Estimating Income Responses to Tax Changes: A Dynamic Panel Data Approach

Bertil Holmlund[*] and Martin Söderström[§]

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Abstract
Recent research on the behavioral effects of taxes has to a large extent focused on the elasticity of taxable income with respect to the net-of-tax rate, i.e., one minus the marginal tax rate. We offer new evidence on this matter by making use of a large panel of Swedish tax payers over the period 1991-2002. Changes in statutory tax rates as well as discretionary changes in tax bracket thresholds provide exogenous variation in tax rates that can be used to identify income responses. We estimate dynamic income models which allow us to distinguish between short-run and long-run effects in a straightforward fashion. For men, the estimates of the long run elasticity of earned income with respect to the net-of-tax rate hover in a range between 0.25 and 0.30. Lower estimates are obtained when other definitions of income are used. For women, the estimates are typically not significantly different from zero.

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[*] Bertil Holmlund, Department of Economics, Uppsala University, Box 513, SE-751 20 Uppsala, Sweden.
E-mail: Bertil.Holmlund@nek.uu.se
[§] National Institute of Economic Research, Box 3116, SE-103 62 Stockholm, Sweden.
E-mail: Martin.Soderstrom@konj.se

1. Introduction

Research on the behavioral effects of labor taxation has largely been focusing on the impact on hours of work and labor force participation. More recently, a literature has emerged that focuses on the impact on taxable income and other measures of income. One reason for this new direction is that taxes may affect individual behavior along a number of margins in addition to the effect on hours or participation, such as work effort and job mobility. By examining the impact on income, one could arguably capture a wider set of responses than those studied in traditional labor supply studies. The new literature is mainly based on US data and has so far not converged to a consensus view regarding the quantitative magnitudes of the behavioral responses. Studies of income responses to changes in tax rates have rarely focused on European experiences.

The present paper makes several contributions to the empirical literature on income responses to marginal tax changes. First, we highlight the distinction between short run and long run responses by estimating dynamic models. Previous research has in general been vague as to whether the estimated elasticities of interest have pertained to the short run or the long run. In fact, the modeling approaches commonly used have not been adequate for distinguishing between short run and long run responses. We estimate dynamic panel data models within which both short run and long run effects can be identified. Second, we examine behavioral differences between men and women, an issue where the previous literature has been largely silent. Third, our study provides the first empirical analysis of the impact of Swedish tax changes subsequent to the major reforms in 1990-1991. These changes have been targeted at high income earners and involved tax hikes as well as tax cuts.

We make use of a large panel data set that comprises information for 12 years, namely 1991-2002. We identify the effects of income tax changes on income by exploiting two main sources of exogenous variations in the tax rules. First, changes in the statutory tax rates have occurred in 1995 as well as in 1999. Second, the “kinks” of the progressive tax schedule have been subject to discretionary changes which induce exogenous changes in marginal tax rates for a given level of income.

The broad features of the Swedish tax system have remained largely intact since the early 1990s, when the “tax reform of the century” was introduced. This major reform involved substantial simplifications and base broadening of the tax system. One key element was the

introduction of a two-tiered marginal tax schedule for earned income. The idea was that most income earners should only pay the proportional municipality tax (hovering around 30 percent). For incomes above a certain threshold, a state tax kicked in at the marginal rate of 20 percent. The state tax was raised to 25 percent in 1995. From 1999 and onwards, the state tax has comprised two levels, viz. 20 and 25 percent.

A noteworthy element of the Swedish tax system is its treatment of the individual, rather than the family, as the basic tax unit. The tax schedule for earned income pertains to individual income and is independent of spousal income. Another notable element is the so-called dual income tax system, i.e., the fact that earned income and capital income are subject to different tax treatments: earned income is subject to progressive taxes whereas income from capital is taxed at the flat rate of 30 percent.

The conventional approach to the estimation of income responses to tax changes has involved regressing changes in log income on changes in the log of the net-of-tax rate, where the net-of-tax rate is defined as one minus the marginal tax rate. This regression framework in first differences is typically, implicitly or explicitly, derived from a relationship between the *levels* of income and the marginal tax rate. However, the "difference specification" in the regression models implicitly assumes immediate adjustment to changes in tax policy. If the adjustment is lagged rather than immediate, the model is misspecified. Our approach also posits a relationship between the levels of income and tax rate but allows for lagged adjustment. This leads to an "error correction" specification which encompasses the conventional regression model as a special case and yields estimates of short run as well as long run responses.

Our estimates of the income responsiveness to the net-of-tax rate vary depending on which measure of income that is used. For men, the most robust results are obtained for earned income (wages plus entrepreneurial income), where we estimate long run elasticities in a range between 0.25 and 0.30. The estimates are lower for other measures of income, such as taxable income. For women, the estimates are typically not significantly different from zero.

The paper proceeds by providing a brief overview of previous research. Section 3 describes the Swedish tax system and the data are described in section 4. The empirical analysis is presented in section 5 and section 6 concludes.

2. Previous Research

2.1 Theoretical Issues

Recent research on income responses to tax changes has several forerunners. One strand consists of the large literature on labor supply where the focus is on how taxes affect hours of work and labor force participation. This literature builds on the canonical model of labor supply, where wage rates are taken as given and individual choices are dictated by preferences and budget restrictions (see Blundell and MaCurdy, 1999, for a survey of this research). A smaller and more recent literature has examined how wage rates respond to changes in the tax system in imperfectly competitive labor markets. In this literature, hours of work are determined by the worker (as in the canonical model) or through some bargaining mechanism, whereas wages may be set by firms (as in efficiency wage models) or through individual or collective bargaining (as in search models or trade union models).

The recent focus on how taxes affect income is motivated by the view that taxes may have a multitude of effects on individual behavior in addition to the traditional labor supply responses. This view emphasizes that traditional estimates of the labor supply responsiveness to tax rates may substantially underestimate the overall effect, the reason being that individual adjustment along other margins are ignored. Taxes may affect work effort, what type of jobs that are accepted, and incentives for geographical and occupational mobility. This line of argument has been articulated by Martin Feldstein in a series of papers; see Feldstein (1995a, 1995b, 1999). A normative conclusion that follows from this perspective is that tax distortions are more serious, the higher the elasticity of taxable income is with respect to changes in tax rates. Indeed, Feldstein (1999) shows that the elasticity can be used to compute the deadweight loss from income taxes.

The literature on how wages are affected by the tax system in imperfect labor markets has paid particular attention to the role of higher tax progressivity, i.e., the impact of a rise in the marginal tax rate relative to the average tax rate. A common result, in a variety of models, is that higher tax progressivity leads to wage moderation, which in turn will bring about a fall in equilibrium unemployment. The intuition for such a result is perhaps most easily seen in a bargaining model, where a higher marginal tax rate raises the cost of wage increases and leads the parties in the bargain to opt for lower wages. Although the result is reasonably robust

across a variety of models and specific assumptions, it is not completely robust.[1] So in the end and as usual, empirical work is needed to establish how taxes affect wages, hours and labor income. By and large, the empirical literature tends to confirm that increased tax progressivity is conducive to wage moderation, but there are also some conflicting results.[2]

The normative implications of estimated elasticities of income with respect to tax rates will generally depend on what one assumes about labor market imperfections. High elasticities reflect potentially large tax distortions from the perspective of the traditional model. In a bargaining model, by contrast, a rise in the marginal tax rate that leads to wage moderation and to a decline in overall income may conceivably be welfare improving via the associated increase in overall employment. Indeed, there is typically an optimal degree of tax progressivity in models of imperfect labor markets; see Holmlund and Kolm (1995) and Sorensen (1999) for elaborations of this idea.

The recent literature on income responses to tax rates has, implicitly or explicitly, been framed within the context of the canonical model, where income responses are viewed as the outcome of individual choice rather than individual or collective bargaining. We make no attempt in this paper to identify the precise income-generating effects at work. In all likelihood, actual incomes are influenced partly by individual choice and partly by bargaining mechanisms.

2.2 Empirical Research on Income Responses to Tax Changes

The empirical literature on the responses of taxable income to changes in tax rates was pioneered by Lindsay (1987) and Feldstein (1995a, 1995b). The key parameter of interest in their studies as well as in the subsequent literature was the elasticity of taxable income with respect to the net-of-tax rate, i.e., one minus the marginal tax rate. This elasticity – ETI for short – was found to be remarkably high in these early studies which exploited data from US tax reforms in the 1980s. Lindsay reported ETIs in a range between 1.6 and 1.8, whereas Feldstein's estimates ranged from 1.0 to 3 depending on the income definition used.

[1] Contributions to the theoretical literature on taxes in imperfectly competitive labor markets include Hoel (1990), Koskela and Vilmunen (1996), Lockwood and Manning (1993), Pissarides (1998), Hansen (1999), Sorensen (1999), Fuest and Huber (2000) and Sandemann Rasmussen (2002). Bovenberg (2003) provides a comprehensive treatment.

[2] Contributions to the empirical literature include Lockwood and Manning (1993), Holmlund and Kolm (1995), Wulfsberg (1997) and Slok et al (2000).

The subsequent literature has addressed a number of pitfalls that plagued the seminal papers and also highlighted the sensitivity of the estimates to alternative specifications and data. A crucial issue has been to separate the impact of tax policy from other factors that may have affected the evolution of incomes. In the US, cuts in marginal tax rates among high income earners occurred concomitantly with rising income inequality, a development that easily can produce large ETI-estimates even absent much impact from tax policy. The contributors following Lindsay's and Feldstein's papers have typically arrived at much smaller ETIs than their predecessors. There is, however, substantial variation in the reported estimates.

The post-Feldstein contributions to the US literature include papers by Auten and Carroll (1999), Samartino and Weiner (1997), Gruber and Saez (2002), Kopczuk (2005), Saez (2003), Moffitt and Wilhelm (2000) and Giertz (2006). Giertz (2004) provides a recent survey of this literature. These studies typically adopt instrumental variables estimation of "difference specifications", i.e., they regress changes in income on changes in the net-of-tax share while treating the tax variable as endogenous. A very brief summary of the results reads as follows: (i) ETI is typically positive, although not always so; (ii) ETI is typically smaller than unity, although not always so; (iii) the "preferred estimates" are typically located in a range between 0.2 and 0.5.

Three Swedish studies have examined the effects of the Swedish tax reform 1990-91 (Selén, 2002; Hansson, 2004; and Ljunge and Ragan, 2005). These studies adhere to the conventional difference specification and report estimates of ETI in a range between 0.2 and 0.4. A study on Norwegian data by Aarbu and Thoresen (2001) present ETI estimates close to zero, hovering between -0.6 and 0.2.

Despite a good deal of research, there is thus considerable dispersion of the estimates. The reasons for the differences are not well understood. The definition of income seems to matter, but it is not clear exactly how and why. The results are sensitive to sample selection rules, but exactly how remains unclear. And the strategies employed to control for exogenous income trends seem to affect the results.

3. The Swedish Tax System

A major tax reform took place in Sweden during 1990 and 1991 (see Agell et al, 1996, for details). The reform involved broadening of the tax bases and cuts of the statutory marginal

income tax rates. An important ingredient was the introduction of a dual income tax, where earned income and income from capital were taxed according to different schedules. The new proportional capital income tax, levied on dividends, interest income and capital gains, was set at 30 percent and has remained at this level. The tax on earned income consisted of two parts, one "local" and one national. The local income tax – determined by the local and regional governments – was proportional to income (above a basic deduction) but varied across localities. In 1991, the national average of the local income tax rates stood at 31 percent. On top of the local income tax, a national (state) tax kicked in at a rate of 20 percent for earned taxable incomes above 170,000 SEK, which corresponded to the 75th percentile of the distribution of taxable incomes.[3] By 1991, the income tax schedule pertaining to earned income thus involved two brackets with (average) marginal rates of 31 and 51 percent.

Although the main features of the new tax system have remained intact over the following years, several changes have taken place. One important change took place in 1995 when the national tax rate was raised to 25 percent. This system was modified 1999 when two brackets – 20 and 25 percent – for the national tax was introduced. This basic structure remains in place as of 2007. By 1999, the top rate kicked in at the 95th percentile of the distribution of taxable incomes.[4] Table A1 in the appendix describes in detail the evolution of tax bracket thresholds over the period 1991-2002.

We use mainly two sources of exogenous variation in tax policies that should enable identification of behavioral responses. A first source is the changes in the statutory national tax rate: the increase from 20 to 25 percent in 1995 and the introduction in 1999 of a two-bracket system. The 1999 reform implied that some individuals actually experienced cuts in the marginal tax rate since the threshold for the 25 percent rate was increased. A second source is the discretionary changes in the income thresholds which determine when the national tax kicks in; tax payers close to the threshold may be exposed to changes in the marginal tax rate through these bracket adjustments.

One might also wish to consider a few other ingredients of the tax system, such as changes in the proportional local tax rates. However, the local tax rates have changed very little over the

[3] Based on data for individuals aged 20-59 and positive taxable income.
[4] Based on data for individuals aged 20-59 and positive taxable income.

studied period; the averages have hovered between 30 and 31 percent. Actual individual local tax rates are affected by mobility decisions and should be treated as endogenous.

Taxable income is obtained after various deductions from gross income. First, there are work-related deductions that may be requested by the tax payers and will be scrutinized by the tax authorities. Expenses caused by travel to work are the typical examples; such expenses are deductible if they exceed a certain amount. To arrive at taxable income, two further deductions are undertaken without any involvement by the tax payer. There is a "basic deduction" (grundavdrag) and there are social security fees that have been partly or wholly deductible. The basic deduction varies with the level of assessed income up to a ceiling and takes a hump-shaped pattern, whereby the effective marginal tax rate is reduced at low incomes and increased over a range of incomes higher up in the distribution. Employee social security fees did not exist in the beginning of the studied period, but became increasingly important during the 1990s and had reached 7 percent of assessed income by the end of the decade.[5] These fees are proportional up to a ceiling beyond which the marginal rate is zero. They involve some actuarial elements, however, and should not be treated as entirely analogous to ordinary taxes.

4. The Data

The data come from a longitudinal data base, LINDA, which is a 3.35 percent random sample of the Swedish population. LINDA is based on a combination of several registers, for example income tax registers and population censuses.[6] From this data base, all individuals aged 20 to 59 are extracted for 12 consecutive years, viz. from 1991 to 2002. We focus on the years following the major tax reform of 1990-91, thus avoiding the complications associated with the changes in capital income taxation. This procedure gives us around 160,000 individuals per year, and in total around 1.9 million observations. An individual is on average observed 9.4 times, 113,904 individuals are observed all 12 years, and there are 204,276 unique individuals. When allowing for lags, our typical period of estimation is 1993-2002.

In addition to rich information on incomes, the data include information on human capital attributes as well as some demographic characteristics (age, gender, education, marital status

[5] Assessed income is gross income minus work-related deductions. More information on income definitions are given below.
[6] For a description of LINDA, see Edin and Fredriksson (2000).

and the number of children). We have added information on local labor market conditions, measured as the ratio between the number of vacancies and the number of unemployed and referred to as labor market tightness.[7] Labor market conditions matter for bargaining outcomes and influence the risk of being quantity-constrained in labor supply decisions.

The fraction of tax payers affected by the national tax has hovered between 19 and 26 percent over the period 1991-2002. The top national rate of 25 percent has affected around 5 percent of the tax payers since its introduction in 1999. Although there have been no drastic changes in the statutory income tax rates, the changes that have occurred as well as "bracket switching" entail a non-trivial number of tax changes that can be taken as exogenous to individual behavior. To illustrate, consider a measure of the change in the individual marginal tax rate, $\Delta\hat{\tau}_{it}$, of the form

$$\Delta\hat{\tau}_{it} = \tau\left[Y_{it-1}(1+g); z_t\right] - \tau\left(Y_{it-1}; z_{t-1}\right) \tag{1}$$

where subscript *i* refers to individual *i*, Y_{it-1} refers to taxable income as of year *t*-1, *g* is the general growth in incomes and z_t captures the tax code. The first term on the right-hand side is the predicted marginal tax rate pertaining to year *t* and the second term is the actual marginal tax rate in year *t*-1. Eq. (1) gives a measure of the change in the marginal tax rate that is independent of fluctuations in the individual income level. Over the period 1992-2002, there are around 90,000 observations where $\left|\Delta\hat{\tau}_{it}\right| \geq 0.05$ holds, i.e., where the marginal tax rate increases or decreases by at least 5 percentage points. All these changes take place in the upper half of the income distribution and two thirds of them occur in 1995 and 1999, i.e., the years when changes in the statutory tax rates kick in.[8] Over 70 percent of the changes pertain to men.

An analogous measure for changes in average tax rates reveals very little action in the data: tax policies have had almost negligible effects on average tax rates over the studied period.

[7] We are grateful to Kerstin Johansson for giving us access to these data. The local labor market is based on the commuting patterns of individuals in 284 municipalities of Sweden, resulting in 100 local labor markets. The tightness measure is defined as the number of vacant jobs divided by the number of job seekers registered at the public employment offices. The number of job seekers is the sum of the stock of openly unemployed, and the stock of participants in active labor market programs.

[8] The local tax rate is set at the national average in these calculations; the measure is thus not affected by changes in tax rates that are due to residential mobility.

There are only some 20 observations where the (predicted) average tax rate increases or decreases by more than 5 percentage points, and around 1500 observations where the changes exceed 3 percentage points. Although some people are exposed to substantial changes in actual average tax rates, these changes are to an overwhelming degree driven by income shocks rather than by changes in tax policy. These observations suggest that it will be difficult to achieve credible identification of income responses to changes in average tax rates.

There are a number of income variables in the data. We focus on earned income, with or without associated transfer payments, and exclude income from capital and capital gains. Earned income includes labor income and entrepreneurial income. [9] Most social transfers are taxed as labor income; this includes for example unemployment benefits and sickness benefits. Welfare payments (socialbidrag) are not taxed and child benefits are also tax free.

We consider four income concepts: (i) *earned income* (*YE*), which includes labor income and entrepreneurial income but excludes social transfers; *broad income* (*YB*), which includes taxable transfers in addition to earned income; *assessed income* (*YA*), which equals broad income minus work-related deductions; and *taxable income* (*YT*), which is assessed income minus deductions that are determined by the tax authorities.[10] The definition of taxable income has changed over the studied period as the rules pertaining to deductibles have changed. It is mainly the increasing importance of deductible social security fees that has been driving the change. We focus on a "constant law" definition of taxable income, which motivates a slight adjustment of the official definition. The definition we adopt is $YT \equiv YA - D(YA)$, where $D(.)$ is the basic deduction. This definition applies as the official definition of taxable income in the beginning of the 1990s. $D(.)$ is essentially stable over the studied period except for inflation adjustment. We thus ignore the deductible social insurance fees so as to obtain a definition that is consistent over time.[11]

Table 1 shows some descriptive statistics concerning incomes. Earned income exhibits much more variation than the other income variables, a fact that reflects that transfers are excluded in earned income but included in the other income measures. Transfers produce a sizeable

[9] Entrepreneurial income captures self-employment income associated with unincorporated businesses. Owners of incorporated businesses receive their compensation in the form of wages and salaries.
[10] In LINDA, these four measures correspond to (i) primärinkomst (CPRIM), (ii) sammanräknad förvärvsinkomst (CSFVI), (iii) taxerad förvärvsinkomst and (iv) beskattningsbar förvärvsinkomst.
[11] The focus on constant-law taxable income is standard in the literature. We have also found that the results are more robust if we use the constant-law definition as opposed to the official measure.

difference between broad income and earned income; the average difference between the two measures amounts to almost 10 percent (not shown in the table). The correlation matrix reveal a high degree of correlation between changes in broad income and assessed income but more modest correlations between earned income and the other income variables.

Table 1 about here

The fraction of people with positive earned income has hovered between 85 and 87 percent over the period 1993-2002. The fraction fell sharply (from 91 to 86 percent) over the period 1991-1993, when a deep recession hit the Swedish economy. The fraction with positive broad income has been around 95 percent over the period 1993-2002. The fraction of entrepreneurial income in earned income is 6 percent on average. Women accounts for 49 percent of the sample. See Table A2 in the appendix for more information on the sample.

The income distribution has widened over the period. Table 2 shows the evolution of incomes by various percentiles. For earned income, the growth in nominal income has been 25 percent for the 10th percentile and 60 percent for the 99th percentile. Adjusted for inflation, these numbers correspond to roughly 5 and 40 percent real income growth. Aside from these divergent trends at the bottom and the top, there are modest increases in income inequality in the major part of the distribution. These broad patterns hold for all measures of income.

Table 2 about here

Previous research, largely based on US data, has often tried to identify income responses to cuts in marginal tax rates by using data showing sharply widening income differentials. A difficulty that arises in this setting is to separate the effects of tax cuts from other determinants of increasing income dispersion. If the tax cuts are concentrated at the top, there is an obvious risk that the income responses will be overstated. The risk of overestimating the income responses should be smaller in the Swedish setting. The main statutory tax change has involved a tax hike rather than a tax cut for top incomes, something that would tend to underestimate rather than overestimate the income responses (absent suitable controls for rising income differentials). We will, however, also control for trend changes in the income distribution.

5. Empirical Analysis

5.1 Empirical Strategy

The previous empirical literature in this area has typically employed panel data and regressed the change in log income on the change in the log of the net-of-tax rate. A few other covariates are usually also included. Our specification is a generalization of this benchmark formulation where the benchmark obtains as a special case. The basic model is specified as a dynamic income equation of the form

(2) $$y_{it} = \alpha + \gamma \Delta n_{it} + \lambda n_{it-1} + \rho y_{it-1} + X_{it}\beta + \eta_i + \varepsilon_{it}$$

where y_{it} is log income pertaining to individual *i* in year *t*, and $n_{it} \equiv \ln(1-\tau_{it})$ is log of the net-of-tax rate where τ_{it} is the marginal tax rate. X_{it} is a vector of other regressors, η_i is an individual-specific fixed effect and ε_{it} is a mean zero random error term. The short run effect of interest is captured by γ and the presumption is that $\rho \in (0,1)$ holds. The long run effect is thus given by $\lambda/(1-\rho)$. Although there is often a conjecture that the response in stronger in the long run than in the short run, the specification is not restrictive in that respect. The response may be stronger in the short run than in the long run for a variety of reasons. For example, if a tax hike increases tax avoidance, this may well be a "one-time effect" rather than a gradual adjustment. Adjustments along other margins may entail more gradualness.

The individual-specific fixed effects can be removed by first differencing:

(3) $$\Delta y_{it} = \gamma \Delta^2 n_{it} + \lambda \Delta n_{it-1} + \rho \Delta y_{it-1} + \Delta X_{it}\beta + \Delta \varepsilon_{it}$$

The remainder error term and the differenced lagged dependent variable is correlated (since the former contains ε_{it-1} and the latter y_{it-1}). Anderson and Hsiao (1981) suggested the use of either y_{it-2} or $\Delta y_{it-2} = y_{it-2} - y_{it-3}$ as instrument for Δy_{it-1}; the instrument is valid as long as ε_{it} is not serially correlated. The use of y_{it-2} as instrument is known as the "level" form of the Anderson and Hsiao estimator, whereas the use of Δy_{it-2} is referred to as the "difference" estimator. An advantage of the level estimator is that we can exploit data available from year

t=3 and onwards (since y_{it-2} is available from t=3), whereas the difference estimator is not available until t=4 (since Δy_{it-2} is first available at year t=4).

An endogeniety problem specific to the problem at hand concerns the net-of-tax rate. This variable is clearly endogenous when the tax system is progressive. In general, we can write the net-of-tax rate as a function $n_{it} = n(y_{it}; z_t)$, where z_t captures the tax code.[12] Analogously, $n_{it-1} = n(y_{it-1}; z_{t-1})$. It is obvious that n_{it} is endogenous because it depends on income in the current period. However, it is clear that n_{it-1} is also correlated with the error term in (3) since it contains lagged income. To deal with these issues we construct two instruments, in addition to y_{it-2}. These instruments are as follows:

(4a) $$n_{it}^{p} = n(y_{it-2}^{P,t}; z_t)$$

(4b) $$n_{it-1}^{p} = n(y_{it-2}^{P,t-1}; z_{t-1})$$

where $y_{it-2}^{P,t}$ and $y_{it-2}^{P,t-1}$ are predicted taxable incomes pertaining to period t and t-1, respectively. These predictions are based on observed taxable incomes in year t-2.[13] We inflate y_{it-2} by the growth of median income between year t-2 and t (as well as between t-2 and t-1).[14] The model is thus exactly identified.

We have computed two measures of marginal tax rates. The *statutory* rates are the tax rates that apply to taxable income and consist of the local tax rate plus the national tax. The second measure is a broader concept and can be referred to as the *effective* marginal tax rate; this measure recognizes income-dependent basic deductions and social security fees. A well-informed agent, behaving according to the canonical labor supply model, would care about effective tax rates rather than the statutory ones. But the rules concerning deductions and fees

[12] In the regressions, y_{it} stands for log income. With some abuse of notation, we also let y_{it} represent the level of income when discussing instruments.
[13] We use actual rather than constant law taxable income in these computations. By doing so, we incorporate more "up to date" information about the prevailing tax code.
[14] The national averages of the 284 local tax rates are applied when constructing the instruments since the actual local tax rate is endogenous to mobility decisions. The actual local tax rate in LINDA contains some inconsistencies. Tax changes associated with mobility across municipalities do not always match with the timing of mobility. This means that some fairly large tax changes can be recorded even for individuals who have not moved. As measure of the actual local tax rate we have used LINDA to compute the median tax rate prevailing in each municipality in each year.

are complex and it is not clear that they are well understood by the tax payers. The statutory rules, however, are fairly simple since they involve only two or three brackets. It may well be the case that the statutory rules come closer than the effective rates to what agents perceive as relevant for their decisions. Ultimately, this is an empirical issue. We have found that the two measures yield very similar results, presumably reflecting the fact that the major changes in the tax system are those arising from changes in statutory rates and bracket adjustments. By Occam's razor we opt for the simpler alternative and focus on results based on statutory tax rates.

Some remarks are in order regarding how our approach is related to the specifications used in previous work. Note that the conventional specification obtains as a special case of (3) by setting $\lambda - \gamma = \rho = 0$, i.e.,

(5) $$\Delta y_{it} = \gamma \Delta n_{it} + \Delta X_{it}\beta + v_{it}$$

This is the benchmark specification in Auten and Caroll (1999) and Gruber and Saez (2002) as well as several other studies. Gruber and Saez and others argue that it is important to control for first-period income and thus include the lagged income level as an additional regressor, i.e.,

(6) $$\Delta y_{it} = \gamma \Delta n_{it} + \kappa y_{it-1} + \Delta X_{it}\beta + v_{it}$$

The lagged income variable may appear in a linear fashion as in (6) and in Auten and Carroll (1999), or as a flexible spline function as in Gruber and Saez (2002). The endogeniety of Δn_{it} is recognized and the typical procedure is to instrument by means of lagged income and the current tax system, i.e., an instrument of the form $n_{it}^{p} = n(y_{it-1}^{P,t}; z_t)$ is used.

We see at least two potential problems with this conventional approach. First, it fails to make a clear distinction between short run and long run effects. A common view seems to be that the parameter on Δn_{it} should capture long run effects, at least if the time differencing encompasses several years (three years, say). This interpretation is problematic when the lagged income level is included among the regressors and the tax variable appears only as a

differenced term.[15] A second issue concerns the econometric methodology. The inclusion of lagged income among the right-hand side variables is typically motivated by mean reversion arguments. It has been argued that there is a need to control for the possibility that large positive (negative) shocks to income in a particular year are offset by slow (fast) income growth in subsequent years. It seems unclear, however, whether the explicit inclusion of lagged income among the regressors will worsen or cure the disease. Under plausible assumptions, lagged income is correlated with the error term and should be instrumented.

Finally, it is worth noting that our specification can be expressed as an error correction model which incorporates mean reversion in the sense that income changes in a period are related to the previous period's distance from long-run equilibrium. The error correction form of eq. (2) can be written as

$$\Delta y_{it} = \gamma \Delta n_{it} + (\rho - 1)\left[y_{it-1} - \left(\frac{1}{1-\rho} \right)(\lambda n_{it-1} + \alpha + X_{it}\beta) \right] + \eta_i + \varepsilon_{it} \tag{7}$$

where the squared brackets include the error correction term which is zero in long-run equilibrium. Shocks to income are offset through lagged adjustment towards equilibrium provided that $\rho \in (0,1)$ holds.

5.2 Empirical Results

Our data comprise 12 years, i.e., 1991 through 2002. We employ the Anderson-Hsiao level estimator in order to maximize the number of time periods and thus end up with 10 years covering the period 1993-2002. We require that taxable income in 1991 should be above median taxable income (126,700 SEK) in the overall distribution (for those with positive incomes in that year). The reason for this cutoff is that the tax reforms of main interest have affected individuals well above median earnings. Recall that only 20-25 percent of the tax payers have been affected by the national tax and only around 5 percent by the top bracket in place since 1999. There is no obvious criterion, however, for choosing the appropriate limit for sample inclusion. Although the changes in the marginal tax rates have been most pronounced among people with relatively high incomes, an exclusive focus on these groups

[15] If the level of the tax variable had appeared among the regressors in (6) with parameter γ', the long run effect would be obtained as $-\gamma'/\kappa$.

would weaken identification. Some results are sensitive to the chosen rules for sample inclusion and we discuss these issues as we proceed. Note that the sample inclusion cutoff applies to the 1991 income, thus minimizing the risk of choosing a sample based on endogenous outcomes. In addition to this cutoff rule, we also require $YT_{i,t-2} \geq 25,000$, which approximately corresponds to the fifth percentile of the overall distribution of taxable incomes (for $YT_i > 0$) over the studied years. Sensitivity checks with respect to this selection rule will also be presented as we proceed.

Results for the pooled sample of men and women are set out in Table 3. The estimates correspond to eq. (2), estimated as first differences as given by eq. (3). In addition to the tax variables, we include as covariates age squared, number of children, local labor market tightness and dummies for marital status, education and year.[16] We also include controls for changes in the income distribution that are unrelated to tax policy. These controls are produced by interacting log taxable income in 1991 with polynomial trends.[17]

Table 3 about here

Some general remarks are in order before discussing details. First, the instruments are strong as judged by very high F-values for inclusion of the instruments in the first stage. Second, the IV-estimates reported in the tables are very different from OLS results (not reported). OLS yields negative and large coefficients on the net-of-tax rates, whereas IV generally yields positive estimates. These differences are as should be expected given a progressive tax system where the net-of-tax rate is decreasing in income. Third, it worth noting that the lagged dependent variables always enter with coefficients in the range between 0.30 and 0.44, significantly different from zero as well as significantly different from unity.

The point estimates of the long run elasticities vary in a range between 0.12 and 0.19 depending on the definition of income. All these estimates are significantly different from

[16] These variables are all first differenced. Note that the linear age effect cannot be identified in the first difference estimations. Information on the number of children appears to be partly noisy in the data, at least for some years. Yet the variable has a highly significant negative effect in cross section as well as first-difference income equations for females and these estimates are robust across years. We have decided to keep the variable but our key results are robust to the exclusion or inclusion of this variable.

[17] More specifically, we interact (in the level specification) log income 1991 with three trend variables (linear, squared and cubic trends), thus allowing the trend evolution of income to differ depending on income in 1991. These variables are also first-differenced in the estimating equations.

zero. The null that the short run and the long run responses are equal, i.e., that the equality $\gamma = \lambda/(1-\rho)$ holds, is decisively rejected only for broad income (p-value 0.034). In this case, the response is bigger in the long run than in the short run. However, in two out of the four cases, the Arellano-Bond tests for autocorrelation reveal second-order autocorrelation in the differenced residuals. This indicates violation of a key assumption, viz. that the idiosyncratic error term in the level equation, ε_{it} is serially uncorrelated.

Separate results for men and women are shown in Table 4. The results for assessed and broad income are very similar and we confine the presentation to only one of those variables, viz. broad income. The first three columns report results for men and the remaining three show results for women. For men, both the short run and the long run effects are always estimated as positive and statistically significant, but the point estimates vary depending on the chosen income measure. The range of point estimates for the short run is {0.15, 0.39} and the range for the long run is {0.15,0.28}. We can reject the null that the short run response is equal to the long run response only for earned income; in this case the dynamics involves "overshooting" in the sense that the response is stronger in the short run than in the long run. However, there is evidence of second-order autocorrelation in the differenced residuals in two out of the three cases. The best performing specification pertains to earned income where there is no evidence of second order autocorrelation. The long run response is here estimated to 0.28 and is statistically significant.

Table 4 about here

Turning next to the results for women, using the same model, it can be seen from columns (4) to (6) that both the short run and the long run responses are statistically insignificant at conventional levels. The point estimates for the long run vary between 0.04 and 0.09. We have tested whether the differences between male and female responses are statistically significant and found that they generally are (except for earned income).[18]

The three last columns in Table 4 show results from a restricted version of eq. (2) that are applied to the female sample. We try this specification in order to check if a more

[18] We performed this test by pooling the data for men and women and allowing for a full set of interactions between the covariates and gender status. The null is that the parameters pertaining to Δn_{it-1}, n_{it-1} and y_{it-1} are equal for men and women.

parsimonious specification would produce sharper results. The restriction is $\gamma = \lambda$, which forces the long run effect to exceed the short run response. The resulting model thus takes the form

(8) $$y_{it} = \alpha + \gamma n_{it} + \rho y_{it-1} + X_{it}\beta + \eta_i + \varepsilon_{it}$$

which implies the following specification in first-differences:

(9) $$\Delta y_{it} = \alpha + \gamma \Delta n_{it} + \rho \Delta y_{it-1} + \Delta X_{it}\beta + \Delta \varepsilon_{it}$$

The restriction has quite substantial effects for taxable income and broad income: the estimated long run elasticities are now statistically significant and of nontrivial magnitudes (0.19 and 0.26). For earned income, the restriction makes little difference. It turns out, however, that the restriction $\gamma = \lambda$ is forcefully rejected for both taxable and broad income whereas it is accepted for earned income. All in all, there is thus little evidence of significant income responses among women.

Robustness Checks

How sensitive are these results to the chosen cutoff rules for sample inclusion? We have modified the requirement regarding taxable income in 1991 so that it varies by gender, recognizing that median incomes are much lower for women. Instead of using median taxable income in the overall distribution as threshold, we use 153,900 for men and 104,400 for women; these income levels correspond to the 50th percentiles of the male and female distributions of taxable income in 1991 (for those with positive taxable income in that year). A result of this alternative cutoff rule is that the number of observations for men falls by around 100,000 whereas the number of observations for women increases by roughly the same amount. The results are shown in Table 5.

For men, the estimate pertaining to earned income remains almost intact, whereas the estimates for taxable and broad income are markedly reduced although still statistically significant. Autocorrelation prevails for taxable and broad income, but not for earned income. The estimates for women remain small in magnitude and the long run effects are statistically insignificant.

Table 5 about here

We have undertaken a number of other sensitivity tests. The results are fairly robust to the inclusion or exclusion of various non-tax covariates. The results are also very similar if we require no change in marital status, or if we require zero entrepreneurial income. Table 6 reports the results of robustness checks for the models explaining earned income and broad income for men. The estimates pertaining to earned income is quite robust across the alternative specifications with alternative selection rules and covariates. The estimated long run elasticity varies in a range between 0.25 and 0.30. The estimates pertaining to broad income are less robust; the estimated long run elasticity hovers in an interval between 0.12 and 0.22. The residuals are well behaved in the model for earned income (there is no evidence of second-order autocorrelation), but less well behaved in the model for broad income. For women, the robustness checks analogous to those in Table 6 reveal relatively modest departures from the estimates reported in Table 4.

Table 6 about here

In summary, the estimates of the long run elasticity of income with respect to the net-of-tax rate range from 0.1 to 0.3 for men. The model for male earned income performs best. The estimates are here robust to alternative selection rules and covariates and there is no indication of autocorrelation in the idiosyncratic error terms. The long run elasticity hovers between 0.25 and 0.30. The long run effects for women are not significantly different from zero.

Comparisons with Difference Specifications

We now turn to a comparison with results that are based on the traditional difference specification as given by eq. (5) above. To implement this specification, we follow the common practice of instrumenting the net-of-tax rate in year *t* by means of income in year *t*-1 – inflated to year *t* – and the tax code as of year *t*, i.e., $n_{it}^{p} = n(y_{it-1}^{P,t}; z_t)$, where $y_{it-1}^{P,t}$ is predicted income for year *t*. The relevant instrument in the difference specification thus becomes $\Delta n_{it}^{P} = n(y_{it-1}^{P,t}; z_t) - n(y_{it-1}; z_{t-1})$.[19] We have also repeated this exercise for

[19] This instrument is somewhat dubious for reasons discussed in the text. However, we prefer to follow the conventional approach at this stage.

observations that are three years apart, i.e., we compare 1996 with 1993, 1997 with 1994 etcetera. The instrument then takes the form $\Delta n_{it}^{P3} = n(y_{it-3}^{P,t}; z_t) - n(y_{it-3}; z_{t-1})$.

The results are displayed in Table 7. The estimates are fairly robust across alternative sample restrictions and do not differ markedly between men and women. The estimated tax effects are small – ranging between 0.03 and 0.08 – in the models for one year differences. The results for three year differences are fairly similar except for earned income, where we find estimates centering on 0.15.

Table 7 about here

A comparison between the results from our lagged adjustment models and the conventional difference specifications is most naturally done for male earned income; as noted, the dynamic models work best for male earned income. Recall that the dynamic specification nests the conventional formulation (for one year differences) as a special case; the relevant restrictions on eq. (2) are $\lambda - \gamma = \rho = 0$. These restrictions are clearly rejected. It also noteworthy that the estimated long run elasticity from the error correction model is two to four times bigger than the estimate obtained from the conventional specification. However, when looking at earned income in the gender-pooled sample, we find relatively small differences between the error correction estimate (0.185) and the three-year difference estimate (0.137).

On Income Definitions

The estimates are sensitive to the chosen definitions of income. Such sensitivity has also been noted in previous work, but it is difficult to detect a clear pattern in previous work regarding which type of income that is most responsive to tax changes. Presumably the results are sensitive to the details of the tax code which, inter alia, determine how taxable income is defined.

Our results for men, and to a lesser extent also the results for the gender-pooled sample, suggest that earned income is more responsive with respect to the net-of-tax rate than the other types of income. To interpret this "ranking" of tax responsiveness, let us compare earned income (*YE*) and broad income (*YB*) and define the latter as $YB = YE + R(YE)$, where

$R(.)$ represents transfers. The elasticity of YB with the respect to the net-of-tax rate can be written as

$$\frac{d\ln YB}{d\ln(1-\tau)} = \left(\frac{YE}{YB}\right)\left[1+R'(YE)\right]\frac{d\ln YE}{d\ln(1-\tau)} \tag{8}$$

We have $YE<YB$ and $R'(YE)<0$ holds for social insurance benefits like unemployment benefits and sickness benefits. When gross income declines because of spells of unemployment or sickness, benefit payments cover part of the income losses so the fall in YB is smaller than the fall in YE.[20] There is thus a presumption that broad income should be less responsive to tax changes than earned income, a presumption confirmed in our empirical analysis. A similar line of argument would pertain to taxable income and suggest that taxable income should be less responsive to tax changes than earned income.[21]

6. Concluding Remarks

We have proposed a new approach to the estimation of income responses to changes in marginal tax rates. The conventional approach, where changes in income are regressed on changes in tax rates, can only capture long run responses under restrictive and implausible conditions. Our more general approach, which involves application of a standard lagged adjustment framework, nests the conventional specification as a special case and delivers estimates of both short run and long run effects.

Our estimates of long run responses are typically much larger than the estimates we obtain by employing the conventional difference specifications. At the same time, these long run estimates are much smaller than some of the previous estimates in the literature. A caveat, however, is that the statistical performances of the lagged adjustment models are sometimes less than completely satisfactory.

The gender differences are intriguing and in want of further investigation. The conventional wisdom from the labor supply literature is that women are more responsive than men to

[20] In our data we have $R'(YE)=-0.12$ if we estimate the model $R=a+b\bullet YE$ + time dummies. If the model is estimated as first differences we get $R'(YE)=-0.18$.

[21] Write taxable income as $YT=YE+R(YE)-D(YE)$, where $D(.)$ represents deductible expenses, including work-related expenses as well as basic deductions determined by the tax authorities. Deductibles are typically increasing in income, a fact that would imply that YT is less responsive than YE to changes in tax rates.

changes in wages and taxes, a pattern that appears to be in conflict with our results.[22] It should be noted, however, that the tax changes we have studied have affected many more men than women since they have targeted high income earners. It should therefore generally be easier to identify behavioral responses among men than among women.

There is also a need for better understanding of how and why the estimates differ across alternative definitions of income. Much has been said in favor of the view that one should focus on taxable income since this is what matters for the effects on the government's tax revenues. But perhaps this focus misses the difficulty to satisfactory model income variables that are complex outcomes of individual work effort as well as rules pertaining to tax deductions and transfers. It may well be that separate structural approaches to the modeling of the components of taxable income will prove to be the route forward.

The paper has focuses on individual responses and ignored the household context. For married or cohabiting individuals, the economic fortunes of the partner are presumably relevant. It should be a prioritized research agenda to incorporate a family perspective in this area.

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[22] However, Blomquist and Hansson Brusewitz (1990) caution that the conventional results may be artifacts of restrictive functional forms.

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Table 1. Income correlations and other statistics, 1991-2002.

	ln *YE*	ln *YB*	ln *YA*	ln *YT*
ln *YE*	1.000			
ln *YB*	0.725 [0.555]	1.000		
ln *YA*	0.723 [0.553]	0.998 [0.995]	1.000	
ln *YT*	0.704 [0.520]	0.984 [0.956]	0.986 [0.961]	1.000
Means	11.695 [0.048]	11.870 [0.065]	11.860 [0.065]	11.805 [0.070]
St dev	1.147 [0.821]	0.864 [0.525]	0.859 [0.523]	0.840 [0.500]
# observations	1 660 041	1 828 182	1 827 065	1 793 884

Notes: The total number of observations is 1 913 038. The correlation matrix is based on 1 405 225 observations. The last row report the number of observations with positive *YE*, *YB*, *YA* and *YT*, respectively. Numbers in brackets refer to first differences of log incomes. The age range is 20-59.

Table 2. The evolution of income by percentiles, 1991-2002.

	p10	p25	p50	p75	p90	p99
Taxable						
1991	10.88	11.33	11.75	12.06	12.33	12.98
2002	11.07	11.79	12.21	12.48	12.77	13.49
Change 1991-2002 (%)	20.9	58.4	58.4	52.2	55.3	66.5
Assessed						
1991	10.95	11.50	11.85	12.11	12.37	13.00
2002	11.18	11.89	12.25	12.52	12.80	13.50
Change 1991-2002 (%)	25.9	47.7	49.2	50.7	53.7	64.9
Broad						
1991	10.97	11.51	11.86	12.12	12.39	13.03
2002	11.19	11.90	12.26	12.53	12.81	13.51
Change 1991-2002 (%)	24.6	47.7	49.2	50.7	52.2	61.6
Earned						
1991	10.31	11.32	11.83	12.12	12.40	13.04
2002	10.53	11.68	12.25	12.54	12.82	13.51
Change 1991-2002 (%)	24.6	43.3	52.2	52.2	52.2	60.0

Note: The table shows nominal incomes (in natural logarithms) and income changes in percent. Over the period 1991-2002, the consumer price index increased by 20.0 percent.

Table 3. Estimation results, gender-pooled sample.

	(1)	(2)	(3)	(4)
	Taxable income	Assessed income	Broad income	Earned income
Δn_{it}	0.067	0.104	0.117	0.249
	(1.50)	(2.30)	(2.55)	(2.71)
n_{it-1}	0.067	0.085	0.098	0.129
	(2.77)	(3.51)	(3.98)	(2.65)
y_{it-1}	0.417	0.432	0.444	0.300
	(25.90)	(21.31)	(20.68)	(31.89)
Long run elasticity	0.115	0.150	0.177	0.185
	(2.73)	(3.41)	(3.83)	(2.64)
AR(2)	2.91	2.14	1.71	-1.64
Observations	611,216	612,486	612,656	574,857

Notes: The model is estimated in first differences (Anderson-Hsiao using lagged levels as instruments). The *t*-statistics in parentheses are robust to heteroskedasticity and arbitrary intra-individual correlation. Other variables are three education categories, marital status, the number of children, local labor market tightness and year dummies. Lagged income and the two tax variables are treated as endogenous and instrumented as described in the text. Observations with income lower than 126,700 SEK in 1991 are excluded (overall median taxable income in 1991). Observations with $YT_{it-2} < 25000$ SEK are also excluded. Controls for trends in the income distribution are accomplished by means of interactions between income 1991 and trend polynomials as described in the text. The Arellano-Bond statistic for serial correlation, AR(2), is asymptotically N(0,1) and tests for second-order serial correlation in the first-differenced residuals.

Table 4. Estimation results by gender, benchmark specification

	Men			**Women**			**Women** (restriction $\lambda = \gamma$)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Taxable income	Broad income	Earned income	Taxable income	Broad income	Earned income	Taxable income	Broad income	Earned income
Δn_{it}	0.147	0.205	0.388	-0.129	-0.110	-0.041			
	(2.67)	(3.62)	(3.54)	(1.52)	(1.31)	(0.21)			
n_{it-1}	0.091	0.125	0.193	0.024	0.047	0.023			
	(2.96)	(3.94)	(3.21)	(0.58)	(1.14)	(0.25)			
n_{it}							0.103	0.129	0.054
							(2.84)	(3.46)	(0.76)
y_{it-1}	0.401	0.426	0.314	0.460	0.502	0.289	0.456	0.497	0.290
	(19.52)	(15.84)	(23.31)	(19.46)	(15.24)	(22.93)	(19.40)	(15.17)	(22.87)
Long run elasticity	0.151	.218	.281	0.044	.094	.033	0.190	0.256	0.077
	(2.89)	(3.74)	(3.18)	(0.58)	(1.13)	(.25)	(2.72)	(3.12)	(0.76)
m2	4.03	2.51	-0.35	-1.95	-1.63	-1.30	-1.50	-1.12	-1.29
Obs.	421,416	422,428	396,596	189,800	190,228	178,261	189,800	190,228	178,261

Note: The *p*-values for equality between the coefficients for Δn_{it} and n_{it-1}, i.e., $\lambda = \gamma$, in columns (4), (5) and (6) are 0.005, 0.004 and 0.596. See also notes to Table 3.

Table 5. Estimation results by gender, alternative cutoff rules.

	Men			**Women**		
	(1)	(2)	(3)	(4)	(5)	(6)
	Taxable income	Broad income	Earned income	Taxable income	Broad income	Earned income
Δn_{it}	0.178	0.223	0.461	-0.224	-0.179	0.026
	(3.21)	(3.91)	(4.20)	(2.55)	(2.12)	(0.12)
n_{it-1}	0.056	0.080	0.182	0.028	0.039	-0.019
	(1.84)	(2.57)	(3.05)	(0.64)	(0.94)	(0.19)
y_{it-1}	0.353	0.362	0.301	0.524	0.541	0.286
	(15.98)	(12.77)	(17.90)	(27.31)	(20.87)	(32.27)
Long run elasticity	0.086 (1.82)	.125 (2.50)	.260 (3.01)	0.058 (0.64)	.085 (.93)	-.026 (.19)
AR(2)	3.46	2.25	-0.61	-3.42	-3.01	-1.83
Observations	312,871	313,608	298,020	298,591	299,295	275,994

Notes: The cutoff rules for income 1991 are gender specific as described in the text. Otherwise the notes to Table 3 apply.

Table 6. Robustness checks for earned income and broad income, men.

	Earned income			Broad income		
	Long run elasticity	AR(2)	Observations	Long run elasticity	AR(2)	Observations
Benchmark specification	.281 (3.18)	-.35	396,596	.218 (3.74)	2.51	422,428
No trends	.292 (3.45)	-1.04	396,596	.222 (3.63)	2.80	422,428
Few covariates	.281 (3.13)	-0.27	396,596	.221 (3.64)	2.35	422,428
29<age<50	.287 (2.43)	-.32	241,655	.221 (2.78)	1.27	253,846
No change in marital status	.293 (3.24)	-.18	387,746	.222 (3.81)	2.72	412,961
No entrepreneurial income	.254 (3.09)	-1.70	367,126	.156 (3.27)	0.68	392,229
Include if $YT_{i,t-2} > 0$	.285 (3.20)	-.10	397,719	.194 (3.53)	3.23	424,044
Include if $YT_{i,t-2} \geq 50,000$	.288 (3.24)	-.24	394,860	.185 (3.52)	3.05	420,205
Include if $YT_{i,t-2} \geq 100,000$	.307 (3.51)	-1.09	387,859	.121 (3.10)	2.77	410,886

Note: Few covariates mean inclusion of the tax variables, the trends, age squared and the year dummies. See also notes to Table 3.

Table 7. Estimation results, conventional difference specifications.

	One year differences			Three year differences		
	(1)	(3)	(3)	(5)	(5)	(6)
	Taxable income	Broad income	Earned income	Taxable income	Broad income	Earned income
Men						
Δn_{it}	0.037 (5.20)	0.033 (4.71)	0.078 (5.52)	0.046 (4.32)	0.036 (3.35)	0.137 (6.97)
Observations	470,880	471,944	447,928	373,213	374,113	352,284
Women						
Δn_{it}	0.031 (3.19)	0.031 (3.11)	0.035 (1.63)	0.043 (2.69)	0.031 (1.79)	0.158 (4.23)
Observations	212,270	212,721	201,586	167,932	168,312	158,192
Men and women						
Δn_{it}	0.034 (5.82)	0.031 (5.42)	0.061 (5.15)	0.042 (4.75)	0.031 (3.47)	0.137 (7.85)
Observations	683,150	684,665	649,514	541,145	542,425	510,476

Note: See notes to Table 3.

APPENDIX

Table A1. Income bracket thresholds for the Swedish state tax, 1991-2002.

	First bracket	Tax rate (%)	Fraction affected (%)	Second bracket	Tax rate (%)	Fraction affected (%)
1991	170,000	20	26.2			
1992	186,600	20	20.6			
1993	190,600	20	20.6			
1994	198,700	20	22.5			
1995	203,900	25	19.2			
1996	209,100	25	20.0			
1997	209,100	25	22.0			
1998	213,100	25	22.8			
1999	219,300	20	23.8	360,000	25	5.2
2000	232,600	20	24.3	374,000	25	5.7
2001	252,000	20	23.1	390,400	25	6.1
2002	273,800	20	21.1	414,200	25	5.8

Note: The thresholds refer to taxable income in nominal SEK beyond which the state tax kicks in. The fraction of affected tax payers refer to individuals aged 20-59 with positive taxable incomes.

Table A2. Sample characteristics (means).

	1991	**1996**	**2002**
Female	0.488	0.490	0.491
Age	38.51	39.20	39.95
Compulsory school	0.266	0.256	0.173
Upper secondary school	0.488	0.443	0.497
University	0.220	0.260	0.311
PhD	0.005	0.006	0.008
Married	0.497	0.454	0.412
Local labor market tightness	0.033	0.026	0.138
# individuals	154,183	160,236	161,848