THE INCOME ELASTICITY OF THE PERSONAL INCOME TAX IN GREECE

By

Dr N. TATSOS *

Tax revenues obtained according to given statutory rates fluctuate with changes in economic activity. Thus, since the magnitude of the tax base usually changes directly along with the level of economic activity, tax revenues increase during periods of inflation and diminish during periods of deflation. But, changes in tax revenues may not only occur automatically as a result of changes in national income, but may also be attributable to discretionary changes in tax legislation and administration. The significant lags in response, however, make it impossible to make any definitive statement about the actual degree of stability likely to result from the operation of the fiscal framework. Because of these lags, discretionary fiscal policy may be too late too prevent serious crises in the economy, or, at any rate, to late to be of maximum efficiency in controlling inflation and depression.

Because of the timing problem, many ecomomists recommend that «automatic stabilizers» should be built into the government's budget. Actually, there are already built into the fiscal system a number of these automatic stabilizers. Certain public expenditures, for example, are geared to move in a counter-cyclical fashion and tax yields obtained from given statutory tax rates rise and fall with changes in the level of income.

---

* The author, formerly a tutor in Economics at Bangor University, is now with the Bank of Greece, Economic Research Department. The views expressed in this paper do not necessarily represent the views of the Bank.

Two measures may be employed to appraise the automatic responsiveness of taxes to income changes: the marginal rate of taxes or their built in flexibility, and the sensitivity or income elasticity of taxes. The term «built-in flexibility» is often used erroneously as a synoym for «elasticity» so it is appropriate here to make a clear distinction between the two.

Formally, the built-in flexibility of any tax or any set of taxes may be defined as $\Delta T/\Delta Y$ where T is tax yield, Y is national income computed before tax and Δ is the change in the respective items. The yield depends upon the size of the tax base and the rate structure. However, since changes in the size of the tax base are positively correlated with changes in national income, practically all taxes exhibit some degree, though sometimes a very small degree of built-in flexibility.

The relation between changes in tax yields and changes in national income can also be expressed through the concept of income elasticity. The income elasticity of the tax yield measures the responsiveness of changes in tax revenue to changes in national income and may be defined as the ratio of the percentage change in tax yield to a given percentage change in national income. Thus, the income elasticity of a tax can be expressed as

$$E_T = \frac{\Delta T / T_o}{\Delta Y / Y_o} \qquad (1)$$

where E_T stands for income elasticity, T_o and Y_o stand for the tax yield and national income at the beginning of the period, and Δ denotes changes in the respective variables. [1]

From the above definitions we see that built-in flexibility is equal to the marginal rate of taxation or to elasticity times the average tax rate. It remains, however, to be decided whether we are primarily interested in built-in flexibility or elasticity. The latter measure has certain comparative advantages as a yardstick in the analysis of different taxes. First of all, this method enables comparisons between taxes of varying yields. It is also more appropriate if we want to obtain measurable coefficients of taxes that have yield insignificant in relation to GNP. On the other hand, comparisons

1. It must be pointed out that the terms of formula (1) may be adapted to refer not only to national income, but also to GNP, personal income, or any other aggregate, depending on the type of tax in question.

of absolute changes of yields between changes of income are not indicative of the possible high responsiveness of a tax. Finally, we may make international comparisons where different monetary units are involved.

Built-in flexibility, on the other hand, gives a more direct measure of the contribution to automatic stabilization. Nevertheless, if taxes are considered from the point of view of potential stabilizers, the sensitivity measure seems to be more appropriate.

INCOME ELASTICITY

The basis of much discussion in the literature is the Musgrave-Miller [I] coefficient which is defined as the proportion of the other-wise change in national income that is prevented because of the existence of built-in stabilizers. The formula of the coefficient in the case of taxes is:

$$b = \frac{c . E_T . ro}{1 - c + c . E_T . ro} \qquad (2)$$

As can be seen, the determinants of the coefficient b are the marginal propensity to consume (c), the built-in elasticity of the tax yield (E_T), and the average tax rate (ro).

Every tax consists of a tax base and a tax rate schedule which is applied to the base. Therefore the income elasticity of the tax yield can be expressed in two stages; the elasticity of the tax yield T with respect to the base B, and the elasticity of the base with respect to an income measure Y. This can be written as:

$$E_T = \frac{\Delta T / To}{\Delta B / Bo} \cdot \frac{\Delta B / Bo}{\Delta Y / Yo} = Et . Eb \qquad (3)$$

As can be seen from this formula E_T, varies directly with the elasticities Et and Eb, where Et stands for the rate elasticity and Eb for the base elasticity of the tax in question. The value of E_T may, therefore, be expected to depend on such factors as the rate structure of the tax, the change in the tax base, the change in the income concept used, the schedule of exemptions and deductions, evasion, and so on.

Looking at equation (3) we also notice that elasticity may be written as:

$$E_T = \frac{Mt}{At} \tag{4}$$

where Mt and At represent the marginal tax rate and the average tax rate respectively. Thus, the different types of tax structure: progressive, proportional, and regressive, can be easily defined, depending on whether Mt is higher, equal, or less than At.

The value of income ecasticity will vary considerably from one tax to another. It is generally believed that with personal and corporate income taxes the value of the elasticity is relatively high, depending on the rates and the bases of these taxes. Thus, the progressive income tax produces proportionately greater swings in yields than the swings in the level of income.[2] This is due to a high Et while the high income elasticity of the corporate income tax is due to a high Eb. As far as indirect taxes are concerned the value of E_T seems to be on average much lower because they have proportional or even regressive rates and stable tax bases.

The income elasticity of the overall tax system, which consists of various taxes is equal to the weighted average of the elasticities of its components, the weights being the yields of each individual tax. Thus, a tax system can be considered to be elastic only if the weighted average of the elasticities of its components is greater than unity.

If T represents the aggregate yield and T_1, T_2 and T_3 are the yields of its three components we have:

$$E_T = \frac{Y}{T} \cdot \frac{\Delta T}{\Delta Y} = \frac{Y}{T1 + T2 + T3} \cdot \frac{\Delta(T1 + T2 + T3)}{\Delta Y} =$$

$$\frac{1}{T1 + T2 + T3}\left(Y\,\frac{\Delta T1}{\Delta Y} + Y\,\frac{\Delta T2}{\Delta Y} + Y\,\frac{\Delta T3}{\Delta Y}\right) =$$

2. If has peen argued [2] that an automatic tax change is stabilising during inflation if the elasticity is higher than unity. However, this only applies to the case where all increases are money increases. If some of the increase in national income reflects real increases in output, this criterion is not necessary. In this case in order to have a good stabilising performance it is necessary to have an increase in real taxes. Hence, for a complete offset the rise in real taxes will have to be greater than the excess demand that causes the inflationary pressures.

$$\frac{T1E1 + T2E2 + T3E3}{T1 + T2 + T3} = \frac{T1}{T} E1 + \frac{T2}{T} E2 + \frac{T3}{T} E3 \qquad (5)$$

where E1, E2 and E3 are the income elasticities of the three components, and the elasticity of the total tax system is shown to be equal to the weighted average of the elasticities of all its components. The above relationship hodls true not only when T1, T2, T3 represent three different taxes, but also when they represent different components of the same tax.

The measurement of Elasticity

Economists studying the elasticity of the individual income tax over time often adopt a procedure which is to solve an equation of the form

$$\log T = \log a + b \log Y \qquad (6)$$

where T stands for income tax revenue, a is a constant, Y represents an income aggregate and b is the required elasticity coefficient. Solving this equation for b yields a constant tax-income elasticity coefficient, which represents an average of $\frac{\Delta T}{T} \Big/ \frac{\Delta Y}{Y}$ over the period under consideration. Since this period usually covers several years, the coefficient is the average of the elasticities for each specific year. However, it would be preferable to calculate the yearly percentage changes in tax yield and income. This is because it is important to be certain of trend movements, especially when the graduated income tax is examined for a period when there was a substantial rise in the level of per capita income. Moreover, formula (6) does not take into account discretionary changes in tax legislation.

In what follows we have attempted to measure the income elasticity of the personal income tax in Greece by taking into account year-by-year percentage changes, and by trying to isolate the effects of the various discretionary changes. Two methods were employed for this purpose ; one based on a "stable" tax system, and another which utilizes the dummy variable technique.

I. THE STABLE TAX SYSTEM METHOD

The first method adopted for estimating the elasticity of the individual income tax is based on the tenet that elasticity can only be measured with reference to a so-called "stable" tax system, i. e. a system that has remained unchanged throughout the period. A review of the Greek tax system reveals that from 1960 to 1974 the legislation for the individual income tax has been changed five times. This means that there has been a change in tax rates every two or three years and therefore there has not been a "stable" system for more than a very few years. However, if the period under consideration is extended, it appears that the longest stable period occurred under the tax system that was in effect from 1958 to 1962 inclusively.

A liability equation, of the same form as equation (6), was used for this subperiod of five years. The equation was tried, using both its normal and logarithmic forms, and using taxable income, declared income, Net National Income minus agricultural income, and personal income minus transfers and agricultural income, as the independent variable. Equation (7) was finally thougth to be the most satisfactory alternative.

$$\log T = -0.3249 + 0.8786 \log TI \qquad (7)$$

$$R^2 = 0.960$$

$$D-W = 1.775$$

where TI is taxable income. This equation can be written in non-linear form as

$$T = 0.4732 \quad TI^{0.8786} \qquad (8)$$

Equation (8) shows the relationship between income tax revenue and taxable income in the period 1958-62. It shows the response of tax liabilities to taxable income and, therefore, reflects the income tax legislation during the «stable» tax system period.

However, at this point, it should be interesting to examine the validity of the above liability equation. As R. Musgrave [2, p. 507] has pointed out, «the value of Et exceeds 1 for all flat-taxes, whether on income, sales, or property». It has also been noted [3, p.47] that «the progressive income tax should produce proportionately greater swings in tax yields than income. This is a typical characteristic of the progressive rates, and consequently Et> 1». Thus, statements like these may seem to reject equation (8) since the coefficient for the average rate elasticity appears to be too low.

However, a distinction can be made here between progressivity at a point in time and progressivity over time. It is generally agreed that a rate structure is progiessive at a point in time when the average and /or the marginal rate of the tax increases while moving up the income scale. The rate structure is proportional when the average and the marginal tax rate remain constant and, it is regressive when the average and /or the marginal rate of the tax falls with the rise of income. We may define a tax to be progressive, proportional or regressive over time if its rate elasticity is greater than, equal to, or less than one respectively. From these definitions it is clear that progressivity at a point in time is appropriate for equity considerations and that progressivity over time refers to tax elasticity. Confusion may arise from the fact that progressivity at a point in time normaly implies that there is progressivity over time as well [3]. Nevertheless, it is not impossible to have a tax that is progressive at a point in time and regressive over time. It is possible for this paradox to occur if the taxable income of all taxpayers increases, but at different rates, so that taxable income of those in the higher income brackets increases less than the taxable income of those in the lower income brackets. [4]

This can best be explained by a numerical example which utilizes the tax legislation in effect between 1958 and 1962. Let us assume that there are two groups of taxpayers and two time periods. Group One has income equal to 20,000 Drs in period I, increasing to 28,000 Drs in period II, that is an increase of 40 per cent. Group Two has income equal to 100,000 Drs in period I increasing to 105,000 in period II, an increase of 5 per cent. The effective tax rates are 7.6 and 14.9 per cent for Group One and Group Two respectively and we assume that they remain unchanged throughout the whole time.

We notice that the percentage changes of the total tax is only 8.23 and therefore the overall tax elasticity is 0.760. Thus, although the tax is progressive at a point in time, it is regressive over time. So, elasticity does not depend only on the tax rates, but also on the initial distribution of income,

---

3. It should pe noted that progressivity over time by no means implies that there is progressivity at a point in time.

4. The average marginal rate for a given rate schedule is found by $j = dT/dB = \sum_{i=1}^{r} t_i B_i / dB$, where t_i = tax rate for pracket i, dB_i = income change in bracket i, and r = number of brackets. If, then, the per bracket distrtibution of taxable income remains unchanged over time, dT/dB will be constant and Et will be unity even if the tax is progressive at a point in time.

Taxpayers	Period I		Period II	
	Income	Tax	Income	Tax
Groupe One	20000	1520	28000	2128
Groupe two	100000	14900	105000	15645
Total	120000	16420	133000	17773

the relative changes of income in each income group, and the width of the tax brackets.[5]

This illustration can be regarded as a rather unusual case. It should be remembered, however, that evasion is practised mainly by the high income groups, so that the taxable income of these groups tends to increase at a slower rate than it otherwise would.[6]

If the «stable» income tax system were not only to be used for the limited five years' period but were to be in effect throughout the whole period under consideration, and assuming that other critical factors remained unchanged, the relationship between tax liabilities and taxable income for the period 1960-74 could be given by the equation (8). By making these assumptions, estimates for tax revenue can be made from equation (8) for each year in question. In other words, tax liability can be calculated as if the «stable» system was still in effect.

However, usually whenever there is a change in tax rates, there is also a change in the level of personal exemptions and deductions. Taxpayer allowances and the corresponding amounts for wife and child allowances are provided in the Monthly Statistical Bulletin of Public Finance. These three elements were added together for 1962 (the last year of the «stable» system»)

5. It must be noted that a constant distribution of income does not necessarily imply that there is a constant distribution per tax bracket. Also, if the brackets are very wide, we may have substantial changes in the income distribution without any effects on the average marginal tax rates,

6, A regression for the period 1968-71, when legislation was very strict for tax evasion, showed average rate elasticity of 1.284.

and the total was divided by the number of taxpayers for that year. The result (the level of personal deductions per taxpayer) was then multiplied by the number of taxpayers in each of the subsequent years. For instance, the income tax legislation in 1970 was different from that in the early 1960's and the exemption level as well as the level of family allowances were substantially increased. To calculate the total size of these provisions net of the effects of discretionary changes, total deductions for 1962 were divided by the number of taxpayers for that year and the figure obtained was then multiplied by the total number of taxpayers in 1970. This method gives an approximation of the level of deductions that would have existed in 1970 if income tax legislation had not been changed.

Since each time the level of deductions changed, it represented an increase, the derived estimates are in all cases lower than the real values given in the official statistics. The difference between the actual and the estimated levels of deductions was therefore added to the taxable income for each year. The relevant figures are given in Table I. Examining this table we

TABLE I

Actual and Estimated Levels of Deductions, Taxable Income, and Income Tax Revenue, based on the 1958-62 tax legislation

Million Drs

Year	Deductions		Taxable income		Income tax revenue	
	Actual	Estimated	Actual	Estimated	Actual	Estimated
1960	4317.322	—	7210.431	—	1111.200	—
1961	4245.990	—	9061.125	—	1442.600	—
1962	4438.487	—	9688.082	—	1527.800	—
1963	4069.827	3545.828	10329.380	10853.378	1432.600	1662.230
1964	4450.169	3838.483	12093.303	12704.988	1764.000	1908.950
1965	5767.062	3814.877	13148.274	15100.458	1723.900	2221.800
1966	6612.012	4323.672	15418.807	17707.147	2094.800	2555.450
1967	7508.360	4865.736	18837.835	21470.458	2594.200	3026.910
1968	11723.385	6727.739	26157.532	31153.177	2976.400	4197.930
1969	12857.777	7289.547	29503.521	35071.750	3379.800	4658.480
1970	16001.746	8904.819	34502.915	41599.841	4052.841	5412.260
1971	17488.956	9738.636	40445.867	48196.186	4806.200	6159.410
1972	26249.866	10964.417	43930.897	59216.345	4866.600	7380.940
1973	28626.474	11909.412	50402.314	67119.376	5822.400	8239.720
1974	32213.861	13387.295	70161.287	88987.852	8965.600	10556.660

Source: NSSG. Public Finance Statistics and Personal Income Tax Statistics, various years.

notice that in 1974 the actual amount of personal deductions was more than twice the estimated amount. From the figures of taxable income we also see that due to the increasing levels of personal allowances taxable income in 1974 was lower tnan it otherwise would have been by over 18 million Drs.

We believe that the above method provides a good approximation of the level of taxable income net of discretionary changes in personal allowances. Taxable income calculated in this way was then used in equation (8) to obtain estimates of tne level of tax liability that would have occurred if the tax legislation had not been changed. After that, the calculation of the values of the base and of the rate elasticities was an easy task.

However, before we proceed to the measurement of elasticity, it should be pointed out that the considerable discrepancy between the actual and the estimated levels of tax liability (Table I) is due also to the fact that income tax rates were much higher in the early 1960's than they were afterwards. It should be remembered that an individual with an income of 50000

TABLE II

Income Tax Elasticity : The «stable» system method

Year	et	eb	$E_T = et.eb$
1960-61	1.162	1.977	2.297
1961-62	0.852	1.105	0.941
1962-63	0.731	1.028	0.751
1963-64	0.870	1.386	1.205
1964-65	0.869	1.380	1.199
1965-66	0.869	1.545	1.342
1966-67	0.868	2.623	2.276
1967-68	0.858	5.194	4.456
1968-69	0.872	0.943	0.822
1969-70	0.869	1.542	1.340
1970-71	0.870	1.478	1.286
1971-72	0.867	1.628	1.412
1972-73	0.872	0.475	0.414
1973-74	0.863	1.587	1.369
Average elasticity			1.508
Weighted average			1.431

Drs would have paid 2800 Drs in income tax in 1974 and 5500 Drs in 1960. The amounts for incomes of 100000 Drs and 800000 Drs are 14900 and 350800 respectively in 1960 and 7900 and 236400 respectively in 1974.

The total elasticity of the personal income tax in Greece is shown in Table I. Also shown are the values of the base and the rate elasticities. Looking at the table we find the expected result that rate elasticity fluctuates less than base elasticity.[7] While tax rate elasticity remains almost stable throughout the period, due to the assumptions on which the analysis is based, base elasticity varies considerably from one year to another. The unusually high value of the coefficients for the years 1967 and 1968 are due to the political events of that period.[8]

The table shows the simple average elasticity for the period 1960-74 as well as the weighted average elasticity; the weights used were the income tax liabilities for each year in question. The estimates show that the elasticity of the personal income tax in Greece has not been very satisfactory, given the properties of this tax.

II. THE DUMMY VARIABLE METHOD

The elasticity coefficients presented in Table II were calculated by making the assumption that the 1958-62 conditions prevailed throughout the whole period under consideration. Many tax reforms have been enacted in Greece, making such an assumption unreasonable. So we adopted another method for measuring income tax elasticity which does not require the assumption of a «stable» tax system. This method is more realistic in that elasticity is measured for each year, taking into account the income distribution and tax legislation in effect during the year in question (or in the previous year).

The level of total taxable income reported on tax returns, and the corresponding tax liability, as provided in the official statistics, were used to make a multiple regression analysis. The approach that was used is based on dummy variables.

---

7. In fact the coefficient of taxaple income in equation (8) is the mean value of the rate elasticities shown in table II.

8. In April 1967 a military regime took over the government of the country and this had an effect on the income tax returns of the taxpayers who declared all their income because of the fear of severe punishments.

A dummy variable is a variable that is constructed to describe the variation of the variable under consideration. Dummy variables are mainly used as proxies for other variables which cannot be measured or if they can be measured when no observations are available. In general, the dummy variable technique can be applied to any variable whose variation is capable of falling into mutually exclusive classes. Thus, it is surprising that though widely used in economics and other sciences, it does not seem to have been used for calculating the income elasticity of taxes.[9]

However, it would be appropriate, before advancing to the application of this technique for measuring elasticity, to explain in more detail the idea of introducing dummy variables.

Suppose there is a liability equation of the following form :

$$T = a + bPI \qquad (9)$$

where T stands for income tax revenue and P I for personal income, which may be taken as a proxy of the tax base.

The relationship between tax liability and personal income can also be shown diagrammatically as in Figure I.

It is obvious that whenever there is a change in tax rates the liability function in figure I will change slope because the coefficient b that represents progressivity will probably not remain stable. Moroever, changes in tax rates are usually accompanied by changes in other factors that influence the constant term of the function. So, as well as there being a change in the slope of the function there will also be a shift.

The very purpose of dummy variables is that they are introduced when exogenous changes occur[10].

---

9. An exception is N. Singer [4] who estimated the income-elasticity of state income-tax revenues using U. S. data. However, his approach differs condsiderably from the one adopted in the present study. Singer introduced a dummy variable whenever there was a change in rates, base, or withholding procedures.
Elasticities were estimated, then, from a log-linear rélationship between T and Y such as $\log T = a + b \log Y + \sum_{i=1}^{n} c_i D_i$ as well as from a linear relation as $T = a + bY + \sum_{i=1}^{n} c_i D_i$

10. A dummy variable can be used to take into account a qualitative change. However, if the period is short only a limited number of dummies can be included.

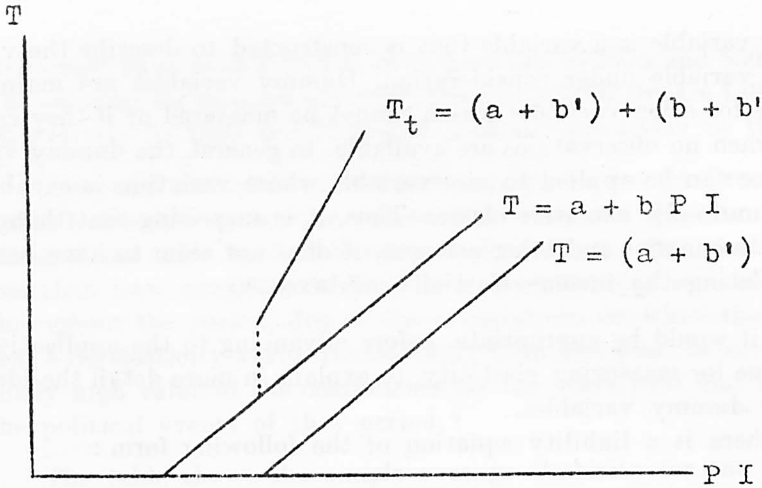

FIGURE I

Therefore, in the case of a shift in the function, equation (9) becomes

$$T=a+bPI+b'D1 \qquad (10)$$

where D1 is a dummy variable that has the value of zero for all the years prior to the year of a change, and the value of one thereafter. Thus, if the change takes placei n year t, the liability equation for the period beginning at year t becomes

$$T_t=a+bPI+b'=(a+b')+bTI \qquad (11)$$

If, in addition, the function shifting, the slope also changes, i.e. the progressivity, this change can be taken into account by introducing an appropriate dummy variable in the function. A second dummy variable, D2, can be introduced equalling the product of PI and D1, or D2=PI.D1. It follows that the value of D2 will either be equal to zero or personal income. Since, for the years prior to the change in legislation, we have D1=0, the product D1 and TI will be equal to zero. For the period after year t, D1=1 and therefore D2=PI. Equation (10) then becomes:

$$T=a+b\ PI+b'D1+b''\ D2 \qquad (12)$$

and the liability equation for the period beginning in year t can be written as

$$T_t = (a+b') + (b+b'') \, PI \tag{13}$$

To apply this method using data from Greece, the period 1960-74 must be divided into five subperiods according to the tax legislation in effect, and eight dummy variables must be introduced. Thus, the liability equation takes the following form:

$$T = a + b_0 \, PI + b1D1 + b2 \, D2 + b3D3 + b4D4 + b'1D'1 + b'2D'2 + b'3D'3 + b'4D'4 \tag{14}$$

The liability for the five subperiods, therefore, are:

First subperiod (1960-1962) $T = a + b_0 \, PI$ (15)

Second subperiod (1963-1964) $T = (a + b1) + (b_0 + b'1) \, PI$ (16)

Third subperiod (1965-1967) $T = (a + b2) + (b_0 + b'2) \, PI$ (17)

Fourth subperiod (1968-1971) $T = (a + b3) + (b_0 + b'3) \, PI$ (18)

Fifth subperiod (1972-1974) $T = (a + b4) + (b_0 + b'4) \, PI$ (19)

The above liability equations show the relation between tax liabilities and personal income under the different income tax schedules during the periods in which they were in effect. In estimating equation (14) we get:

$$\underset{}{T = -983.43} + \underset{(0.0397)}{0.0287 \, PI} - \underset{(563.39)}{80.92 \, D1} - \underset{(4254.44)}{1030.68 \, D2}$$

$$-\underset{(3576.87)}{2758.34 \, D3} - \underset{(3562.13)}{2762.90 \, D4} - \underset{(0.00588)}{0.00035 D'1} +$$

$$+ \underset{(0.00440)}{0.00001 \, D'2} - \underset{(0.00403)}{0.00049 \, D'3} - \underset{(0.003990)}{0.000002 \, D'4}$$

$R^2 = 0.987$
D—W=3.141

As can be seen the results are far from satisfactory, but this is not surprising given the fact that we have nine explanatory variables and fifteen observations.

As has been mentioned, the variables Dj (j=1. . . . 4) takeinto account changes in tax legislation other than changes in the tax rates. Thus, if we introduce taxable income as the relevant income variable we automatically take into account changes in personal, and other allowaces, which are the main factors causing the liability function to shift. The first set of dummy variables (Dj) can, therefore, be dropped and, so, the degrees of freedom are increased. Moreover with estimates of taxable income that are adjusted for discretionary changes in allowances, we can use the derived liability equaticns to estimate tax revenue net of discretionary changes.

Once tax liabilities and taxable income have been estimated as if there were no changes in the tax legislation, the calculation of elasticity coefficients become an easy job.

The calculations were based on data derived from the Monthly Statistical Bulletin of Public Finance. It should be noted here that two different sets of data appear in the above publication referring to tax revenues. There are data for income tax assessed as well as data for income tax collected. It is interesting to make the calculations with both sets of data and see how different are the results.

The estimated equations are as follows:

$$T = -1892.16 + \underset{(0.0615)}{0.4252}\, TI - \underset{(0.0303)}{0.0622}\, D'1 - \underset{(0.0349)}{0.1197}\, D'2 - \underset{(0.0475)}{0.1917}\, D'3 - \underset{(0.0532)}{0.1942}\, D'4 \qquad (20)$$

$R2 = 0.993$

$D-W = 2.074$

and

$$T = -1791.81 + \underset{(0.0599)}{0.4097}\, TI - \underset{(0.0295)}{0.0598}\, D'1 - \underset{(0.0340)}{0.1135}\, D'2 - \underset{(0.0463)}{0.1847}\, D'3 - \underset{(0.0518)}{0.1928}\, D'4 \qquad (21)$$

$R^2 = 0.992$

$D-W = 2.026$

where equation (20) refers to tax revenue assessed and equation (21) to tax revenue collected. As can be seen, all coefficients in both equations have the expected sign and standard errors are very low. In addition, the coefficient of determination has a very satisfactory value[11] and there is no evidence of first order serial correlation in the residuals.

Elasticity will first be measured for tax revenues assessed. Equation (20) for each of the five subperiods becomes:

1960 - 1962	$T = -1892.16 + 0.4252\ TI$
1963 - 1964	$T = -1892.16 + (0.4252 - 0.0622)\ TI$
1965 - 1967	$T = -1892.16 + (0.4252 - 0.1197)\ TI$
1968 - 1971	$T = -1892.16 + (0.4252 - 0.1917)\ TI$
1972 - 1974	$T = -1892.16 + (0.4252 - 0.1942)\ TI$

or

$$T60\text{-}62 = -1892.16 + 0.4252\ TI \quad (22)$$
$$T63\text{-}64 = -1892.16 + 0.3630\ TI \quad (23)$$
$$T65\text{-}67 = -1892.16 + 0.3055\ TI \quad (24)$$
$$T68\text{-}71 = -1892{,}16 + 0.2335\ TI \quad (25)$$
$$T72\text{-}74 = -1892.16 + 0.2310\ TI \quad (26)$$

The next stage is to estimate taxable income net of discretionary changes. To do so the level o deductions per taxpayer was calculated for each year immediately preceding the year of change in legislation. The figures obtained were then multiplied by the number of taxpayers in the year of change. The method employed is similar to the one used when elasticity was estimated with reference to a «stable» tax system or a «base» period. The difference is that in the present case the «base period» each time there was a change in legislation is the year immediately preceeding the year of change. Thus, the level of total tax deductions that would have been granted in say, 1968 if there had been no changes in legislation that year,can be found in the following way. The total amount of deductions in 1967 was divided by the number of taxpayers in that year. The figure thus derived, showing the amount of deductions per taxpayer in 1967, was then multiplied by the total number of taxpayers in 1968. The result

11. It should be noted that the near perfect fit is due to the method used to fit the liability equations.If there is one dummy for each specific year, the residual for each year in question will be absorbed by the relevant coefficients of the dummies. Thus, if we have n years and one explanatory variable, the inclusion of n-2 dummies will give a perfect fit.

shows the amount of total deductions in 1968 assuming that there was no change in legislation that year. The estimation of taxable income net of discretionary changes can then be made easily. The results appear in Table III. In the same table appear the actual and estimated values for income tax assessed and income tax collected for the period under consideration.

TABLE III

Actual and estimated values for taxable income, income tax assessed and income tax collected

Million Drs

Year	Taxable income		Income tax assessed		Income tax collected	
	Actual	Estimated	Actual	Estimated	Actual	Estimated
1960	7210.43	—	1535.00	—	1504.00	—
1961	9061.12	—	1889.50	—	1850.80	—
1962	9688.08	—	2026.60	—	1989.40	—
1963	10329.38	10853.44	1928.20	2722.72	1889.40	2654.80
1964	12093.30	—	2438.30	—	2383.60	—
1965	13148.27	14492.53	2247.30	3368.62	2204.40	3279.12
1966	15418.81	—	2964.40	—	2913.50	—
1967	18827.83	—	3656.50	—	3601.50	—
1968	26157.53	27499.28	4887.20	6508.87	4175.40	6353.48
1969	29503.52	—	5045.80	—	4923.30	—
1970	34502.91	—	6087.80	—	5890.80	—
1971	40445.87	—	7537.80	—	7267.40	—
1972	43930.90	50490.50	7605.60	9897.37	7091.80	9568.50
1973	50402.31	—	9954.10	—	9332.90	—
1974	70161.29	—	14584.40	—	13687.90	—

Source: NSSG. Monthly Statistical Bulletin of Public Finance. Data for taxable income from Personal Income Tax Statistics.

To estimate income tax assessed net of discretionary changes in 1963, for instance, equation (23) would not be appropriate for it shows tne relationship between tax revenue assessed and taxable income according to the tax legislation that was first in effect in 1963. In order to estimate income tax assessed as it would have been in 1963 if the system had not changed that year, we used equation (22). The other estimates appearing in the fourth column of table III were derived in a similar way, i.e. by using the liability equation for the period preceding the year of change.

The elasticity coefficients are shown in table IV. The estimates for the simple average and weighted average elasticities are also shown in the table.

TABLE IV

Personal Income Tax Accruals. Elasticity Coefficients.

Year	eb	et	E_T
1960-61	1.977	0.899	1.779
1961-62	1.104	1.049	1.158
1962-63	1.028	2.855	2.935
1963-64	1.386	1.549	2.148
1964-65	1.452	1.923	2.792
1965-66	1.545	1.848	2.856
1966-67	2.728	1.056	2.880
1967-68	5.304	1.694	8.984
1968-69	0.959	0.254	0.243
1969-70	1.403	1.219	1.710
1970-71	1.606	1.383	2.221
1971-72	1.769	1.260	2.229
1972-73	0.524	2.096	1.098
1973-74	1.909	1.186	2.266
Simple average			2.521
Weighted average			2.523

The elasticity coefficients for tax revenue collected were estimated in a similar way. More specifically equation (21) becomes

1960 - 1962 $T=-1791.81+0.4097\ TI$

1963 - 1964 $T=-1791.81+(0.4097-0.0598)\ TI$

1965 - 1967 $T=-1791.81+(0.4097-0.1135)\ TI$

1968 - 1971 $T=-1791.81+(0.4097-0.1847)\ TI$

1972 - 1974 $T=-1791.81+(0.4097-0.1928)\ TI$

or

$$T_{60-62}=-1791.81+0.4097\ TI \quad (27)$$

$$T_{63-64}=-1791.81+0.3499\ TI \quad (28)$$

$$T_{65-67}=-1791.81+0.2962\ TI \quad (29)$$

$$T_{68-71}=-1791.81+0.2250\ TI \quad (30)$$

$$T_{72-74}=-1791.81+0.2169\ TI \quad (31)$$

Using the above liability equations and the methodology just described, we estimated the elasticity coefficients shown in table V.

TABLE V

Personal Income Tax Payments. Elaasticity Coefficients.

Year	eb	et	E_T
1960-61	1.977	0.898	1.778
1961-62	1.104	1.082	1.195
1962-63	1.028	2.781	2.858
1963-64	1.386	1.531	2.123
1964-65	1.452	1.894	2.748
1965-66	1.545	1.863	2.878
1966-67	2.728	1.068	2.913
1967-68	5.304	1.659	8.799
1968-69	0.959	1.400	1.342
1969-70	1.403	1.159	1.626
1970-71	1.606	1.356	2.178
1971-72	1.769	1.275	2.254
1972-73	0.524	2.145	1.124
1973-74	1.909	1.190	2.271
Simple average			2.577
Weighted average			2.589

We can now make some comparisons between the estimates of table IV and table V, as well as between the elasticity coefficients obtained by the stable system method and the dummy variable method.

To begin with, looking at the overall elasticity for the period 1960-1974, we notice that the coefficients given in tables IV and V are almost identical. This is not surprising given that we used annual data for our computations. The tables show that the base elasticity was below unity in 1968-69 and 1972-73 indicating that there was a faster increase in GNP than in taxable income. Tax accruals and collections, however, increased substantially in the latter period resulting in an elasticity coefficient higher than one. However, in 1968-69 there was only a small increase in acruals in proportion to the rise in the tax base and the tax rate elasticity was as low as 0.254. Also, both tables show that tax rate elasticity was low in 1960-61 indicating that the rise in tax revenues then was in percentage terms less than the rise in taxable income.

Next, comparing the results obtained by using the dummy variable method with those obtained by using the stable sysem method, we notice that the former technique gives rise to higher elasticity coefficients. This can be explained by the fact that the latter method does not take into account changes in the distribution of taxable income (see footnotes 4 and 6), changes in exemptions which in turn affect progressivity, improvements in the administrative procedure and enforcement, amongst other things.

CONCLUSIONS

One of the criteria for evaluating the adequacy of a tax structure is its automatic responsiveness to economic activity. The problem of finance has become the major concern of many less industrialised countries, and many of them seek additional sources of tax revenue by increasing tax rates and/or by making other adjustments in the tax structure. However, such alterations often face strong resistance from the public. As a consequence, frequently increases in tax rates can induce taxpayers to search for ways of tax evation or avoidance. Moreover, it is generally accepted that tax structures must be highly responsive to economic fluctuations if they are to meet the requirements for countercyclical fiscal policy. Thus, the greater the automatic response of the tax yield over a given period of time, the less the amount that must be increased or decreased through discretionary changes in the tax law to satisfy the needs of fiscal policy.

Variations in the yield of a tax that occur automatically in direct response to changes in economic activity are measured by the income elasticity of that tax.

The GNP elasticity of the personal income tax was found to be considerably high. Generally, a very important finding of this study is the important role that the personal income tax has to play in the revenue system of a developing country. Even if the estimated elasticity coefficients do not indicate a very high degree of automatic responsiveness, if we take into account the improvement in the quality of tax administration over the period, they certainly show the potential which the income tax has for a less industrialised country in the context of the requirements of a rapidly growing economy. However, the tax has not yet reached the highest possible degree of administrative efficiency and it does not yet exploit the revenue potential of the country. Hence, there is still much room for improvements in the income tax system to enable it to provide more revenue yield. More speficically, the conclusion to be drawn is that in view of the high tax base elasticity of the personal income tax policy makers might do well to adopt measures which would secure a huller coverage of the base rather than those directed at increases in tax rates.

REFERENCES

1. R. Murgrave and M. Miller : «Buil-tin flexibilitgy, Ameĕican Economic Review 1948.

2. R. Musgrave : «Public Finance». Mc Graw-Hill 1959.

3. H. Ishi : «The income elasticity of the tax yield in Japan», Hitotsubashi Journal of Economics 1968.

4. N. Singer : «The use of dummy variables in estimating the income elasticity of state income tax revenues», National Tax Journal 1968.