STUDIES IN DOMESTIC FINANCE NO. 5

TAX REVENUE FORECASTING
A Methodological Study
With
Application to Turkey

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I. Introduction

Elementary textbooks of econometrics tell us that forecasting of economic variables in an area for the application of regression analysis. However, this technique cannot be used straightforwardly in every circumstance.

Certain conditions have to be met for the meaningful application of regression analysis. In particular, (i) a stable quantitative relationship must exist between the variable to be forecast and its determinants; (ii) the same relationship must be expected to continue during the forecast period; (iii) sufficient quantitative information must be available on this relationship; and (iv) the magnitudes of the determinants in the forecast period must be known.

In the case of tax revenue forecasting, the application of regression analysis tends to be difficult because the third condition often fails to hold.

The tax structure changes frequently in most countries. When it changes, the relationship between the revenue and its determinants is prone to change; rather, tax structure changes are often aimed at changing this relationship.

The estimates of revenue function parameters obtained from regressions that ignore the effects of tax structure changes would be biased—since such regressions falsely assume that the parameters do not change. Naturally, the revenue forecast based on those biased parameter estimates would also be biased.

To obtain unbiased forecasts, it is necessary to estimate the revenue functions under the present tax structure—the structure that will generate future revenue. 1/

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1/ Even this is not always the case in reality. Tax structure can, and most likely will, change during the forecast period as well as during the observation period. And if it does, the second condition above may fail to obtain.
The procedure would be simple if one could take regressions using only the observations pertaining to the present tax structure. However, the frequent structural changes tend to make the time series under the present tax structure too short to permit any meaningful regression analysis.

Despite the technical difficulties, one is frequently compelled to project the future tax revenues. The purposes of this paper are to examine the remedial or compromisory methods for estimating the revenue functions under the present tax structure and to apply combinations of the remedial methods for forecasting the future tax revenues of the central government of Turkey--a country where the tax structure has frequently changed in the recent past.

II. Alternative Methods for Estimating Revenue Functions

(i) Dummy Variable Method

An obvious solution to the problem of tax structure changes would be to introduce the tax structure into the regression equations explicitly as one of the revenue determinants. Although a tax structure is not quantifiable, statisticians have made it possible to introduce non-quantifiable determinants into regression equations by inventing dummy variables.

One may consider for expositional simplicity the case where tax revenue depends on a variable X and the tax structure, while the revenue elasticity with respect to X is constant under each tax structure. If T observations are available but the first N belongs to tax structure A, and the last T-N to another structure B, which is the "present structure," one may write the relationship between the revenue and X as follows:

\[ R_t(A) = e^{a_0 X_t + a_1 U_t(A)} u_t(A) \quad t = 1, \ldots, N (1-1) \]

\[ R_t(B) = e^{b_0 X_t + b_1} u_t(B) \quad t = N+1, \ldots, T (1-2) \]
where $R_t(A)$ and $R_t(B)$ are the revenues observed under structures A and B, respectively, and $U_t(A)$ and $U_t(B)$ are the random error terms. By defining
\[ d_0 = a_0 - b_0 \quad \text{and} \quad d_1 = a_1 - b_1, \]
the above relations can be rewritten as a single equation:
\[ R_t = e^{d_0 D_t} x_t + d_1 D_t U_t, \]
where $D_t$ is the dummy variable which takes the value 1 for the revenues observed under structure A (i.e., for $t = 1, \ldots, N$) and value 0 for other observations (i.e., for $t = N+1, \ldots, T$). If $\ln U(A)$ and $\ln U(B)$ are distributed with zero mean and with the same constant variance, a single regression using all the T observations can be applied to relation (2) to obtain the best linear unbiased estimates of the four parameters, $a_0, b_0, a_1$ and $b_1$. 1/

However, this classical method can be applied only if a sufficiently large number of observations are available for each structure. In the case of the single right-hand variable presented above, at least two observations must be available for each structure. 2/ Therefore, the dummy variable method cannot be applied in a situation where structure changed in two successive years or in the last year of the observation period. These situations are not at all rare.

1/ It may be reasonable to expect that the changes in tax structure, which are likely to change the parameters of revenue function, change the variance of the error terms, too. Some transformation of the variables is then required to ensure the homoscedasticity of the $\ln U$ term. See Edmond Malinvaud, Statistical Methods of Econometrics, Rand McNally & Company, 1966, Chapter 8, Section 4.

2/ If the condition is not fulfilled, the regression of form (2) is impossible as it represents a case of exact multiple co-linearity.
A different line of approach was sought by economists faced with this difficulty. 1/ It consists of generating a series of hypothetical revenues which would have obtained had the present tax structure been effective for a longer period. Since the hypothetical revenue series are supposed to reflect the present structure only, it is unnecessary to consider the effect of tax structure changes in this case. Here the question is how to construct the hypothetical revenue series. Generally not much information is available on the magnitudes of the hypothetical revenues, and one would have to introduce certain assumptions to substitute for the missing information. The two approaches discussed below have been developed in this direction.

(ii) **Constant Rate Method**

This is a mechanical approach the procedure of which may be explained by taking import duty revenue for example. 2/ The import duties can be broken down into sub-taxes according to the rates under the present structure; the sub-tax imposed at rate \( r_1 \), the one imposed at \( r_2 \), and so on. The first step in the constant rate method is to construct the base series for each of the sub-taxes are calculated by applying the current rates to the corresponding sub-tax bases. The hypothetical import duty revenue is the sum of these hypothetical sub-tax revenues.

This method presents a serious operational problem. For some taxes the detailed data may not be available to permit the construction of the sub-tax bases and even if they were available, the procedure would be prohibitively

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2/ Cf. Bahl, op. cit., for a more complete discussion.
tedious in many cases. For import duty, one would have to look into the import statistics using extremely disaggregated classification.

Furthermore, the method depends on a highly implausible assumption that changes in tax structure do not affect the magnitudes of the sub-tax bases. The assumption implies that resource allocation is not affected by the changes in relative prices, which are not generally acceptable. It also implies that tax delinquencies are independent of tax structure, which is disputable. In addition, this method completely ignores the information that may be derived from the revenue observations under the abolished structures. Considering these theoretical and operational difficulties, the constant rate method seems to be of very little practical value.

(iii) **Prest Method**

The Prest method also consists of generating hypothetical constant tax structure revenue series, but by a procedure less tedious than the constant rate method. 1/ The Prest procedure may be illustrated with a diagram. 2/ In Figure I, points \( R_1(A), \ldots, R_3(A) \) and \( R_4(B), \ldots, R_7(B) \) represent the actual revenue from the Turkish income tax for 1965-1971 period. The tax structure changed in 1968, and A indicates the structure before the change, while B indicates the structure after the change, i. e., the present structure. \( R_4(A)* \) is the estimate

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Income Tax Revenue
TL Billion

Figure 1

Year
of the hypothetical revenue in 1968 which would have been realized if structure A had been effective in this year. The hypothetical revenue is not generally observable, but may be estimated fairly easily. 1/

The revenue series under structure A is then adjusted to reflect the revenue impact of the change in the tax structure. The adjustment can be made in a variety of ways, but it requires some assumption on the relationship between the revenues under Structure A and under structure B. The one Prest used in the paper on the U. K. income tax was that the revenues generated under different tax structures are proportional to each other, which may be called the "proportionality hypothesis." 2/ With this assumption, the hypothetical revenues in 1965, ..., 1967 which would have been obtained under structure B can be derived using the following formula:

\[ \text{Hypothetical revenue under structure B in year } t = \frac{R_4(B)}{R_4(A)} \times \text{Actual revenue in year } t. \]

\[ R_1(B)', ..., R_3(B)' \] are the estimates of hypothetical revenues derived in this manner. Supplementing \[ R_4(B), ..., R_7(B) \] with these estimates, one obtains seven revenue observation series which are supposed to belong only to structure B.

1/ When the government introduces a new tax structure, the tax authorities usually estimate the additional revenue from the change in the course of drafting the revenue budget forecast. The hypothetical revenue under the old structure may be estimated as the residual after subtracting this estimate of additional revenue from the actual revenue in the year of the structural change. However, these sorts of estimates of the additional revenues are of an ex ante nature, and the actual additional revenues can be very different from what was expected at the revenue budget forecasting stage. Better estimates of the additional revenues can be obtained only if the revenue pattern under the old system is identified, which is subject to the problem this paper is concerned with.

2/ Alternatively, it may be assumed that the difference between the revenue under structure A and that under structure B is constant over time. Or, it is also possible to assume that the ration between structure A revenue and structure B revenue changes in a certain manner. A serious problem is that the choice of such assumptions tends to be arbitrary.
The assumption used for generating the hypothetical revenue series, e.g., the proportionality hypothesis, again tends to restrict the usefulness of the method. For example, in the case of constant elasticity revenue functions, the implication of the proportionality hypothesis is that the elasticity with respect to $X$ is not affected by the change in tax structure. 1/ In many cases the validity of such assumptions is not known a priori. :

(iv) Conclusion

The examination of the remedial approaches which are currently used suggests that in the situation where the dummy variable method is not applicable, recourse to certain arbitrary assumptions is unavoidable. And it contains a risk because one is not prevented from choosing assumptions which favor a theory one wishes to test. At present one can minimize this risk only by trying to be conscientious. The appropriateness of the assumptions to be used should be carefully examined, taking into consideration the nature of the tax in question and utilizing all additional information available.

III. Estimation of Tax Revenue Functions for Turkey

In Turkey, the ratio of the central government tax revenue to GDP increased from 13.6 percent in 1962 to 18.7 percent in 1971. 2/ The structures of taxes changed almost every year in this decade, and the growth of revenue seems attributable to the tax structure changes to a large extent.

Therefore, it is necessary for the purpose of revenue forecasting to identify the revenue functions under the present tax structure. However, the

1/ If the revenue function is with a constant marginal tax-income ratio, the proportionality hypothesis implies a change in the constant term and the marginal tax coefficient by $1 - \frac{R_4(B)}{R_4(A)}$.

2/ The Turkish Savings Bond Scheme is treated as a tax in this paper.
task is complicated not only by the frequency of the structure changes but also by the two recent tax measures.

The tax measures of 1970 changed the structures of a wide range of taxes and introduced five new taxes—Real Estate Capital Gain Tax, Motor Vehicle Purchase Tax, Construction Tax, Operation Tax, and Football Pool Tax. 1/ The revenues under the tax structures resulting from the 1970 tax measures were observed only in 1971, the last year of the observation period. Therefore, the applicability of the dummy variable method for estimating the revenue functions under the present structures is highly restricted.

Furthermore, in 1972 the government introduced three new taxes—Fiscal Balance Tax, Real Property Tax, and central government revenue sharing of the municipality tax—and changed the structures of a number of taxes, including those introduced by the 1970 tax measures.

Since the tax revenues in 1972 are not yet finalized, it is impossible to have even a single revenue observation under the 1972 tax structure. 2/ For this reason, I estimated the revenue functions under the 1971 tax structure, instead of the "present" or the 1972 structure, and attempted some adjustments on the direct forecast figures to derive the projections for 1972 and the Third Five-Year Plan period (1973-1977).


2/ Fortunately, the levy structure of the Fiscal Balance Tax is almost the same as that of the savings bond scheme. abolished at the same time as the Fiscal Balance Tax was implemented. And hence, the revenue function for the fiscal Balance Tax can be estimated using the observations on the gross revenue from the savings bond scheme.
The exercise below assumes that the revenue function for each tax does not change its form, and that the parameters of individual functions remain the same under each tax structure. These assumptions are made for the sake of convenience; but that the forms do not change may be defended in this case on the ground that the tax structure changes during the decade in question were not drastic. They were limited to relatively minor manipulations of rates, coverages and exemption provisions. However, it is possible that the parameters of revenue functions change under a given tax structure. For example, an increase in income tax rates may intensify taxpayer's efforts to evade the tax immediately after the rate increase, but such effort may diminish as time passes and taxpayers accustom themselves to the new rates.

(i) Framework of the Exercise

This exercise focussed on the determination of the short-term tax revenue impacts of economic growth and price inflation. For this reason, I adopted a partial equilibrium model; I did not take into consideration the effects of the changes in tax revenue and tax structure on economic growth, production and trade patterns, rate of price inflation, etc.

(ii) Data

The observation period was confined to 1962-1971, as the revised national accounts statistics series goes back only to 1962. The tax revenue data are taken mainly from the Budget Revenue Bulletin, published by the Ministry of Finance.

Three criteria were used for determining the extent of disaggregation of the tax: (a) the stability of the revenue pattern, (b) minimization of the number of changes in the structure related to each class of taxes, and (c) minimization of the interdependency of revenues from different classes of taxes.
Criterion (b), which has been motivated by the consideration that one should try to use the orthodox dummy variable method as much as possible, would lead to a disaggregation according to tax laws. However, the more disaggregated the tax, the greater will be the number of tax classes with interrelated revenues. The interrelation makes it necessary to take into account the effect of the changes in the structure of one class of taxes on the revenue from others, which increases the number of required dummy variables, which in turn decreases the applicability of the dummy variable method. The following disaggregation was adopted after an examination of the structures of individual taxes:

- Income Tax
- Corporation Tax
- Savings Bonds - Fiscal Balance Tax
- Defense Tax on Buildings
- Motor Vehicles Tax
- Inheritance and Gift Taxes and Real Estate Purchase Tax
- Production Tax (other than on petroleum; domestic goods and imports)
- Petroleum Production Tax (domestic products and imports)
- Sugar Consumption Tax
- Banking and Insurance Transactions Tax
- Ptt Service and Transportation Tax
- Stamp Duty (other than on imports)
- Tax on Importation (Import Duty and Stamp Duty on Imports)
- Other Taxes

(iii) Methods

Where it was possible, the revenue function was estimated by the dummy variable method. Where it straightforward application was impossible,
we used certain restrictive assumptions such as proportionality hypothesis. The Prest method was used when it was considered better than the constrained regression with dummy variables. However, we did not apply the constant rate method for reasons stated above.

A crucial requirement for the application of the Prest method is an estimate of the additional revenue from the structural change in the year in which the first tax collection was made under the new structure. These estimates were collected from various sources. In a number of cases the ex post estimates were available. Where only the ex ante estimates could be obtained, we adjusted the figures assuming that the "unexpected developments" after the estimation affected the additional revenue and the total revenue proportionally. This assumption results in the following formula:

\[
\text{Actual Total Revenue} = \frac{\text{Ex ante Estimate}}{\text{Total Revenue Budget Estimate}} \times \text{Total Revenue}
\]

In applying the dummy variable method, we included in the revenue series the estimates of the hypothetical revenue from the old structure in the first year of collection under the new structure. This gives us an additional revenue observation for each of the abolished structures. The inclusion of the estimated hypothetical revenues would reduce the efficiency of the estimated parameters when the error term in the "estimated revenue" does not follow the same distribution as the error term in the actual revenues. However, the loss of efficiency may be smaller compared with the gain resulting from having additional observations. 1/

1/ It may be noted that in this case all the information that could be derived from the actual revenue series is utilized. In the remedial methods discussed in Section II, some of the information is deliberately suppressed.
In testing the hypothesis that the expected value of an estimated coefficient is zero, we adopted the conventional 95 percent confidence level in the case of ordinary variables. If the hypothesis is that a certain structure change did not affect a coefficient of an ordinary variable (i.e., the expected value of the estimated coefficient of a dummy variable is equal to zero), 80 percent confidence level was adopted because it is known that a structure change is likely to affect the magnitude of the coefficient. Even when the hypothesis had been accepted with 80 percent confidence level, we did not remove the dummy variable from the equation if the removal caused a serious deterioration of the Durbin-Watson statistics. The Durbin-Watson statistics for regression including the estimates of hypothetical revenues have been calculated using the residuals corresponding to the actually observed revenues only.

(iv) **Estimated Revenue Functions**

The estimated revenue functions are presented below. The following symbols are used in the presentation of the regression results.

- **R** Revenue, measured in TL million at current prices.
- **SA, SB, ...** Dummy variables representing abolished structures A, B, ..., which take value 1 for the revenues under the corresponding structures and value 0 for revenues under other structures.
- **N** Number of observations.
- **N** Number of estimates of hypothetical revenue included in the regression.

The standard error of each estimated parameter is given in the parentheses below the point estimate.
Income Tax: dummy variable method

\[
\ln R = -7.63 + 5.62 \text{SA} - 1.14 \text{SC} \\
(2.56) \\
+ (1.38 - .51 \text{SA} + .10 \text{SC}) \ln \text{GDP} \\
(0.04) (0.23) (0.10)
\]

\[
R^2 = 0.996, \text{DW} = 1.89, N = 12, N^* = 3
\]

GDP stands for GDP at current market prices. Structure C was effective in 1965-1967. The revenue function was obtained from a regression using the observations for 1962-1970. The 1971 observations were excluded as the effect of the Personnel Law of 1970 may cause an upward bias in the estimate of the elasticity with respect to GDP.

Corporation tax: dummy variable method

\[
\ln R = -6.53 - 0.09 \text{SA} - 0.15 \text{SB} + 1.26 \ln Y02(-1) \\
(1.34) (0.09) (0.07) (0.12)
\]

\[
R^2 = 0.975, \text{DW} = 2.32, N=11, N^* = 9
\]

Y02 stands for the gross value added in current producers' prices in industries, construction, trade, transportation and financial services. The coefficient of SA is small and not statistically significant, but its removal increases the DW statistics.

Savings Bond: dummy variable method

\[
\ln R = -7.21 + 1.33 \text{SA} + (1.24 - .08 \text{SA}) \ln \text{YSB} \\
(0.53) (0.60) (0.05) (0.05)
\]

\[
R^2 = 0.977, \text{DW} = 1.57, N=11, N^* = 1
\]

YSB stands for gross value added at current producers' prices in industries, construction, trade, transportation, financial services and public services. The structure was changed only once in 1967. The Savings Bond Scheme

1/ The Personnel Law raised the wages and salaries of civil servants and the employees of state enterprises, and its impact on the Turkish national accounts was significant in 1971. The share of the income subject to income tax in GDP is believed to have increased considerably.
has been abolished in 1972, and replaced by Fiscal Balance Tax with the structure the same as the post-reform Savings Bond Scheme. Therefore, one may base the revenue forecast for the new tax on this regression result.

**Defense Tax on Buildings:** dummy variable method

\[
\ln R = -8.17 - 0.86 SA + 1.54 \ln YO_5
\]

\[
(0.65) \quad (0.05) \quad (0.08)
\]

\[
R^2 = 0.996, \quad DW = 1.62, \quad N = 11, \quad N^* = 1.
\]

YO_5 stands for the gross value added at current producers' prices in housing sector. This tax has been abolished in 1972, as the new Property Tax Law came into effect. However, the revenue under the new tax law is not yet assessed.

**Motor Vehicles Tax:** simple regression

\[
\ln R = -9.55 + 0.80 \ln GDP + 1.00 \ln PGDP
\]

\[
(2.00) \quad (0.13) \quad (0.11)
\]

\[
R^2 = 0.996, \quad DW = 1.00, \quad N = 9
\]

The structure of this tax has remained unchanged since 1963. **Inheritance and Gift Taxes and Real Estate Purchase Tax:** constrained dummy variable method

\[
\ln R = -13.45 + (1.66 - 0.025A) \ln GNP
\]

\[
(1.05) \quad (0.09) \quad (0.01)
\]

\[
R^2 = 0.980, \quad DW = 1.38, \quad N = 12, \quad N^* = 2
\]

The orthodox dummy variable method cannot be applied as the laws concerning these taxes on property transfers were modified in 1970.

**Production Tax:** constrained dummy variable method

\[
\ln R = -3.51 + (0.99 - 0.01 SA) \ln GDP
\]

\[
(0.92) \quad (0.08) \quad (0.01)
\]

\[
R^2 = 0.969, \quad DW = 2.21, \quad N = 12, \quad N^* = 2
\]

Constrained dummy variable method was used for the same reason as above.
Petroleum Production Tax: constrained dummy variable method

\[ \ln RR = -15.16 + (3.29 \cdot SA - 1.14 SB - 1.07 SC - 1.01 SD - 0.70 SE) \ln GDPR - 3.22 \ln PGDP \]

\[ R^2 = 0.932, \; DW = 2.54, \; N = 15, \; N* = 5 \]

RR stands for revenue deflated by GDP deflator with value 1 for 1968.

Monopoly Revenue and Production Tax: dummy variable method

\[ \ln R = -3.99 - 0.23 SC - 0.26 SE + 0.99 \ln GDP \]

\[ R^2 = 0.951, \; DW = 2.37, \; N = 9 \]

Foreign Travel Expenditure Tax: simple regression

\[ \ln R = -11.59 + 1.52 \ln GDP - 0.0657 ROX \]

\[ R^2 = 0.975, \; DW = 1.51, \; N = 9 \]

ROX stands for the official exchange rate expressed at TL per US dollar.

The structure did not change since this tax had been introduced in 1963, but it was abolished in 1971 and the 1972 revenue is expected to be nil.

Sugar Consumption Tax: simple regression

\[ \ln R = 0.19 + 0.88 \ln GDP - 0.70 \ln R(-1) \]

\[ R^2 = 0.650, \; DW = 2.96, \; N = 9 \]

The structure of this tax did not change during the observation period.

However, the remittance of the tax to the Treasury tended to be irregular, mainly affected by the financial position of the Turkish Sugar Corporation.

Bank and Insurance Transactions Tax: constrained dummy variable method

\[ \ln R = -0.93 + (0.97 - 0.07 SA - 0.03 SB) \ln Y18 \]

\[ R^2 = 0.996, \; DW = 2.35, \; N = 13, \; N* = 3 \]
Y 18 stands for gross value added in the financial service sector. The dummy variables represent the changes in tax rates. The present rate became effective at the end of July 1970, and only 1 observation is available under the new rate, which prevents the use of orthodox dummy variable method. This revenue function has been chosen after experimenting with various types of constrained dummy variable regressions.

**PTT Service Tax and Transportation Tax:** Prest Method

\[
\ln R = -4.43 + 0.85 \ln \text{GDP} \\
(0.82) (0.07)
\]

\[R^2 = 0.939, \, DW = 1.25, \, N = 10\]

During the observation period, the structures of these two taxes were modified to a minor extent in 1970. Since these changes are not likely to affect the revenue elasticity with respect to GDP, the Prest method based on the proportionability hypothesis was used for this revenue function.

**Stamp Duty:** simple regression

\[
\ln R = -15.29 + 1.40 \ln \text{GDP} + 1.22 \ln \text{PGDP} \\
(3.03) (0.43) (0.43)
\]

\[R^2 = 0.988, \, DW = 2.05, \, N = 10\]

Although the structure of Stamp Duties was modified in 1970, the results of dummy variable regressions indicated no changes in the parameters. Therefore, a simple regression has been chosen as the basis for revenue forecasting.

**Customs Duties and Stamp Duty on Imports:** dummy variable method

\[
\ln R = 2.63 + 0.56 - 0.13 SA - 0.07 SB - 0.02 SC + 0.02 SE \ln M \\
(0.69) (0.08) (0.01) (0.01) (0.01)
\]

\[R^2 = 0.970, \, DW = 1.41, \, N = 16, \, N^* = 6\]
M stands for imports at c.i.f. value in TL million. These taxes are both levies on imports, and the Stamp Duty revenue partially depends on the Customs Duty revenue as the former is charged on the import value including the latter.

Other Taxes: constrained dummy variable method

\[
\ln R = -5.50 + (.99 - .04 (SA + SB + SC)) - .02 \ln GDP, \\
(2.25) (.19) (.02) \\
R^2 = .90, \quad DW = 1.21, \quad N = 14, \quad N* = 4
\]

The structure was changed in 1970, and the revenue under the present structure was observed only in 1971. The form of the revenue function has been chosen after experiments with various constrained regression.

As it may be observed, all the revenue functions are of constant elasticity type. However, this is not the result of presupposing the functional form. The form for each revenue function was selected after experimenting with various simple functional forms; the constant elasticity form gave the best regression result in each case. Price variable was introduced separately only in 4 out of 16 equations, also after examining the results of preliminary regressions. In most equations the effect of price inflation and real growth of other assumed determinant variable could not be separated.

(v) Taxes Introduced in FY1970

Five new taxes were introduced in 1970 by the Financing Law, and the revenues from these taxes were observed only in 1971. 1/ It is impossible to determine the revenue function for these taxes with regression analysis. The only additional information is the Ministry of Finance revenue budget forecast for 1972, which is supposedly in 1971 prices.

1/ The 1971 revenue from these taxes was about 2.7 percent of the total tax revenue.
In order to approximate the future revenue from these new taxes under the present structure, we assumed that the elasticity of real revenue from these taxes is constant with respect to real GDP.

With this assumption, the elasticity estimate may be approximated by

\[
\frac{\ln (RR_{1972}/RR_{1971})}{\ln (GDPR_{1972}/GDPR_{1971})}, \quad 1/
\]

where RR_{1972} is the revenue budget forecast after eliminating the expected additional revenue from 1972 tax measures related to these new taxes, and RR_{1971} is the actual revenue in 1971. Assuming 7 percent real GDP growth in 1972, the estimate of b is .21.2/

(vi) **The Effect of Structure Changes in the Past**

The revenue functions estimated with the dummy variable method enable us to see the effects of the past structure changes on the revenue patterns. The regression results indicate that these structure changes generally tended to improve the revenue elasticities. An important exception is the income tax structure change of 1968, which reduced the elasticity from 1.48 to 1.38. On the other hand, the exemption of income less than TL 14,400 from the purchase of savings bonds (1967) improved the revenue elasticity of the savings bond scheme from 1.16 to 1.24, despite its negative impact on revenue.

1/ b is the solution to a pair of simultaneous equations:

\[
\ln RR_{1972} = a + b \ln GDPR_{1972} \\
\ln RR_{1971} = a + b \ln GDPR_{1971}
\]

2/ It must be noted that b differs from the elasticity of revenue in current prices with respect to GDP in current prices. Under the present assumption, the latter is

\[
b' = \frac{2 \ln R}{2 \ln GDP} = b + (1-b) \frac{2 \ln PGDP}{2 \ln PGDP + 2 \ln GDPR}
\]

When b is less than unity, b' is greater than b but less than unity under ordinary circumstance, i.e., both the rate of price inflation and the real GDP growth rate are positive.
The result of a simulation indicates that had the 1962 tax structure been maintained, the tax revenue in 1971 would have been TL 20.8 billion, whereas the actual 1971 revenue was TL 32.6 billion. The revenue from the taxes introduced in 1963-1971 accounts for TL 2.5 billion or 7.6 percent of the 1971 revenue. Hence, the remaining TL 9.3 billion may be considered as attributable to the changes in the structures of the taxes, which existed in 1962.1/ Table I summarizes the effect of the structure changes in 1963-1971. It shows that, while the tax revenue grew by 141 percent in real terms in this period, about 62 percent of the growth was brought about by the introduction of new taxes and other structure changes, and that the latter's contribution was much greater than the former.

Table I: Effect of Tax Structure Changes on Revenue
(TL billion in 1971 prices)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Revenue</td>
<td>13.5</td>
<td>32.6</td>
<td>19.1</td>
</tr>
<tr>
<td>Hypothetical Revenue under 1962 Structure</td>
<td>13.5</td>
<td>20.8</td>
<td>7.3</td>
</tr>
<tr>
<td>Difference</td>
<td>0</td>
<td>11.8</td>
<td>11.8</td>
</tr>
<tr>
<td>New Taxes</td>
<td>0</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Other structure changes</td>
<td>0</td>
<td>9.3</td>
<td>9.3</td>
</tr>
</tbody>
</table>

IV. Revenue Projection for 1972-1977

Table II presents the tax revenue forecast for 1972-1977 under the 1971 structure. Except for the income tax and the new taxes introduced by the Financing law of 1970, the figures are the direct results of the extrapolation 1/

1/ The foreign travel expenditure tax was abolished before 1971. Nevertheless, a revenue of TL 293 million was collected in 1971 from this tax. No other taxes were abolished in this period.
of the revenue functions. The simulation assumed a real annual GDP growth rate of 7 percent for 1972 and 7.8 percent for the 1973-77 period. 1/ The annual rate of price inflation is assumed to be 10 percent for the entire simulation period. The sectoral gross value added and imports are projected on the basis of the time trend regression of their ratio to GDP.

The revenue from the income tax was projected by applying the rate of revenue increase implied by the estimated elasticity to the preceding year's revenue, taking the actual 1971 revenue as the base. 2/ This deviation from the direct forecasting procedure (the substitution of the assumed future values for the determinant variables in the revenue functions) was chosen because of the Personnel Law of 1970. The Law raised the salaries and wages of the public sector employees, effective from 1971, and hence it is most likely that the share of the income liable to the income tax in GDP increased significantly in 1971. This upward shift will not be reversed in the near future. However, the elasticity of income tax revenue with respect to GDP is not likely to be affected by the change in the upward shift in the share of the income-tax liable income. 3/

1/ The target GDP growth rate in the Third Five-Year Plan (1973-1977) is 7.8 percent.

2/ The GDP elasticity of 1.38 implies that the nominal revenue growth rate associated with a given nominal GDP growth rate, g, will be \((1+g)^{1.38}-1\).

3/ Let \(Y\) be the income subject to the income tax and \(k\) be the unknown ratio of \(Y\) to GDP. If the revenue from the income tax is subject to the pattern \(R = AY^b\), then it can be also expressed by \(R = A(kGDP)^b\) = \(A'GDP^b\).
TABLE II: Revenue Projection for 1972-77 1/
(in TL million, current prices)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Tax</td>
<td>12,001</td>
<td>15,233</td>
<td>19,335</td>
<td>24,541</td>
<td>31,151</td>
<td>39,540</td>
</tr>
<tr>
<td>Corporation Tax</td>
<td>2,293</td>
<td>2,985</td>
<td>3,803</td>
<td>4,644</td>
<td>6,167</td>
<td>7,847</td>
</tr>
<tr>
<td>Fiscal Balance Tax 2/</td>
<td>1,518</td>
<td>1,932</td>
<td>2,459</td>
<td>3,129</td>
<td>3,983</td>
<td>5,070</td>
</tr>
<tr>
<td>Defense Tax on Buildings</td>
<td>1,282</td>
<td>1,932</td>
<td>2,459</td>
<td>3,129</td>
<td>3,983</td>
<td>5,070</td>
</tr>
<tr>
<td>Motor Vehicles Tax</td>
<td>138</td>
<td>162</td>
<td>189</td>
<td>222</td>
<td>259</td>
<td>304</td>
</tr>
<tr>
<td>Inheritance and Gift Taxes and Real Estate</td>
<td>1,518</td>
<td>1,932</td>
<td>2,459</td>
<td>3,129</td>
<td>3,983</td>
<td>5,070</td>
</tr>
<tr>
<td>Purchase Tax</td>
<td>953</td>
<td>1,271</td>
<td>1,702</td>
<td>2,276</td>
<td>3,042</td>
<td>3,866</td>
</tr>
<tr>
<td>Production Taxes</td>
<td>5,305</td>
<td>6,290</td>
<td>7,458</td>
<td>8,842</td>
<td>10,148</td>
<td>12,430</td>
</tr>
<tr>
<td>Petroleum Production Tax</td>
<td>3,421</td>
<td>3,310</td>
<td>3,451</td>
<td>3,598</td>
<td>3,751</td>
<td>3,911</td>
</tr>
<tr>
<td>Monopoly Revenue and Taxes</td>
<td>3,421</td>
<td>4,068</td>
<td>4,838</td>
<td>5,753</td>
<td>6,542</td>
<td>8,137</td>
</tr>
<tr>
<td>Sugar Consumption Tax</td>
<td>613</td>
<td>798</td>
<td>777</td>
<td>921</td>
<td>948</td>
<td>1,081</td>
</tr>
<tr>
<td>Banking and Insurance</td>
<td>1,973</td>
<td>2,438</td>
<td>3,013</td>
<td>3,723</td>
<td>4,600</td>
<td>5,684</td>
</tr>
<tr>
<td>Transactions Tax</td>
<td>1,973</td>
<td>2,438</td>
<td>3,013</td>
<td>3,723</td>
<td>4,600</td>
<td>5,684</td>
</tr>
<tr>
<td>PTT Service Tax and Transportation Tax</td>
<td>374</td>
<td>433</td>
<td>501</td>
<td>580</td>
<td>671</td>
<td>776</td>
</tr>
<tr>
<td>Stamp Tax</td>
<td>1,488</td>
<td>1,861</td>
<td>2,326</td>
<td>2,908</td>
<td>3,636</td>
<td>4,546</td>
</tr>
<tr>
<td>Customs Duty and Stamp Duty on Imports</td>
<td>3,319</td>
<td>3,508</td>
<td>3,708</td>
<td>3,919</td>
<td>4,142</td>
<td>4,378</td>
</tr>
<tr>
<td>Other Taxes</td>
<td>749</td>
<td>888</td>
<td>1,053</td>
<td>1,249</td>
<td>1,482</td>
<td>1,758</td>
</tr>
<tr>
<td>Subtotal</td>
<td>37,749</td>
<td>45,723</td>
<td>55,298</td>
<td>67,379</td>
<td>82,263</td>
<td>100,926</td>
</tr>
<tr>
<td>New Taxes 3/</td>
<td>996</td>
<td>1,113</td>
<td>1,245</td>
<td>1,392</td>
<td>1,557</td>
<td>1,741</td>
</tr>
<tr>
<td>Total</td>
<td>38,745</td>
<td>46,836</td>
<td>56,543</td>
<td>68,771</td>
<td>83,820</td>
<td>102,667</td>
</tr>
</tbody>
</table>

Total Revenue as Percent of GDP 18.9 19.3 19.7 20.2 20.7 21.4

1/ Revenue under the 1971 tax structure
2/ Projected on the basis of revenue function for savings bonds scheme.
3/ Taxes collected in 1971 for the first time.
4/ Budget estimate adjusted for price inflation in 1972.
As it was stated earlier, the most recent tax structure changes took place in 1972, but the revenues under the structures after the 1972 tax measure have not been observed yet. The only available information on the 1972 tax revenue is the revised official estimate (as of August 1972) of TL 38.3 billion in 1971 prices. This figure is about 8.9 percent higher than my projection for 1972 in 1971 prices. The difference may be attributable to the 1972 tax measures, which are incorporated in the official estimate (but not in my projections). 1/

An examination of the structure changes in 1972 suggests that they would not change the revenue elasticity of the entire tax system with respect to GDP. With this, one can derive a set of revenue projections adjusted for the 1972 tax measures; in current prices, the adjusted annual projections would be 8.9 percent higher than the total revenue projections in Table II. Table III presents the result of the adjustments.

Table III: Adjusted Revenue Projection

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenue in Current Prices TL Billion</th>
<th>Revenue in 1971 Prices TL Billion</th>
<th>Revenue As % of GDP</th>
<th>Real Growth Rate of Revenue, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>42.2</td>
<td>38.3 /1</td>
<td>20.6</td>
<td>17.6 /2</td>
</tr>
<tr>
<td>1973</td>
<td>51.0</td>
<td>42.1</td>
<td>21.0</td>
<td>9.9</td>
</tr>
<tr>
<td>1974</td>
<td>61.6</td>
<td>46.2</td>
<td>21.3</td>
<td>9.8</td>
</tr>
<tr>
<td>1975</td>
<td>74.9</td>
<td>51.1</td>
<td>21.8</td>
<td>10.5</td>
</tr>
<tr>
<td>1976</td>
<td>91.3</td>
<td>56.7</td>
<td>22.4</td>
<td>10.8</td>
</tr>
<tr>
<td>1977</td>
<td>111.8</td>
<td>63.1</td>
<td>23.1</td>
<td>11.4</td>
</tr>
</tbody>
</table>

/1 Revised official estimate as of August 1972.
/2 Growth over the actual 1971 revenue; hence a part of this is due to the structure changes in 1972.

1/ This interpretation is somewhat bold, it is not known what assumptions were adopted for the official estimate with respect to the growth rate, the rate of price inflation, etc. in 1972.
It may be noted that the real growth rate of the total revenue in this projection tends to increase as the time passes, whereas both the real GDP growth rate and the rate of price inflation are assumed constant for 1973-1977. It implies that the elasticity of total revenue with respect to GDP increases from year to year. This is because the revenue functions assume that the elasticities of the revenue from individual taxes are constant with respect to GDP or its components. Therefore, the elasticity of the total revenue with respect to GDP is a weighted average of composite elasticities, whereas the weight is the share of the revenue from each tax in the total revenue. 1/ The revenues from the more GDP-elastic taxes increase faster, and their shares increase while the shares of other taxes decrease as GDP grows. Therefore, the elasticity of total tax revenue with respect to GDP increases from year to year under a given tax structure.

V. Result of Alternative Revenue Projections

In addition to projecting the future revenue with the revenue functions, I experimented with a set of simulations for the same period using the results of simple regressions which ignore the effect of tax structure changes.

1/ Let $R_i$ and $B_i$ be the revenue from the $i$-th tax and the related sectoral gross value added. Then, the elasticity of the total revenue, $R$, with respect to GDP is

$$\frac{dR}{dGDP} \cdot \frac{GDP}{R} = \sum \frac{dR_i}{dGDP} \cdot \frac{GDP}{R_i} = \sum \frac{R_i}{R} \left( \frac{dR_i}{dGDP} \right) \frac{GDP}{R_i} = \sum \frac{R_i}{R} \left( \frac{dR_i}{dGDP} \right) \left( \frac{dGDP}{B_i} \right) \left( \frac{dGDP}{R_i} \right)$$

Therefore, the elasticity of total revenue with respect to GDP is the weighted average (with $R_i/R$ as the weights) of the products of the revenue elasticity with respect to the sectoral gross value added and the latter's elasticity with respect to GDP.
In Table IV, the results (indicated as B) are compared with the corresponding projection by the revenue functions (indicated as A). The ratio of B to A may be regarded as an indicator of the distortion due to the simple regression.

Although the total revenue forecasts by the two methods differ only slightly, it should not be regarded as the justification for using the simple regression method. In this particular case, the effect of the upward distortions for some taxes and that of the downward distortions for others worked to offset each other in the projection of the total revenue. However, there are no reasons to believe that such is always the case. The distortions are clear for some individual taxes. In the case of the fiscal balance tax, the neglect of the negative revenue impact of the introduction of exemption provision into the savings bond scheme has caused a strong downward distortion. In the case of the defense tax on buildings and the taxes on imports (customs duty and stamp duty on imports), the simple regression's assumption that rate changes did not affect the revenues has resulted in remarkable upward distortions in the forecasts.

It may be noted that for some taxes B is smaller than A in the 1972 projection, but the relation is reversed in the 1977 projection. This is also the result of the upward distortion in the elasticity estimate by the simple regression due to the neglect of the impacts of structure changes. The petroleum production tax represents an extreme example for this.
Table IV: Revenue Projections by Alternative Methods  
(TL million in current prices)

<table>
<thead>
<tr>
<th>A Revenue Functions</th>
<th>B Simple Regressions</th>
<th>Ratio B/A</th>
<th>A Revenue Functions</th>
<th>B Simple Regressions</th>
<th>Ratio B/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Tax</td>
<td>12,001</td>
<td>11,933</td>
<td>0.994</td>
<td>39,540</td>
<td>38,116</td>
</tr>
<tr>
<td>Corporation Tax</td>
<td>2,293</td>
<td>2,319</td>
<td>1.011</td>
<td>7,847</td>
<td>8,698</td>
</tr>
<tr>
<td>Fiscal Balance Tax</td>
<td>1,518</td>
<td>1,260</td>
<td>0.830</td>
<td>5,070</td>
<td>2,426</td>
</tr>
<tr>
<td>Defense Tax on</td>
<td>1,428</td>
<td>619</td>
<td>1.446</td>
<td>1,398</td>
<td>3,686</td>
</tr>
<tr>
<td>Motor Vehicles Tax</td>
<td>138</td>
<td>138</td>
<td>1.000</td>
<td>304</td>
<td>304</td>
</tr>
<tr>
<td>Inheritance and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gift Taxes and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real Estate Purchase Tax</td>
<td>953</td>
<td>1,032</td>
<td>1.083</td>
<td>4,066</td>
<td>4,751</td>
</tr>
<tr>
<td>Production Tax</td>
<td>5,305</td>
<td>5,296</td>
<td>0.998</td>
<td>12,430</td>
<td>13,115</td>
</tr>
<tr>
<td>Petroleum Production Tax</td>
<td>3,175</td>
<td>2,654</td>
<td>0.899</td>
<td>3,911</td>
<td>9,245</td>
</tr>
<tr>
<td>Monopoly Revenue and Production Tax</td>
<td>3,421</td>
<td>2,937</td>
<td>0.859</td>
<td>8,137</td>
<td>6,687</td>
</tr>
<tr>
<td>Sugar Consumption Tax</td>
<td>613</td>
<td>613</td>
<td>1.000</td>
<td>1,081</td>
<td>1,081</td>
</tr>
<tr>
<td>Banking and Insurance Transactions Tax</td>
<td>1,973</td>
<td>1,910</td>
<td>0.968</td>
<td>5,684</td>
<td>6,579</td>
</tr>
<tr>
<td>PTT Service Tax and Transportation Tax</td>
<td>374</td>
<td>330</td>
<td>0.882</td>
<td>437</td>
<td>454</td>
</tr>
<tr>
<td>Stamp Tax/2</td>
<td>1,488</td>
<td>1,488</td>
<td>1.000</td>
<td>4,546</td>
<td>4,546</td>
</tr>
<tr>
<td>Customs Duty and Stamp Duty on Imports</td>
<td>3,319</td>
<td>3,721</td>
<td>1.121</td>
<td>4,378</td>
<td>5,844</td>
</tr>
<tr>
<td>Other Taxes</td>
<td>749</td>
<td>649</td>
<td>0.866</td>
<td>1,758</td>
<td>1,849</td>
</tr>
<tr>
<td>Subtotal</td>
<td>37,749</td>
<td>37,100</td>
<td>0.983</td>
<td>100,926</td>
<td>107,718</td>
</tr>
<tr>
<td>New Taxes/3</td>
<td>996</td>
<td>996</td>
<td>1.000</td>
<td>1,741</td>
<td>1,741</td>
</tr>
<tr>
<td>Total</td>
<td>38,745</td>
<td>38,096</td>
<td>0.983</td>
<td>102,667</td>
<td>109,459</td>
</tr>
<tr>
<td>Total Revenue as</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of GDP</td>
<td>18.9</td>
<td>18.6</td>
<td>21.4</td>
<td>22.8</td>
<td></td>
</tr>
</tbody>
</table>

/1 Revenue under the 1971 tax structure.
/2 Revenue function estimated by simple regression.
/3 Projection based on two observations.
VI. Summary

In a country where the tax structure was changed frequently in the recent past, the projection of future tax revenue presents a technical problem for which no solutions of general applicability have been found. The projection should be based on the revenue function for the present tax structure. Ideally, this revenue function should be estimated with regression using the revenue observations pertaining only to the present tax structure, but it is generally impossible.

A plausible solution is to introduce tax structures into the regression equations. Since tax structures are non-quantifiable, they have to be transformed into some quantities in order to make the regression feasible. This may be achieved by the use of dummy variables, but the applicability of the dummy variable method is also limited because of the frequent structure changes which make the revenue series pertaining to each of the structures too short.

The remedial approaches suggested by the economists faced with the problem rely on some arbitrary assumptions. Nevertheless, in some cases such approaches are the only alternative to the regression ignoring the effect of tax structure changes. The estimation of the revenue functions for Turkey was faced with this situation. In most such cases we used constrained dummy variable regressions.

The estimated revenue functions show that the tax structure changes in 1963-1971 tended to increase the revenue elasticities. The result of a simulation indicates that the structure changes were responsible for about 62 percent of the real growth in the total tax revenue in this nine-year period.
In 1971, the tax revenue to GDP ratio was 18.7 percent. Our projection shows that this ratio will increase to 21.4 percent in 1977 if the 1971 tax structure is maintained, and to 23.1 percent if the additional revenue from the 1972 tax measures grows at the same rate as the revenue under the 1971 structure.