Sieg, Holger

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Vierteljahrshefte zur Wirtschaftsforschung

Provided in Cooperation with:
German Institute for Economic Research (DIW Berlin)

Suggested Citation: Sieg, Holger (1999) : An Empirical Analysis of Income Taxation and Labor Supply in Germany, Vierteljahrshefte zur Wirtschaftsforschung, ISSN 0340-1707, Duncker & Humblot, Berlin, Vol. 68, Iss. 2, pp. 243-248

Labor Supply and its Determinants

An Empirical Analysis of Income Taxation and Labor Supply in Germany*

By Holger Sieg**

Summary

This article focuses on imputing and estimating income tax rates using panel data. The empirical results of this paper provide insights into the structure of the German income tax system and show that German tax reforms in the 1980s had only a modest impact on effective tax rates. This may explain why there are no significant responses in labor supply in the data even though tax reforms were supposed to provide a better incentive structure.

1. Introduction

One of the most prominent features of labor markets in modern societies is the existence of (progressive) income taxation. These taxes have a major impact on earnings and potentially create substantial disincentive effects on labor supply. These perceived disincentive effects together with a desire to reduce the size of government were the major driving forces behind most tax reforms enacted in the United States and Europe during the 1980s (Blundell 1992). Progressive income taxation not only causes inefficiencies in labor markets, but also provides the most important tool to redistribute resources and alter the distribution of economic welfare throughout the economy. Mirrlees (1971), in his seminal paper on optimal taxation, shows that there is a significant tradeoff between the scope of redistribution (measured by the progressivity of the tax rate) and the welfare loss encountered in the economy, i.e., a tradeoff between equity and efficiency (Stiglitz 1987).

In this paper, we discuss different approaches for approximating or estimating the effective tax function, which maps economic income into tax liabilities, using data from the German Socio-Economic Panel (GSOEP). Once we have estimated this mapping, we are in a position to analyze its properties and compare them to those found to be desirable in the theoretical literature on income taxation. One of the major findings of this paper is that German tax reforms in the 1980s only had a modest impact on effective tax rates. This provides an explanation as to why we find no significant responses in labor supply in the data even though tax reforms were supposed to provide a better incentive structure.

The rest of the paper is organized as follows. Section 2 presents a discussion of tax reforms in Germany in the 1980s. Section 3 presents the analytical framework and discusses how to impute and estimate tax function and marginal tax rates based on panel data. Section 4 discusses data requirements and presents the empirical results. Section 5 concludes the analysis.

2. Tax Reforms in Germany in the 1980s

The German government designed a comprehensive reform of the income tax system that was passed by both houses of the German parliament in 1985. The new tax laws were implemented in three stages in 1986, 1988, and 1990. This section reviews the basic goals of this legislation and discusses its most important changes to the tax law. At least four different goals were pursued with these reforms.

First, marginal tax rates were lowered to improve the incentives for work. The lowest marginal tax rate was decreased from 22 percent to 19 percent. The highest tax rate was lowered from 56 percent to 53 percent. The steep increases in the marginal tax rates characteristic of the tax structure in 1985 were reduced. In particular, the marginal tax rates on taxable incomes between DM 40,000 and DM 75,000 were significantly decreased. Reforms, enacted at the same time in the United States and the United Kingdom, also featured large reductions in the highest marginal tax rates. In contrast to those changes, the German tax reforms did not significantly lower the marginal tax rates for high-income earners. The highest marginal tax

* Financial support was provided by the William Larimer Mellon Fund and the German National Scholarship Foundation.

** Duke University.

rate was only lowered by three percentage points, reflecting the fiscally conservative approach toward tax reforms that dominated German politics in the 1980s (Bös 1992).

Second, the tax structure was to be simplified. After implementation of the third step of the reform, over 90 percent of income taxpayers faced a tax formula with a marginal tax rate that increased linearly with taxable income. While this clearly lowers tax rates for individuals with taxable income between DM 25,000 and DM 120,000, it is not clear that it simplifies the actual computation of the tax liabilities. Unlike the American Tax Reform Act of 1986, which eliminated most of the tax exemptions and thus radically simplified the tax structure, the German tax reforms did not eliminate most tax exemptions and deductions. There were only limited attempts to broaden the tax base by abolishing loopholes in the tax code. While a comprehensive discussion of these tax benefits is beyond the scope of the paper, it should be noted that most of the substantial exemptions are related to families (tax splitting), child rearing, and work-related expenses.

Third, the tax reform was to ease the tax burden for families with children. The child deductions were increased from DM 432 to DM 3,942 per child. The household deduction for single-parent families was increased from DM 4,212 in 1986 to DM 5,616 in 1990. Single-parent families are also now eligible for child-care deductions up to DM 4,000 for the first child and up to DM 2,000 for any additional child. These measures were combined with an improved maternity leave policy that gave additional benefits to working mothers. Parents paying for the education of children aged 18 and over were awarded additional tax allowances not to exceed DM 4,200.

Fourth, the size of the government was to be reduced by cutting taxes while limiting expenditure growth and keeping budget deficits under control. Resources were shifted from the public to the private sector. The total loss of revenues was estimated to be up to DM 50 billion per year. Consequently, the total share of revenues as a percentage of GNP was expected to decline.

3. Estimating and Imputing Tax Rates

The discussion of the changes in the formal tax code indicates that the tax reforms should have a significant impact on the tax liabilities of individuals and households. The magnitude of these impacts is not obvious and there is no simple functional relationship between household characteristics and tax liabilities. This is a problem, since many standard economic models indicate that individual and household behavior depends on the tax function and its derivatives. This section provides a nontechnical discussion of different ways to impute and estimate tax functions and its derivatives. Readers who are more interested in econometric aspects of the estimation procedure should consult Sieg (1998).

Income taxation affects individual decisions through the budget constraint. Tax payments are based on taxable income that differs from economic income due to the provisions of the tax laws. The relationship between an individual's economic income in year t, i_{nt}, and his taxable income, i_{nt}^T, is denoted by the function, $g_t(\cdot)$. This function captures the impact of tax exemptions and tax deductions that drive a wedge between economic and taxable income.[1] In addition, tax deductions are linked to individual characteristics, x_{nt}. There are significant tax benefits associated with marriage, children and the ownership of houses, businesses and other items. More formally, the mapping from economic income to taxable income can be expressed as:

$$i_{nt}^T = g_t(i_{nt}, x_{nt}). \tag{1}$$

Tax payments are a function of taxable income. Let $T_i^f(i_{nt}^T)$ denote this mapping. We assume that the (effective) tax function is intertemporally separable, i.e., taxes paid in period t depend on income in t, but not on income in other periods. The tax function is indexed by the time period, indicating that it can change over time. Tax liabilities of a individual n at t are then given by:

$$\begin{aligned} T_{nt} &= T_t^f(i_{nt}^T) \\ &= T_t^f(g_t(i_{nt}, x_{nt})) \\ &= T_t(i_{nt}, x_{nt}). \end{aligned} \tag{2}$$

The composite function $T_i(i_{nt}, x_{nt})$ is referred to as the effective tax function since it relates tax liabilities directly to economic income. The effective tax function stands in contrast to the formal tax function, $T_i^f(i_{nt}^T)$, which relates tax liabilities to taxable income.

So far we have assumed that the econometrician observes tax rates. However, this is not likely to be the case, since neither taxable income nor the mapping from economic income to taxable income is typically observed. Earlier studies dealt with this issue by approximating taxable income using information about individual characteristics and computing the effective tax rates by applying the formal tax function to an approximate measure of taxable income (Schwarze 1995). This method completely ignores the fact that we have in many cases good measures of taxes paid by individuals.

Alternatively, we can treat the effective tax function as unknown and estimate it directly by exploiting observed income and tax payment. Introducing a stochastic component into tax payments, T_{nt}, we can express the underlying relationship between tax liabilities and income as follows:

$$T_{nt} = T_t(i_{nt}, x_{nt}) + u_{nt}. \tag{3}$$

[1] Also note that this approach extends to the case in which i_{nt} is a vector of different income categories, including capital income for example.

Assuming a parametric specification on $T_i(i_{nt},\chi_{nt})$ and imposing a conditional moments restriction on error term u_{nt}, we can estimate this function using standard parametric instrumental variable estimators. If the tax function is linear in the parameters we can use two-stage least squares (2SLS) or three-stage least squares (3SLS). If the function is nonlinear in the parameters, we can use a generalized method of moments (GMM) estimator. If we are concerned about function misspecification problems, we can estimate both the tax function and its first derivative using nonparametric techniques. Details of the econometric issues encountered in this part of the analysis are discussed in Sieg (1998).

There are a number of advantages and limitations to this approach. It has been argued that taxes paid by an individual (or a household) may not represent only individual applications of tax regulations, but may include deductions based on economic choices. Broadly speaking, tax deductions may be linked not only to (exogenous) household characteristics, like the number of children, but also to (endogenous) choices, like the consumption of certain types of goods. If that were the case, we would need to include these goods in the vector of conditioning variables.

Income need not be measured by an one-dimensional variable. The estimation-based approach easily extends to the case in which income is a vector of different income categories, including nonlabor income where different types of income are taxed at different rates. There is also no need to impose the assumption that tax payments are separable across household members.

Finally, the error term should be considered as a transitory error. If households made repeated systematic errors filing their tax returns, or if the population consisted of different types of tax filers, then it would be difficult to estimate effective tax rates correctly. But again, imputing tax rates from the tax code would also produce misleading results in this scenario.

Summarizing the discussion above, an estimation-based approach can be used to compute effective tax rates under fairly weak assumptions. It should be seen as complementary to other methods, helping the researcher to get a handle on a fairly complex problem.

4. Data Requirements and Empirical Results

The aim of the analysis is to estimate effective tax functions for individuals. Hence, the following variables must be observed by the econometrician: tax payments of the individual, labor income, and other sources of income. We also need to control for observed heterogeneity across individuals. Consequently the following variables are useful: marital status, the number of household members, and the number of children aged 16 and under. To estimate a model of household behavior (instead of individual behavior), we also need information on other household members, including tax payments, earnings and other relevant observed characteristics of the different household members.

The model presented in Section 3 can be estimated using data collected by the German Socio-Economic Panel. The GSOEP has the advantage that it contains very detailed information about gross and net income, as well as tax payments of the households (at least for earlier waves of the panel). It also contains some important information about nonlabor income that is useful to check some of the underlying assumptions of the model. In this paper we use the same sample as in Sieg (1998) to conduct the empirical analyses. We briefly review some of the main characteristics of that data set as they apply to this topic. Interested readers should consult the paper above for an extended discussion of construction of the sample and its properties.

The sample consists of 1,490 households, including both married couples and singles. Tax payments of an individual are defined as the difference between his or her gross and net labor incomes. This tax measure is based only on taxes on labor income and does not include taxes paid on nonlabor income. German tax laws specify two important sources of nonlabor income: income from financial assets (capital income) and rental income. Tax payment as defined here is a reasonable measure provided that most members of the sample do not obtain significant amounts of such nonlabor income. The GSOEP provides some information regarding those two sources of nonlabor income. Respondents are asked whether they received income from these sources in the previous year, and if so, how much. Based on this information, the importance of nonlabor income for household members in the sample can be evaluated. Only 273 of 1,138 households reported any income from financial assets in 1985, and 96 percent of these households had a capital income below DM 2,000. Only five households exceeded DM 8,000. Only 118 out of 1,138 reported to have a positive income from rentals, with 56 receiving more than DM 6,000. Analyses for the other five years produce similar results. In short, for the vast majority of the households and, therefore, of individuals in the sample, nonlabor income is negligible.

For a few selected years the GSOEP contains a second measure of tax payments, which is called wage and income taxes paid. This tax measure includes taxes on nonlabor income, but it does not include social security taxes. Recall that the first tax measure, the difference between gross and net labor income, includes social security taxes paid but does not include taxes paid on nonlabor income. The first measure allocates relatively higher tax payments to the male and lower tax payments to the female in the household. It turns out that, in absolute terms the two measures are relatively similar. In 1985 the average difference between these two measures was roughly DM 1,140 per household. We can conclude from this comparison that social security taxes are significantly higher on average than taxes on nonlabor income. Summarizing the discussion above it can be argued that in spite of the

drawbacks mentioned above the tax measure used in this analysis seems to be a reasonably good measure for most of the sample.

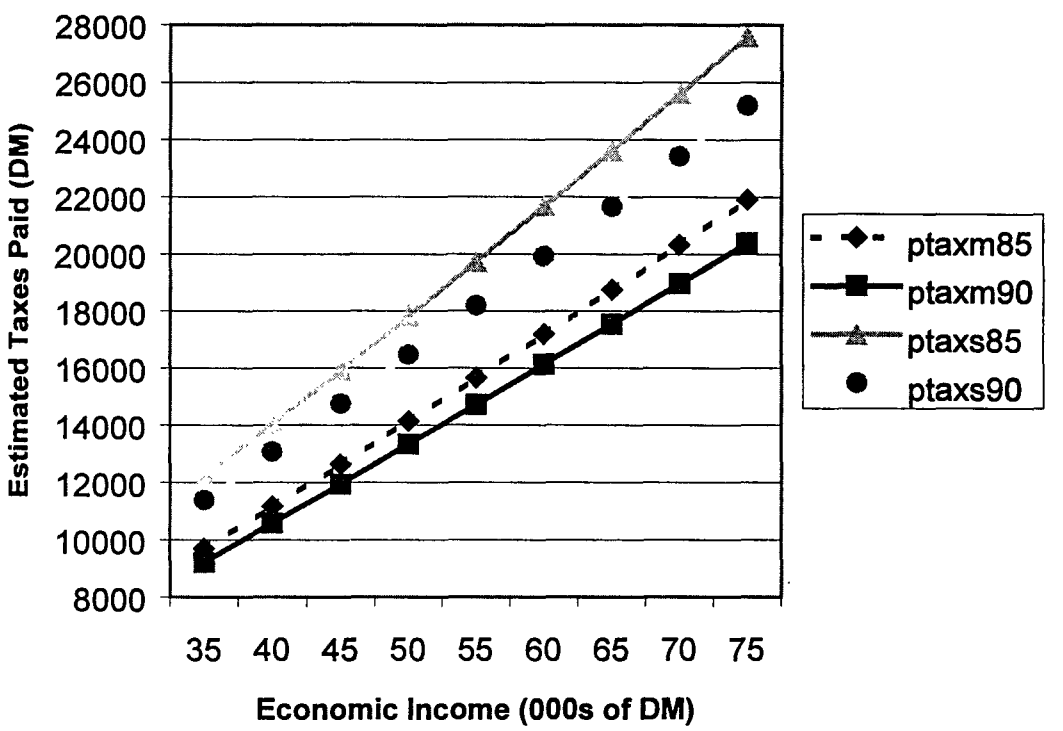
Since we are interested in the relationship between income and taxes, it is useful to study the empirical income distributions in the sample. The median of the 1985 gross income distribution is DM 40,800. The first and the third quantiles are DM 33,360 and DM 54,000, respectively; 90 percent of the sample have incomes between DM 26,400 and DM 84,000. The shape of the 1990 income distribution is similar to the one in 1985 but it shifted to the right by approximately DM 4,000. The new median is DM 44,870 and 90 percent of the household heads earn between DM 29,600 and DM 84,600.

An inspection of these statistics shows that there are only a few observations for low- and high-income earners. By construction of the data set, those who work less than 20 hours a week are excluded. This explains why there are so few incomes below DM 25,000. Agents with incomes over DM 100,000 might be undersampled in the GSOEP. We conclude from the analysis of income distribution that the sample does not contain many agents in the tails of the income distribution and is not therefore a representative sample of the underlying population. Ignoring both low- and high-income households is not problematic, since the underlying theory probably does not capture the behavior of agents in the tails of the income distribution very well. Also tax reforms in Germany were primarily aimed at middle class households.

As pointed out in the previous section, we can estimate the effective tax functions directly using data on tax liabilities and income. Sieg (1998) estimates a number of

Figure 1

Tax Functions Based on Parametric Estimation

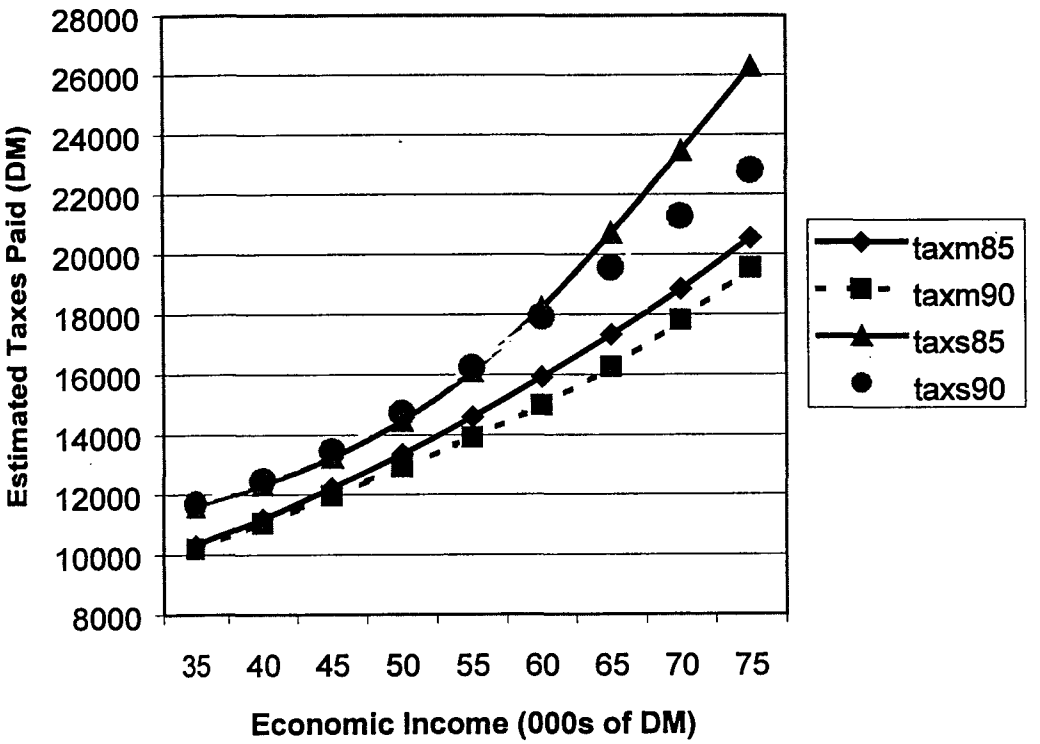


Notes:
ptaxm85 = taxes paid in 1985 for married male, two children
ptaxm90 = taxes paid in 1990 for married male, two children
ptaxs85 = taxes paid in 1985 for single male, no children
ptaxs90 = taxes paid in 1990 for single male, no children

Source: Author's calculations using GSOEP.

Figure 2

Tax Functions Based on Non-Parametric Estimation



Notes:
taxm85 = taxes in 1985 for married male, two children
taxm90 = taxes in 1990 for married male, two children
taxs85 = taxes in 1985 for single male, no children
taxs90 = taxes in 1990 for single male, no children

Source: Author's calculation's using GSOEP.

different specifications and the reader should look there for the full set of results. The major findings of these estimations are illustrated in Figures 1 and 2, which show the estimated effective tax functions for 1985 and 1990 for two types of agents: a married male with two children and a single male without children. The estimated tax functions in Figure 1 are based on parametric estimation techniques in which the effective tax function is approximated by a low dimensional polynomial. Figure 2 shows results from nonparametric Kernel estimators. The two techniques provide very similar estimates of the tax functions. The major difference is that the nonparametric technique yields a slightly more progressive tax structure for married families with children. One of the surprising results of this exercise is that the estimated effective tax functions have properties that differ significantly from the formal tax functions discussed in Section 2. Consequently, empirical work of taxes and labor supply should not ignore the wide range of possibilities offered by the German tax code to lower tax payments through exemptions and deductions.

There are four empirical findings that deserve special attention. First, the effective tax functions are almost linear and not very progressive. This finding is in sharp contrast to the formal tax function and suggests that the function that transforms economic income into taxable income is concave. Second, there are significant monetary benefits associated with marriage and having children. The benefits increase with income, so that individuals and households with high income benefit more from the tax code than those with low income do. Third, effective marginal tax rates are between 17 percent and 35 percent over the income range

of DM 25,000 to DM 75,000, which covers more than 80 percent of the sample. Finally, the effective marginal tax rates were only moderately lower in 1990 compared to 1985.

5. Conclusions

This article discusses how to estimate tax functions and their derivatives based on data available in the GSOEP. This approach is a useful alternative to more commonly used approaches that impute (unobserved) taxable income based on household characteristics and provisions of the tax code. The empirical results of this paper provide an explanation why there are no significant responses in labor supply in the data even though tax reforms were supposed to provide a better incentive structure. German tax reforms had a modest impact on effective tax rates. Furthermore, Sieg (1998) finds that labor supply elasticities are small, especially for married males who work more than 20 hours per week on average. These two findings together suggest that male labor supply is not likely to be affected by changes of the tax code.

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