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A Model for Simulating Wage Income Tax Revenues in the Federal Republic of Germany - Structure, Predictive Power and Application

ALFRED BOSS

I. The Purpose of the Paper

In the Federal Republic of Germany different models are used in order to forecast wage income tax revenues. The federal government e.g. is interested in such forecasts because of her obligation to prepare a medium-term projection of the economic development and a medium-term plan of government expenditures and revenues. The government uses specific procedures (LIETMEYER 1986). The purpose of this paper is to present a *model for simulating wage income tax revenues* that was developed in the end of the seventies (BOSS 1978) and that was refined many times in the course of the eighties. The model is based on data from wage income tax statistics for 1983 and from the NATIONAL INCOME AND PRODUCT ACCOUNTS (NIPA). It is used to forecast wage income tax revenues and to simulate the revenue effects of specific tax policy measures.

II. The Structure of the Model

2.1. Outline

Wage income tax statistics for 1983 give information on the distribution of the taxpayers by "tax classes" and gross wage income and on the average gross wages of groups of taxpayers (STATISTISCHES BUNDESAMT 1986). In order to deduce the corresponding distributions for the years following 1983 specific assumptions on the development of the number of taxpayers and the average wage income are used. Applying the tax laws of the single years the distributions of taxpayers by tax classes and taxable (wage) income are derived. Using the tax formula wage income tax revenues are calculated for groups of taxpayers and for all taxpayers. The model does not include any feedback effects of tax policy measures on employment, real wages, etc.

2.2. Distributions of Taxpayers by the Level of Gross Wages

The model is based on the distributions of three main groups of taxpayers by gross wages. The first group includes unmarried taxpayers, the second group consists of couples with one income earner, the third group comprises couples with two income earners. The distinction is necessary because there are specific tax allowances that vary according to the marital status and the number of income earners.

Wages and salaries reported in the 1983 tax statistics are lower than wages and salaries according to the NIPA. The difference is about 3.5 per cent. However, there are some reasons for necessarily having a difference. Firstly, the NIPA figure includes specific non-taxable wages. Secondly, there is "underreporting" in the tax statistics because the FEDERAL STATISTICAL OFFICE does not receive wage and tax data for all employees. As a consequence any model based on the 1983 tax statistics will lead to an underestimation of tax revenues. However, it is easy to correct the results of using the *simulation model*.

As to the distributions of taxpayers by gross wages in the years following 1983 it is assumed that the gross wages of all 1983 taxpayers increase by the same rate as average earnings (per employee) according to the NIPA. In addition, it is assumed that the number of taxpayers in all groups develops in the same way as the number of employees in the German economy on the whole.

2.3. Deductions, Tax Allowances and Taxation

The gross wages of 640 groups of taxpayers are reduced by standard deductions and specific tax allowances in order to derive taxable (wage) incomes. In detail this means that gross wages are reduced by the "Werbungskostenpauschbetrag" (non-itemized work-related deductions), the "Sonderausgabenpauschbetrag" (non-itemized deduction for charitable contributions etc.), the "Arbeitnehmerfreibetrag" (standard deduction for all employees) and the "Weihnachtsfreibetrag" (Christmas bonus tax allowance) (Table 1).

In addition, specific allowances for the taxpayers' children are subtracted from gross wages as well as the "Vorsorgeaufwendungen" (e.g. contributions to social security), additional "Werbungskosten" (itemized work-related deductions) and other allowances e.g. for people above the age of 60.

The tax allowance for children was reintroduced in 1983. The amount was 432 per annum for 1983 to 1985; it was raised to 2484 DM in 1986. The allowances are subtracted from the gross wages of the taxpayers according to the number of children they have to take care for. Information on the number of children is available from the

Table 1
Fixed Deductions and Allowances for Different Tax Classes
 (Groups of Taxpayers)

Category	Tax class				
	I	II	III with- out V	III/V	IV/IV
Werbungskostenpauschale	564	564	564	1128	1128
Sonderausgabenpauschbetrag	270	270	540	540	540
Arbeitnehmerfreibetrag	480	480	480	960	960
Weihnachtsfreibetrag	600	600	600	1200	1200
Total	1914	1914	2184	3828	3828

Source: Income Tax Law for the Federal Republic of Germany, §§ 9 a, 10 c and 19.

basic tax statistics for 1983; especially it is known for groups of taxpayers if the number is 1, 2, 3 or 4 or more. As to the years following 1983 there is information on the overall number of children from other sources (BUNDESANSTALT FÜR ARBEIT 1988), but not on the distribution by groups of taxpayers. It is assumed that the development of the number of children is the same in all groups. As to the computational procedure the tax allowance for children is "depreciated" year by year by the rate of decline of the number of children (*Table 2*).

As to the "Vorsorgeaufwendungen" (mainly contributions to social security) the prescriptions of the income tax law are applied. For households with two income earners this is not possible in a precise way because there is no information on the shares of the two single income earners in total gross wages. It is assumed that both earners share 50 per cent of total wage income.

Using specific supplementary information for all taxpayers in 1983 and using some relatively weak assumptions it is possible to find out the amount of the additional "Werbungskosten" (itemized work-related deductions) that have to be subtracted from gross wages in different wage income groups (*Table 3*). Details cannot be explained in this paper (see BOSS 1987). The amount of additional "Werbungskosten" is a relatively constant fraction of gross wages. Therefore, all gross wages are reduced by 2.4 r in order to take account of them.

Table 2
**Number of Children According to Statistics on
 "Kindergeld" Payments (Government Transfers to Households with Children)
 and Income Tax Statistics**

Year	Number of Children (in 1000) according to	
	"Kindergeld" Statistics	Income Tax Statistics
1980	12541	14838
1981	12299	.
1982	11593	.
1983	11164	13658
1984	10812	.
1985	10664	.
1986	10480	.

Source: STATISTISCHES BUNDESAMT, ed., 1980 and 1983, Fachserie 14, Reihe 7.3;
 BUNDESANSTALT FÜR ARBEIT, ed., 1980 to 1988, Amtliche Nachrichten.

A similar procedure is used in order to estimate the amount of additional allowances that are not work-related (see BOSS 1987). It turns out that these allowances amount to some 3 per cent of gross wages for the taxpayers on average and that they do not depend very much on the level of gross wages (*Table 4*). The 3.0 per cent figure is used for all groups of taxpayers.

Adding 3.0 per cent and 2.4 per cent and considering that there are some taxpayers with standard allowances only (i.e. "Arbeitnehmerfreibetrag" (standard deduction for employees) and "Weihnachtsfreibetrag" (Christmas bonus tax allowance)) gross wages are reduced by 4.5 per cent for 1983 and a bit less for the years thereafter - the reason for this being the experience for the development from 1980 to 1983.

Having derived taxable (wage) incomes for all the 640 groups of taxpayers the tax formula is applied in order to calculate tax revenues for all the taxpayers. Wage income tax revenues are calculated as

Table 3
**"Werbungskosten" (Work-related Deductions) in per cent of
 Gross Wages by Gross Wage Income Groups in 1983 -
 All (Wage Income) Taxpayers**

Gross wages from ... up to ... DM	"Werbungskosten"	
	total	itemized (above standard deductions)
0 - 2 400	11.5	.
2 400 - 4 800	16.1	.
4 800 - 7 200	10.4	.
7 200 - 9 600	9.2	2.3
9 600 - 12 000	7.7	2.3
12 000 - 16 000	6.7	2.5
16 000 - 20 000	5.6	2.4
20 000 - 25 000	5.3	2.7
25 000 - 30 000	4.8	2.7
30 000 - 36 000	4.4	2.6
36 000 - 40 000	4.2	2.5
40 000 - 45 000	4.1	2.5
45 000 - 50 000	4.0	2.4
50 000 - 55 000	4.0	2.4
55 000 - 60 000	3.9	2.4
60 000 - 65 000	3.8	2.4
65 000 - 70 000	3.8	2.4
70 000 - 75 000	3.8	2.5
75 000 - 80 000	3.8	2.6
80 000 - 85 000	3.8	2.7
85 000 - 90 000	3.9	2.8
90 000 - 95 000	3.9	2.9
95 000 - 100 000	4.0	3.0
100 000 - 150 000	3.7	3.0
150 000 - 200 000	2.7	2.3
Total	4.3	2.4

Source: Own calculations (for details see Boss 1987).

Table 4
**Additional Deductions in per cent of Gross Wages in 1983 -
 Taxpayers without Those with Standard Deductions**

Gross wages from ... up to ... DM	Additional Deductions	Additional Deductions above standard deductions ("Arbeitnehmer- und Weihnachtsfreibetrag")
0 - 2 400	68.8	.
2 400 - 4 800	32.3	.
4 800 - 7 200	21.2	2.9
7 200 - 9 600	15.6	2.5
9 600 - 12 000	13.6	3.3
12 000 - 16 000	12.0	4.0
16 000 - 20 000	10.9	4.6
20 000 - 25 000	8.8	3.8
25 000 - 30 000	7.7	3.6
30 000 - 36 000	7.3	3.8
36 000 - 40 000	6.9	3.7
40 000 - 45 000	6.5	3.4
45 000 - 50 000	6.0	2.9
50 000 - 55 000	5.6	2.6
55 000 - 60 000	5.3	2.4
60 000 - 65 000	5.1	2.4
65 000 - 70 000	4.9	2.3
70 000 - 75 000	4.6	2.2
75 000 - 80 000	4.3	2.0
80 000 - 85 000	4.1	2.0
85 000 - 90 000	3.9	1.9
90 000 - 95 000	3.7	1.8
95 000 - 100 000	3.6	1.7
100 000 - 150 000	3.3	1.7
150 000 - 200 000	2.4	1.5
Total	6.8	3.0

Source: Own calculation (for details see Boss 1987).

$$T = \sum_{i=1}^{32} \sum_{j=1}^{20} x_{ij} t_{ij};$$

Notation:

- x_{ij} = number of taxpayers in a specific group,
 t_{ij} = wage income tax,
 T = overall wage income tax revenues,
 j = index for classifying according to the number of children and the marital status,
 i = index for the classification according to gross wages.

III. Testing the Model

Before applying the simulation model it is necessary to test it. This is done stepwise. The procedure can be considered as starting by "soft" testing and ending in "hard" testing.

At first, it is tested if the sum of all hypotheses introduced into the model leads to the wage income tax revenues reported in the *1983 wage income tax statistics*. The result is that the "predicted" revenues (118,47 billions DM) are very close to the "actual" revenues (119,13 billions DM). However, this is not too much surprising because some of the hypotheses underlying the model are numerically specified by means of the information included in the *1983 tax statistics*. Nevertheless, the deviation between actual revenues and revenues derived by using the model is small remembering the simplifications used in specifying the relations between allowances and gross wages; e.g. proportionality in relation to gross wages and independency with respect to tax class, i.e. marital status and number of children, was assumed several times. It is remarkable that simplicity in the structure of the model does not exclude (relative) precision in its consequences for revenues. More sophisticated procedures of adjusting the model's hypotheses to the actual conditions in the 1983 data base (e.g. SPLINE functions, method of ordinary least squares) would not help very much; applying them would mean waste of resources.

A harder test follows. Its purpose is to find out if the revenues derived by using the model are the same as the cash revenues that actually flew to government in 1983. These cash revenues are different from those reported in the *income tax statistics for 1983* because of specific reasons. Thus, before testing it is necessary to calculate a cash

revenue figure vis-à-vis which a comparison only is useful. Such a comparable revenue figure can be derived by adding to the cash figure some specific tax revenue losses that result from specific tax credits (for employees in Berlin, for employees in mining and for saving activities of low income employees) and by taking into consideration the technical details of collecting wage income taxes in the Federal Republic of Germany (Table 5, for details see BOSS 1987).

Table 5

Wage Income Tax Revenues, Cash and Adjusted Cash Revenues 1983 - 1988
(Billions DM)

Year	1983	1984	1985	1986	1987	1988
Revenues on a cash basis	128.89	136.35	147.63	152.23	164.18	168.41 ^{c)}
Corrections ^{a)} necessary to arrive at comparable revenues	-8.25	-8.97	-11.44	-12.11	-13.10	-14.11 ^{c)}
Comparable revenues on the basis of the model ^{b)}	120.64	127.38	136.19	140.12	151.08	154.30

a) Including tax credits (for employees in Berlin, for savers, etc.) and discrepancies because of the procedure of tax collection (a priori allowances versus tax concessions in the course of the income tax assessment etc.).

b) Sum of the preceding two lines.

c) Estimated.

Source: BUNDESMINISTERIUM DER FINANZEN, ed., Finanzbericht 1989 and unpublished data.

Comparing the revenues according to the model and the adjusted ("comparable") actual revenues it follows that the model works sufficiently. The deviation for 1983 is in the range of 2 per cent (Table 6). This is a very small deviation remembering the extent of underreporting that is immanently included in the model's results.

A final hard test relates to the model's ability of predicting correctly the time path of wage income tax revenues. The predicted revenue figures are based on the specific tax laws of the 1983 - 1988 period. The "forecast error" of the model is about 2 per cent for 1984 and 1985. It grows a little bit for the years thereafter (Table 6). However, the NIPA basis (figures for gross wages and employees) for 1985 to 1987 probably will be

adjusted somewhat upwards in the future. Such an adjustment would result in smaller "forecast errors".

Table 6
Predicted and Actual Wage Income Tax Revenues 1983 - 1988
(Billions DM)

Year	1983	1984	1985	1986	1987	1988
Predicted revenues	118.47	125.22	133.03	134.67	143.64	145.08
+ Deviation between - model and reality (p.c.)	2.17 (1.8)	2.16 (1.7)	3.16 (2.4)	5.45 (4.0)	7.44 (5.2)	9.22 (6.4)
= Actual revenues	120.64	127.38	136.19	140.12	151.08	154.30

Source: Own calculations.

On the whole the model seems to have survived testing. Thus it does make sense to apply it for forecast purposes as well as for simulation purposes.

IV. Application of the Model

4.1. Macroeconomic Data Base

In order to apply the model it is necessary to have a prediction of the macroeconomic development; especially it is necessary to introduce a forecast of gross wages per employee and of employment in the German economy. The forecast below rests upon the development projected by the German central government in mid 1988 (BUNDESMINISTERIUM DER FINANZEN 1988); however, the projected figures (*Table 7*) are somewhat adjusted in order to include additional information that became available since then.

Table 7
Gross Wages and Employment in the Federal Republic of Germany

Year	Gross Wages per Employee	Number of Employees
	Change over previous year (per cent)	
1988	3.2	0.6
1989	3.1	0.4
1990	3.5	0.5
1991	4.5	0.5
1992	4.5	0.5

Source: BUNDESMINISTERIUM DER FINANZEN, ed.,
 Finanzbericht 1989.

4.2. Forecast of Wage Income Tax Revenues

Wage income tax revenues will increase by only 2.6 per cent in 1988; this is due to the tax cut as of January 1988. Wage income tax revenues are predicted to rise by 6 per cent in 1989; the increase will be much higher than the increase of gross wages because "bracket creep" is a significant feature of the German income tax law. The elasticity of wage income tax revenues with respect to gross wages is in the range of 1.75.

4.3. Simulating the Impact of Changing the Tax Formula and Changing Specific Standard Deductions and Tax Allowances

When applying the model for simulation purposes one has to bear in mind that the model does not incorporate any feedback effects of tax policy. Consequently the model does exclude any supply side effects on tax revenues. It can only be used to get an idea of the (first round) impact effect of a specific policy measure.

The new tax formula effective as of January 1990 is expected to reduce wage income tax revenues by about 25 billions DM (*Table 8*). The tax revenue loss will increase in the years following 1990 if nominal income will continue to rise. Raising the tax allowance for children will reduce revenues by 1.7 billion DM.

Table 8
**Impact of (actual and fictitious) Tax Policy Measures on
 Wage Income Tax Revenues in the Federal Republic of Germany**
 (Billions DM)

Tax Policy Measure	1990	1991	1992
New Tax Formula as of 1990	-24.7	-26.9	-29.4
Increase of allowances for children from 2484 DM to 3024 DM	-1.7	-1.7	-1.7
Abolishment of the "Arbeitnehmerfreibetrag" (480 DM)	3.0	3.1	3.2
Abolishment of the "Weihnachtsfreibetrag" (600 DM)	3.8	3.9	4.0

Source: Own calculations using the *simulation model*.

Some fictitious measures are simulated, too. Abolishing a specific part of tax-free wages for employees ("Arbeitnehmerfreibetrag") would raise revenues by about 3 billions DM; abolishing the Christmas bonus tax allowance (tax-free income of 600 DM) would lead to about 4 billions DM of additional wage income tax revenues (*Table 8*).

4.4. Changes of Income Tax Law and Dynamics of Wage Income Tax Revenues

Changes of the income tax law may imply changes in the elasticity of tax revenues with respect to gross income or with respect to the tax base. As a consequence the problem of "bracket creep" may become more or less important.

The new tax formula that will be introduced in the Federal Republic of Germany in 1990 will not lead to significant changes in this respect. The overall elasticity will remain (at least for the early nineties) extremely high though slightly falling (*Table 9*). The components of the overall elasticity will hardly change, too. As a consequence tax cuts will remain necessary year by year in order to avoid disincentive effects on labour supply and savings.

Table 9
Wage Income Tax Elasticity and its Components 1991 - 1994

Year	1991	1992	1993	1994
Elasticity of wage income tax revenues with respect to nominal gross wages	1.74	1.72	1.70	1.68
Elasticity of wage income tax revenues with respect to taxable (wage) income	1.43	1.42	1.42	1.41
Elasticity of taxable (wage) income with respect to nominal gross wages	1.22	1.21	1.20	1.19

Source: Own calculations using the *simulation model*.

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