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Nonparametric structural estimation of labor supply in the presence of censoring

Che-Yuan Liang *

Uppsala Center for Fiscal Studies, Department of Economics, Uppsala University, P.O. Box 513, SE-75120, Uppsala, Sweden
Research Institute of Industrial Economics, P.O. Box 55665, SE-10215, Stockholm, Sweden

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ABSTRACT

This paper extends the nonparametric structural method to estimate labor supply developed by Blomquist and Newey (2002) to handle cases in which there are individuals who do not work. The method is then applied to married women in Sweden from 1973 to 1999. I find an uncompensated wage elasticity of 0.98 and an income elasticity of -0.10, with the participation margin accounting for one third of the wage elasticity and two thirds of the income elasticity. The elasticities vary, however, a lot over time due to differences in tax systems and demographics. I also find results consistent with tax rates being around the net government revenue maximizing rates.

1. Introduction

The responsiveness of labor supply to taxation is of great interest to policymakers, as it is crucial for the welfare evaluation of tax systems. There are many difficulties involved in estimating labor supply, and there exists a large literature that uses different approaches with varying results. Today, there is a general belief that male labor supply is not very responsive, but there is no consensus regarding female labor supply. Blundell and MaCurdy's (1999) survey of the literature finds uncompensated wage elasticities ranging from 0 to 2 and income elasticities ranging from −1 to 0.5 for women. The bounds are so widespread that they are useless for policy evaluation. This lack of convergence and understanding of the reasons for the dispersion illustrates the need for additional methodological developments in this area of research.

Blomquist and Newey (2002) developed a nonparametric structural method that is attractive in many ways relative to other methods in the literature. However, their method does not account for censoring and is hence not suitable for estimation of groups with considerable numbers of individuals who choose the corner solution of zero hours of work. This paper contributes by extending their method to handle censoring. The proposed extension fully accounts for the fact that wage rates of individuals that do not work are not observed. In addition to estimation of expected hours of work, I also develop methods to estimate the participation probability and expected tax revenues from labor income using the same approach. This makes it possible to sort out responses on the extensive participation and intensive hour conditional on work margins and to evaluate the cost of tax reforms. The methods are then applied to married women in Sweden from 1973 to 1999.

Compared to other countries, Sweden's tax burden is and has generally been very high. Its total tax revenues as share of gross national product have been consistently among the top two (with Denmark) among the OECD countries during the sample period (OECD, 2008). A testable hypothesis that is relevant to countries with a high tax burden and to groups with high responsiveness of labor supply is whether tax rates are above the net government revenue maximizing rates. This would be a nearly indisputable sign of suboptimal tax rates as rate reductions would lead to government revenue gains. Most studies from the 1980s produced labor supply elasticities that would reject this hypothesis for prime-aged working men (see, e.g., MaCurdy, 1992). More recent studies that focus on taxable income find more support, especially for men with high incomes (see, e.g., Goolsbee, 1999; Mofitt and Wilhelm, 2000). For female labor supply, there is much less consensus. The empirical application in this paper provides an assessment on this issue for a large and economically important group, which is considered to be more sensitive to taxation than married men and faces very high tax rates.

* Uppsala Center for Fiscal Studies, Department of Economics, Uppsala University, P.O. Box 513, SE-75120, Uppsala, Sweden. Tel.: +46 18 4711633; fax: +46 18 4711478.
E-mail address: che-yuan.liang@nek.uu.se.

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There have been several sweeping reforms to the Swedish tax system during the period of study. The overall tax level increased in the 1970s to a historical peak in 1980, decreased during the 1980s until 1991 with the "tax reform of the century", and finally increased a little since then. The tax system did not change much in the 2000s until the earned income tax credit reform in 2007. During this period, the labor supply of married women also rose from an average level of 55% to 87% of regular full-time hours (a 58% increase), which nearly bridges the entire gap between them and their almost exclusively full-time working husbands. The empirical application in this paper also provides an assessment of the role of tax policy in raising female labor supply and creating gender equality at work. This is of great policy interest, as the labor markets in many OECD countries today are similar to that of 1973 Sweden (OECD, 2009).

Blomquist and Newey (2002) start from a labor supply model that is similar to the one used by Burtless and Hausman (1978), where the labor supply decision depends on the whole budget set. Since budget sets are typically nonlinear due to progressive tax and transfer systems, a large number of variables are needed to fully characterize them. Rather than linearizing the budget set as in most reduced-form approaches, Burtless and Hausman (1978) account for the whole budget in the estimation by making several distributional assumptions. Blomquist and Newey (2002) instead derive an expected hours of work expression by integration over each tax bracket without such distributional assumptions. This expression contains two low-dimensional functions that account for all tax brackets by entering them in a systematically organized way. They then estimate this expression nonparametrically.

Censoring adds three complications to their derivation. First, additional variables describing the points of censoring are needed to fully describe the budget sets. However, when a censoring point is constant across individuals, in this case at zero hours of work, the additional variable is a constant. This does not change the dimensionality of the budget sets. Second, censoring modifies the budget sets. When it occurs at an end point of the budget set, it can be modeled by adding a correction term for that end tax brackets. However, this does not affect the integration over all tax brackets. The correction term depends on variables characterizing the adjacent tax bracket, which, however, already enter the integration of all tax brackets. It turns out that this term is nonparametrically collinear with the other terms.

Third, the gross wage rate is needed to construct the budget sets, and these are not available for nonworking individuals. I proceed by imputing gross wage rates which are used to impute some budget set variables. It turns out that the true budget set can be described by the imputed budget set, the imputed gross wage rate, and the imputed gross wage rate error. This increases the dimensionality of the budget sets by one and adds another error term that needs to be integrated over. The resulting expected hour expression has the same structure as Blomquist and Newey (2002) expression, but adds one dimension to each term.

This paper is closely related to that by Kumar (forthcoming), who also attempts to account for censoring for expected hours of work. I arrive at a rather different labor supply function, although the structure of the empirical specifications that we use are both similar (but not identical in my case) to the original specification by Blomquist and Newey (2002). My derivation of the labor supply equation is an improvement over his in two respects: it accounts for censoring in observed hours of work[1] and imputed gross wage rate errors. To sort out responses on the participation and hour margins, I derive and estimate a structural participation function within the original framework, whereas he applies a nonparametric sample correction method. I also derive and estimate an expression for tax revenues from labor income.

[1] Both of us account for censoring in desired hours of work. Observed hours of work additionally contain optimization and measurement errors.

This paper then uses the proposed extension to estimate the labor supply of married or cohabiting women (henceforth referred to as married women) in Sweden from 1973 to 1999 with data from 4 years. My empirical specification is an improvement over Blomquist and Newey's (2002) in that I add demographic control variables. Since budget sets typically do not vary much between individuals, the identification mainly relies on tax reforms. The controls are included nonparametrically and structurally unlike in the work of Kumar (forthcoming) on American data. This flexibility allows the responsiveness not only to be a function of the tax system but also of demographics. In contrast to the constant elasticity assumption often made in the literature, there is some evidence that labor supply elasticities vary with tax systems and demographics (e.g., Goolsbee, 1999; Heim, 2007).

Labor supply estimates are usually summarized in terms of elasticities for linear budget sets. A problem is that the budget sets are nonlinear. There are therefore many net wage rates, and it is usually not possible to vary one rate in isolation. Extrapolation is also needed to infer behavior on linear budget sets. I use a wage elasticity concept that rotates the whole actual budget sets and an income elasticity concept that shifts the whole actual budget sets. I allow and account for heterogeneous responses by summing responses over individuals. This is similar to the kind of elasticity suggested by Blomquist et al. (2011) in the taxable income context.

I find a statistically significant uncompensated wage elasticity of 0.98 and a statistically significant income elasticity of -0.10. However, the elasticities are very tax system and demographics dependent; the wage elasticity varies between as much as 0.24 (in 1999) and 1.55 (in 1980) and the income elasticity between −0.01 (in 1999) and −0.26 (in 1973). The responsiveness is largest when tax rates and progressivity are high, and it has decreased since 1980. Furthermore, I find that the participation margin accounts for a third of the wage elasticity and two thirds of the income elasticity indicating that both the extensive and intensive margins are important. I also find that the elasticities of tax revenues are statistically insignificant which is consistent with tax rates being around the revenue maximizing rates.

Besides the large behavioral effects of taxation, simulations also reveal that the development of the tax system can explain a lot of the rise in female labor supply during the sample period. However, changes in gross wage rates and demographics also contributed importantly to the rise.

The paper proceeds as follows. The next section discusses the methodological challenges in estimating labor supply and different approaches in the literature. Section 3 derives the labor supply functions. Section 4 describes how the functions are estimated. Section 5 describes the data. Section 6 reports the estimates and contains a heterogeneity analysis of the responsiveness within the sample period. The last section concludes and compares the results with those found by previous related studies.

2. Methodological background

Like the main strand in the literature, I depart from a static secondary-earner framework; i.e., I do not account for dynamic savings concerns and I account for the income of the other spouse as if it were unearned income. There are, even within this framework, several major difficulties in estimating the effects of taxation on the labor supply. One is that there are selection problems in gross wage rates and unearned incomes as they typically covary with observable or unobservable variables that may have their own effects on the labor supply. Another difficulty arises because the nonlinear tax and transfer system, with its many tax brackets, creates nonlinear budget sets that have many segments. Individuals can therefore affect the marginal tax rate that they face by selecting which segment to place themselves in. Hours of work and the net tax rate are therefore simultaneously determined. The nonlinearities also create kinks in the budget set on which there is no net wage. An additional