" Sector with Neutral Capital Income Taxation

S_X	S_Y	V	Estimate of Harberger Model (%)	Scarf Algorithm Estimate (%)
−1.0	−1.0	−1.0	19.74	17.97
−1.0	−0.5	−1.0	17.08	15.81
−0.5	−0.5	−1.0	13.87	12.70
−1.0	−1.0	−0.5	14.98	13.88
−1.0	−0.5	−0.5	11.68	10.98
−0.5	−0.5	−0.5	9.87	9.20

cases are shown in table 5.[7] The algorithmic estimates indicate that the discriminatory taxes cause slightly less resource misallocation and therefore a slightly smaller dead-weight loss. These facts are confirmed by noting that table 4 also indicates a smaller change in the price of capital services than do the comparable cases in column 10 of table 3. In all cases the percentage of deviation between the two approaches correctly implemented is small, indicating that, despite its several shortcomings, Harberger's model does not give a poor approximation, even for analyzing tax distortions as large as these.

Somewhat more ambiguity occurs in comparing the dead-weight loss estimates, although again the answers do not conflict. I would argue, however, that, in giving a point estimate, the Harberger approach may give the user of that technique a false sense of precision. While Harberger qualifies his results as rough estimates, the approach of this section gives an explicit upper and lower bound for the welfare loss.[8] In the six comparable cases, the Harberger corrected point estimate is always well within the upper and lower bounds prescribed in table 4 and is somewhat larger than their arithmetic or geometric mean. The geometric mean, of course, forms the Fisher "ideal" index (Fisher 1927). Again, however, the point estimate provided by the Harberger method does not deviate far from what one would arrive at with the technique of this section.

[7] The two models are not strictly comparable. One difference is the fact that two consumer classes are dealt with in this section, while the Harberger approach encompasses only a single-consumer or market demand relationship. The Scarf algorithm method was also run with a single consumer, and the results in terms of resource allocation across the two production sectors, prices, and dead-weight loss were nearly identical with the examples with two consumer classes reported here. So this does not account for the small differences in the results between Harberger's method and those of this section. The differences are due to the local assumptions of the Harberger model and the lack of an income effect in its demand specification.

[8] Of course, for a multitude of reasons, the numerical accuracy of these bounds themselves needs qualification.

The Scarf algorithm approach of this section allows the incorporation of a labor-leisure choice in the model. A fairly simple and possibly unrealistic demand function for leisure was analyzed in Shoven (1973) and Shoven and Whalley (1972). The more recent study covered the same elasticity cases reported on here. The general results were that the welfare loss estimates were approximately the same as in the fixed-labor-supply case, as long as leisure was valued at the wage rate. It is possible that the value of production can actually be higher in the presence of the distortion than in its absence. That is, the inefficiency of the distortion can be manifested totally in a decreased consumption of leisure. The lesson from that earlier analysis, then, is that the change in NNP is likely to be a poor estimate of the efficiency loss if there is a substantial elasticity in the supply of labor.

Given that the two approaches, when applied correctly to two production-sector data, are in broad agreement as to the incidence and efficiency effects of capital income taxes, the major advantage of the Scarf algorithmic method is its capability to analyze a more disaggregated description of production. The Harberger producer-surplus approach can likewise be disaggregated, but the general equilibrium model he uses to solve for the capital reallocation cannot easily incorporate more than a two-way division of production, except for the case in which all elasticities of substitution are the same (Hoffman 1972).

In order to evaluate the impact of disaggregation, the 12-sector data of table 2 were analyzed using the Scarf algorithm. The results for a selective subset of the 12 production-sector cases are contained in table 6. As intermediate products are not explicitly considered, it is necessary to interpret consumers as demanding value added from each of the 12 sectors. What is compared is the current tax situation (with each of the 12 sectors facing the different effective tax rates, as shown in column 9, table 2) with a flat-tax regime, with the tax rate set at 45.16878 percent (for comparability with the two-sector results just presented). As above, the equal-yield tax rate and the corresponding net price of capital were computed and are reported. Compared with the two-sector results shown in the previous set of tables, the loss estimates for these 12-sector cases are 10–70 percent higher. The efficiency cost as a percentage of the surtax yield now goes as high as 24.4 percent. The restrictiveness of the two-sector bifurcation of production is seen by noting that large relative price differentials develop between sectors which had previously been aggregated together in the "corporate" sector. In particular, the price of petroleum and coal products is shown to rise as much as 24 percent relative to the price of communication and public utilities with the switch to neutral capital income taxation. While the two-sector results had indicated that the price of the "corporate" sector's output would fall, it is seen in table 6 that the price of some components of that sector would rise relative to the

TABLE 6

SELECTIVE SUMMARY OF 12 SECTOR RESULTS

Case*	Observed Equilibrium	1	2	3
	A. Consumer Demand Elasticities = 1; Fixed Factor Supplies			
$S_{1,2,3}$	...	−1.0	−0.75	−0.25
S_{4-12}	...	−1.0	−0.25	−0.25
Surtax removal:				
P_1/Y_1	1.00000/ 16.281	1.13667/ 14.322	1.14850/ 14.197	1.07483/ 14.680
P_2/Y_2	1.00000/ 25.298	1.19444/ 21.180	1.20492/ 21.027	1.09027/ 22.487
P_3/Y_3	1.00000/ 2.770	1.15212/ 2.404	1.17168/ 2.368	1.10970/ 2.419
P_4/X_4	1.00000/ 3.216	0.96275/ 3.340	0.96454/ 3.339	0.94226/ 3.304
P_5/X_5	1.00000/ 17.865	0.99713/ 17.916	0.99753/ 17.937	0.98936/ 17.480
P_6/X_6	1.00000/104.291	0.93235/111.859	0.93539/111.670	0.91523/110.309
P_7/X_7	1.00000/ 3.144	1.01668/ 3.092	1.01817/ 3.093	0.98789/ 3.081
P_8/X_8	1.00000/ 4.874	1.07470/ 4.535	1.07906/ 4.524	0.99339/ 4.750
P_9/X_9	1.00000/ 54.487	1.00463/ 54.236	1.00582/ 54.257	0.98013/ 53.816
P_{10}/X_{10} ..	1.00000/ 16.761	0.96786/ 17.318	0.96940/ 17.317	0.95340/ 17.019
P_{11}/X_{11} ..	1.00000/ 13.883	0.87008/ 15.956	0.87477/ 15.895	0.83382/ 16.118
P_{12}/X_{12} ..	1.00000/ 33.744	0.99968/ 33.755	1.00003/ 33.796	0.99244/ 32.915
P_L	1.00000	1.00000	1.00000	1.00000
P_K	1.00000	1.29695	1.30453	1.14267
R	37.168	24.665	24.809	21.731
Shift factor	...	0.00000	−0.03749	0.610853
ΔNNP† ...	...	1.344	0.774	0.477
ΔNNP‡ ...	...	3.300	2.808	1.762
Equal yield:				
P_K	1.00000	1.00971	1.01792	0.80915
R	37.168	36.759	36.877	35.774
Tax Rate .	...	0.86466	0.86044	1.05006
	B. Consumer Demand Elasticities = 0.5; Fixed Factor Supplies			
$S_{1,2,3}$	...	−1.0	−0.75	−0.25
S_{4-12}	...	−1.0	−0.25	−0.25
Surtax removal:				
P_1/Y_1	1.00000/ 16.281	1.14982/ 15.276	1.17555/ 15.144	1.10548/ 15.371
P_2/Y_2	1.00000/ 25.298	1.21625/ 23.079	1.24727/ 22.845	1.13786/ 23.542
P_3/Y_3	1.00000/ 2.770	1.16216/ 2.585	1.19441/ 2.556	1.13551/ 2.580
P_4/X_4	1.00000/ 3.216	0.96788/ 3.290	0.97361/ 3.289	0.95204/ 3.270
P_5/X_5	1.00000/ 17.865	0.99879/ 17.993	1.00053/ 18.025	0.99278/ 17.790
P_6/X_6	1.00000/104.291	0.93784/108.395	0.94490/108.277	0.92506/107.588
P_7/X_7	1.00000/ 3.144	1.02246/ 3.130	1.02890/ 3.128	1.00064/ 3.119
P_8/X_8	1.00000/ 4.874	1.09141/ 4.696	1.11011/ 4.669	1.02938/ 4.767
P_9/X_9	1.00000/ 54.487	1.00963/ 54.580	1.01501/ 54.581	0.99086/ 54.311
P_{10}/X_{10} ..	1.00000/ 16.761	0.97172/ 17.114	0.97616/ 17.121	0.96059/ 16.968
P_{11}/X_{11} ..	1.00000/ 13.883	0.88024/ 14.894	0.89270/ 14.829	0.85279/ 14.916
P_{12}/X_{12} ..	1.00000/ 33.744	1.00118/ 33.944	1.00276/ 34.008	0.99561/ 33.555
P_L	1.00000	1.00000	1.00000	1.00000
P_K	1.00000	1.32957	1.36463	1.20969
R	37.168	25.286	25.952	23.006
Shift factor	...	−0.16777	−0.36883	0.37659
ΔNNP† ...	...	1.298	0.657	0.390
ΔNNP‡ ...	...	2.363	1.857	1.164
Equal yield:				
P_K	1.00000	1.04844	1.09151	0.89259
R	37.168	37.122	37.452	36.357
Tax rate ..	...	0.84094	0.81494	0.96741

* Sector 1, agriculture; 2, real estate; 3, crude oil and gas; 4, mining; 5, contract construction; 6, manufacturing; 7, lumber and wood products; 8, petroleum and coal products; 9, trade; 10, transportation; 11, communication and public utilities; 12, services.

† \$ billion. Calculated at new (i.e., nondistortionary) prices.

‡ \$ billion. Calculated at old (i.e., observed) prices.

TABLE 7

Fisher Index of Social Waste
Consumer Demand Elasticities = 1.0; Fixed Factor Supplies

2 Sectors			12 Sectors		
S_X	S_Y	$ Billion	$S_{1,2,3}$	S_{4-12}	$ Billion
−1.00	−1.00	1.49	−1.00	−1.00	2.11
−1.00	−0.50	1.19	...	...	...
−1.00	−0.25	1.00	...	...	...
−0.75	−0.25	0.97	−0.75	−0.25	1.47
−0.50	−0.50	0.99	...	...	...
−0.50	−0.25	0.89	...	...	...
−0.25	−0.25	0.69	−0.25	−0.25	0.92

price of labor. The added detail of this disaggregated analysis thus gives a somewhat different picture and information which may be valuable in the making of policy decisions.

As has been shown in tables 4 and 6, a change in tax rates causes a vector of changes in outputs which must be aggregated to arrive at a single-number dead-weight loss estimate. This condensation of information is subject to the usual index number problems, and I have presented the Paasche and Laspeyres measures of the inefficiency resulting from the distortionary taxation of capital income in the 1953–59 U.S. economy. Nonetheless, policy makers often want a single number, and not a range of numbers (they want the impossible solution to the index number problem). One technique of combining the Paasche and Laspeyres indices into a single loss estimate is to form the Fisher "ideal" index (Fisher 1927), which is the square root of their product. The results of such a procedure for the cases shown in part *A* of tables 4 and 6 are shown in table 7. If personally asked to give a point estimate of the efficiency loss due to the U.S. capital income taxes, I would refer to the $S_X = -0.75$, $S_Y = -0.25$ 12-sector model. The Fisher index shows a loss of $1.47 billion in this case, or 11.9 percent of the surtax revenue. The point estimate is somewhat smaller than what one would arrive at from Harberger's published estimates, although, given the magnitude of his two mistakes and the fact that this is for a 12-sector rather than a two-sector analysis, the number is remarkably close to the $2.0–$2.5 billion figure one might get from his work. Needless to say, one would still want to qualify heavily any such point estimate.

IV. Conclusion

This paper has reexamined the results of the Harberger model concerning the static efficiency cost of the U.S. taxation of capital income during the 1953–59 period. I have asserted that Harberger made two significant mistakes in his earlier evaluation of this question, each of which substantially altered his results. The net effect of correcting these errors is to lower the dead-weight loss estimates previously published as ranging from \$1.0 billion to \$2.9 billion approximately 38 percent to a range of \$0.625 billion–\$1.79 billion. The correct results are thus an even smaller fraction of GNP or NNP than previously thought, but the efficiency loss does amount to between 6 and 15 percent of the revenue generated by the distortionary surtax on capital income originating from the "corporate" sector.

Using the corrected data, I have computed the incidence and dead-weight loss using an algorithmic-solution technique for a general equilibrium model. In the two-sector analyses, the results do not differ substantially from the corrected Harberger figures, showing, if anything, that the unequal tax treatment causes less resource reallocation. The conclusion is that, at least in this case, the second-order approximations made in the Harberger analysis are reasonably accurate, even for tax distortions as large as those of this study. The algorithmic approach does explicitly remind one of the fundamental index number problems in describing the static inefficiency effects of a tax distortion with a single number.

One of the advantages of the algorithmic method is its capability of solving a disaggregated general equilibrium model. In order to evaluate the effect of moving to a less aggregated description of production, a 12-sector analysis was presented. The dead-weight loss estimates increased an average of approximately 40 percent from what they were in the two-sector cases. The model also implied that differential capital income taxes caused significant relative output price distortions among sectors which were previously lumped together. It was stated that the added richness of the results of the disaggregated analysis should be valuable to those involved in tax policy evaluation and formation.

The final point which should be made is that, in comparing the Harberger model and approach with the algorithmic-solution procedure in this study, I have not pressed the latter method anywhere near its capabilities. Because of its ability to handle models with many commodities and consumers, detailed incidence studies are feasible. Further, the additional disaggregation may allow studying several distortions simultaneously or, by time-dating commodities, permit a dynamic evaluation of policy alterations. The purpose here was to correct Harberger's errors in his study of the efficiency cost of uneven capital income taxation and to examine how different the results of a similar simple analysis would be with this algorithmic approach. The implementation of the further capabilities of the algorithmic technique in conjunction with more recent economic data is an area of active research for this author and others but is beyond the scope of this study.

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